No. 1

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR REHABILITATION OF POWER PLANTS OF SUM CENTERS PHASE III IN MONGOLIA
November 1999
JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD., TOKYO, JAPAN

BASIC DESIGN STUDY REPORT

ON
THE PROJECT
FOR
REHABILITATION OF POWER PLANTS
OF SUM CENTERS

PHASE III
IN
MONGOLIA

November 1999

JICA LIBRARY
J 1154458 [2]

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD., TOKYO, JAPAN

115
64.3
GRO
RARY
99-165

G R O
C R (2)
99-165

BASIC DESIGN STUDY REPORT

ON
THE PROJECT
FOR
REHABILITATION OF POWER PLANTS
OF SUM CENTERS

PHASE III
IN
MONGOLIA

November 1999

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD., TOKYO, JAPAN


1154458 [2]

PREFACE

In response to a request from the Government of Mongolia, the Government of Japan decided to conduct a basic design study on the Project for the Rehabilitation of Power Plants of Sum Centers, Phase III and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Mongolia a study team from July 3 to August 1, 1999.

The team held discussions with the officials concerned of the Government of Mongolia, and conducted a field study at the study area. After the team returned to Japan, further studies were made, 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 Mongolia for their close cooperation extended to the teams.

November 1999

Kimio Fujita

President

Japan International Cooperation Agency

November, 1999

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for the Rehabilitation of Power Plants of Sum Centers, Phase III in Mongolia.

This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from June 30, 1999 to November 15, 1999. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Mongolia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

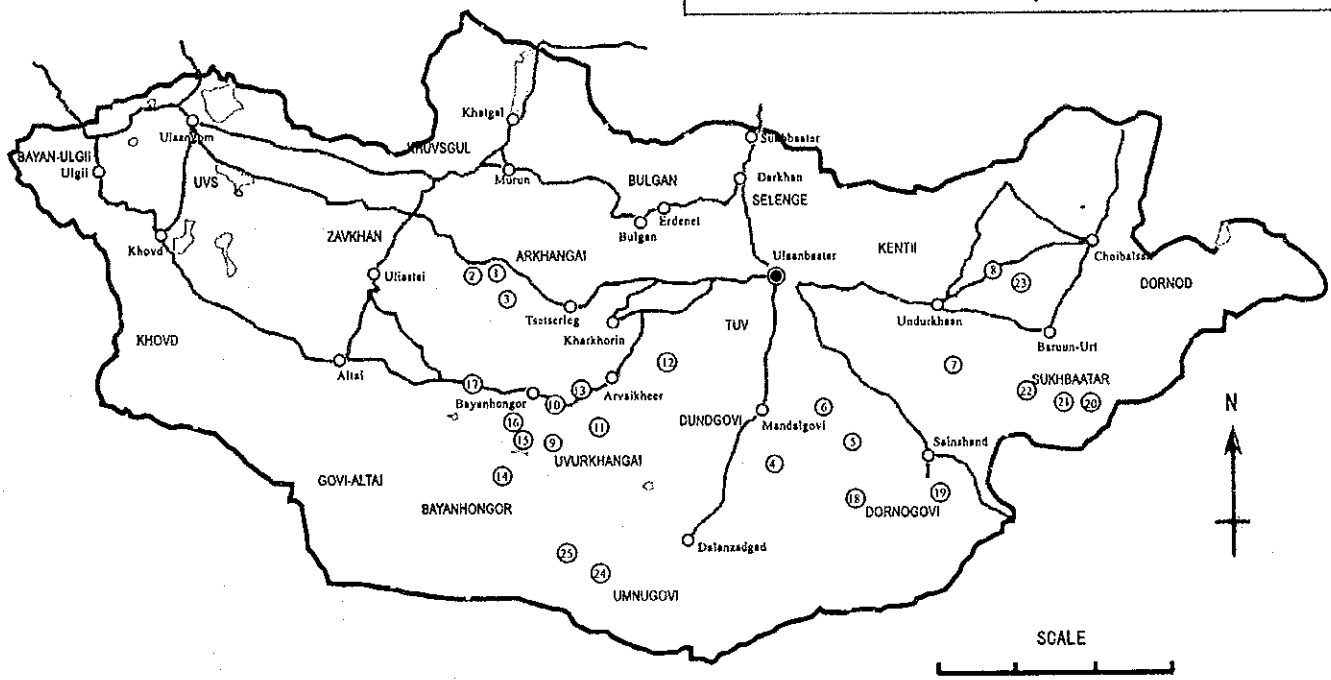
Very truly yours,

Noriaki Matsushima

Project manager,

Basic design study team on
The Project for the Rehabilitation of
Power Plants of Sum Centers, Phase III

Nippon Koei Co., Ltd.



ARKHANGAI
1. Khangai
2. Tsakhir
3. Chuluut

DUNDGOVI
4. Ulziit
5. Undurshil
6. Bayanjargalan

KHENTII
7.Galshar
8.Bayan-Ovoo

UVURKHANGAI
9.Baruunbayan-Ulaan
10.Nariinteel
11.Guchin-Us
12.Bayan-Undur
13.Hairhandulaan

BAYANHONGOR
14.Bayangovi
15.Bogd
16.Jinst
17.Bumbugur

DORNOGOVI
18.Mandakh
19.Saihandulaan

SUKHBAATAR
20.Dariganga
21.Ongon
22.Bayandelger
23.Tumentsogt

UMNUGOVI
24.Noyon
25.Gurvantes

LEGEND
- Sum Center
- Large Town
- Capital
- Main Road

Location Map

Abbreviations

JICA	:	Japan International Cooperation Agency
NK	:	Nippon Koei Company Limited
MOID	:	Ministry of Infrastructure Development
IMF	:	International Monetary Fund
ODA	:	Official Development Assistance
ADB	:	Asian Development Bank
JBIC	:	Japan Bank for International Cooperation
USAID	:	The U.S. Agency for International Development
TACIS	:	EU Programme for Technical Assistance for the Commonwealth Independent States
KFW	:	Kreditanstalt fur Wiederaufbau
WB	:	World Bank
IEC	:	International Electro-technical Commission
ISO	:	International Organization for Standardization
JEC	:	Japanese Electro Technical Committee Standards
JIS	:	Japan Industrial Standards
JEM	:	Japan Electrical Manufacturers' Associations
JCS	:	Japanese Cable Standards

CONTENTS

TABLES

FIGURES

APPENDICES

CHAPTER 1

BACKGROUND OF REQUEST FROM MONGOLIA

CHAPTER 1 BACKGROUND OF REQUEST FROM MONGOLIA

Total 314 Sums are existing in Mongolia at present. The 125 Sums among them, which are located near city centers, are obtaining the electric power supply from main power transmission system being composed of three national electric grids in Central, Eastern and Western areas. In the remaining 189 Sums, the electric power is being supplied by the independent diesel power generation which is installed in Sum centers and no development plan is existing to connect with the national electric grids. All of these diesel engine generators were manufactured in the former Soviet Union and almost of them were installed in the years between 1963 and 1990. A severe situation has been appeared in the Sums after the collapse of the Soviet Union, that is, the Sums were suffering from shortage in power supply and were obliged to perform partial-time supply and load restriction due to super-aging of the Russian made diesel engine generators. Such situation is severely affecting to daily lives of the Sum center inhabitants as well as social and economic activities of the Sum centers.

Under such circumstance, the Government of Mongolia officially requested a grant financial assistance to the Government of Japan in 1996 for the rehabilitation of diesel power generating facilities of 74 Sum centers among the 189 Sum centers, which are severely suffering from shortage in power supply. In the 74 Sum centers, the assistance from Japan has already been extended to 4 Sum centers under a grass-roots grant in 1997, 25 Sum centers under the Project for the Rehabilitation of Power Plants of Sum center Centers Phase I in 1997 (hereinafter called the First Phase Project) and 45 Sum centers under the Project for the Rehabilitation of Power Plants of Sum center Centers Phase II in 1998 (hereinafter called the Second Phase Project). This Project aims to rehabilitate 25 Sum centers among the remaining 115 Sum centers and the scope of work is summarized as below.

1.	Objective Sum centers	:	25 Sum centers
2.	60 kW Diesel engine generators	:	55 units
3.	100 kW Diesel engine generators	:	15 units
4.	Total	:	70 units

The Japanese Government decided to execute a basic design study of the Project and JICA dispatched a mission to Mongolia from July 3 to August 1 in 1999. During the stay, the mission investigated site conditions and collected data associated with the rehabilitation of diesel engine generating facilities based on the discussion with MOID, who is the executing agency of the Project.

The list of members, the investigation schedule, the list of Mongolian personnel, the minutes of meeting etc. are as shown in Annexes 1, 2, 3, 4 and 5.

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2 - 1 Objectives of the Project

At present the electric power supply in the objective Sum centers are in terrible conditions as mentioned in Chapter 1. Major problems being arising in the objective Sum centers are enumerated bellow:

(a) The supply of spare parts of Russian made diesel engine generators has been stopped, which cause a difficulty of the maintenance.

(b) As technical assistance to the equipment maintenance is not available, it is not possible to repair damaged diesel engine generators.

(c) Business operating senses under the market economy is not sufficient and there is not enough fund reserve available for the maintenance and management of the equipment.

(d) Due to deterioration of the existing facilities with aging and reasons as mentioned above, partial-time power supply is prevalent. Most of Sum centers are considered to become non-electrified Sum centers after several years due to the deterioration of the equipment.

Under such situation, the Government of Japan has assisted for rehabilitation of the generating facilities in total 74 Sum centers and contributed to provide a stable electric power supply. The location of the 74 sum centers and the transmission line system in Mongolia are shown in Figures 2.1 and 2.2.

The purpose of the Project is to provide new diesel engine generating facilities to 25 Sum centers facing a serious problem in the electric power supply and to make a soft component in order to maintain the stable and reliable electric power supply and to contribute the improvement and stability of Sum centers.

2 - 2 Basic Concept of the Project

In formulating the basic concept of the Project in this chapter, the following Paragraphs (1) to (8) describes the results of site investigation and home analysis in Japan, and the outline of plan is shown in Paragraph (9).

(1) Relations with Upstream Plans of the Power Sector

The electric power supply to Aimag and Sum Centers is presented with the highest priority in the natural development plan. MOID has the plan to extend the national electric grids to Aimag centers in order to achieve a stable electric power supply in the Aimag centers.

As for the Sum centers, the existing diesel engine generators have to be rehabilitated so that the stable electric power supply can be obtained until the renewal energy generating project will be implemented.

(2) Aid Plans of Other Donors

Aid plans being provided by other donors in the field of power sector are aiming to contribute a development with the target up to the Aimag centers and no target with Sum centers is existing.

(3) Electric Power Supply in Sum Centers

The objective Sum Centers are seriously facing a lack of electric power supply which is obliged to limit the supply due to shortage of a number of operable generators. In most Sum Centers, only one generator is available for the operation and two in a few Sum Centers.

During the summer season, the electric power is supplying in a daytime for the purpose of public demands such as hospital, school and public offices. In some Sum Centers, where small capacity of diesel engine generator is own for the hospital and school, the electric power supply is completely stopped in Summer.

