No.

OUTLINE DESIGN STUDY REPORT
ON
THE PROJECT
FOR
CONSTRUCTION OF DIESEL POWER STATION IN SAMAWAH
IN
IRAQ

JUNE 2005

JAPAN INTERNATIONAL COOPERATION AGENCY
GRANT AID MANAGEMENT DEPARTMENT

G M
J R
05 - 064

PREFACE

In response to a request from the Government of Iraq, the Government of Japan decided to conduct an outline design study on the Project for Construction of Diesel Power Station in Samawah and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Amman, Jordan a study team in two times; from November 17 to December 7, 2004, and from February 15 to 28, 2005.

The team held discussions with the officials concerned of the Government of Iraq, and conducted a field study at the study area through a local consultant. After the team returned to Japan, further studies were made. Then, a mission was sent to Amman, Jordan from May 7 to 14, 2005 in order to discuss a draft outline design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Iraq for their close cooperation extended to the teams.

June, 2005

Seiji Kojima
Vice President
Japan International Cooperation Agency

June, 2005

Letter of Transmittal

We are pleased to submit to you the outline design study report on the Project for Construction of Diesel Power Station in Samawah in Iraq.

This study was conducted by Nippon Koei Co., Ltd, under a contract to JICA, during the period from November, 2004 to June, 2005. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Iraq and formulated the most appropriate outline design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Noriaki Matsushima

Project manager,
Outline design study team on
the Project for Construction of Diesel Power Station in Samawah

Nippon Koei Co., Ltd.

LOCATION MAP

List of Figures & Tables

＜Figures＞

＜Tables＞

Abbreviations

ACSR	:	Aluminum Cable Steal Reinforced
DGP	:	Diesel Generating Plant
E/L	:	Exchange of Letters
CPA	:	Coalition Provisional Authority
CT	:	Current Transformer
GSW	:	Galvanized Steel Wire
HFO	:	Heavy Fuel Oil
JICA	:	Japan International Cooperation Agency
IEC	:	International Electrotechnical Committee
JEC	:	Japanese Electromechanical Committee
JIS	:	Japanese Industrial standard
kVA	:	Kilovolt-ampere
LC	:	Level Control
LO	:	Lubricating Oil
MDO	:	Marine Diesel Oil
MoE	:	Ministry of Electricity
MoO	:	Ministry of Oil
MW	:	Megawatt
PT	:	Potential Transformer

Summary

After the war in Iraq in 2003, the Government of Japan expressed its concern to extend assistance for reconstruction to Iraq, and upon this, JICA dispatched a survey team for Preliminary Study for Reconstruction of Iraq, which covered such areas as power generation, water supply and sanitation, health, and education and employment, to Amman in Jordan from January until March, 2004. The survey team collected relevant information from the authorities of Iraq, CPA, and Iraqi local consultants, then prepared a short list of the prospective projects with their preliminary designs and cost estimates.

Among the shortlist, implementation of seven projects of grant assistance were decided and announced by the Government of Japan. Meanwhile, in order to evaluate the possibility of projects such as mobile power station as subsequent grant assistance, JICA conducted Preliminary Study for Reconstruction of Iraq (Phase 3) form August until October, 2003, upon the request by the Government of Japan.

During the above study, it was turned out that supply of natural gas by Iraqi side, which was the prerequisite condition for the mobile power station, would be difficult in Samawah. At the same time, Iraqi side strongly requested construction of a diesel power plant of 15 MW x 4 nos., which would use heavy fuel oil that was available in Samawah.

The Government of Japan took the above into consideration, and for the purpose of dealing with the serious power shortage in Iraq, requested JICA to conduct additional study to evaluate the possibility of large scale diesel power plant as a alternative of the mobile power station plan. Upon this, JICA dispatched the study team for Preliminary Study (Phase 4 / Outline Design Study on the Project for Construction of Diesel Power Station in Samawah) to Amman in three times in November, 2004, February and May 2005. The study team discussed with officials from the Ministry of Electricity, the Ministry of Oil, and Muthannna Governorate in Iraq, then confirmed the contents of the requested project. Besides, the study team surveyed current situation of power supply in Muthanna Province and Samawah, and collected basic data related to propriety and possibility of the requested project with assistance of local consultants in Iraq. Based on such collected information, outline design of the project with its cost estimate was prepared.

As a result of the study mentioned above, it was confirmed that due to damages by the war, power supply in whole country of Iraq is still under constraint, and this also frequently forces power outage in Samawah, Muthanna province. Under such circumstances, the Government of Iraq aims to improve power supply condition urgently by constructing and/or rehabilitating the power facilities, and thus to accelerate the reconstruction of Iraq.

This project is to construct a diesel power station in Samawah city to improve the currently power shortage problem in the area. Power shortage which is serious problem at present in Samawah will be substantially improved by commissioning of the power station of the project, and stable power supply to the region inhabitants would be realized.

The summary of necessary components to attain this project is shown below.

(a) Construction of a new power plant (output of 60 MW).
(b) Installation of 132kV interconnecting facilities and additional electrical equipment in Old Samawah substation.
(c) Construction of fuel pipeline which is connected between new power station and Samawah oil refinery.
(d) Relocation of existing 132kV transmission line.
(e) Training for operation and maintenance.

(a) Construction of a new power plant (output of 60 MW).

Four numbers of diesel engine generator of 15 MW will be installed with the auxiliary equipment such as fuel oil system, lubricating oil feeding equipment, cooling system equipment, air intake and exhaust system, etc. Engine stroke type will not be restricted to either 2-stroke (low speed) or 4-stroke (medium) engine.

(b) Installation of 132kV interconnecting facilities and additional electrical equipment in Old Samawah substation.

For the interconnecting the new power station with the existing Old Samawah substation, two circuits of 132 kV underground power cables will be installed from the 132 kV switchyard in the new power plant to the busbar, which is to be extended, in the substation.

(c) Construction of fuel pipeline which is connected between new power station and Samawah oil refinery.

To transfer the heavy fuel-oil from the existing Samawah Oil Refinery to the new power station, underground type fuel-oil pipeline of about 7.5 km will be constructed.

(d) Relocation of existing 132kV transmission line.

Relocation of the existing 132 kV transmission line, 2 circuits of Sawa – Old Samawah section, will be executed in advance for the smooth implementation of the Project.

(e) Training for operation and maintenance.

The plan of the personal education and training for operation and maintenance is consisted of the following 3 stages.

1) Stage-I: Basic education
2) Stage-II: Training at manufacture's factory
3) Stage-III: Training at Site

The work execution of this project will require 20 months from the conclusion of the contract for construction to completion of the project.

Items to be executed by the Iraqi authorities in case that a grant aid project from Japan is executed are as follows:

(a) Assisting customs clearance at ports of entry into Iraq
(b) Getting clearance from relevant authorities which may be necessary within Iraq for the execution of the Project, including procedure for approval on environmental issues
(c) Allowing Japanese nationals and other nationals involved in the Project entry into Iraq
(d) Exempting customs duties, internal taxes and other fiscal levies which may be imposed in Iraq with respect to the supply of products and services under the Project
(e) Exempting Japanese nationals involved in the Project from customs duties, internal taxes and other fiscal levies which may be imposed in Iraq
(f) Permitting contractors to utilize non-Iraqi insurance companies as necessary
(g) Acquisition of land necessary for the project
(h) The Iraqi side should conduct survey for landmines and unexploded ordinances (UXOs) at the Project site including the site for pipeline and issue the certificate of completion of the survey to the Japanese side within five (5) months from the signature of the Exchange of Letters.
(i) The Iraqi side will responsible for ensuring the safety of all persons, goods and materials related to the Project by taking all necessary measures including patrolling and holding road inspections around the Project site during construction period. In addition to the above, the Iraqi side should take measures necessary for ensuring smooth implementation of the Project requested by relevant parties involved in the Project.
(j) Providing terminal points for public services, such as water supply, telephone, electricity

The Project is judged viable from the following points of view.

1) By the commissioning of this power station, power supply to inhabitants in Samawah and its surrounding area of 100- 120 thousand people will be improved and time for power outage will

decrease.

2) Resolution of power shortage by this Project will also contribute to raise the level of local inhabitants' living, and in turn to further the reconstruction of Iraq.
3) MoE has much experience in construction, operation and maintenance of large scale thermal power plants, and such experience will be instructive for implementation of the Project.
4) MoO is committed to supply required quantity and quality of heavy fuel oil as the fuel of the Project.
5) Land for the power station is currently governed by MoE, so problem on land acquisition will not occur. The Project is designed with consideration for environmental conservation, thus negative impact due to its implementation will be insignificant.

Contents

[Appendices]

Chapter 1 Background of the Project

Chapter 1 Background of the Project

After the war in Iraq in 2003, the Government of Japan expressed its concern to extend assistance for reconstruction to Iraq, and upon this, JICA dispatched a survey team for Preliminary Study for Reconstruction of Iraq, which covered such areas as power generation, water supply and sanitation, health, and education and employment, to Amman in Jordan from January until March, 2004. The survey team collected relevant information from the authorities of Iraq, CPA, and Iraqi local consultants, then prepared a short list of the prospective projects with their preliminary designs and cost estimates.

Among the shortlist, implementation of seven projects of grant assistance were decided and announced by the Government of Japan. Meanwhile, in order to evaluate the possibility of projects such as mobile power station as subsequent grant assistance, JICA conducted Preliminary Study for Reconstruction of Iraq (Phase 3) form August until October, 2003, upon the request by the Government of Japan.

During the above study, it was turned out that supply of natural gas by Iraqi side, which was the prerequisite condition for the mobile power station, would be difficult in Samawah. At the same time, Iraqi side strongly requested construction of a diesel power plant of 15 MW x 4 nos., which would use heavy fuel oil that was available in Samawah.

The Government of Japan took the above into consideration, and for the purpose of dealing with the serious power shortage in Iraq, requested JICA to conduct additional study to evaluate the possibility of large scale diesel power plant as a alternative of the mobile power station plan. Upon this, JICA dispatched the study team for Preliminary Study (Phase 4 / Outline Design Study on the Project for Construction of Diesel Power Station in Samawah) to Amman in three times in November, 2004, February and May 2005. The study team discussed with officials from the Ministry of Electricity, the Ministry of Oil, and Muthannna Governorate in Iraq, then confirmed the contents of the requested project. Besides, the study team surveyed current situation of power supply in Muthanna Province and Samawah, and collected basic data related to propriety and possibility of the requested project with assistance of local consultants in Iraq. Based on such collected information, outline design of the project with its cost estimate was prepared.

Chapter 2 Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

(1) Upstream Projects and Objectives of the Project

Due to damages by the war, power supply in whole country of Iraq is under constraint, and this also frequently forces power outage in Samawah, Muthanna province. Under such circumstances, the Government of Iraq aims to improve power supply condition urgently by constructing and/or rehabilitating the power facilities, and thus to accelerate the reconstruction of Iraq.

This project is to construct a diesel power station in Samawah city to improve the currently power shortage problem in the area. Power shortage which is serious problem at present in Samawah will be substantially improved by commissioning of the power station of the project, and stable power supply to the region inhabitants would be realized.

(2) Summary Description of the Project

The summary of necessary components to attain this project is shown below.

(a) Construction of a new power plant (output of 60 MW).
(b) Installation of 132kV interconnecting facilities and additional electrical equipment in Old Samawah substation.
(c) Construction of fuel pipeline which is connected between new power station and Samawah oil refinery.
(d) Relocation of existing 132kV transmission line.
(e) Training for operation and maintenance.

The list of major equipment and materials necessary for the project is shown in next page.