On the other hand, in the winter season, the electric power is providing about 6 hours in a day mainly for the purpose of central heating facility.

(4) Present Conditions of Existing Generating Facilities and Basis Conception

The operating conditions of the existing generating facilities at the time of site investigation, i.e. July 1999, are shown in Table 2.1. It was found as the result of site investigation that 33 units among 62 existing generators in the objective 25 Sum centers are operable conditions. All of the Sum centers were suffering from shortage in power supply and were obliged to perform partial-time supply and load restriction. Under such circumstances, the current generating

output does not represent actual demand and it is not possible to estimate the potential demand from available operating records.

The major reasons of inoperativeness are super-aging of diesel engine generators. In all the objective Sum centers, many generating facilities have already been damaged and it is not possible to repair them due to financial problem and difficulty in obtaining spare parts of the superannuated equipment. Most of the currently operating generators will also be considered to be inoperative condition in near future because of difficulty in arranging necessary budget for operation and maintenance.

For repairing of the existing diesel engine generators which can not be operated, machines need to be brought into a workshop but no workshop is available at present. Moreover, the facilities are generally very old and the models have already been modified. Auxiliaries and spare parts are mostly out of stock and it is the present situation that parts of other generators have been utilized for the repair.

The diesel engine generators, even which is operable or repairable at present, will not be expected to continue the operation to supplement generating capacity for a long time under parallel operation with the new facilities. Considering the above conditions, the followings are basic conceptions of the Project to solve the problems:

(a) Repair of the existing generating facilities is not taken into account.

(b) Grade up of the existing generating facilities is not taken into account.

(c) Parallel operation with the existing generating facilities is not taken into account.

In addition, Sum Centers are facing the following situation.

- Electric power supply is not sufficient in Winter season by the reason why the demands for lighting and central heating system become larger.
- The existing electric power supply capacity is not corresponding to the increasing demand due to population.
- Only one generator is available in a Sum center and it cause a long term stoppage of electric power supply during repair or maintenance.
- It is difficult to prevent a damage in advance because a regular maintenance can not be carried out because of no availability of spare parts and maintenance tools and insufficient technical capability of the staff.

Taking the above situation into consideration, the basic conception of the Project are presented as follows.

(a) The output of generators will be selected in consideration of the increase of electric power demand with a growth of population.

(b) At least 2 units of generators will be installed in a Sum Center.

(c) Spare parts for 3 years and one set of maintenance tools will be provided.

(d) Maintenance tools and a vehicle will be provided for mobile maintenance team.

(e) Soft component for operation and maintenance will be provided.

Table 2.1 Inventory of Existing System (1/2)

Aimag	Sum	Existing Diesel Generator				
		Capacity	Production Year	Operating Condition	Reason of Impossible	Tool
Arhangai	Khangai	100 kW	1974	Impossible	Excitation transformer trouble	×
		60 kW	1987	Possible		
		60 kW	1987	Impossible	Generator Trouble	
		60 kW	1980	Impossible	Crankshaft damage	
	Tsakhir	60 kW	1987	Possible		△
		60 kW	1970	Impossible	Use as for the part exchange	
	Chuluut	60KW	1987	Impossible	Cylinder wear and radiator trouble	×
		30KW	1987	Possible		
		60KW	1981	Impossible	Cooling water system and radiator trouble	
		30KW	1981	Possible		
Dundgovi	Ulzit	100 kW	1987	Possible		×
		60 kW	1987	Impossible	Engine trouble	
	Undurshil	100 kW	1985	Possible		△
	Bayanjargalan	60 kW	1988	Possible		△
Hentii	Galshar	60 kW	1979	Possible		△
		60 kW	1979	Impossible	Cylinder wear and Lubricating oil system trouble	
	Bayann-Ovoo	60 kW	1979	Possible		×
		60 kW	1979	Impossible	Crankshaft damage	
Uberhangai	Baruunbayan-Ulaan	60 kW	1988	Possible		×
		60 kW	1984	Impossible	Crankshaft damage	
		30 kW	1984	Impossible	High fuel efficiency	
	Narinteel	60 kW	1983	Possible		×
		60 kW	1984	Impossible	Use as for the part exchange	
		30 kW	1984	Possible		
	Guchin-Us	60 kW	1984	Possible		×
		60 kW	1983	Impossible	Crankshaft damage	
		30 kW	1986	Possible		
	Bayan-Undur	30 kW	1974	Possible		△
		60 kW	1984	Impossible	Cooling water leakage	
		60 kW	1987	Possible		
	Hairhandulaan	60 KW	1971	Impossible	Use as for the part exchange	△
		60 kW	1986	Possible		
Bayanhongor	Bayangovi	60 KW	1984	Possible		△
		60 kW	1985	Impossible	Use as for the part exchange	
	Bogd	60 kW	1984	Possible		△
	Jinst	60 kW	1987	Possible		△
	Bumbugur	60 kW	1984	Impossible	Crankshaft damage	×
		60 kW	1985	Possible		
		60 kW	1988	Impossible	Use as for the part exchange	

Table 2.1 Inventory of Existing System (2/2)

Aimag	Sum	Existing Diesel Generator				
		Capacity	Production Year	Operating Condition	Reason of Impossible	Tool
Dornogovi	Mandakh	60kW	1985	Possible		△
		60kW	1985	Impossible	Crankshaft damage	
	Saihandulaan	60KW	1985	Possible		△
		60KW	1984	Possible		
Sukhbaatar	Dariganga	60KW	1979	Possible		△
		100KW	1989	Impossible	Use as for the part exchange	
	Tumentsogt	200KW	1976	Possible	High fuel efficiency	△
		200KW	1975	Impossible	Crankshaft damage	
		60KW	1995	Possible		
		315KW	1983	Possible		
		315KW	1983	Possible		
		315KW	1983	Impossible	Oil supply system and lubrication oil system trouble	
	Ongon	60KW	1986	Possible		×
		60KW	1985	Possible		
	Bayandelger	100 kW	1979	Possible		×
		100 kW	1971	Impossible	Oil pump damage	
		60 kW	1979	Possible		
Umnugovi	Noyon	100 kW	1975	Impossible	Crankshaft damage	△
		60 kW	1984	Possible		
		60 kW	1984	Impossible	Use as for the part exchange	
	Gurvantes	100 kW	1988	Impossible	High fuel efficiency	△
		60 kW	1988	Possible		
		30 kW	1983	Possible		

(5) Power Demand Forecast of Sum Center

The power demand of each sum was forecasted in 5 years using collected data of each category as shown in Table 2.2. The forecast was made considering the true power demand taking into account the existing load and assumed operating hours. The maximum power demand is estimated from a daily load pattern after 5 years being made by the power demand forecast.

(a) Basic Data for Power Demand Forecast

Power demand is generally analyzed on at least three categories of consumers for general demand (household), industrial demand and third industry demand. It is evident that the more abundant detailed data is available, the more accurate demand forecast is possible.

From the category-wise power demand data obtained in the site investigation, the demand is classified into the following three groups:

(i) General demand

(ii) Public demand

(iii) Civilian demand

In calculating the maximum power demand, the conception of "peak of general demand does not coincide with peak of public and civil demand" is adopted and the maximum power demand after 5 years is obtained by the daily load pattern after 5 years.

(b) Demand Forecast

(i) General demand

The general demand occupies about 70% of the total demand. A specific feature of the seasonal pattern of power consumption is that the power consumption is considerably larger and longer in winter than that in summer. Therefore, the demand forecast is performed only for the winter demand.

As for the winter demand, individual room heating and lighting are assumed to be sustained for almost 24 hours. The peak demand appears in the period of 18: 00 to 23: 00, and the demand in the other time is estimated to be about 10 to 50 % of the peak demand.

The general demand is assumed to increase at a growth rate of 1.7% per annum corresponding to the national population growth rate. The 8.8% increased demand after 5 years is taken as 100% and the hourly demand is distributed as given below:

1~7 hr	8~9 hr	10~11 hr	12~13 hr	14~16 hr	17 hr	18~23 hr	24 hr
10 %	20 %	10 %	20 %	10 %	50 %	100 %	10 %

(ii) Public demand

The public demand is consumption in public offices, schools, hospitals, etc., which are operated mainly during the daytime. Especially, the maximum demand of school is assumed to appear in winter as the new yearly term is commenced in September. The daily power consuming time of public offices, schools, culture centers, etc. is assumed to be 8: 30 to 17: 00. The demand of hospitals and for room heating may continue 24 hours a day, and the whole day operation is assumed for these items. The operation of petrol stands is closed at 18: 00, and this is taken into account. At the present stage, there are no extention plans of public facilities in the objective Sum centers and there is no possibility of significant growth of public demand. Thus, the growth of public demand is not taken into account.

The hospital and room heating loads are assumed to be 24 hour loads, and other demands are distributed for the period of 8 to 23 o'clock as given below:

1~7 hr	8~9 hr	10~11 hr	12~13 hr	14~16 hr	17 hr	18~23 hr	24 hr
0 %	100 %	100 %	50 %	100 %	100 %	100 %	0 %

(iii) Civilian demand

Hotels, wool processing plants, etc. are included in this category, but most of them have stopped operation due to non-availability of electric power supply. These installations may restart their operation again if the power supply becomes available in near future. Therefore, these loads need to be taken into account. Their operations are mainly during the daytime.

This demand is distributed in the period of 8 to 23 o'clock in the same manner as the other demand of the public demand.

1~7 hr	8~9 hr	10~11 hr	12~13 hr	14~16 hr	17 hr	18~23 hr	24 hr
0 %	100 %	100 %	50 %	100 %	100 %	100 %	0 %

(iv) Overall demand of Sum center

The overall power demand of each Sum center is estimated as a sum of the above Paragraphs (i), (ii) and (iii) in hourly basis. As example, daily load pattern of Khangai Sum center is shown in Figure 2.3.

(c) Power Loss

There are two methods in estimating power loss in distribution lines; one is to calculate theoretically (I^2R) based on current, conductor size and distance, and the other is to obtain as the difference between generated energy and consumed energy. For the Sum centers under the Project, reliable data for consumed energy can not be obtained due to lack of proper energy meters. Therefore, the power loss is calculated by the above theoretical method.

As the power loss depends on a load current, the loss corresponding to the maximum power demand is considered for selection of the required generating output.

(d) Required generating output

Required generating output is obtained as a sum of the maximum power demand after 5 years and the corresponding power loss. Aim of this Project is to provide generating facility which has a larger capacity than the required generating output.

Maximum power demand (kW), power loss (kW) and required generating output (kW) of each Sum center are tabulated in Table 2.3.

Table 2.2 Power Demand Data of Each Category

(kW)

Aimag		Sum	General Demand	Public Demand												Civilian Demand		
				Total	Public Office	School	Kindergarten	Hospital	Veterinary Hospital	Communication	Heating	Cooperative Society	Filling Station	Culture Center	Bank	Library, Public Hall	Total	Factory	Others
ARKHANGAI	1	Khangai	34.4	22.6	0.5	8.6	0.5	7.0	0.0	0.0	0.0	0.0	0.0	4.0	1.0	1.0	26.3	8.5	17.8
	2	Tsakhir	22.4	34.0	1.2	10.2	0.0	5.4	0.0	1.2	0.0	0.0	0.4	15.6	0.0	0.0	60.0	40.0	20.0
	3	Chuluut	72.0	64.0	9.0	19.0	1.0	6.0	0.0	2.0	0.0	15.0	5.0	5.0	1.0	1.0	35.0	20.0	15.0
DUNDGOVI	4	Ulziit	104.3	42.5	2.0	5.5	2.5	5.0	1.0	3.0	0.0	15.0	2.5	3.0	0.5	2.5	30.0	25.0	5.0
	5	Undurshil	92.3	25.0	1.0	5.0	2.0	5.0	1.0	1.0	1.0	0.0	1.0	4.0	1.0	3.0	26.5	10.0	16.5
	6	Bayanjargalan	108.0	22.9	2.0	6.5	1.0	4.0	2.0	1.0	0.0	0.0	0.9	4.5	0.5	0.5	26.9	21.5	5.4
KHENTII	7	Galshar	96.1	94.8	3.2	4.5	0.4	3.9	0.3	2.8	72.6	0.0	4.4	2.4	0.3	0.0	13.9	13.9	0.0
	8	Bayan Ovoo	85.0	47.0	1.0	8.0	1.0	6.0	1.0	4.5	17.0	3.0	3.0	2.0	0.5	0.0	4.0	4.0	0.0
UVURKHANGAI	9	Baruunbayan-Ulaan	80.0	50.5	15.0	8.0	5.0	15.0	0.0	1.5	0.0	0.0	1.0	4.0	1.0	0.0	25.0	20.0	5.0
	10	Nariinteel	81.0	101.0	2.0	12.0	8.0	17.0	2.0	9.0	20.0	8.0	15.0	5.0	1.0	2.0	60.0	30.0	30.0
	11	Guchin-Us	105.0	25.6	2.1	5.0	5.0	4.0	1.0	1.0	0.0	0.0	0.0	3.5	1.0	3.0	23.0	15.0	8.0
	12	Bayan-Undur	107.4	64.3	2.0	17.4	4.5	20.4	0.0	4.7	8.4	0.0	0.2	6.7	0.0	0.0	30.0	4.9	25.1
	13	Hairhandulaan	106.0	47.0	10.0	15.0	1.0	8.0	0.0	1.0	0.0	1.0	0.0	10.0	1.0	0.0	20.0	15.0	5.0
BAYANKHONGOR	14	Bayangovi	85.0	62.0	6.0	20.0	10.0	15.0	0.0	3.0	0.0	0.0	1.0	6.0	1.0	0.0	15.0	15.0	0.0
	15	Bogd	76.5	42.0	2.5	8.0	5.0	8.0	1.5	1.0	0.0	5.0	2.0	5.0	1.0	3.0	33.0	33.0	0.0
	16	Jinst	60.0	29.0	5.0	7.0	4.0	5.0	0.0	2.0	0.0	0.0	0.0	5.0	1.0	0.0	23.0	20.0	3.0
	17	Bumbugur	90.0	44.8	3.6	15.0	5.0	3.0	0.0	1.0	0.0	10.0	1.2	3.5	0.5	2.0	20.0	18.0	2.0
DORNOGOVI	18	Mandakh	70.0	36.0	5.0	6.5	3.0	6.0	1.0	5.0	0.0	0.0	3.0	2.5	1.0	3.0	44.0	34.0	10.0
	19	Saihandulaan	170.0	50.7	2.0	6.2	3.0	10.0	0.0	1.5	15.0	10.0	1.0	1.0	0.2	0.8	32.0	20.0	12.0
SUKHBAATAR	20	Dariganga	125.0	76.5	1.5	25.0	6.0	30.0	2.0	5.5	0.0	0.0	2.5	3.0	0.5	0.5	11.0	5.0	6.0
	21	Ongon	70.0	94.4	6.0	24.0	0.0	2.0	0.0	2.0	60.4	0.0	0.0	0.0	0.0	0.0	40.0	40.0	0.0
	22	Bayandelger	120.0	174.0	15.0	75.0	20.0	25.0	3.0	15.0	0.0	10.0	5.0	2.0	1.0	3.0	24.0	17.0	7.0
	23	Tumentsogt	140.0	50.9	1.3	2.0	0.0	3.0	0.0	0.2	4.0	0.0	4.0	0.7	0.0	0.0	75.0	75.0	0.0
UMNUGOVI	24	Noyon	110.0	35.5	2.5	3.5	4.0	3.0	1.0	1.0	0.0	10.0	2.0	4.5	1.0	3.0	20.0	15.0	5.0
	25	Gurvantes	100.0	46.0	2.0	3.0	2.0	4.0	2.0	2.0	20.0	0.0	0.0	5.0	2.0	4.0	30.0	22.0	8.0

Table 2.3 Maximum Demand, Power Loss and Required Generation

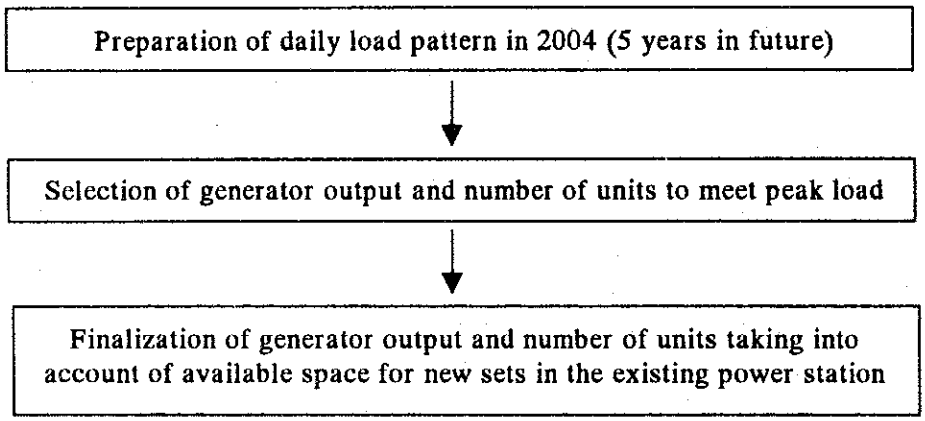
Aimag		Sum	No. of Circuit (cct)	Type of Conductor	Max. Estimated Demand (1) (kW)	Power Loss (2) (kW)	Required Generation (1) + (2) (kW)
ARKHANGAI	1	Khangai	6	ACSR	67.6	1.9	69.5
	2	Tsakhir	5	ACSR	106.2	5.5	111.7
	3	Chuluut	3	ACSR	138.2	15.4	153.6
DUNDGOVI	4	Ulziit	4	ACSR	132.2	10.6	142.8
	5	Undurshil	3	ACSR	115.5	33.0	148.5
	6	Bayanjargalan	5	ACSR	130.7	7.8	138.5
KHENTII	7	Galshar	3	ACSR	187.6	9.5	197.1
	8	Bayan Ovoo	2	ACSR	121.1	17.8	138.9
UVURKHANGAI	9	Baruunbayan-Ulaan	2	ACSR	119.0	17.2	136.2
	10	Nariinteel	3	ACSR	205.1	34.7	239.8
	11	Guchin-Us	5	ACSR	127.2	7.6	134.8
	12	Bayan-Undur	3	ACSR	158.8	20.4	179.2
	13	Hairhandulaan	3	ACSR	135.1	8.1	143.2
BAYANKHONGOR	14	Bayangovi	3	ACSR	123.2	12.3	135.5
	15	Bogd	4	ACSR	116.1	25.0	141.1
	16	Jinst	3	ACSR	84.6	17.7	102.4
	17	Bumbugur	3	ACSR	113.8	32.0	145.8
DORNOGOVI	18	Mandakh	4	ACSR	118.1	8.5	126.6
	19	Saihandulaan	3	ACSR	221.5	39.7	261.2
SUKHBAATAR	20	Dariganga	3	ACSR	175.5	5.0	180.5
	21	Ongon	3	ACSR	172.5	24.1	196.6
	22	Bayandelger	2	ACSR	229.3	63.8	293.1
	23	Tumentsogt	9	ACSR	211.9	36.3	248.2
UMNUGOVI	24	Noyon	6	ACSR	133.2	21.9	155.1
	25	Gurvantes	3	ACSR	143.2	8.6	151.8

(6) Optimum Generating Output and Number of Units at Sum Center

In selecting unit generator output and number of units for each Sum center, the criterion that the generation can follow the daily load pattern after 5 years in a most economical manner was considered.

Unit generator output of 60kW and 100kW, which is using in the existing diesel engine generators as well as in the First and Second Phase Project, is adopted and the same capacity in a Sum center is selected to minimize the initial investment cost and be easy for operation and maintenance since a load distributor is required in case of parallel operation of different capacities.

The procedure for selection of generator output and number of units is shown below:



The output of diesel engine generators and number of units were decided in the most economical way as the result of the above procedure, which satisfy the peak demand (kW) of each Sum center. Daily load pattern including the operating generator out put for every Sum Center is shown in Figure 2.4. The selected generator output and quantity of units for each Sum center are presented in Table 2.5, and summarized in Table 2.4.

Table 2.4 Selected Generator Unit Capacity and Number of Units

1)	Number of Sum centers	25 Sum centers in 8 Aimags
2)	60 kW diesel engine generator	55 sets
3)	100 kW diesel engine generator	15 sets
4)	Total number	70 sets
5)	Total capacity	4,800 kW

Table 2.5 Selected Generator Capacity and Quantity of Units

No.	Aimag	Sum	100 kW	60 kW	Total Generator Capacity (kW)
1	ARKHANGAI	Khangai	-	2	120
2		Tsakhir	-	2	120
3		Chuluut	-	3	180
4	DUNDGOVI	Ulziit	2	-	200
5		Undurshil	-	3	180
6		Bayanjargalan	-	3	180
7	KHENTII	Galshar	2	-	200
8		Bayan Ovoo	-	3	180
9	UVURKHANGAI	Baruunbayan-Ulaan	-	3	180
10		Nariinteel	-	4	240
11		Guchin-Us	-	3	180
12		Bayan-Undur	-	3	180
13		Hairhandulaan	-	3	180
14	BAYANHONGOR	Bayangovi	-	3	180
15		Bogd	-	3	180
16		Jinst	-	2	120
17		Bumbugur	-	3	180
18	DORNOGOVI	Mandakh	-	3	180
19		Sayhandulaan	3	-	300
20	SUKHBAATAR	Dariganga	-	3	180
21		Ongon	2	-	200
22		Bayandelger	3	-	300
23		Tumentsogt	3	-	300
24	UMNUGOVI	Noyon	-	3	180
25		Gurvantes	-	3	180
	TOTAL		15	55	4,800

(7) Transportation to the Site

Almost of the roads in Mongolia have not yet been paved except in Ulaanbaatar city and main routes from the capital. Those roads are in a bad condition due to insufficient maintenance. Under such situation, it is very difficult to transport the facilities to be supplied by the Project to the objective 25 Sum centers since a width of the roads from Aimag center to the Sum centers become narrower and a large truck may not go on the road.