List for the Major Facilities

No.	Item	Specifications	Q'ty	Unit	Remark
Mechanical Facilities	Diesel Engine	2-stroke or 4-stroke Engine Using Oil: Heavy Fuel Oil	4	sets	
	Fuel Oil System				
	HFO Storage Tank	500kL, Cylindrical Type	4	sets	
	HFO Service Tank	120kL, LC(Level Control)/Alarm	2	sets	
	MDO Storage Tank	120kL, Cylindrical Type	1	set	
	HFO Oil Purification System	Pumps, Mortars, Tanks, Duplex Type	1	set	
	Lubricating Oil (LO) System				
	LO Tank	120kL, Tanks for System Oil	1	set	4-stroke is required 2 sets
	LO Tank	120kL, Tanks for Cylinder Oil	1	set	only for 2-stroke
	LO Sump tank	Square Type	4	sets	
	LO Centrifugal Separator	Pumps, Mortars, Tanks	1	set	
	Cooling Water System				
	Cooling Water Pump	For High and Low Temperature	4	sets	
	Make-up Water System)	Pumps, Heaters	1	set	
	Radiator	For High and Low Temperature	1	set	
	Air Compressor System				
	Air Compressor for Starting	Air Compressor, Starting Air Tank	2	sets	
	Air Intake and Exhaust Gas System				
	Exhaust Stack	H=40m	4	sets	
	Exhaust Silencer	Less than 70dB	8	sets	
	Intake Silencer	Filter	4	sets	
Electrical Facilities	Generator	11kV, 50HZ, 3Phases	4	sets	
	Main Transformer	3 Phases, 50 HZ, 11kV/132kV, 50MVA	2	sets	
	132KV Switchgear	Circuit Breaker, Disconnecting Switch, CT, PT	1	set	
	Protection and Operation Panel	Operation Panel for Generator and Switchgear, Various Protection Panel	1	set	
Building and Civil Facilities	Power House	Steel Structure	1	set	
	Other Buildings	Office, Crew Lodge, Guard, Oil Purification Room, Parking, etc.	1	set	
	Road in the Yard	Width=10m	1	set	
	Drainage System in the Yard	Drain, Oil Separator	1	set	
	Boundary Fence		1	set	
132 KV Interconnecting Facilities	132kV Connecting Cable (from Power Station to Substation)	XLPE 200mm^2, Length=200m, Single Core	1	set	
Additional Equipment in Existing Substation	132 kV Switchgear	Circuit Breaker, Disconnecting Switch, CT, PT	1	set	
	Protection and Operation Panel	Operation Panel for Switchgear	1	set	
	Bus Conductor	CU Cable 500 mm^2, Length=100m	1	set	
	Gantry for Bus Bay	Single Bus, H=8m	1	set	
Pipeline	Pipeline	Carbon Steel Pipe, 4 inch ϕ	1	set	
	Pump (refinery side)	75kVA (37.5kVA x 2)	1	set	
	Generator (ditto)	100kVA (50kVA x 2)	1	set	
Relocation of Existing Transmission Line	Tower (New)	Heavy Angle Tower (SS14), H30m×3	1	set	
	132kV Transmission Line (2 circuits)	ACSR 240 mm2 (3×800m)	1	set	

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Concept

Scale of the Project

The scale of the project (total generating output) is 60 MW, which is minimum required to meet the present power demand in Samawah. Present load demand for the whole Muthanna province is estimated at 200 MW approximately. Meanwhile, the electric supply from the national grid is assumed at about 50 MW in average, although it fluctuates largely time by time. Even after the CPA's gas turbine plant of 38 MW starts its operation, there will exist a large gap between the load demand and supply. Thus the power of 60MW from the Project will be consumed completely in the province.

Location of the Project Site

The location of the project site is determined near the existing Old Samawah substation by reason of the followings:

- For convenience of management and security reason, it is preferable to locate all power facilities such as substations and power stations within one area.
- The said location is advantageous for easy line connection to the existing Old Samawah substation.
- The distance from the Samawah refinery does not cause any difficulty for fuel transportation by pipeline, even though the distance is the longest among the all alternatives.
- The said area is currently under control by the Ministry of Electricity.
- There exists enough open space at the west and south side of the existing Old Samawah substation, although its north side is blocked by the housing area.

The location of the project site is shown in DWG-01:

General Layout of the Power Station

General layout of the power station is established taking consideration of i) easiness of the construction works, ii) safety of operation and maintenance, and iii) environmental effect to the circumference. Future extension of the facilities is not taken into account in this design.

General layout of the project site is shown in DWG-02:

Powerhouse Building

The size of the powerhouse building is studied taking consideration of i) maintenance space for regular inspection and overhaul of all facilities, ii) work shop space for the construction works in

the future, and iii) prevention of increasing temperature and noise in the building.

Number of Unit and Unit Capacity

Alternative number of unit and unit capacity is studied for i) 15MW x 4 nos, which Iraqi side requested, and ii) 6MW x 10 nos, in which unit capacity is smaller and number of units is larger. Both options are compared from viewpoint of operation and maintenance, construction period and cost, etc, then optimum option is adopted.

(2) Weather Conditions

The following criteria will be applied for design of facilities of this project:

- Maximum ambient temperature : ＋55℃
- Minimum ambient temperature : －5℃
- Maximum water temperature : ＋35℃
- Altitude : 6 - 9 m
- Wind Velocity : 170 km/hr
- Earthquake coefficient : 0.1

(3) Design Standards

The International Electrotechnical Commission Standard (IEC) shall be applied to the design of all electrical and electromechanical equipment. In case not covered by IEC, Japanese Industrial Standard (JIS) and the Japanese Electrotechnical Committee (JEC) Standard shall be applied.

(4) Construction Environment in Iraq

In Iraq, construction contractors have not yet been well matured. Generally their sizes are rather small. Meanwhile, due to security reason after the war, opportunity for labour is only little at this moment, thus there are no difficulties in employing necessary number of laborers.

Available contractors for electrical works are mostly engaged in rehabilitation projects of the steam thermal plants or gas turbine plants, and there are no contractors with experiences of erection for large scale diesel generators. Therefore, Iraqi contractors can be employed only for supporting works.

On the basis of the circumstances above, installation works of the equipment in this project is included in the scope of the Japanese firms, and supervisors for installation works will be assigned to guide the local engineers and labors. When Japanese supervisors cannot enter Iraq due to security reason, foreign supervisors who have equivalent capability will be dispatched

(5) Establishment of Grades of Facilities and Equipment

In Iraq, there are almost no experienced engineer who is familiar with operation and maintenance of the diesel power plant in large scale. Thus, it will take rather long time to master the

complicated operation and maintenance technique.

Therefore, the generating facilities of the project shall be as simple as possible and easy in operation and maintenance. The high-class computer control is easy for operation, but its repairing is very difficult when some troubles occur. It is better not to adopt the modern technology that is difficult to understand for local staffs.

The system composition shall ensure high reliability of operation based on high stability of equipment.

(7) Methods of Purchase and Implementation Period

(a) Method of Purchase

The supply including erection of generation facilities and construction works under the project will be implemented by the following manufacturers and contractors:

Diesel generation facilities		
Diesel engines	:	Diesel engine/electric apparatus manufacturer
Electric facilities	:	Electric apparatus manufacturer
Installation work and civil/building structures	:	Construction contractor

It is a usual practice that a diesel engine manufacturer deals with complete diesel generator sets including electrical apparatus.

As for construction materials, civil and architectural materials should be procured basically in Iraq. However for powerhouse, to secure construction period and hedge risks in site works, prefabricated and coated steel materials will be imported and then erected by the local contractors.

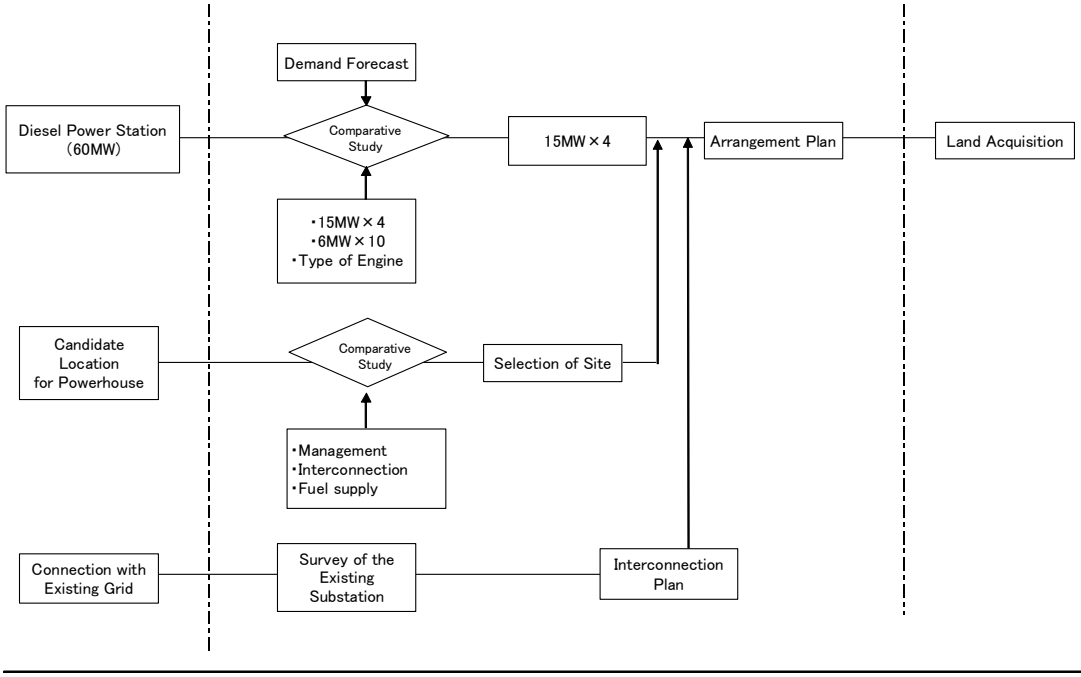
(b) Principle for Implementation Schedule

The necessary period for implementation of this project covering design and manufacture, transport, site construction, site tests and transfer of technology (personal education and training for operation and maintenance), and civil and building construction, requires 20 months from the conclusion of the contract up to completion.

2-2-2 Basic Plan (Facilities Plan/Equipment Plan)

The flow chart of the outline design Study, which was carried out to confirm and justify the contents of Request for Grand Aid for a generation project, is shown in Fig. 2-1 below.

Fig. 2-1 Flow Chart of Outline Design Study



2-2-2-1 Generating Facilities

In preparing outline design of the project, technical properties of generating facilities are designed with attentions to easiness in operation and maintenance and as well as economy in overall operation cost. Equipment and accessories are designed with due consideration to weather conditions in the desert region.

(1) Number of Units and Unit Capacity

Two options which are 15MW x 4sets and 6MW x 10sets are selected as the combination of number of the unit and unit capacity for diesel engine generator sets. These two options are considered being without clear advantage on the other as seen in the Table 2-1.

As the result of this study, 15MW x 4sets is selected as number of the unit and unit capacity for the Project by reason of the followings:

- There is no local engineers who have experiences of operation and maintenance for diesel engine plant which is large-scale type same as this Project.
- Power shortage problem at Muthanna province is very seriously, so the region inhabitants strongly request to supply of the sufficient power as soon as possible.

Table 2-1 Comparative Table of Diesel Engine Generator (15MW×4sets and 6MW×10sets)

	Description	Diesel Engine Generator	
		Case-1: 15MW × 4sets	Case-2: 6MW × 10sets
1	Operation Experience in Iraqi	×	△
		−	There are three power station (Erbil、Dohuk、Sulimaenia) of 7.5MW×4sets of diesel engine generator constructed by UNDP in Iraqi. ※Using oil is marine diesel oil, not fuel oil.
2	Transportation	△	○
		It is necessary to divide the engine for transportation, because the engine size wouldn't clear the regulation of transportation in Kuwait. (limitation of height is 5m from ground level.)	It is possible to transport by one package except some kinds of engine.
3	Construction at Site	×	△
		There are any difficult works at site, especially, assembly of engine, setting of engine generator on the foundation and complicated wiring and piping works. All Japanese manufactures requested to supervise at site by Japanese engineers in their company or foreign engineers who have ability equal to or higher than Japanese engineers.	There is no need to assemble the engine at site. But there are any difficult works same as Case-1. All Japanese manufactures requested to supervise at site by Japanese engineers in their company or foreign engineers who have ability equal to or higher than Japanese engineers.
4	Operation and Maintenance	△	×
		It is need to sufficient skill for operation and maintenance. Maintenance cost is lower than Case-2, because of number of cylinders and units is nearly half of Case-2.	It is need to sufficient skill for operation and maintenance. Maintenance cost is higher than Case-1, because of number of cylinders and units is around double of Case-1.
5	Construction Cost	○	△
6	Construction Period	○	×
		Around 20 months	Around 26 months(it is possible to start operation for 5 unit [30MW] at the stage of around 22 months.)
7	Lower of Generating Output as Maintenance	△	○
		Number of times for periodic inspection of engine is 2 times per year. It is necessary to take 2 weeks for one inspection. Accordingly generating output is 45 MW for 4 months during these maintenance.	Number of times of periodic inspection of engine is same as 15MW engine. Accordingly generating output is 54 MW for 10 months during these maintenance.

(2) Engine Stroke Type (2-stroke and 4-stroke)

Engine stroke type (2-stroke and 4-stroke) is reviewed in the Table 2-2.

As shown in the comparative table, both engine stroke types have its merits and demerits of their characteristic, so engine type would not be restricted to either 2-stroke (low speed) or 4-stroke (medium speed) engines.