The local transportation companies are inexperienced in handling many large materials, and the large trucks owned by the companies are limited. The transportation companies shall arrange by rental of trailers and large trucks from the former Soviet Union from private owners.

Therefore, the preparations for the plan of transportation shall be made thorough going putting emphasis on the inland transportation.

(8) Implementation Schedule

The weather condition in Mongolia is required to be paid attention for preparing the implementation schedule of the Project. It is easily understood that installation works can not be done during a winter season under the temperature below -30 or –40 °C. The installation of the new generating facilities must be completed before the winter season so that the electric power can be supplied to the central heating facilities. Therefore the implementation schedule is prepared taking into account the installation period between August and October following the setting of concrete foundations.

The installation works is scheduled to be carried out by 4 parties to the objective 25 Sum centers so that the Project can be completed within the limited period.

(9) Outline of the Plan

Based on the result of the above analysis, the project outline to the 25 Sum centers are given below:

(a) Purchase of diesel engine generating facilities

(b) Fabrication of concrete foundations for the equipment

(c) Execution of installation works

(d) Commissioning tests prior to taking over

(e) Technical guidance for operation and maintenance during the equipment installation

(f) Provision of stove for starting of diesel engine

(g) Supply of maintenance tools and a vehicle for the mobile maintenance team established in 3 Aimag centers

(h) Execution of Soft Component

The mobile maintenance teams are arranged in 3 Aimag centers taking into consideration of the maintenance teams to be established in 6 Aimags under the Second Phase Project with due discussion with MOID.

In order to establish a proper operation and maintenance for the diesel engine generators to be provided under the Project, a soft component will also be executed aiming at promotion of capability for the management of power supply business as well as the operation and maintenance of the facilities

2 - 3 Basic Design

2 - 3 - 1 Design Concept

(1) Meteorological Conditions

(a) Temperature and Humidity

Ambient temperature varies site by site. The relative humidity is generally low and it has no significant variation among the locations. In design of the Project, the criteria in the Second Phase Project will be applied basically, but for the lowest temperature in the winter season, the result of site investigation will be applied:

Minimum ambient temperature	:	–43 °C
Maximum ambient temperature	:	+44 °C
Maximum relative humidity	:	70 %

(b) Wind Velocity and Sandstorms

The maximum wind velocity in the ranges of 20 to 30 m/sec has been recorded. Especially, in the Gobi desert area in the south to southeast of the country, the wind is generally strong throughout a year except for the seasonal transition period of June to July. Therefore, the sandstorm protection measures are required in the equipment design in these areas. In the Project, the maximum design wind speed is taken at 30 m/sec.

(c) Rainfall and Snowfall

According to the past snowfall record of each sum, the maximum snowfall is between 20 to 30 cm. In the Project, the equipment is of indoor use and will not be much affected by rainfall and snowfall.

(d) Lightning

A lot of thunderstorms has been recorded in the mountainous areas in the west. Especially, during from spring to summer there are a lot of lightning hits and many records of damages to the electric facilities are reported especially damage of AVR. Such damages seem to be caused by a lightning surge through distribution lines. To avoid this kind of damages, a provision of proper equipment or facilities, such as installation of the insulation transformer between the generator circuit and the distribution line and of the lightning arresters on the incoming line pole, etc. are designed.

(2) Geographical Conditions and Water Quality

The output of diesel engine goes down with increase in altitude due to lower atmostic air pressure. Therefore, to obtain the required output, the engine output is required to select with one class higher output. In this Project, a diesel engine with turbo-charger which has a higher output is adopted and also the output is corrected by altitude.

Mechanical damages and burning of bearings were observed in many Sum centers. This seems to be caused by insufficient lubricating effects as lubricating oil does not circulate properly on the friction surfaces due to extremely low temperature in winter. There were examples of radiators having resulted to puncture due to frosting. Air heating is required for restarting diesel engine in winter, and simple facilities specific to power station use need to be provided.

2 - 3 - 2 Design Criteria

(1) Applied Standards

For design of equipment and materials, standards of Japanese Industrial Standard (JIS), Japanese Electro-technical Committee (JEC), Japanese Electric Manufacturers Association (JEM), International Electro-technical Commission (IEC), Japanese Cable Standard (JCS) and other international organizations will be applied.

(2) Generating Equipment

The under-mentioned criteria and standards are applied in design, manufacturing, factory tests, commissioning tests, etc. of diesel engine generators and auxiliary facilities to be provided to the objective Sum centers.

(a) Specifications of equipment

Basic specifications of equipment are as follows:

Table 2.6 Equipment Specifications

Electric System	:	3-phase, 4-wire
Frequency	:	50 Hz
Rated voltage	:	400 - 230 V
Maximum voltage	:	440 - 254 V

(b) Used languages and measuring units

The English language will be used for drawings, documents, data, etc., and the SI unit will be applied basically to measuring unit indications. However, instruction manuals and others will be translated into the Mongolian language so that operators in Sum centers can easily understand the contents. For indicated units, the metric system will be shown together for portions difficult to understand. Nameplates will be prepared in both the English and Mongolian languages.

(c) Kind of fuel

Burning fuel will be Russian light fuel, No. 305-73 of the GOST standard (corresponding to No. 2 of K2204 of JIS Standard).

(d) Unit output of generating equipment

Generators with two kinds of unit outputs, 100 kW and 60 kW, will be provided to each sum.

(e) Variation of revolution speed and generator frequency

Within ± 4% (under static operation)

(f) Variation of generator voltage

Within ± 5%

(3) Installation Works

The installation works will be carried out in accordance with the Technical Standards for Electrical Facilities promulgated as the regulation of the Ministry of International Trade and Industry of Japan. Specifications, standard practices of manufacturers, etc. will be applied for inspection and tests at site. After the installation is completed, the commercial operation test will be carried out to confirm generator characteristics with real load connected to distribution lines for five hours, and equipment will be adjusted finally if required.

2 - 3 - 3 Basic Design

The basic design of the Project is explained below.

(1) Utilization of Existing Facilities

At the objective Sum centers, some diesel engine generators constructed by the former Soviet aid are still under operation. Therefore, these power houses, distribution lines, etc. can be

used for the Project. However, the houses is required to repair damaged parts such as door, window, etc.

The design under the Project is based on the assumption that the new generating facilities are to be installed after removal of all unusable items in the existing power houses. If a Sum center has an intention to utilize the existing equipment as far as possible, it is recommended to use separately the removed generators for the heating facility with own arrangement because the parallel operation with the new equipment is not considered in the Project.

The existing power houses can be used in the foreseeable future after rehabilitation, such as replacement of doors, windows, furniture, fittings, etc., painting of inner and outside surfaces, roof repairing, etc.

(2) Composition and Layout of Generating Facilities

(a) Bus arrangement

In the existing power stations, diesel generators are operated under single unit operation, and the single bus system is adopted for power takeout in case that there is more than one generator and distribution outlet. In the Project, the bus circuit is necessary to operate generators in parallel and to send out to distribution circuits. For the Project, the single bus arrangement, which is simple and easy in operation and applied in the existing system, is adopted.

(b) Connection method and electric system

The low tension synchronizing system is adopted to all the existing system, and the same system is also adopted in the Project. The electric system is the 3-Phase, 4-wire system, same as the existing system. Figures 2.5 - 1 through 2.5 – 5 show single line diagrams of the existing power stations in Sum centers.

(c) Grounding system

In the existing facilities, the generator neutral is directly grounded at the selected one point, while the nongrounded system is applied to the distribution system. The same system as the existing one is applied to the Project.

(d) Composition of station service circuits

In the existing power station, the station service power is taken directly from the power outgoing circuit. The station service power covers a wide range, such as building

lighting, convenience outlets and others. In the Project, the station service circuit will be provided and used as the auxiliary source.

(e) Equipment arrangement

As new equipment are to be installed in the existing houses, the arrangement of diesel generators, control panels, etc. shall be designed taking into account convenience in operation and space for maintenance. Especially, at overhauling, all the engines have to be disassembled and the space for disassembled parts and working spaces for technicians are required. As diesel generators and control panels are to be connected with wirings and pipings together with auxiliary facilities, a functional arrangement must be designed taking into account safety, economy and convenience in maintenance. The present layout in existing power houses and arrangement plan of new equipment of each sum is shown in Figures 2.6 - 1 through 2.6 – 25.

In basic design of the Project, specifications of generating facilities will be determined taking into account the interchangeability with those of the grassroots grant and the First Phase Project. Further, the design shall be conducted with emphasis on economy of operation cost. Auxiliaries and associated facilities must be designed with specifications for very cold area from very severe meteorological conditions in Mongolia. The technical particulars of the designed generating facilities are mentioned below.

Diesel Engines

			100 kW Unit	60 kW Unit
(a)	Type	:	4-cycle, water-cooled, direct fuel injection system with turbocharger	
(b)	Unit capacity	:	Over 100 kW	Over 60 kW
(c)	Number of units	:	15 sets	55 sets
(d)	Engine output	:	Over 150 PS	Over 95 PS
(e)	Revolution speed	:	1500 rpm	
(f)	Overload rating	:	110% (30 min.)	
(g)	Fuel supply system	:	Automatic fuel feeding system	
(h)	Lubricant supply system	:	Gear pump (forced lubrication)	
(i)	Cooling system	:	Radiator system (with motor-operated dumber)	
(j)	Starting system	:	Starter motor system	
(k)	Suction system	:	Oil bath or air filter system	
(l)	Exhausting system	:	Silencer system	
(m)	Kind of fuel	:	Diesel oil (ASTM No. 2)	
(n)	Governor system	:	Mechanical all speed governor	
(o)	Preheating system	:	Glow plug system	

Generators

			100 kW Unit	60 kW Unit
(a)	Type	:	Horizontal axis, revolving field, air cooled, compound 3-phase synchronous AC generator	
(b)	Electric system	:	3-phase, 4-wire system	
(c)	Unit capacity	:	125 kVA	75 kVA
(d)	Number of units	:	15 sets	55 sets
(e)	Generator voltage	:	AC 400 - 230 V	
(f)	Frequency	:	50 Hz	
(g)	Number of poles	:	4 poles	
(h)	Power factor	:	0.8	
(i)	Exciting system	:	Brushless system	
(j)	Excitor cooling system	:	Self ventilation, air-cooled system	