Table 2-2 Comparative Table of 15 MW Diesel Engine (Low Speed & Medium Speed)

No.	Item		Low Speed (2-stroke) Engine	Medium Speed (4-stroke) Engine
1	Stroke		There are 2-stroke (compression and combustion) per a rotation of crank shaft.	There are 4-stroke (inhalation, compression, combustion and exhausting) per two rotation of crank shaft.
2	Usable Oil		It is possible to use the H.F.O including extremely poor-quality oil.	It is possible to use the H.F.O including poor-quality oil.
3	Lowering Rate of Generating Output (at air temperature 55℃)		Approx. 3%	Approx. 4%
4	Cooling System		Large	Small
5	Dimension(Incl. Auxiliary System)		Large 2.0～2.5	Small 1.0
6	Dimension(Engine Foundation)		Large Vibration of engine is larger than medium speed engine.	Small -
7	Weight (Engine Body)		Large 2.0	Small 1.0
8	Life Time (Past Record)		More than 30 years	More than 30 years
9	Supply Experiences of 15 MW class as Land Type Power Plant (using oil is H.F.O.)		Around 20 units	Around 500 units
10	O／M	1) Difficulty of Operation	No difference (Both engines have any experiences of operation at developing country)	
		2) Service Network	Few (difficult to arrange the spare parts)	Many
		3) Maintenance Frequency	Few (the number of combustion is fewer than medium speed engine)	More than low engine
		4) Difficulty of Maintenance	Regular inspection is easier than medium speed, because the number of cylinder is fewer. But, it is difficult to repair as breakdown and to overhaul of engine, because the length of cylinder is longer and heavier than medium speed engine.	Regular inspection is more difficult than low speed, because the number of cylinder is more. But, it is easy to repair as breakdown and to overhaul of engine, because the length of cylinder is shorter and lighter than low speed engine.
		5) Maintenance Cost	Cost of regular inspection is lower than medium speed engine, but cost of repair as breakdown and overhaul of engine is higher. ※If the engines are normal operated for 30 years, the maintenance cost	Cost of regular inspection is higher than low speed engine, but cost of repair as breakdown and overhaul of engine is lower.
11	Availability		328 (365-37) days/year/unit	
12	Conversion to Gas Fuel in the Future		Possible (Both engines have supply record)	
13	Other		Load following capability is lower than medium speed engine.	Load following capability is higher than low speed engine.

(3) Type of Powerhouse

As for the type of powerhouse, the normal type powerhouse to arrange all normal (open) type machines in line and to have overhead travelling hoist. Such hoist will be used for both erection and inspection/maintenance purpose.

(4) Fuel Oil

Fuel oil which will be supplied by MoO for the project is heavy fuel oil refined at Samawah oil refinery. It is very difficult to use the HFO without treatment, because HFO contains many impurities such like carbon, metals, sulfur and sludge, etc.

The power station will have 2 systems of fuel tank; for both HFO and MDO. MDO is fired during 30 minutes each after machine starting and before stopping. Even under normal operation, the fuel system is required to have an automatic mechanism to changeover from HFO to MDO when operating output goes down below 25% of the rated output.

Fuel Storage Tanks

3 kinds of fuel tanks, for HFO as main fuel, for MDO as auxiliary fuel, and for LO as lubricating of diesel engine, are required. The selected storage capacities are 4 x 500 kl for HFO, 1 x 120 kl for MDO, and 2 x 120 kl for LO.

HFO which will be supplied for this Project is of quality which both 2-stroke (low speed) and 4-stroke (medium speed) engines can use as their fuel.

(5) Equipment Layout

The equipment layout of diesel generators, control boards, auxiliary facilities, etc. in the power station building must be designed taking into account easiness of operation and space for maintenance. At the time of overhaul of engine-generators, engines will be completely disassembled and space for placing all disassembled component parts and for necessary works is required. Diesel generators, control boards, auxiliary facilities, etc. are connected each other with electric wiring and piping. Therefore, systematic arrangements of all items are to be planned taking into account safety, economy and easiness in operation and maintenance.

Equipment layout of the new power station is shown in Drawing DWG-03.

(6) Operation System

The normal operation of diesel generating equipment that is large-scale type Project will be executed by plural operators**;** the operation covering starting, stopping, switching of load, etc. The diesel engines are started with air-starting equipment and protective machine stopping devices and other protective and alarming apparatus are provided.

The diesel generating equipment will be provided with the following protection items:

i) Speed rise of diesel engine
ii) Stop of water flow and temperature rise of cooling water for diesel engine
iii) Abnormal drop of lubricating oil pressure for diesel engine
iv) Voltage rise and overcurrent of generator

When such protective apparatus detected an abnormality, the circuit breaker of generator circuit is opened automatically and diesel engine stop operation, and fault is informed to operators with visual indication and audible alarm on control boards.

(7) Diesel Engine

Major technical particulars of the diesel engines are mentioned in the following Table 2-3:

Table 2-3 Major Technical Particulars of Diesel Engines

(a)	Engine type	:	2-stroke (low speed) or 4-stroke (medium speed), supercharged, water cooled, medium speed, diesel engine with radiator cooling system
(b)	Unit capacity	:	15 MW (rated generating output)
(c)	Number of unit	:	4 units
(d)	Overload output	:	110% for 1 hour
(e)	Lubrication System	:	Manual oil feeding system
(f)	Fuel system	:	Automatic fuel feeding system, manual supply
(g)	Cooling system	:	Air cooled radiator cooling system
(h)	Starting system	:	Compressed air starting system
(i)	Intake air system	:	Oil bath filter type
(j)	Exhaust gas system	:	Silencer type
(k)	Kind of fuel	:	Heavy fuel oil, Marine diesel oil
(l)	Governor system	:	Electronic type or hydraulic type

(i) Speed Governor

The speed governor will be of hydraulic type or electronic type, and the governor will have speed adjusting range of plus and minus 5% of the rated speed at no-load condition.

The following characteristics shall be guaranteed:

(a) When 100% load is suddenly separated

Variation of rotating speed	within 15%
Time for reinstatement	within 10 seconds

The speed droop will be adjustable during operation in the range of 0 to 6%.

(ii) Compressed Air System

The compressed air system for starting engine generator will consist of an air compressor, an air reservoir, a pressure reducing valve, a safety valve, pressure gauges, pressure switches, magnetic valves, drains and all piping works necessary for operation of the system. The maximum operating pressure of this system will not exceed 2.5 Mpa.

(a) Air Compressor

The air compressor will be driven by AC motor, air-cooled with a cooling fan. Reciprocal air compressor of 2-stage compressing type will be adopted.

(b) Operating System

The air compressor will be installed in the power station building, and be provided with automatic operating device to feed air to the pressure tank up to a pre-set pressure.

(c) Installation Method

The air compressor and driving motor will be mounted on a common base plate, and the driving belt will have construction to adjust driving tension.

(d) Air Filling

The delivery rate of air compressor will be determined to fully charge the compressed reservoir up to the maximum working pressure within one hour.

(e) Air Reservoir

The welded portions of air reservoir will conform to requirements of JIS standard and be certified by the Japan Boiler Association. The reservoir capacity will not be sufficient to start the engine generator not less than 3 times without recharging. The air reservoir will be provided with a safety valve and a drain valve for condensed water.

(iii) Fuel Oil System

The diesel engine is normally operated with C-heavy oil. However, due to specific features of the diesel engine it needs operation with light fuel during 30 minutes each after starting and before stopping the engine.

The fuel oil system will consist of facilities in the following Table 2-4. The complete fuel oil system diagram is presented in Drawing. DWG-04. Meanwhile, the fuel oil treatment system diagram is presented in Fig. DWG-05.

Table 2-4 Fuel Oil Supply Facilities

	Marine Diesel Oil System	Heavy Fuel Oil System
Oil storage tank	1x120 kl with level gauge	4 x 500 kl with level gauge
Buffer tank	—	with level gauge and electric heater
Transfer pump	Gear pump	Gear pump

Service tank	with level switch	with level alarm and electric heater
Purifier unit	Single type	Duplex type
Unloading pump	25 m^3/hr x 2.5 kg/cm^2	100 m^3/hr x 3.0 kg/cm^2
Fuel oil filter	Single - automatic cleaning – cartridge system, HFO-MDO mixer and changeover valve	
Fuel oil heater	Electric system	

In addition fuel oil flow meters, pressure adjusting valves, etc. will be included.

(iv) Lubricating Oil Feeding Equipment

The lubricating oil feeding equipment will consist of facilities in the following Table 2-5.

Table 2-5 Lubricating Oil Facilities

Lubricating oil tank	1 x 120 kl with level switch
Lubricating oil priming pump	Gear pump
Lubricating oil cooler	Plate, or shell & tube system
Lubricating oil filter	Automatic reverse flow washing system
Lubricating oil cleaning unit	Automatic sludge discharging type, with level switch
Turbocharger lub. Oil tank	with level switch
Turbocharger lub. oil pump	Gear pump
Turbocharger lub. oil cooler	Plate, or shell & tube system
Turbocharger lub. oil filter	Duplex

(v) Cooling System Equipment

The cooling water system of diesel engine will basically consist of 2 systems; engine cooling water system and heat exchanger cooling system. The cooling system will consist of facilities the following Table 2-6. The cooling system diagram including fire hydrant system is presented in Fig. DWG-06.

Table 2-6 Engine Cooling System Facilities

Cooling system	Air-cooling radiator system
Prime water pump	
High temp. side cooling water tank	
Low temp. side cooling water tank	
High temp. side cooling water pump	Volute pump
Water softening system	Service pump, Intake pump
Low temp. side cooling water system	Volute pump
Radiator	Air cooled, 2-stage heat exchanger

(vi) Air Intake and Exhaust System

Air Intake System

The engine air intake system will consist of an oil bath air filter of wet type, a turbo-blower supercharged, a charge air cooler and an intake air silencer. Outdoor air will be extracted to obtain lower air temperature compared with air in the power house.

Exhaust Gas System

The engine exhaust gasses will be released to the atmosphere through an exhaust pipe with a silencer at its end. The engine will be provided with an exhaust pipe leading to the outside of the power house wall and fitted with an exhaust silencer. The silencer will be of floor mounting type.

All exhaust piping in the power house will be wrapped with thermal insulating materials. The exhaust piping will be provided with a flexible section or an expansion joint and all be sloped to a drain pocket with a drain cock outside the building.

(8) Generators

Major technical particulars of generators are as given in the following Table 2-7:

Table 2-7 Technical Particulars of Generators

(a)	Generator type	:	Horizontal shaft, revolving field, air cooled, compound winding, 3-phase AC synchronous generator
(b)	Unit capacity	:	15 MW class
(c)	Number of units	:	4 sets
(d)	Installed location	:	Indoor generator room
(e)	Electric system	:	3-phase, 3-wire system
(f)	Generator voltage	:	11 kV
(g)	Frequency	:	50 Hz
(h)	Power factor	:	0.8
(i)	Exciter type	:	Brush-less system
(j)	Cooling system	:	Self-ventilating air-cooled system
(k)	Number of poles	:	8 or more
(l)	Insulation class	:	F class

(i) Limit of Temperature Rise

The temperature rise of generator under the full-load condition shall not exceed the following limit values:

Stator windings:	100 ^{o}C	(embedded thermometer)
Rotor windings:	110 ^{o}C	(resistance)
Bearings:	75 ^{o}C	(thermometer)

(ii) Voltage Variation Rate

The inherent voltage variation rate shall not exceed the following values:

When full load with 0.8 power factor is suddenly separated	40%
When full load with 1.0 power factor is suddenly separated	30%

(iii) Allowable Over Speed

The generator shall mechanically withstand to operation at 120% of the rated speed for one minute under no-load and no-excitation condition.

(iv) Insulation Strength

The commercial frequency insulation strength of the generator shall be as follows:

Stator winding:	2 x (rated voltage) + 1,000V	1 minute
Rotor winding:	10 x (exciting voltage)	1 minute

(v) Protective Relays

The following protective relays will be mounted on the generator control board:

- Generator differential relays
- Generator overvoltage relays
- Emergency stop switch
- Generator loss of excitation relays
- Generator earth overvoltage relays
- Main transformer differential relays

When the above protective relays operate with faults, the circuit breakers of generator circuits will automatically open and diesel engines be stopped, and at the same time occurrence of faults is informed to operators with indications on the control board and audible alarm.

(9) Electric Facilities

The 11 kV generator circuits will be stepped up to 132 kV with the main transformers and connected with the existing bus line in Old Samawah substation. Unit system is adopted for the main circuits from generators to main transformers in view of easiness in operation and maintenance, and in future expansion of circuits and interconnection with other systems.

The single line diagram of the power station is presented in DWG-07.

(i) Main Transformers

Major particulars of the main transformers are as given in the following Table 2-8:

Table 2-8 Technical Particulars of Main Transformers

Type	3-phase, outdoor oil-immersed transformer with off-load tap changer
Rated capacity	50 MVA
Rated voltage	Primary 11 kV Secondary 132 kV
Vector group	Dyn 11
Cooling system	Oil-immersed self-cooling
Number of units	2 sets

(a) Limits of Temperature Rise

The temperature rise of main transformer shall not exceed the following limits under full-load condition:

Transformer windings:	65°C	(resistance method)
Transformer oil:	60°C	(temperature method)

(b) Tap Changer

The tap changer will be installed on the secondary side, and its changeover step will be 2.5%.

(c) Protective Apparatus

The following relays will be installed on the main control board:

- Buchholtz relays
- Temperature relays
- Overcurrent relays
- Main transformer differential relays

(ii) Station Service Transformers

The station service transformers will supply power to lighting in the power house, auxiliary equipment, etc. Particulars of the station service transformers are as given in the following Table 2-9:

Table 2-9 Technical Particulars of Station Service Transformers

Type	:	3-phase, outdoor oil-immersed transformer with off-load tap changer
Rated capacity	:	250 kVA
Rated voltage	:	Primary 11 kV Secondary 400 - 230 V
Vector group	:	Dyn 11
Cooling system	:	Oil-immersed self-cooling
Number of units	:	2 sets

The tap changer will be installed on the primary side, and its changeover step will be 2.5%.

The temperature rise alarming apparatus and overcurrent relays will be installed on the main control boards.

(iii) Switchgear and Control Boards

The switchgear and control boards will be of enclosed, self-standing and vertical panels, and will be provided in the powerhouse for the following circuits:

- 132 kV circuits
- 11 kV circuits
- Generator circuits
- Other circuits

The required number of panels for the above circuits is mentioned below.

(a) 132 kV circuits

- Main transformer secondary circuits	2 panels
- 132 kV feeder circuits	2 panels

(b) 11 kV circuits

- Generator circuits	4 panels
- Station service transformers	1 panel

(c) Other circuits

- Low tension circuit	1 panel
- DC source circuit	1 panel
- Synchroscope panel	1 panel
- Diesel generator operating panels	4 panels

(10) Environmental Considerations

According to MoE, the Ministry of Environment had given clearance to build and run the diesel power station in Samawah provided there would be a complete combustion and a proper management of waste residual oil.

Environmental items which are conceivable in case of implementation of the Project are listed in the following table.

		Environmental Items \ Rating	Rating: Construction	Rating: Operation	Basis of Judgement, and Countermeasures Taken in Design
SOCIAL	1	Resettlement	D	D	There is no inhabitants within the Project area.
	2	Split of Societies	D	D	From the landuse situation, no impact is anticipated.
	3	Aborigines	D	D	There is no case within the Project area.
	4	Friction	D	D	All local inhabitants request additional power supply. Most of labours will be procured locally.
	5	Economic Activities	D	D	Local market is held periodically within the Project area, but local inhabitants agree to move its location.
	6	Public Facilities	D	D	There is no social facilities such as school, hospital, etc., around the Project area.
	7	Trafficis	B	D	Width of the surrounding road of the Project area is sufficient enough.
	8	Commons, Rights	D	D	Radiator is adopted as cooling system, thus impact due to water take is insignificant.
	9	Cultural Heritage	D	D	There is no case within the Project area.
	10	Change of Views	D	D	The Project is located nearby the existing substation, thus no impact will occur.
NATURAL	11	Precious Nature	D	D	The Project area is a wasteland.
	12	Precious Animals, Plants	D	D	There is no case within the Project area.
	13	Vegetation	D	D	There is no case within the Project area.
	14	Landscape	D	D	Yard elevation of the power station will be as almost the same as original ground.
	15	Groundwater	D	D	Water take from underground water is not planned.
	16	Surface Water (volume)	D	D	A large quantity of water take/discharge is not planned.
	17	Surface Water (temperature)	D	D	A large quantity of water take/discharge is not planned.
	18	Air Pollusion	B	B	Exhaust of Nox, SOx Countermeasure: Concentration at ground level will be controlled by heightening the stacks.
	19	Water Pollusion	D	B	Contamination of water quality by wasted oil Countermeasure: Wasted oil will be separated from water with separator, and be burnt.
	20	Soil Contamination	D	D	Oil protecting dikes will minimize the influence when the oil leakage occurs
	21	Noise/Vibration	B	B	Noise and vibration to local inhabitants due to diesel engine operation Countermeasure: Plants will be installed at southern side of substation, where no houses exists nearby.
	22	Ground Subsidence	D	D	Water take from underground water is not planned.
	23	Offensive Odor	D	D	There is no case.

Rating
- A : Strong Impact is expected.
- B : Little Impact is expected.
- C : Unknown.
- D : Impact is insignificant.

Little impact is expected in items such as air pollution, noise/vibration, etc, but they can be prevented by appropriate considerations in design and construction. The major environmental considerations adopted in this Project are as follows.

Countermeasures Against Noise and Vibration

The best method to reduce influence of noise and vibration derived from the operation of diesel generators is to separate engines from surrounding houses as far as possible. The proposed power station site is selected with enough separation from such houses as well as the existing main road.

Countermeasures Against SOx and NOx

Environmentally harmful SOx and NOx gases are generated due to burning of oil. Although no numeric standard is established in Iraq yet, the gas concentrations at ground level will be within the specified limits which are set out in the World Bank's guideline, with enough stack height.

Protection from Oil

Oil protecting dikes with sufficient capacity will be constructed surrounding the oil tanks to minimize influence to the surrounding area to the minimum even when oil leakage due to failures of oil tank occurs.

Countermeasures Against Waste Oil

Regarding waste oil generated due to the use of C-heavy fuel, oil reservoir of large capacity will be constructed in the power house and accumulated oil will be pumped out when required.

2-2-2-2 132 kV Interconnecting Facilities

For the interconnecting the new power station with the existing Old Samawah substation, two circuits of 132 kV underground power cables will be installed from the 132 kV switchyard in the new power plant to the busbar, which is to be extended, in the substation..

Major specifications of the cable are as follows:

Type : 132 kV cross-linked polyethylene insulated, vinyl sheathed (XLPE) cable with cupper conductors

Size : 200 mm^2 (single core)

2-2-2-3 Relocation of Existing 132kV Transmission Line

Relocation of the existing 132 kV transmission line, 2 circuits of Sawa – Old Samawah section, will be executed in advance for the smooth implementation of the Project.

The major specifications of the materials are as follows:

Supports (Towers):	Heavy angle tower (SS14), approx. 30m height x 3
132 kV Power conductor: (Double circuits)	ACSR (240 sqmm), approx 3 x 800m
Overhead earthing wire:	GSW 50 sqmm, approx. 1 x 800m

2-2-2-4 Fuel-oil Pipeline

To transfer the heavy fuel-oil from the existing Samawah Oil Refinery to the HFO storage tank in the new power station (approx. 7.5 km), fuel-oil pipeline will be constructed under the ground with the following specifications.

Carbon steel pipe:	4-inch dia
Pump at oil refinery:	75 kVA (37.5 kVA x 2)
Generator at oil refinery:	100 kVA (50 kVA x 2)

2-2-2-5 Civil and Building Structures

(1) Soil Conditions at the Proposed Power Station Site

The study team carried out soil investigation with standard penetration tests at the power station site in 5 bored holes up to the depth of 62m in total to estimate the rough soil bearing capacity of the subsoil during the outline design study. Up to around 2.5m from the ground surface, soil is clay, and below this the soil is silty sand which is comparatively dense. Considerable bearing capacity of N-value at 50 can be obtained to around 8m.

In common practice for design of diesel engine foundation, piling is adopted in case that N-value of ground soil is less than 50. Thus in this Project also, piles will be driven up to solid foundation of N-value at 50. Piles will be of concrete, cast at site.

(2) Power Station Land

The power station land necessary for arranging diesel generating facilities is about 280m x 140m. Its formation height is about EL. 8m above sea level.

(3) Foundations of Diesel Generators

The foundations for diesel generators must withstand the machine weight and unbalanced inertia and vibrating forces caused by the operation of diesel engines, and vibration derived from engine operation shall not badly affect other equipment and buildings.

(4) Buildings of Power Station

The power station is used for normal continuous operation of 4 diesel engine generators and therefore a powerhouse building of exclusive use is planned. The area of building is to be determined with due consideration to space to install diesel generating equipment, auxiliary equipment (starting air system, fuel transfer pumps, C-heavy oil pre-treatment facilities, etc.), supplemental facilities (fuel service tanks, air tanks, etc.), electric facilities, etc., and space necessary for normal operation and inspection (including overhaul) and maintenance.

The building will be constructed with steel structure. An overhead travelling hoist will be provided for engine installation and maintenance purpose, and the steel structure shall have strength to support the load of hoist. The building shall be of fire-resistant construction as fuel oil and lubricant are treated normally in the building.

Sufficient ventilation must be provided to avoid temperature rise and from hygienic consideration for operators. In this plan, the forced ventilation with blowers will be applied.

2-2-3 Outline Design Drawings

Outline design drawings of the project are shown below:

No.	Figure Number	Figure Title
1	DWG-01	Location of the Project Site
2	DWG-02	General Layout of the Project Site
3	DWG-03	Equipment Layout of the New Power Station
4	DWG-04	Fuel Oil System Diagram
5	DWG-05	Fuel Oil Treatment System Diagram
6	DWG-06	Cooling Water System Diagram (incl. Fire Hydrant System)
7	DWG-07	Single Line Diagram

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

Work items of the implementation stage of the project are as follows:

a) Civil construction works comprising land leveling, roads in the premises, drain ditches, various foundations, etc.
b) Building construction works for powerhouse building, an office and crew lodge, etc.
c) Supply, erection, test and taking over of diesel generating facilities including auxiliary facilities
d) Construction of fuel pipeline which is connected between new power station and existing oil refinery
e) Installation of additional equipment in Old Samawah substation
f) Installation of 132kV interconnecting facilities
g) Relocation of existing 132kV transmission line

All items of works need to be executed in good coordination.

Fundamental subjects and items that need special attentions are mentioned below.

(1) Iraqi Coordinating Agency

(a) Arrangement of budget and staff necessary for executing responsibilities of the Iraqi side

Some portions of works of this project are to be executed by the Iraqi side. Such assigned works need to be executed timely with good coordination with other related works. The necessary budget and staff must be secured for this purpose.

(b) Transfer of technology

In this project, utmost effort must be made to the transfer of technology by participation of proposed operation and maintenance staff to the site erection and tests. Through a series of site works, basic principles of generating equipment, and technology of assembling and disassembling of diesel generators and other works will be transferred to Iraqi technicians. MoE must fully understand that such participation of engineers and technicians is required not only for execution of the Iraqi side duties related to the project but also for technology transfer aimed at future execution of machine maintenance by Iraqi workers.

(2) Implementation Contractors

Under the project, various kinds of works such as civil and building works, supply and erection of diesel generators, supply and erection on interconnecting underground cables, etc. will be executed, and various works are executed at the same time in the premises of power station. Each construction is closely related with others in work relation and schedule. Therefore, a Japanese contractor will assume overall responsibilities to whole works in security of quality, guarantee of characteristics, schedule management, etc.

In accordance with specifications prepared by the consultant, the contractor will carry out civil

and building works, and design, manufacture, factory inspection, packing for export, transport to site, erection, site tests and taking-over of generating equipment and materials. Through the site construction, equipment erection works and tests, the contractor will perform transfer of technology to Iraqi staff.

The plan of the personal education and training for operation and maintenance is consisted of the following 3 stages.

1) Stage-I: Basic education
2) Stage-II: Training at manufacture's factory
3) Stage-III: Training at Site

1) Stage-I: Basic education

Training Place – Iraq

Subjected Trainee – All staffs for operation and maintenance

Contents of Education

a) Basic Technical knowledge of DGP
b) Particulars of DGP
c) Operation method of DGP
d) Maintenance method of DGP

2) Stage-II: Training at manufacture's factory and existing DGP

Training Place – Manufacture's factory and existing DGP

Subjected Trainee – Representative staffs for operation and maintenance

Training Factory

a) Diesel Engine Manufacturer
b) Purifier Manufacturer
c) Electrical Equipment and Control Manufacturer
d) Steam Boiler Manufacturer

3) Stage-III: Training at site

Training Place – Project site in Samawah

Subjected Trainee – All staffs for operation and maintenance

Contents of Education

a) On-the-job Training during installation works

b) Attendance to commissioning tests

2-2-4-2 Implementation Conditions

(1) Safe Site Works

Various kinds of site work such as erection of heavy equipment, works at high location and other works will be executed in parallel in the same power station premises. Therefore, utmost cares must be taken to security of safe working.

Before commencing site works, detailed work plans shall be prepared through detailed discussions among working groups, and safe and efficient working environment shall be established by providing danger warnings, safety fences, etc.

(2) Coordination of Various Works

In the power station site, various kinds of site work such as civil and building works, erection of diesel generating facilities and electrical facilities, installation of underground lines, etc. must be executed under good coordination. Relocation of the existing 132kV transmission line, and civil and building works must be completed before the commencement of diesel generator erection, and the interconnecting transmission lines must be constructed before the site tests of diesel generators.

For timely completion of the project as a whole, various kinds of work must be executed in parallel in the premises of power station. Each work is closely related with others in work relation and schedule.

Therefore, the consultant and contractor must take utmost care for coordination of each component work, responsibility to each work, safety of workers and facilities, quality control, etc. The implementation plan must be prepared to ensure efficient and smooth execution of site works as a whole under good coordination among each other.