Auxiliary Equipment and Accessories

(a)	Protection and control board					
	i)	Installation place	:	Indoor, generator room		
	ii)	Control system	:	Manual, one man control system		
	iii)	Protection system	:	Automatic breaking, indication, alarm		
(b)	DC supply facilities					
	i)	Kind of battery	:	Lead battery/for very cold weather		
	ii)	Battery capacity	:	manufacturer standard		
	iii)	Battery voltage	:	24 V (12Vx2)		
	iv)	Rectifier output voltage	:	24 V		
	v)	Rectifier rated current	:	manufacturer standard		
	vi)	Installing place	:	Indoor, generator room		
	vii)	Preheating system	:	Air heating and space heater		
(d)	Low tension distribution board					
	i)	Capacity of insulation trans.		150kVA	250kVA	300kVA 400kVA
	ii)	Board type	:	Indoor, self supporting type		
	iii)	Board ratings	:	600 V, 600 A, 12.5 kA		
	iv)	Bus capacity	:	600 A		
	v)	Installation place	:	Indoor, generator room		
	vi)	Main circuit breaker	:	air circuit breaker		
	vii)	Main circuit breaker rating	:	600V	600V	600V 600V
	viii)	Distribution circuit breaker type	:	Air fuseless type		
	ix)	Distribution circuit breaker ratings	:	600 V, 225 A, 6.3 kA		
	x)	Instrument PT ratings	:	400/110 V, 100 VA		

	xi)	Instrument CT ratings	:	300/5 A, 25 VA
(e)	Insulation transformers			
	i)	Type	:	Oil-filled type
	ii)	Rated capacity	:	150 kVA 250 kVA 300 kVA 400 kVA
	iii)	Rated voltage	:	Input 400 - 230 V / Output 400 - 230 V
	iv)	Connection vector	:	Dyn 11
	v)	Cooling system	:	Oil-filled, self-cooled

(3) Operating Methods

For operation system, the manual system which is the same as those of the grassroots grant and the First and the Second Phase Project is adopted. The manual system has merits in view of compactness in construction, easiness in operation and maintenance. The protection system performs automatic breaking, indication and alarm with the help of static relays, and the manual system is employed for resetting. Technical particulars are mentioned blow:

(a) Basic system	:	Manual, one-man operation and control system
(b) Starting system	:	Cell motor starting system
(c) Stopping system	:	Manual stop system
(d) Protection system	:	Automatic breaking, indication and alarm system with associated relays
(e) Recovery system	:	Manual recovery system
(f) Operation system	:	Manual governor operation, and automatic load allotting operation system

(4) Parallel Operation Methods

During the peak load time, all the provided generators need to be operated, and machines are to be operated in parallel. Three methods are available for parallel operation under synchronism, i.e. manual system, automatic system and manual - automatic changeover system. Among these, the manual system is selected for the Project in view of easiness in maintenance. During parallel operation under synchronism, generators are operated with control of governors. Technical particulars of this system are mentioned below:

(a) Synchronizing equipment	:	Manual system with synchro lamp
(b) Load distribution	:	Manual with load limiter

(c) Installation place : Indoor

(d) Number of units controlled : 2 to 4 units

(5) Spare Parts

Spare parts are essential to maintenance of the generating equipment. The spare parts are classified into three categories, namely, A: Consumable parts, B: Parts to be replaced after predicted operating hours and C: Parts to be replaced at trouble. The A: Consumable parts for 3 years and the B are to be supplied together with each generating unit as standard spare parts, and the C is to be supplied in each Sum center.

(6) Maintenance Tools and Meters

Normal operation and maintenance can be performed with the help of standard tools and meters. The standard tools are to be supplied with one set each for each unit. Special tools and meters necessary at emergency are also required for maintenance, and one set of them is to be supplied to each Sum center.

(7) Factory Inspections and Tests

Factory inspection and tests are to be carried out before shipment of equipment and materials, whether the manufactured equipment and materials satisfy specifications and performance figures or not is to be confirmed. All generators are to be tested before shipment, and their shipment will be approved after passing the inspection and tests. The inspection and tests of two sets each of 100 kW and 60 kW units will be attended by inspectors of the Client/Consultant. Objectives of attendance inspection and tests are as given below:

(a) Diesel engine

(b) Generator

(c) Auxiliary equipment and accessories

(d) Insulation transformer

(e) Protection and control equipment

(f) Low tension distribution board

(g) Distribution materials

(h) Installation materials

(i) DC source equipment

(j) Spare parts

(8) Installation Materials

The installation materials are to include all materials necessary for executing installation works. Major materials necessary for installation works are classified as follows:

(a) Power cables and terminal processing materials

(b) Control cables and terminal processing materials

(c) Conduit pipes and fittings

(d) Grounding materials (insulated conductors, grounding rods, connecting clamps, etc.)

(e) Pedestals, hangers, supports, etc.

(9) Materials for Connecting with Distribution Lines

The generated energy is to be delivered to consumers in Sum centers through the existing distribution lines. The existing power cables have already been deteriorated and their cable sizes do not satisfy the required capacity, therefore new cables will be supplied and installed as required. Length of new cables will be determined considering connection between the low tension distribution board and the existing first pole, and connecting clamps, power cable protecting pipes, cable fittings and bands, etc. will be included in the scope of supply. Thunders are frequent and there have been a lot of damages to generator windings. Therefore, lightning arresters will be provided at the connecting points of power cables and overhead distribution lines to avoid ingress of lightning surges. Necessary connecting materials and their technical particulars are given below:

(a) Power cables

i)	Type	:	Crosslinked PE insulated, PVC sheathed cupper conductor cable
ii)	Rated voltage	:	600 V
iii)	No. of cores and size	:	4-core x 100 mm^2

(b) Connecting clamps

i)	Type	:	PG clamp
ii)	Material	:	Aluminum alloy (bi-metallic)
iii)	Connecting sizes	:	16 to 50 mm^2 - 100 mm^2

(c) Protecting pipes for power cables

i)	Materials	:	Tin galvanized steel pipes with protecting caps at the end
ii)	Size	:	Diameter 100 mm

(d) Cable supporters and bands

i)	Type	:	Adjustable bands for circular wooden pole
ii)	Materials	:	Stainless steel
iii)	Fixing fitting	:	Bolt type
vi)	Size	:	Diameter 200 to 300 mm

(e) Lightning arresters

i)	Type	:	Outdoor, zinc oxide type
ii)	Rated voltage	:	450 V
iii)	Discharging current	:	1,500 A

(10) Materials for Connecting with Existing Generators

As mentioned in Paragraph (4) of Sub-clause 2-2, rehabilitation of the existing generating facilities will not be conducted under the Project and the parallel operation with the existing generators is also not considered. Therefore, any connecting materials are not required.

(11) Heating Facilities

In the project areas, the minimum temperature goes down to below - 40 °C in winter season. Even in plain and desert areas, the minimum winter temperature goes down to below - 30 °C. When generators are not operated, the room temperature goes down to a similar level. In such a case, the following problems arise:

(a) If the temperature of a day tank goes down exceeding a certain limit, fuel becomes sherbet form and fuel feeding becomes not possible.

(b) If the temperature of battery electrolyte goes down below - 15 °C, the solution freezes and the battery function can not be maintained.

(c) Though antifreezing solution is mixed in radiator, the solution freezes if ambient temperature goes down below - 30 °C. Then, radiator cooling fins are damaged due to increase of volume.

(d) Under very low temperature, the lubricating oil loses its viscosity and becomes solidified. Then the lubricant can not circulate the bearing and this causes burning of the bearing if a machine is started under such a condition.

Under such a situation, only countermeasure to the very low temperature is to raise the room temperature to make the machine to normal status before machine starting. Various methods are conceived for room heating, but use of simplified stoves, which are simple in construction and easy in maintenance, will be most economical and appropriate. The simplified stoves are available in Mongolian market and can be operated with dried cow and horse dung. Fuel can

be obtained easily and is economical, and is effective in coordination with environment. The outline view of stove is shown in Figure 2.7 and its technical specifications are mentioned below:

(a) Type : Stationery simplified stove

(b) Kind of fuel : Dried cow and horse dung, firewood or coal

(c) Size and weight : Over 50 cm in height, over 69 cm in width and over 76 cm in depth

(d) Possible heating capacity : 17,200 to 21,500 kcal/hr.

(12) Generator Foundations

The generator foundation is an important structure for stable operation of a diesel generator which involves rotational movement. Generally, the weight of generator foundation requires over 2 to 3 times against the generator weight to avoid resonance among generators and maintain operation stability. The diesel generators are fixed to the foundations with anchor bolts, and anti-vibration materials and leveling liners are inserted between generator beds and foundations.

There are two methods for construction of generator foundations. One is the method to place concrete at site, and the other is the method to manufacture pre-fabricated concrete panels at factory and install at site. In the Project, the latter method will be adopted. By manufacturing pre-fabricated panels at manufacturing plants in Ulaanbaatar, a better quality control and lower cost can be attained and in addition fabrication period can be shortened. Detailed construction of pre-fabricated foundation is shown in Figure 2.8, and its particulars are mentioned below:

(a) Type : Pre-fabricated reinforced concrete panel

(b) Size : 2.8 m in height, 1.8 m in width and 0.3 m in thickness

(c) Strength : 210 kg/cm^2

(13) Maintenance and Repairing Tools

During the site investigation, MOID requested to supply the maintenance and repairing tools for the mobile maintenance team which is being planned to arrange in Aimag centers. The operation and maintenance of the power station in Aimag center is taken charge by Energy Authority under control of the MOID. The establishment of organization for maintenance,

inspection and adjustment of the equipment at Sum centers by some engineers elected from the power station in Aimag center make it possible to maintain without trouble. The power station has enough engineers for the establishment of new organization. In the opinion of MOID for the expense, the expense for repairing will be collected by each sum as in the past, and the shortage will be appropriated subsidies. However, it is necessary to supply the tools to the power station because of no maintenance and repairing tools and no vehicles for traveling, and to instruct method of maintenance and repairing for the generator made in Japan in this Project to the engineers.

This Project covers over 8 Aimags, but over 16 Aimags in which a grass-roots assistance and the First and Second Phase Project are included. The number of the generators supplied from Japan by a grass-roots assistance, the First Phase Project, the Second Phase Project and planed by this Project are shown in Table 2.7. It is judged that the supply to 3 Aimags is reasonable, in consideration of good use of the tools. Selected Aimags, covered Aimags and number of Sum centers by the mobile maintenance team established in each Aimag are shown in Table 2.8.

The tools supplied to each mobile maintenance team under this Project are shown as below. The details are shown in Table 2.9.

(a) Truck type vehicle with 4WD : 1 set

(b) Measuring instruments and meters : 1 lot

(c) Tools for overhaul and standard tool : 1 lot

Table 2.7 Number of Installed Generators of Each Project(1／4)

Aimag	Sumber	Glassroots Grant		First Stage		Second Stage		Third Stage	
		100kW	60kW	100kW	60kW	100kW	60kW	100kW	60kW
1 UMNUGOVI	1 Bajandalai								
	2 Bajan-Ovoo								
	3 Bulgan								
	4 Gurvantes								
	5 Mandal-Ovoo			0	2			0	3
	6 Manlai	0	3						
	7 Noyon								
	8 Nomgon								
	9 Sevrei			0	2			0	3
	10 Khanbogd								
	11 Tsogt-Ovoo								
	12 Khlmrmen								
	13 Tsogttsetii								
	Sub-total	0	3	0	4	0	0	0	6
	Number of Sums	1		2		0		2	
2 GOBI-ALTAI	14 Erdene					3	0		
	15 Tsogt					3	0		
	16 Chandmani					3	0		
	17 Altai					0	3		
	18 Delger								
	19 Taishir								
	20 Bugat								
	21 Tseel					0	3		
	22 Tugrug								
	23 Sharga								
	24 Tonkhil					0	3		
	25 Dariv					0	3		
	26 Khaliun								
	27 Biger					0	2		
	28 Khukhmorit					0	3		
	29 Bajan-Uul								
	30 Jargalan								
	31 Guunlin								
	Sub-total	0	0	0	0	9	17	0	0
	Number of Sums	0		0		9		0	
3 BAYANKHONGOR	32 Shinejinst			0	2				
	33 Bajan-Under					3	0		
	34 Bajanlig			0	2				
	35 Bajangovi							0	3
	36 Bogd							0	3
	37 Jinst							0	2
	38 Baansagaan			0	3				
	39 Bajantsagaan					3	0		
	40 Khureemaral			0	3				
	41 Gurvanbulag								
	42 Jargalant			3	0				
	43 Galuut			0	3				
	44 Erdenesogt	1	2						
	45 Bajan-Ovoo								
	46 Bajan-Bulag			0	2				
	47 Buutsagaan					2	0		
	48 Bumbugur							0	3
	49 Ulziit								
	50 Zag								
	Sub-total	1	2	3	15	8	0	0	11
	Number of Sums	1		7		3		4	

Table 2.7 Number of Installed Generators of Each Project(2/4)

Aimag		Sumber	Glassroots Grant		First Stage		Second Stage		Third Stage	
			100kW	60kW	100kW	60kW	100kW	60kW	100kW	60kW
4 DORNOGOBI	51	Erdene								
	52	Delgerekh								
	53	Zamin-Und								
	54	Mandakh							0	3
	55	Saikhandulaan							0	3
	56	Khatanbulag					3	0		
	57	Khuvsgul					0	3		
		Sub-total	0	0	0	0	3	3	0	6
		Number of Sums	0		0		2		2	
5 SUKHABAATAR	58	Ongon							2	0
	59	Dariganga							0	3
	60	Naran					2	0		
	61	Bajandelger							3	0
	62	Erdenetsagaan					3	0		
	63	Sukhbaatar								
	64	Tumentsogt							3	0
	65	Tuvshinshiree								
	66	Uulbajan								
	67	Munhkhaan								
	68	Burentsgot								
		Sub-total	0	0	0	0	5	0	8	3
		Number of Sums	0		0		2		4	
6 DORNOD	69	Matad								
	70	Sumber								
	71	Khalkhol								
	72	Khulunbuir					0	2		
	73	Tsagaan-Ovoo					3	0		
	74	Chuluunkhoroot								
	75	Bajan-Uul								
	76	Bajandun								
		Sub-total	0	0	0	0	3	2	0	0
		Number of Sums	0		0		2		0	
7 KHENTII	77	Gurvanbajan								
	78	Bajan-Adraga			0	2				
	79	Binder			0	3				
	80	Batshireet			2	0				
	81	Norovlin			0	2				
	82	Burenkhaan								
	83	Dadal			3	0				
	84	Galsbar							2	0
	85	Bayan Ovoo							0	3
		Sub-total	0	0	5	7	0	0	2	3
		Number of Sums	0		5		0		2	
8 DUNDGOVI	86	Ulziit							2	0
	87	Undurshil							0	3
	88	Bayanjargalan							0	3
	89	Adaatsag								
	90	Erdenedalai								
		Sub-total	0	0	0	0	0	0	2	6
		Number of Sums	0		0		0		3	
9 UVURKHANGAI	91	Bogd					3	0		
	92	Baruunbayanulaan							0	3
	93	Guchin-Us							0	3
	94	Bajan-Undur							0	3
	95	Khairhandulaan							0	3
	96	Nariinteel							0	4
	97	Bajanteeg								
		Sub-total	0	0	0	0	3	0	0	16
		Number of Sums	0		0		1		5	

Table 2.7 Number of Installed Generators of Each Project(3/4)

Aimag	Sumber	Glassroots Grant		First Stage		Second Stage		Third Stage	
		100kW	60kW	100kW	60kW	100kW	60kW	100kW	60kW
10 KHUVSGUL	98 Jargalant			0	3				
	99 Galt			0	2				
	100 Shine-Ider			0	3				
	101 Tumurbulag								
	102 Burentogtokh								
	103 Tsetserleg								
	104 Arbulag			0	2				
	105 Bayanzurkh			0	2				
	106 Chandamani-Undur			0	2				
	107 Tsagaan-Uur					0	3		
	108 Tsagaan-Uul								
	109 Ulaan-Uur			0	2				
	110 Renchinlhumbe					2	0		
	111 Tunel								
	112 Tosontsengel								
	113 Alag-Erdene								
	114 Khatgal	1	2						
	115 Tsagaannuur					2	0		
	116 Erdenebulgan					2	0		
	Sub-total	1	2	0	16	6	3	0	0
	Number of Sums	1		7		4		0	
11 ARKHANGAI	118 Khangai							0	2
	119 Tariat								
	120 Tsahir							0	2
	121 Chulunt							0	3
	Sub-total	0	0	0	0	0	0	0	7
	Number of Sums	0		0		0		3	
12 ZAVKHAN	122 Shiluustei								
	123 Durvuljin					3	0		
	124 Jaruu								
	125 Erdenekhairkhan					3	0		
	126 Zavkhanmandal					3	0		
	127 Urgamal					2	0		
	128 Santmargats					0	3		
	129 Tsetseen-Uul					3	0		
	130 Ider					0	3		
	131 Ikh-Uul								
	132 Tes					3	0		
	133 Tsagaanchuluut								
	134 Tsagaankhairkhan								
	135 Telmen								
	136 Tudevtei								
	137 Songino					3	0		
	138 Otgon								
	139 Numrug					2	0		
	140 Asgat					0	3		
	141 Bayankhairkhan								
	142 Bulnai								
	Sub-total	0	0	0	0	22	9	0	0
	Number of Sums	0		0		11		0	
13 BULGAN	143 Teshig					3	0		
	Sub-total	0	0	0	0	3	0	0	0
	Number of Sums	0		0		1		0	

Table 2.7 Number of Installed Generators of Each Project(4/4)

Aimag	Sumber	Glassroots Grant		First Stage		Second Stage		Third Stage	
		100kW	60kW	100kW	60kW	100kW	60kW	100kW	60kW
14 UBS	145 Undurkhangai								
	146 Tsagaankhairkhan					0	3		
	147 Zuunkhangai					3	0		
	148 Khyargas					0	3		
	149 Baruuntruun								
	150 Malchin					0	3		
	151 Zuungobi					2	0		
	152 Bukhmurun								
	153 Zavkhan								
	154 Tes					2	0		
	Sub-total	0	0	0	0	7	9	0	0
	Number of Sums	0		0		6		0	
15 KHOVD	155 Miangad								
	156 Zereg			0	2				
	157 Darvi			2	0				
	158 Altai								
	159 Uiench								
	160 Bulgan					3	0		
	161 Tsetseg					0	3		
	162 Must			2	0				
	163 Munkkhkhairkhan					0	2		
	164 Mankhan								
	165 Chandmani			0	2				
	166 Khovd								
	167 Buyant								
	168 Durgun								
	Sub-total	0	0	4	4	3	5	0	0
	Number of Sums	0		4		3		0	
16 BAYAN-ULGII	164 Tolbo								
	165 Tsagaannuur								
	166 Bulgan	1	2						
	167 Deluun					2	0		
	168 Altai								
	169 Bujant								
	170 Bajannuur								
	171 Altantsugts								
	Sub-total	1	2	0	0	2	0	0	0
	Number of Sums	1		0		1		0	
	Total Number of Generators	3	9	12	46	74	48	12	58
	Total Number of Sums	4		25		45		25	

Table 2.8 Allocation of Maintenance Team

	Aimag of maintenance team	Aimags to be covered by maintenance team	No. of Sum				
			Glassroots	1st stage	2nd stage	3rd stage	Total
1	Govi-Altai	Govi-Altai	0	0	9	0	9
2	Bayankhongor	Bayankhongor	1	7	3	4	15
3	Khuvsgul	Khuvsgul	1	7	4	0	12
		Bulgan	0	0	1	0	1
4	Zavkhan	Zavkhan	0	0	11	0	11
5	Khentii	Khentii	0	5	0	2	7
		Dornod	0	0	2	0	2
6	Khovd	Khovd	0	4	3	0	7
		Ubs	0	0	6	0	6
		Bayan-Ulgii	1	0	1	0	2
7	***Sukhbaatar***	Sukhabaatar	0	0	2	4	6
		Dornogobi	0	0	2	2	4
8	***Uvurkhangai***	Uvurkhangai	0	0	1	5	6
		Arkhangai	0	0	0	3	3
9	***Dondgovi***	Dondgovi	0	0	0	3	3
		Umnugovi	1	2	0	2	5

Note: 1～6 Aimag which was established by Second Phase Project
7～9 Aimag which will be established by Third Phase Project

Table 2.9 List of Tools for Mobile Maintenance Team

No.	Description
(a) Mobile Maintenance Car	
1	Pick Up 4WD
(b) Meter for Adjustment, Test, Inspection and Troubleshooting	
1	Injection Nozzle Tester
2	Compression Gauge
3	Cylinder Gauge (50-150 mm)
4	Piston Filler Gauge (230 mm, 0.05-0.38 mm)
5	Outside Micrometer (100~125mm)
6	Dial Gauge (0-100 mm)
7	Thickness Gauge (Dial Type)
8	Digital Multilevel Meter (40MW/1000V)
9	Clamp Ammeter (420/1000 A, AC.DC ~600 V)
10	Megohmmeter (250/500/1000 V)
11	Face Meter
12	Pressure Meter (0~10 kg/cm^2)
13	Thermometer
14	Coolant Tester
15	Screw Pitch Gauge
16	Surface Gauge (300mm)
17	Fuel Leak Checker
18	Multi Tachometer
19	Blow-by Pressure Gauge
20	Radiator Cap Tester
21	Hydrometer
22	Sound Scope
(c) Tools for Overhaul, Assembly and Electrical Work	
1	Plyethylene Vessel
2	Drum Pump (Hand Revolution Type)
3	Oil Jug (2L)
4	Oiler (180 ml)
5	Lever Type Grease Gun (500 ml)
6	Tool Set for Maintenance of Engine
7	Pistpn Ring Compressor
8	Piston Ring Tool (Max. 135 mm)
9	Bearing Puller Set
10	Hydraulic Jack (Cap.4 ton)
11	Convex (5.5 m)
12	Files Set (5 files)
13	Frame of Bow Type Saw (250 mm)
14	Fashlight
15	Extra Cord (30 m)
16	Polyethylene Tank (20 L)
17	Wire Brush