2-2-4-3 Scope of Works

In this project, all the works related to power station facilities will be carried out by Japanese contractors as follows:

Table 2-10. Scope of the Works

Japanese Side	Iraqi Side
1. Diesel generating facilities works 2. Civil & building works 3. 132 kV interconnecting works 4. Additional equipment to existing substation 5. Construction of pipeline from Samawah oil refinery 6. Relocation of existing 132 kV T/L	1. Preparation of necessary land 2. Investigation of the unexploded shells and disposal when unexploded shells are found 3. Participation of O&M staff to the site erection and tests

2-2-4-4 Construction Supervision

Before taking up the project under Grant Aid program from Japan, the Japanese Government will at first confirm appropriateness of the project referring to the basic conditions for grant aid. After that, an Exchange of Letters (E/L) is concluded between the two concerned governments, the project implementation will be commenced. In executing the detailed design and project supervision, due attentions must be paid to the followings:

(a) Background of the project implementation is to be understood.
(b) Contents of the Outline Design Study are to be confirmed.
(c) The framework of grant aid assistance from Japan is to be understood.
(d) The contents of Exchange of Letters agreed between the two governments are to be confirmed.
(e) Site working conditions are to be fully taken into account.

Taking into account the above understandings, the contents of consulting services, member of consultants and a necessary organization for execution are mentioned below.

(1) Basic Policies of Construction Supervision

The consultant shall manage and supervise, through the local consultant, the whole phases of work execution of the contractors so that the project works may be surely executed on schedule, with the 3 basic principles as given below:

(a) Schedule Management

(i) For each facility, progress of manufacture, transport and erection of equipment and materials must be reviewed all the time.
(ii) Process of works by both of the Japanese contractors and Iraqi authorities shall be confirmed and coordinated.
(iii) Schedule meetings shall be held at appropriate times for overall schedule management and its adjustment. The schedule meetings will be held weekly during site erection period and daily during the site test period.

(b) Safety Management

(i) Safety arrangement of site works shall be confirmed before starting works.

(ii) In case that many works are executed at the same place, necessary safety measures shall be taken to avoid accidents by confirming working methods and schedules of concerned parties.

(iii) Transporting in and out of equipment and site works near the electrically live parts shall be executed under supervision of a safety manager.

(iv) The areas shall be sectionalized with safety ropes around openings and electrically live parts, to avoid personnel faults.

(c) Quality Control

(i) The implementation contractor is to submit drawings, specifications, calculation data, etc. for approval to the consultant, who will review the submitted documents to confirm conformity to applied standards, contract specifications, etc.

(ii) The consultant will attend the factory tests before shipment of major equipment to confirm whether facilities have been manufactured according to the applied standards and contract specifications.

(iii) The completed works will be tested at site before taking over.

(2) Consulting Services

(a) Detailed Design and Preparation of Tender Documents

(i) Detailed Design

Based on the results of the Outline Design Study, the implementation costs are to be explained to and confirmed by the Iraqi authorities. At the same time responsibilities of the Iraqi side are to be confirmed for timely work execution. Prior to the preparation of tender documents, the detailed design shall be performed, the implementation cost be estimated and construction plan be prepared.

(ii) Preparation of Tender Documents

The tender documents shall be prepared based on the results of detailed design and the construction plan conforming to the requirements of the grand aid rules of Japan.

(b) Construction Supervision

(i) Tendering Process

The process includes the tender calling, questions and answers, attendance to tender closing and opening, evaluation of tender results, assistance to tender negotiation and conclusion of implementation contracts.

(ii) Site Supervision Process

This process comprises meetings among concerned parties before commencing site works, approval process of design drawings, factory inspection before shipment, supervision of site erection works, preparation of progress report during site construction, issue of interim certificates, and attendance to site tests before taking over. Supervision of the site works is to be done through the local consultant.

(iii) Process After Completion of Construction and Erection

This process comprises issue of completion certificate, processing for taking over, and preparation of completion report.

(3) Members of Consultant

To smoothly execute necessary services itemized in Item (2) above, it is required that a senior engineer with ample experience to similar kinds of services and enough understandings to the contents of the project will be nominated as the Project Manager and an effective organization for execution consisting of staffs for detailed design, tendering procedures, review and approval of design, factory inspection, and site supervision need to be established.

(a) Project Manager

Based on full understanding of the background and purposes of the project, the Project Manager will manage overall execution of the project. He will review and understand progress of the project and current problems, and control progress of the works, and instruct and provide advice to constituting members.

(b) Engineers for Detailed Design

Based on the established basic criteria, the engineers will determine specifications of equipment and materials for the project, layout design, detailed design, and construction plan taking into account supply interruption planning, and estimation of project cost.

(c) Engineers for Tendering Process

The consultant shall at first prepare the tender documents and carry out tender calling, questions and answers, tender acceptance, evaluation of submitted tenders, and assistance to negotiation and conclusion of contract.

(d) Engineers for Design Review and Factory Inspection

In the home office, the consultant shall review drawings, specifications, instruction manuals, etc. to be submitted for approval by the implementation contractor, decide approval or not and inform contractors, and carry out factory inspection prior to shipment.

(e) Engineers for Site Supervision

The resident supervising engineer will supervise the entire site works from commencement of construction up to completion of the project. In addition, specialist engineers in charge of civil and building works, electrical facilities, mechanical facilities will be dispatched to the site to perform necessary supervising works.

2-2-4-5 Procurement Plan

(1) Purchasing Sources

The purchasing source of each facility is to be determined with due considerations to availability in Iraq or surrounding countries, easiness in operation and maintenance, construction period and risk hedge against site works.

A plan for purchasing sources of equipment and facilities under this project is presented in Table 2-11 below:

Table 2-11 Purchasing Sources of Major Equipment and Materials

Equipment & Materials	Purchasing Source
Civil and building works:	
Equipment & materials for civil works	Local
Equipment & materials for buildings	Japan/Local
Diesel generating facilities:	Japan
Other facilities:	Japan

(2) Scope of Spare Parts

To continuously operate diesel generators for long time with the original operating characteristics, considerable quantities of spare parts are indispensable. In this plan, spare parts necessary for 2-year operation will be supplied.

(3) Transportation Route to Site

As transportation route to the site, Jordan (Aqaba) or Kuwait routes are most prospective as they have ports that can handle heavy cargos.

Especially, the Kuwait route is about 280 km in distance, shorter than the other, and one day trip is possible up to Samawah. Diesel engines of 15MW class can be transported by dividing into parts under the height limitation of 5 m in public roads in Kuwait. In Iraq, the height limitation in public roads is 6 m.

Road condition in Kuwait route is good. Asphalt paved highway (three lanes in one side) runs in Kuwait up to the border with Iraq. After entering into Iraq, asphalt paved Tampa route (three lanes in one side) and Jackson route (one lane in one side) continue up to Samawah. In both countries, the transmission power lines cross the road in 8 m height approximately. Thus its is enough to set up transportation plan with the above said height limitation at 5 m. During

construction of CPA gas turbine plant in Samawah, a 120 ton gas turbine with a 4.7m high transformer were successfully transported along this route.

Meanwhile, restriction of crossing border by Iraqi nationals and process for tax exemption in customs in the Kuwait port are regarded as shortcoming of this route.

Jordan (Aqaba) route is a prospective alternative, as the road and port conditions are also good. However, it is noted that the security condition near the Baghdad is not fully restored and this may cause higher security cost for transportation.

2-2-4-6 Quality Control Plan

(1) Quality Control of Equipment and Materials to be Supplied

Quality of equipment and materials to be supplied under the project will be controlled in the following steps.

(a) Review of Design Drawings and Specifications and Their Approval

The consultant will review drawings, specifications, calculations, etc. for approval to be submitted by the implementation contractor after conclusion of the contract to review their conformity to applied standards, contract specifications, etc. and will approve them if there are no problems or give necessary comments. The consultant will perform these services in Japan. Equipment and materials will be manufactured after such approval is obtained.

(b) Factory Inspection

After equipment is manufactured it is subject to factory inspection before delivery to the site. The purpose of this inspection is to confirm the equipment is manufactured in accordance with applied standards and contract specifications. Generally, visual inspection and characteristics tests are carried out. The tests of major equipment are attended by the consultant engineers.

(c) Site Supervision and Tests on Completion

The consultant, with assistant of local consultants, will carry out construction supervision with cooperation of MoE engineers so that the site construction and erection works are performed in accordance with the specifications. The completion tests are performed before taking over to confirm whether the works are completed in accordance the specifications or not.

(2) Quality Control of Civil and Building Works

(a) Review of Construction Drawings and Their Approval

Structural design and construction drawings are to be prepared by the contractor and be subject to review and approval by the consultant. These review and approval services of

the consultant will be performed in Tokyo and at site.

(b) Inspection of Materials to be Used

The consultant, with assistant of local consultants, will inspect all the materials to be used for the works before their use. These tests will be performed at the supply origins or at site as required.

(C) Construction Supervision at Site

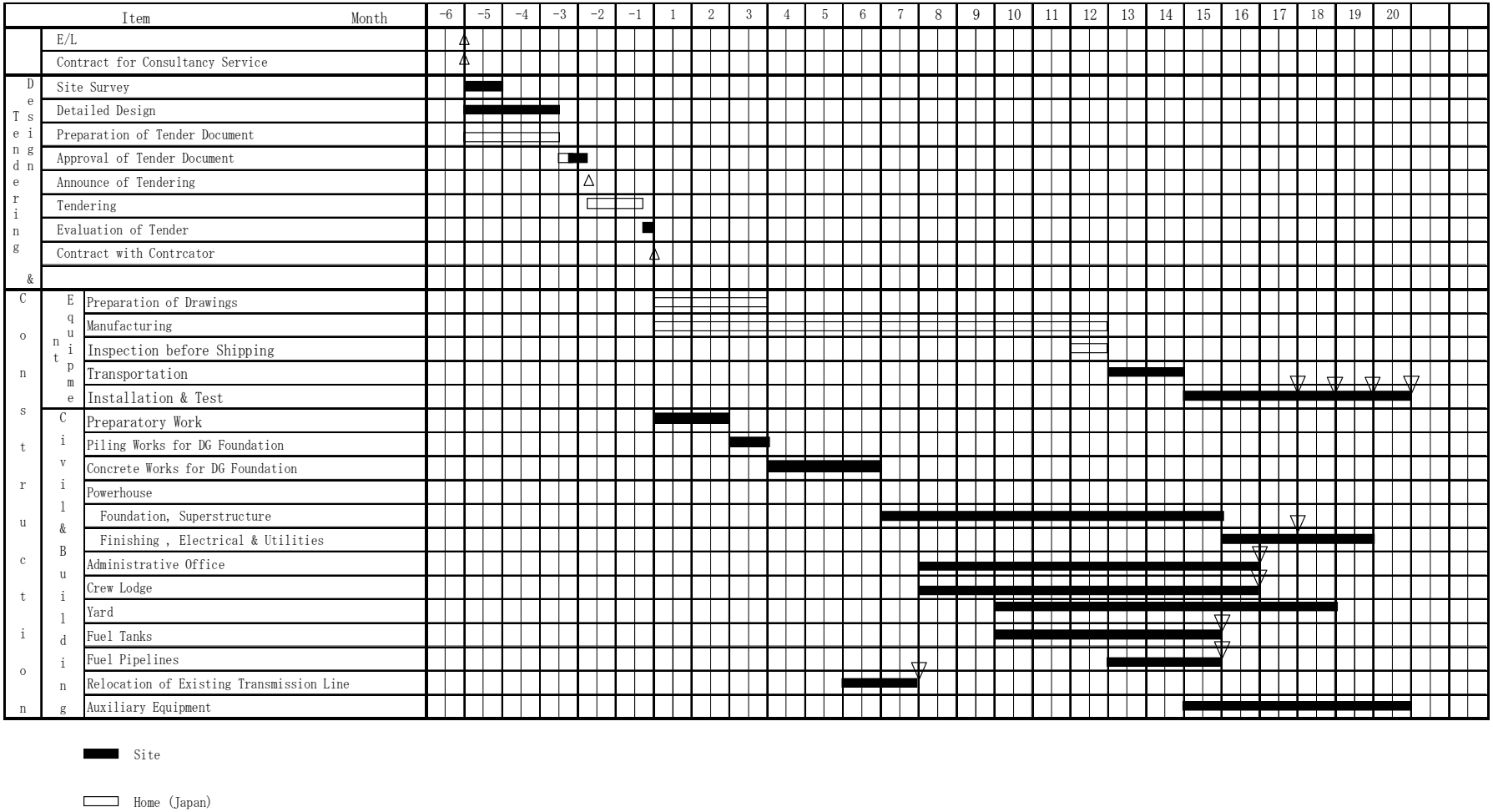
The consultant, with assistant of local consultants, will carry out construction supervision with cooperation of MoE engineers on the soil leveling, concreting (concrete quality and arrangement of steel bars), steel frames of power station building, building works, foundation works, etc. including attendance to some work items.

2-2-4-7 Implementation Schedule

The work execution of this project will require 20 months from the conclusion of the contract for construction to completion of the project.

The estimated implementation schedule is shown in Table 2-12.

Table 2-12 Implementation Schedule



2-3 Obligation of Recipient Country

Items to be executed by the Iraqi authorities in case that a grant aid project from Japan is executed are as follows:

(a) Assisting customs clearance at ports of entry into Iraq

(b) Getting clearance from relevant authorities which may be necessary within Iraq for the execution of the Project, including procedure for approval on environmental issues

(c) Allowing Japanese nationals and other nationals involved in the Project entry into Iraq

(d) Exempting customs duties, internal taxes and other fiscal levies which may be imposed in Iraq with respect to the supply of products and services under the Project

(e) Exempting Japanese nationals involved in the Project from customs duties, internal taxes and other fiscal levies which may be imposed in Iraq

(f) Permitting contractors to utilize non-Iraqi insurance companies as necessary

(g) Acquisition of land necessary for the project

(h) The Iraqi side should conduct survey for landmines and unexploded ordinances (UXOs) at the Project site including the site for pipeline and issue the certificate of completion of the survey to the Japanese side within five (5) months from the signature of the Exchange of Letters.

(i) The Iraqi side will responsible for ensuring the safety of all persons, goods and materials related to the Project by taking all necessary measures including patrolling and holding road inspections around the Project site during construction period. In addition to the above, the Iraqi side should take measures necessary for ensuring smooth implementation of the Project requested by relevant parties involved in the Project.

(j) Providing terminal points for public services, such as water supply, telephone, electricity

2-4 Project Operation Plan

To carry out the actual operation and maintenance of new equipment without difficulties by the staff, the following measures will be needed.

a) Establishment of proper organization for operation and maintenance

To carry out operation and maintenance of modern large equipment, MoE needs to establish a capable organization for operation and maintenance. Not only recruitment of necessary staff, operation manuals and various forms for systematic reporting of operation, inspection, maintenance, faults, etc. need to be arranged.

b) Employment of staffs with experience for operation of diesel engines

For operation and maintenance of large machines to be supplied, considerable technical knowledge is required. It is required to employ staffs with experience for operation of the same scale diesel engines, such as for shipping, as future core staff of the operation and maintenance team.

c) Training during erection period

In Iraq there are no large diesel generators as those to be supplied under the project, and the present operation and maintenance staff has no experience and no knowledge of such large equipment. It is effective to participate in the erection works and become familiar with such equipment through guidance of instructors of the contractor and consultant personnel. The practice to employ local capable workers as operation and maintenance staff is also widely adopted.

Table 2-13 Number of Staff

Position	Number of Person
Director	1
General Management	9
Operation Department	28
Maintenance Department	32
Mechanical	(12)
Electrical	(8)
Instrum Entation	(8)
Technical Services	(4)
Total of Staff	70

*1: Operation staff assignment plan

The new power station is assumed to be operated daily with 4-shift system.

2-5 Cost Estimate for the Project

In case that Grant Aid is implemented, Japan's share of the expenses is as below. Iraq's share of the expense has not been clear, therefore, only the expenses as Japan's Grant are described. This cost estimate is provisional and would be further examined by the Government of Japan for the approval of the Grant.

Table 2-14 Project Cost Estimate

	Item	Cost Estimate (Unit: thousand yen)
A.	Equipment, including Marine Transportation	5,317,358
B.	Installation Work	3,117,792
C.	Inland Transportation and Security	1,784,769
D.	Consulting Services and Procurement Management	668,216
E.	Provisional Sum*	1,813,743
	Total	12,701,878

* Provisional Sum is secured for unforeseen circumstances during the project implementation, and approval by the Government of Japan in advance is required before use.

Period of cost estimate; April, 2005
Exchange Rate; 1US$=107.03YEN

2-6 Other Relevant Issues

In order to implement the project smoothly, obligation itemized in 2-3 should be executed by the Iraqi authorities without delay.

For monitoring and management of the Project, local consultant will be employed by the Japanese consultant until the completion of the Project. Result of monitoring will be reported to the Japanese consultant, which is stationed in Jordan and Japan. Based on such report, the Japanese consultant will take necessary measures through the local consultants.

Chapter 3 Project Evaluation and Recommendations

Chapter 3 Project Evaluation and Recommendations

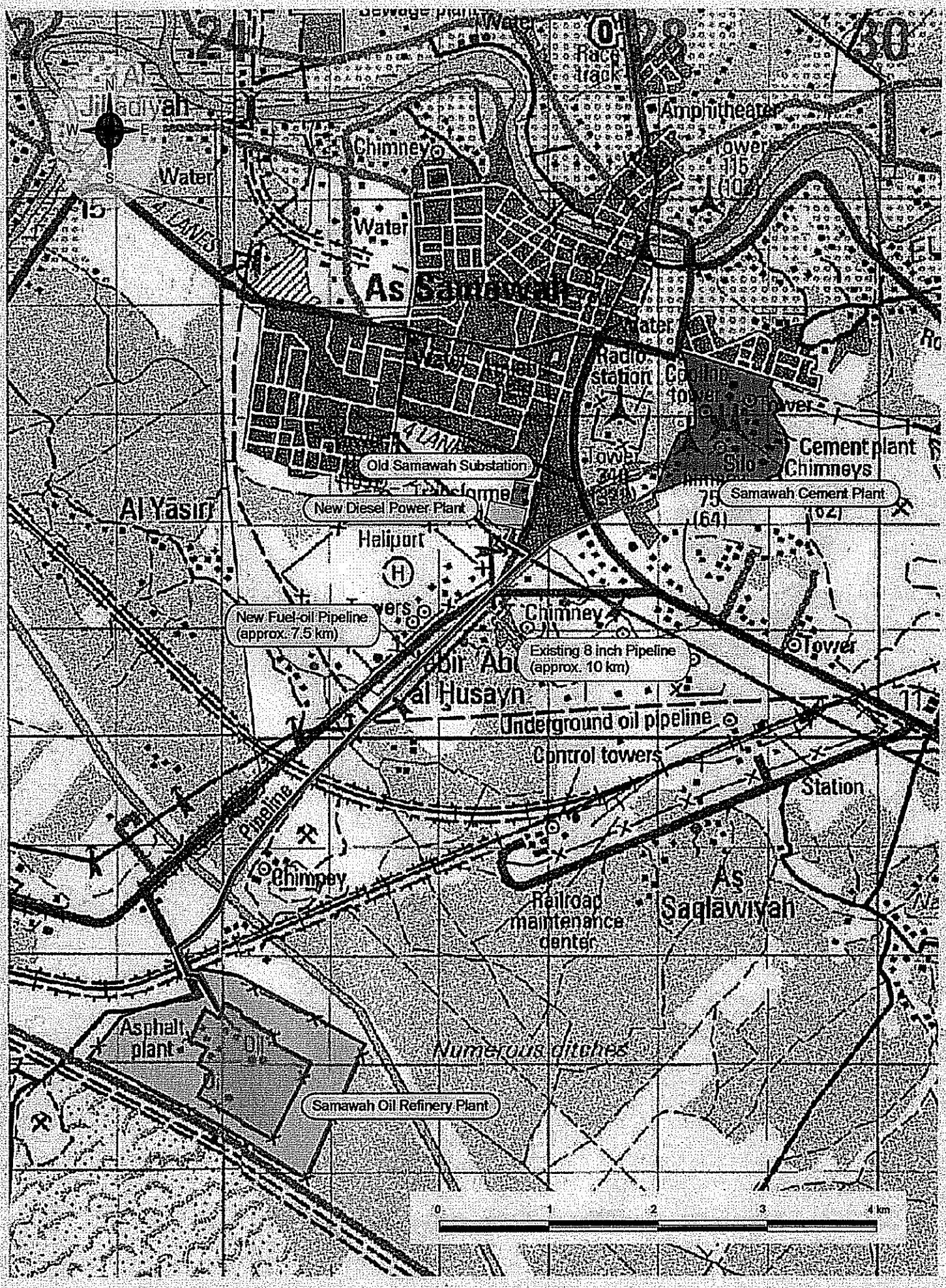
3-1 Project Effects

By the commissioning of the power station in this project, power supply to inhabitants in Samawah and its surrounding area of 100- 120 thousand people will be improved and time for power outage will decrease. This will also contribute to improvement of social services such as health, education etc., and in turn to further the reconstruction of Iraq.

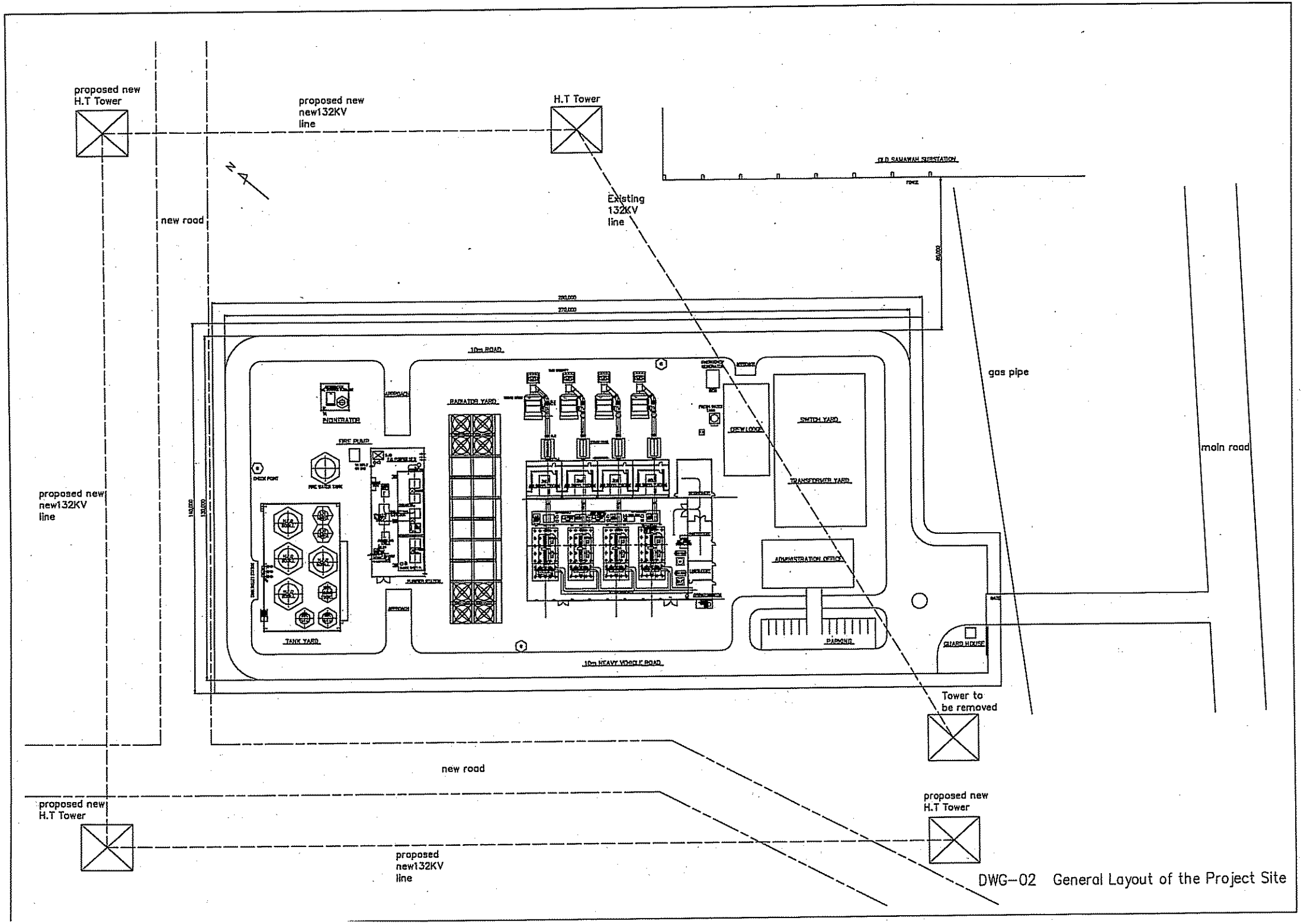
3-2 Recommendations

Iraq has no experience in diesel engines of 15 MW class in unit capacity. Furthermore, pre-treatment for heavy fuel oil is also required, and thus higher capability is required to operate and maintain the equipment in the project. Even though MoE has enough experience in operation and maintenance for steam turbine plants and gas turbine plants, it is necessary to train the operation and maintenance staffs and also to employ staffs with experience for the same scale diesel engines, such as for shipping, so as to establish a proper organization for operation and maintenance of the large scale diesel plants.