No.	Description
18	Paint Brush
19	Torque Wrench (4-20 kgf.m)
20	Torque Wrench (10-50 kgf.m)
21	Vernier Micrometer (300 mm)
22	Magnetic Stand for Dial Gauge
23	V Block
24	Straightg Rule (1 m)
25	Test Pump (50kg/cm2)
26	Chainblock (3 Ton)
27	Wire (10 mm)-3m
28	Vise Plier (200 mm)
29	Tap for Use
30	Tap Dies (6, 8, 10, 12M)
31	Tap Dies (Handle Type)
32	Noga Debrurring Cutter
33	Electric Drill (13mm)
34	Drill (HSS 6.0mm~13mm 0.5mm)
35	Soldering Iron Set
36	Plier for Crimp Contact
37	Nipple
38	Cable Stripper
39	Cutter Knife
40	Piston Ring Tool (100-120mm)
41	Cylinder Liner Rimber
42	PT 1/8 Nipple
43	Soket Wrench Kit
44	Oil Filter Wrench
45	Rubber Hammer
46	Double-Face Sledge Hammer (8LB)
47	Jimmy Bar
48	Jimmy Bar
49	Straight Edge
50	Magnetic Base
51	Push Tool Kit
52	Polyester Sling (20W,1.5 M, 2 PCS)
53	Polyester Sling (25W 2.0 M)
54	Polyester Sling (40W 2.0 M)
55	Work Bench
56	Air Impact Wrench (1/2")
57	Needle Scaler
58	Screw Plate Set
59	Tool Tray 10pcs
60	Magnetic Finger
61	Tube Flaring & Cutting Tools
62	25 Ton Press Water Pump
63	Air Compressor (5.5kw)
64	Hose Band

No.	Description
65	Compressor Oil
66	Hose
67	Soket for Hose (9.0)
68	Soket for Hose (11.3)
69	Soket for Piping (3/8)
70	Plug for Hose (9.0)
71	Plug for Hose (11.3)
72	Plug for Piping (3/8)
73	1/2 Drive Impact Socket (10pcs)
74	Parts Washing Stand
75	Engine Cleaning Gun
76	Water Pump
77	Piston Heater
78	Valve Spring Tester
79	Connecting Rod Aligner
80	Air Valve Lopper
81	Valve Refacer
82	Sealant Repair Kit
83	Dust & Mist Respirator
84	Industrial Goggle
Consumption Articles	
1	Grease (No. 6) 1kg
2	Osmotic Agent (CR-5) 480ml
3	Color Check Agent (6／set)
4	Liquid Packing (200g)
5	Insulating Tape (20m) Black
6	Insulating Tape (20m) Red
7	Insulating Tape (20m) Yellow
8	Insulating Tape (20m) Green
9	Crimp Contact 3.2, 4.3, 5.3, 6.4, 8.4mm/set
10	Crimp Contact 14, 22, 30, 38
11	Sand Paper #100, 10枚/case
12	Saw Blade for Bow Type Saw
13	Waste 1 kg
14	Work Gloves
15	Gum Gloves
16	Oil Stone
17	Vise
18	Abrasive Cloth (80#)
19	Abrasive Cloth (180#)

CHAPTER 3

IMPLEMENTATION PLAN

CHAPTER 3 IMPLEMENTATION PLAN

3 - 1 Implementation Plan

3 - 1 - 1 Implementation Concept

The Mongolian side executing agency of the Project is MOID. However, actual operation and maintenance is to be performed independently by Sum centers which receive new facilities under the Project. Up to the present, MOID has not yet prepared detailed execution plan. While, each Sum center has not enough capability to carry out necessary works though they expressed desire to receive generating facilities under the Project. Therefore, cooperation of a Japanese consultant is required for planning, design and construction supervision for the Project execution under the Sum center level.

The Contractor side duties will be performed on the following items.

(a) Preparatory works for installation works

Removal of the existing generating facilities and repair of the building are to be completed by June 2000. Before commencing site installation works, the Contractor will carefully inspect the access for transport and whether the above works has been completed or not. Also, whether erection of prefabricated foundation concrete is possible or not will be inspected and reported to the Client and Consultant. In case that any preparatory works are not satisfactory, MOID will arrange to instruct the Sum center for proper execution of the preparatory works.

(b) Installation works

As the installation works will take long time if the equipment are installed under the normal procedures, the prefabrication practice will be applied as far as possible to minimize the working period. In addition to trying to shorten the installation period, care shall be taken so as not to cause faults or accidents by mis-wiring and mis-connection. During this period, the Contractor are required to train Sum center's operators for operation and maintenance of the supplied equipment.

(c) Site inspection, tests, trial operation and commissioning tests

It is not possible for the Consultant to attend all items of inspection and tests for all units. Hand over of the generating facilities to the Sum centers should be confirmed by the Consultant/Client with reviewing check lists to be entered in by representatives of both the Contractor and Sum centers. The trial operation is very important to confirm

the performance of equipment (fuel consumption, rated output, final adjustment of protection and control apparatus, etc.). Five hours continuous operation should be carried out and their data should be submitted to the Client and Consultant for acceptance.

The work items of the Consultant and the Contractor to be provided by the Japanese Government and duties of the Mongolian side are mentioned below.

(1) Works by Japanese Consultant

Home Works

(a) Detailed design of diesel engine generating facilities

(b) Preparation of bidding documents for purchase of equipment and materials and for site installation

(c) Bidding procedures and evaluation of bids

(d) Assistance to contract negotiation and conclusion of contract

(e) Approval of manufacturer's drawings and documents, or preparation of comments to them

(f) Attendance to factory inspection and tests prior to shipment

(g) Issue of inspection and test certificates

(h) Explanation and reporting to JICA

Site Works

(a) Preparation of supplemental installation work drawings for diesel engine generating facilities

(b) Review and adjustment of construction schedules for inland transport and site installation

(c) Construction supervision and schedule management for inland transport and site installation

(d) Safety management

(e) Transfer of technology

(f) Approval of execution plan for acceptance inspection and tests

(g) Attendance to acceptance inspection and tests

(h) Preparation of monthly reports for inland transport and site installation

(i) Issue of certificates for works performed and for payment

(j) Preparation of completion records for inland transport and site installation

(k) Performance confirmation one year after taking over

(l) Reporting to concerned parties

(m) Execution of soft component

(2) Works by Japanese Contractor

The Contractor shall carry out design, manufacturing, painting, factory inspection and tests, packing, transport to site, installation, and taking over after confirmation of operating status through site inspection and tests on completion. Acquisition of necessary permits related to inland transport and site installation, assistance to works under supply interruption, works executed in Sum centers, etc. will be performed by the Mongolian side based on the agreement with MOID.

3 - 1 - 2 Implementation Conditions

In executing installation works under the Project, care shall be taken to the followings:

(a) As the installation works involve heavy item handling of diesel generators, auxiliaries, etc., utmost attention shall be paid in carrying out loading and unloading, and simultaneous work execution at high and low elevations.

(b) During installation and assembling of diesel generators and control panels, installation, adjustment, tests, etc. need to be executed under partial shutdown of power supply. In such a case electrically live portion shall be indicated clearly.

(c) Power shutdown for connection with distribution lines, system interconnection, fixing of panel apparatus, etc. shall be shortened as far as possible. Special considerations shall be paid in preparation of working plans and public announcing.

3 - 1 - 3 Scope of Works

(1) Constitution of Generating Facilities

Composition of facilities covering diesel generators, which will be provided under the Project, to existing distribution facilities are mentioned below.

- Diesel engine generators (Low voltage generator)
  ↓
- Power cables (3-phase, 3-wire cables)
  ↓

- Low tension distribution board (Indoor, low voltage, enclosed panel)
  ↓
- Power cables (3-phase, 4-wire cables for outgoing circuits)
  ↓
- Existing distribution lines (First pole of distribution lines)

(2) Scope of Works

To utilize generated energy effectively, the generator circuits need to be connected to the existing distribution lines for delivery of power to consumers. Therefore, the scope of works for supply of equipment and materials and installation works are mentioned below.

(a) diesel engine generator is equipped with fuel tank and so connection to is not considered.

(b) Power cables and terminal processing materials for connection between low tension panel and the existing distribution lines (first pole of line) or the step-up transformers in case that distributions are made by high tension lines, and their installation and connecting works.

(c) Provision of low tension lightning arresters, and their installation on the first line poles with grounding connections.

3 - 1 - 4 Consultant Supervision

MOID is not considering to organize a special project team for execution of the Project same as the cases of the grassroots grant, the First Phase Project, and the Second Phase Project, and is planning to carry out necessary works only by informing execution policies to concerned Sum centers. However, for the Project the number of Sum centers are as many as 25, scattered far from Ulaanbaatar, and therefore smooth execution of the Project seems very difficult without formulation of such a project team. The organization of a project team will be recommended before commencing the site works. This project team will manage the designing and installation works under assistance and advice of the Consultant up to the project completion, besides the team will provide guidance and coordination to Sum centers as the Mongolian side actual executing bodies of the Project.

Under a grant aid project from Japan, an Exchange Note (E/N) is exchanged between the concerned governments and project execution is commenced after confirmation of appropriateness of the project by the Japanese government based on the result of basic design investigation. In executing working design and construction supervision, the followings shall be taken into account:

(a) To understand background in concluding execution of the project.

(b) To understand contents of the basic design report.

(c) To understand basic principles of the grand aid assistance from Japan.

(d) To understand contents of the Exchange Note agreed between the two countries.

(e) To fully take into account the conditions of installation at site.

Taking into account the above considerations, conceived composition of consultant services for contents, executing services and planning are mentioned below.

(1) Consulting Services

(a) Working design and preparation of bidding documents

(i) Working design

Taking into account the results of basic design investigation, the construction cost is to be estimated through site investigation and discussion with the Mongolian side, and works by the Mongolian side are to be clarified. Prior to preparation of bidding documents, detailed design, detailed cost estimate and execution plan must be prepared.

(ii) Preparation of bidding documents

Bidding documents are prepared taking into account the detailed design, execution plan and regulations for grant aid assistance.

(b) Construction supervision

(i) Bidding procedures

These items include announcement for bidding, inquiries and reply, attendance to bid opening, evaluation of submitted bids, and assistance to contract negotiation and conclusion of the contract.

(ii) Supervision procedures

These items include discussions among concerned parties before commencing inland transport and installation works, review and approval of design drawings and documents, inspection and tests of equipment and materials before shipment and issue of certificates, supervision of site transport and installation works, preparation of work reports during site transport and installation, issue of interim certificates, attendance to inspection and tests on completion, etc.

(iii) Procedures after completion of transport and installation

These items include issue of completion certificates, procedures for completion and

taking over, preparation of final report and carrying out of performance inspection after one-year operation.

(2) Consultant Engineers in Charge

To smoothly execute all items of consulting services mentioned in the above Paragraph (1), it is required to appoint a competent Project Manager who has ample experience in similar projects and fully understand the contents of the Project. At the same time establish a competent executing organization by appointing proper staff in charge for detailed design, bidding procedures, review of approval drawings, inspection and tests before shipment of equipment and materials, and supervision of site transport and installation works.

(a) Project Manager

The Project Manager will manage overall execution of the Project with full knowledge on the purpose and background of the Project. He will review overall work schedule and understand related problems, and give adequate advice to each engineer in charge.

(b) Engineer in charge of Working Design

Based on the basic design, this engineer will determine specifications of equipment and materials necessary for the Project, design equipment layout, prepare detailed design for the Project, prepare an execution plan taking into account power interruption plan, and estimate construction costs.