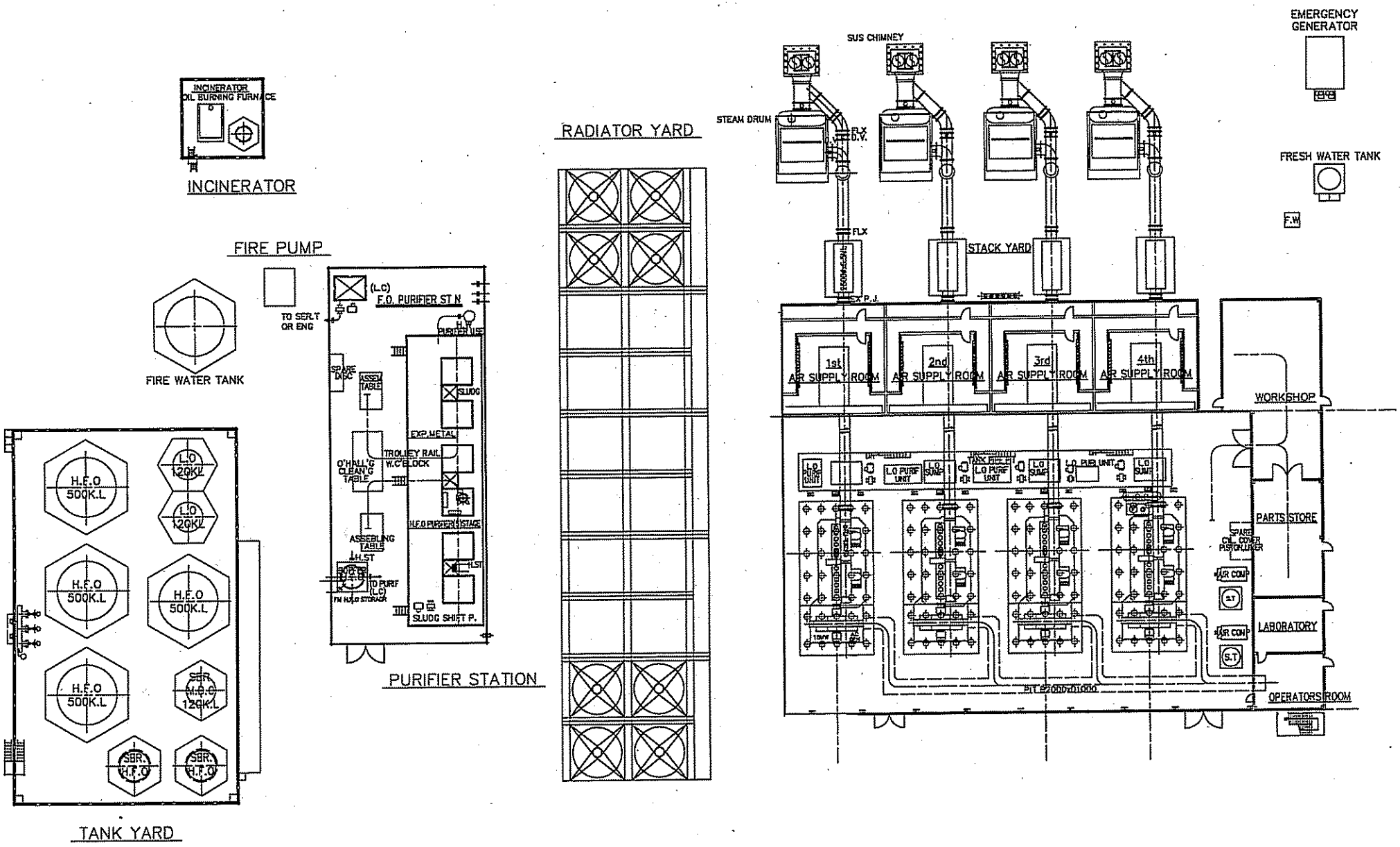
Drawings



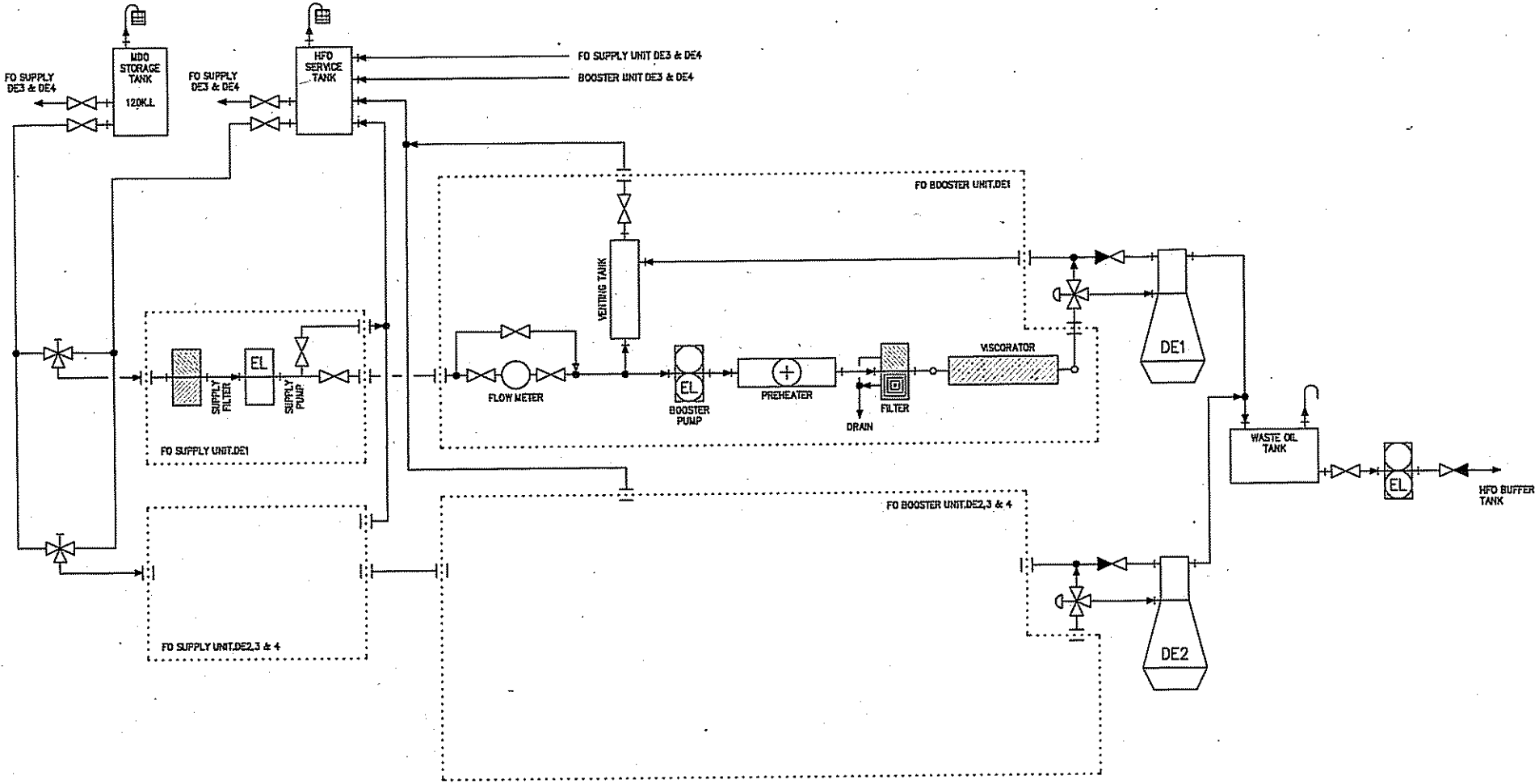
DWG-01 Location of the Project Site



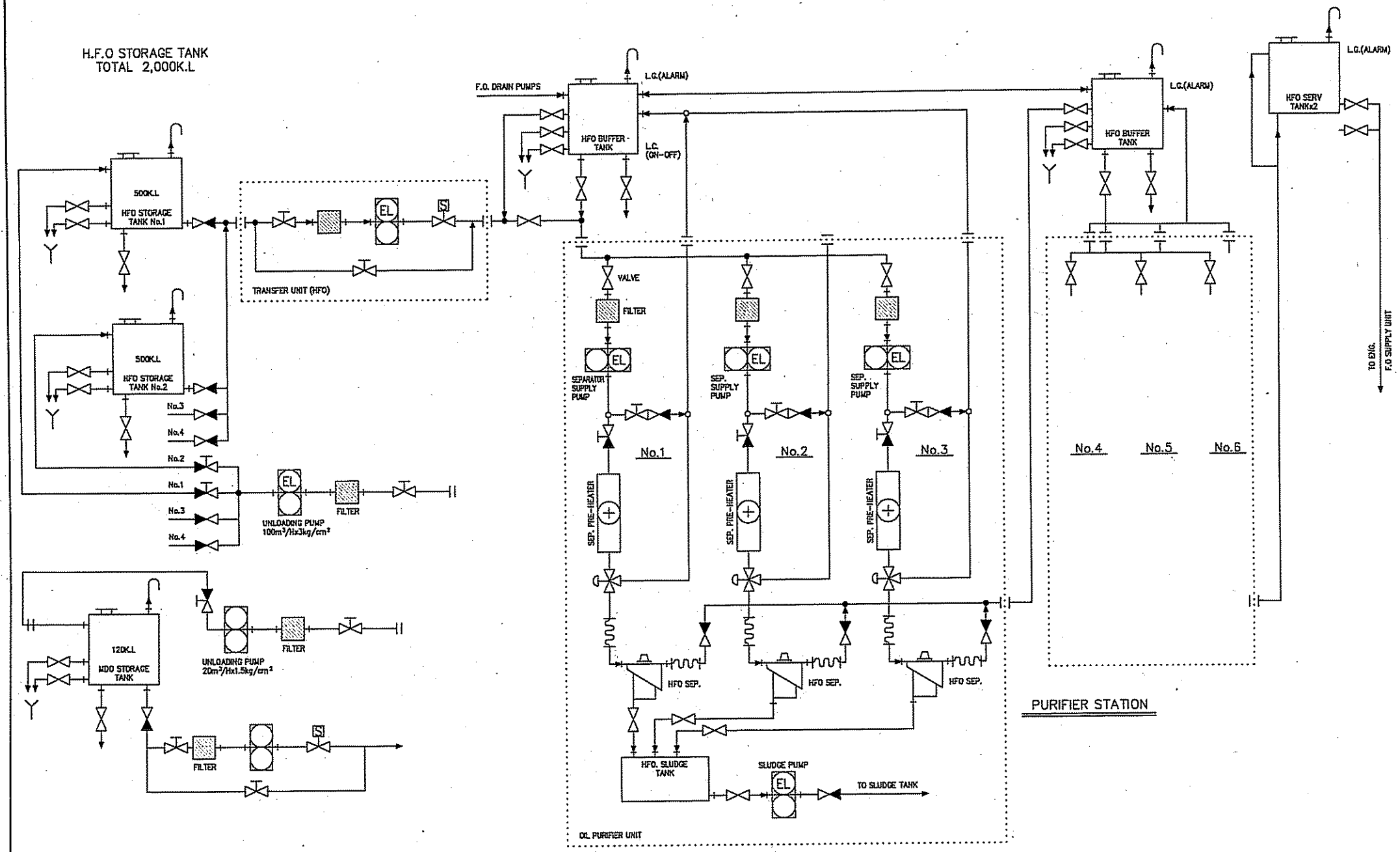
DWG–02 General Layout of the Project Site



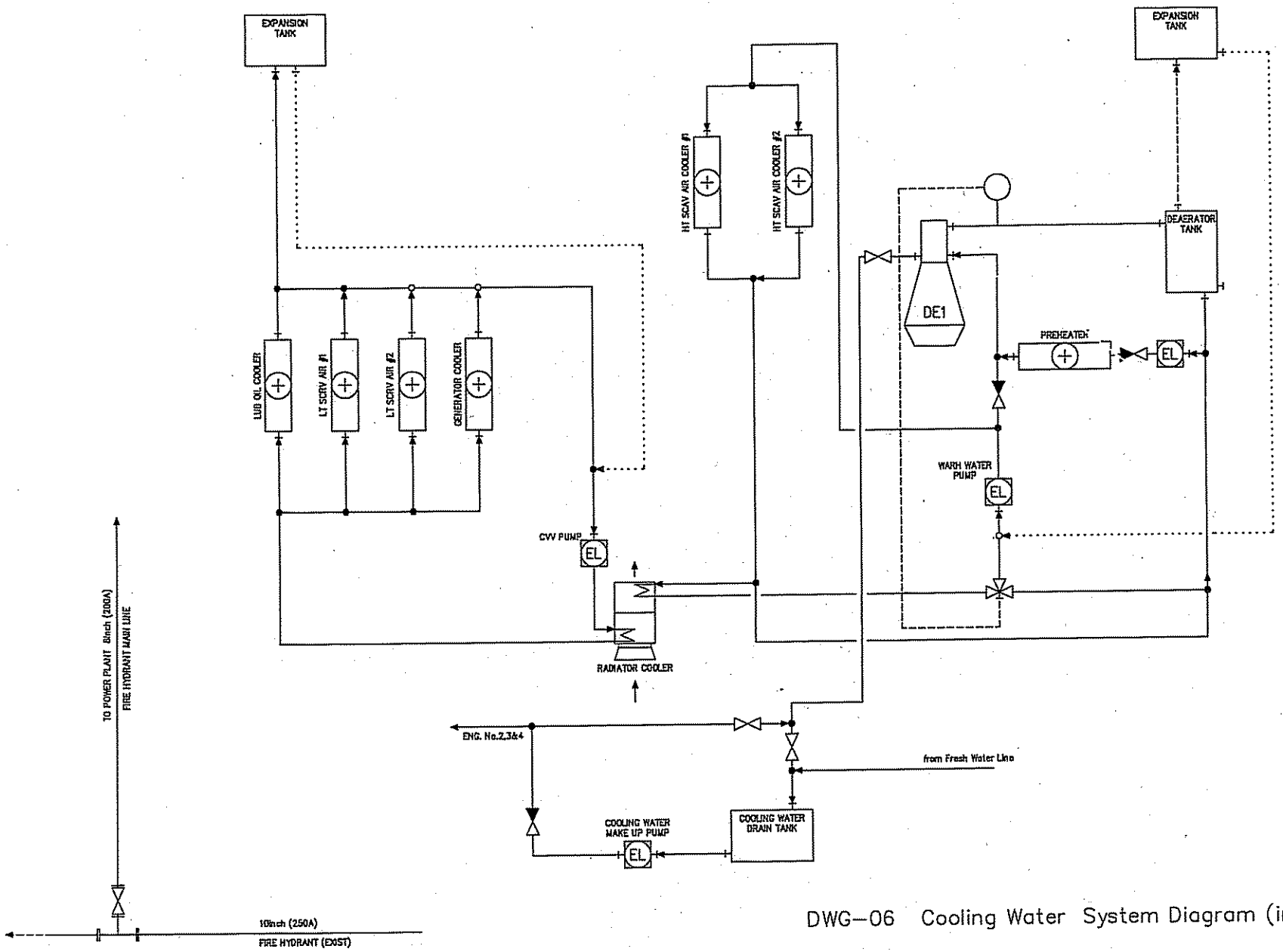
DWG–03 Equipment Layout of the New Power Station



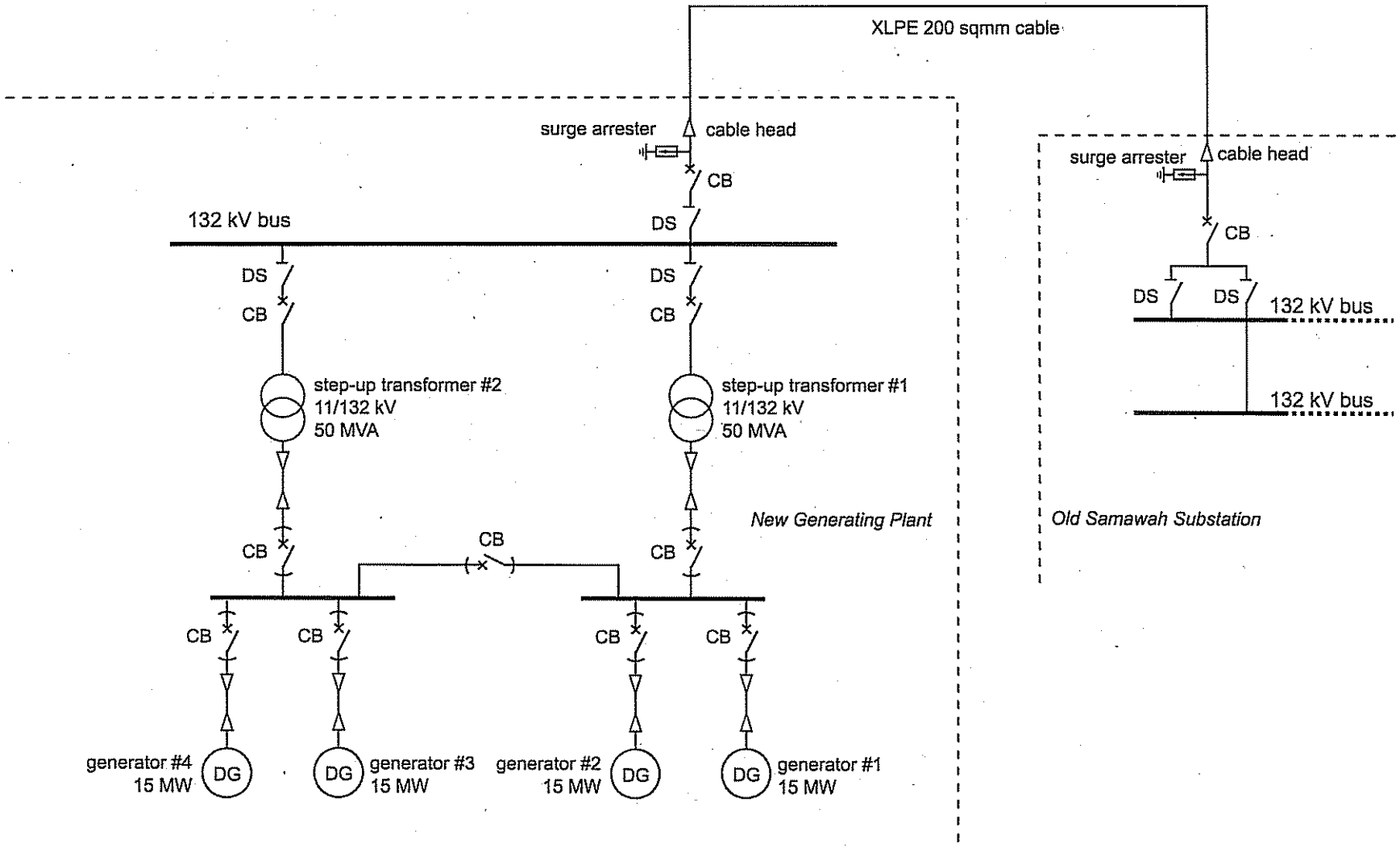
DWG-04 Fuel Oil System Diagram



DWG-05 Fuel Oil Treatment System Diagram



DWG–06 Cooling Water System Diagram (incl. Fire Hydrant System)



DWG-07 Single Line Diagram

Appendices

Appendix 1-1 Member List of the Study Team (Outline Design Study)

Preliminary Study for Reconstruction of Iraq (Phase 4)
Outline Design Study

1.	Chief Consultant	Noriaki MATSUSHIMA	Nippon Koei Co., Ltd
2.	Asst. Chief / Power Supply Planner / Environmental Expert	Masaki WADA	Nippon Koei Co., Ltd
3.	Power Plant Planner I (Diesel Generator)	Akihisa MANITA	Nippon Koei Co., Ltd
4.	Power Plant Planner II (Auxiliary Facilities)	Jun-ichi FUKUNAGA	Nippon Koei Co., Ltd
5.	Building Planner / Natural Condition Surveyor (Topo. & Soil)	Sohei UEMATSU	Nippon Koei Co., Ltd
6.	Procurement Planner / Cost Estimator	Masaru TOKUNO	Nippon Koei Co., Ltd

Appendix 1-2 Member List of the Study Team (Explanation on Draft Report)

Preliminary Study for Reconstruction of Iraq (Phase 4)
Outline Design Study

1.	Leader	Kyojin MIMA	Group Director, Project Management Group I, Grant Aid Management Department, JICA
2.	Project Coordinator	Hiroyuki HAYASHI	Transportation and Electric Power Team, Project Management Group I, Grant Aid Management Department, JICA
3.	Chief Consultant	Noriaki MATSUSHIMA	Nippon Koei Co., Ltd
4.	Asst. Chief / Power Supply Planner / Environmental Expert	Masaki WADA	Nippon Koei Co., Ltd
5.	Power Plant Planner I (Diesel Generator)	Akihisa MANITA	Nippon Koei Co., Ltd

Appendix 2-1 Study Schedule (Outline Design Study)

First Field Survey

No.	Date	Day	Place of stay	Consultant			
				Mr. Matsushima	Mr. Wada	Mr. Manita	Mr. Uematsu
1	11/17	Wed.		-	Haneda-Kansai-(Dubai)		-
2	11/18	Thu.	Amman	-	Dubai-Amman		-
3	11/19	Fri.	Amman	-	Preparation of specifications for local consultant		-
4	11/20	Sat.	Amman	-	Preparation of specifications for local consultant		-
5	11/21	Sun.	Amman	-	Internal meeting		-
6	11/22	Mon.	Amman	Haneda-Kansai-(Dubai)	Meeting with local consultant		Haneda-Kansai-(Dubai)
7	11/23	Tue.	Amman	Dubai-Amman	Courtesy call to JICA Jordan, EoJ		Dubai-Amman
8	11/24	Wed.	Amman	Meeting with local consultant			
9	11/25	Thu.	Amman	Meeting with local consultant			
10	11/26	Fri.	Amman/Kuwait	Data collection	Amman-Kuwait	Data collection	Amman-Kuwait
11	11/27	Sat.	Amman/Kuwait	Data collection	Meeting with Road/Bridge Team	Data collection	Meeting with Road/Bridge Team
12	11/28	Sun.	Amman	Internal Meeting	Kuwait-Amman	Internal Meeting	Kuwait-Amman
13	11/29	Mon.	Amman	Preparation for Plenary Meeting			
14	11/30	Tue.	Amman	Preparation for Plenary Meeting			
15	12/1	Wed.	Amman	Plenary Meeting with Iraqi officials			
16	12/2	Thu.	Amman	Plenary Meeting with Iraqi officials			
17	12/3	Fri.	Amman	Plenary Meeting with Iraqi officials			
18	12/4	Sat.	Amman	Signing of M/D			
19	12/5	Sun.	Amman	Report to JICA Jordan, EoJ			Amman-Dubai
20	12/6	Mon.		Data collection	Amman-Dubai		Dubai-Kansai-Haneda
21	12/7	Tue.		Data collection	Dubai-Kansai-Haneda		-

Second Field Survey

No.	Date	Day	Place of stay	Consultant			
				Mr. Wada	Mr. Manita	Mr. Fukunaga	Mr. Tokuno
1	2/15	Tue.		Haneda-Kansai-(Dubai)			
2	2/16	Wed.	Amman	Dubai-Amman Courtesy call to JICA Jordan, EoJ			
3	2/17	Thu.	Amman	Preparation for Plenary Meeting			
4	2/18	Fri.	Amman	Plenary Meeting with Iraqi officials			
5	2/19	Sat.	Amman	Plenary Meeting with Iraqi officials			
6	2/20	Sun.	Amman	Plenary Meeting with Iraqi officials			
7	2/21	Mon.	Amman	Signing of M/D			
8	2/22	Tue.	Amman	Collection of Information/Data			
9	2/23	Wed.	Amman	Collection of Information/Data			
10	2/24	Thu.	Amman	Report to JICA Jordan, EoJ			
11	2/25	Fri.	Amman	Collection of Information/Data			
12	2/26	Sat.	Amman	Collection of Information/Data			
13	2/27	Sun.	Amman	Amman-Dubai			
14	2/28	Mon.		Dubai-Kansai-Haneda			

Appendix 2-2 Study Schedule (Explanation on Draft Report)

No.	Date	Day	Place of stay	JICA		Consultant		
				Mr. Mima	Mr. Hayashi	Mr. Matsushima	Mr. Wada	Mr. Manita
1	5/7	Sat.		Haneda-Kansai-(Dubai)				
2	5/8	Sun.	Amman	Dubai-Amman Courtesy call to JICA Jordan, EoJ				
3	5/9	Mon.	Amman	Plenary Meeting with Iraqi officials				
4	5/10	Tue.	Amman	Plenary Meeting with Iraqi officials				
5	5/11	Wed.	Amman	Signing of M/D				
6	5/12	Thu.	Amman (Consultants)	Report to JICA Jordan Amman-Dubai		Report to JICA Jordan Preparation of repots		
7	5/13	Fri.		Dubai-Kansai-Haneda		Amman-Dubai		
8	5/14	Sat.				Dubai-Kansai-Haneda		

Appendix 3 List of the Parties Concerned in the Recipient Country

Ministry of Electricity

Dr. Moayed Al-Maayouf	Director General, Planning & Study Office
Mr. Mohammed Ali Jaber	Assistant Director General, Planning & Study Office
Mr. Emil K. Hanna	Expert, Planning & Study Office
Eng. Laith Hamid	Head of Projects Department
Mr. Hussein Magdem Makhfi	Expert, Dibuty Office
Mr. Qusay Neif Mahammed	Projects Managements, Planning & Study Office
Mr. Hisham Jassam	Engineer, Middle Production
Mr. Anmar Anwor Abdul	Engineer, Middle Production

Ministry of Oil

Mr. Abdul Aziz Jabar	Expert, Ministry of Oil

Muthanna Governorate

Mr. Muhammed Ali Hassani	Governor, Al-Muthanna Governorate
Mr. Mohammad H. Mohammad	Deputy Governor of Muthanna
Mr. Raisan Moteshar Fahad	Governorate Committee, Electrical Department
Mr. Saad Rahem	Chief Engineer, Nassiriya Generation Governorate
Mr. Fahem Mahmoud	Manager, Directorate of Al-Muthanna Electricity Distribution