(c) Engineer in charge of Bidding Procedures

This engineer will compile bidding documents and carry out bidding procedures including the bidding announcement, attendance to bid opening, evaluation of submitted bids, and assistance to contract negotiation and conclusion of contract.

(d) Engineer in charge of Drawing Approval and Inspection of Products

This engineer will in Japan review and approve or comment drawings and documents for approval, plans for transport and installation works, various certificates, etc., from contractors, and also inspect and test equipment and materials at manufacturer's works before shipment.

(e) Engineer in charge of Construction Supervision

Resident engineer at site will manage and supervise execution of site transport and installation works from commencement to completion. Engineers in charge of mechanical works (diesel engines), electrical works (generators and instrumentation) and civil works (foundations) will be dispatched to the site when required for supervision of

respective works.

3 - 1 - 5 Procurement Plan

Equipment and materials to be procured under the Project include diesel generators and their auxiliaries, control panels, construction equipment and materials, connecting materials with existing distribution lines, and foundation materials, and most of them will be purchased in Japan. However, certain materials such as sand and stone for concrete, timber, cement, reinforcing bars, etc. will be purchased in Mongolia.

As for foundations, better quality control and reliability of supply period can be secured by manufacturing in Ulaanbaatar instead of placing concrete at Sum centers. Thus, purchase of prefabricated foundations was decided.

As for diesel engines and their auxiliaries, control panels, construction equipment and materials, connecting materials with existing distribution lines, all items will be purchased in Japan in view of security of supply period, transportation cost, maintenance problems after starting operation, etc. Thus, purchase from third countries will not be taken into account.

The selected sources of major equipment and materials purchased under the Project are shown in Table 3.1

Table 3.1 Planed Sources of Purchase of Equipment and Materials

Equipment and Materials	Quantity	Source of Purchase
(1) Purchase of Generating Facilities		
a) Diesel engine generators (main bodies)	100 kW x 15 sets 60 kW x 15 sets	Japan
b) Auxiliaries (starting , cooling and exhausting equipment)	1 lot for 25 Sum centers	Japan
c) Room heating facilities	1 lot for 25 Sum centers	Local
d) Low tension panels	1 lot for 25 Sum centers	Japan
e) Insulation transformers	1 lot for 25 Sum centers	Japan
f) Battery charger	1 lot for 25 Sum centers	Japan
g) Power and control cables	1 lot for 25 Sum centers	Japan
h) Grounding materials	1 lot for 25 Sum centers	Japan

i)	Prefabricated foundations	70 sets	Local
h)	Connecting materials with existing lines (including lightning arresters)	1 lot for 25 Sum centers	Japan
k)	Spare Parts and conSum centerption materials	1 lot for 25 Sum centers	Japan
(2) Maintenance tools for mobile maintenance team		3 sets	Japan

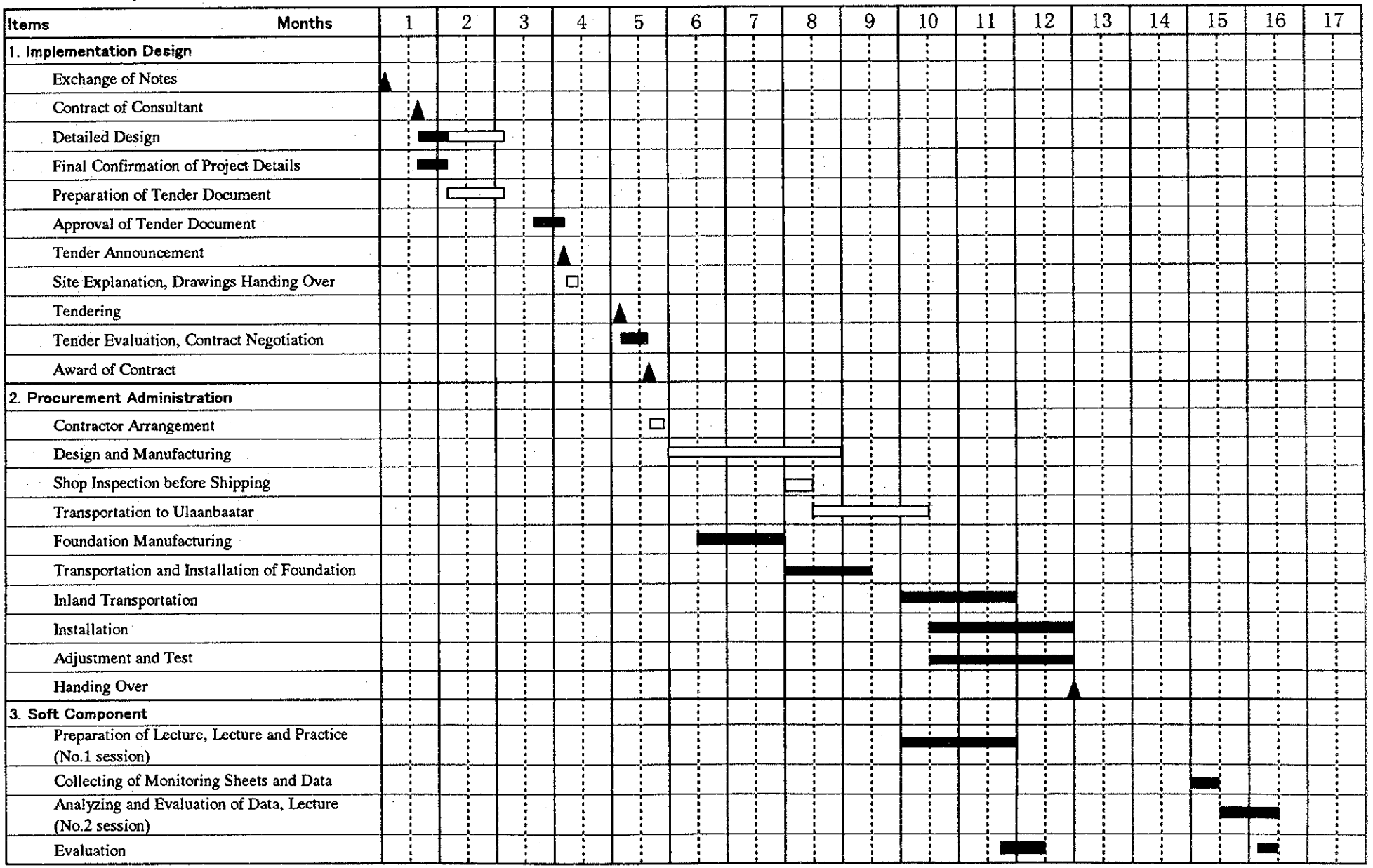
3 - 1 - 6 Implementation Schedule

Taking into account urgency and importance of the Project, the execution of the Project is planned to be completed in one year. From the natural and geographical conditions at site, execution of construction works in winter is not possible, and the implementation schedule was prepared taking into account the site construction during Sum center time only. For project execution, 15.5 months in total including soft component will be required; 1.5 months for working design, 2 months for bidding and conclusion of contract, 3 months for manufacturing of equipment and materials, and 5 months for transport and installation.

The soft component will be executed two times during execution of site installation and after completion of installation to exert the maximum effects and to confirm effects.

The conceived implementation schedule is shown in Table 3.2.

Table 3.2 Implementation Schedule



Notes : Site Domestic

3 - 1 - 7 Obligations of Recipient Country

The Mongolian side duties in case a grant aid from Japan being extended are as mentioned below. (Reference to Annex 5 of the Minutes of Discussion)

(a) Repairing work of power house

(b) Removal and relocation of existing facilities

(c) Acquisition of transport access

(d) Banking arrangement (B/A)

(e) Acquisition of import license to Mongolia and payment of necessary fee

(f) Tax exemption to Japanese personnel to be engaged in the Project and to import and reexport of portable tools for the Project

(g) Acquisition of right of access to the project areas

(h) Acquisition of license from concerned authorities necessary for transportation

(i) Public announcement and execution of power interruption necessary for work execution

(j) Acquisition of land for storing supplied equipment and materials

(k) Other items which can not be provided under the grant aid

3 - 1 - 8 Soft Component

Under this Project, the generators made in Japan will be supplied to 25 Sum centers, however the operators in Sum centers and the engineers in aimags have no knowledge for the new generators so that the existing generators were made in the former Soviet Union. The training for daily operation and repairing of slight troubles will be performed during the installation at site. So that the Sum center power supply by diesel generators provided under the Project can be maintained without troubles, a soft component aiming at promotion of capability for management of power supply business and operation and maintenance of facilities will also be executed.

The contents of soft component are as mentioned below.

(1) Contents of Works

(a) Times of Execution

- First session (Sum centermer session) : August to October 2000 (2.5 months)
- Second session (Winter session) : January to February 2001 (1.0 months)

(b) Necessary Staff

The number of staff necessary for carrying out the sessions is six, which comprise three Japanese and three Mongolian.

- Japanese staff
  - i) Operation and maintenance of diesel engine for engineers of aimag centers
  - ii) Operation and maintenance of diesel engine for operators of Sum centers
  - iii) Operation and management of power supply utilities

- Mongolian staff
  - iv) Interpreter cum assistant-1 for above i)
  - v) Interpreter cum assistant-2 for above ii)
  - vi) Interpreter cum assistant-3 for above iii)

(c) Expected Trainees

The fields of technical training and expected trainees are mentioned below:

	Operation & Maintenance of Diesel Gen. Facilities	Operation & Management of Power Supply Utility
i) Sum center chief or deputy		○
ii) Power station chief and operators of Sum centers	○	○
iii) Power utility engineers of district (members of mobile repairing gangs)	○	
iv) MOID staff in charge		○

(d) Contents of works

- First Session

<u>Operation and maintenance of generating facilities</u>

i) Lecture on basic technology related to generating facilities

ii) Practice on daily operation and maintenance

iii) Lecture and practice on basic trouble shooting technology

iv) Handling practice on inspection apparatus, special tools and meters

v) Lecture and practice on fault diagnosing and repairing technologies

vi) Lecture and practice on disassembly and assembly of diesel engine

vii) Lecture on methods of preparing and entering in monitoring formats

viii) Preparation of basic manuals for operation and maintenance

Operation and management of power supply utilities

i) Lecture and practice on clarification of tariff deciding criteria (recovery of expenditures for maintenance and management) and decision of reasonable tariffs

ii) Public relations with inhabitants related to power supply activities, guidelines related to contract between power utility and beneficiaries and preparation of articles of association (model) (Lecture and practice)

iii) Lecture and practice related to formation of tariff collecting system

iv) Lecture and practice related to management procedures on purchase of spare parts, procedures to request fault repairing

v) Lecture on preparation and filling method of monitoring format

vi) Preparation of basic manual related to bases of management

- Second Session

Operation and maintenance of generating facilities

i) Analysis and evaluation of results of monitoring

ii) Evaluation of the daily operating and maintaining conditions and review of facing problems (in the form of lecture and discussion)

iii) Evaluation related to trouble shooting (in the form of lecture and discussion)

iv) Evaluation related to fault forecasting (in the form of lecture and discussion)

v) Evaluation related to fault diagnose and repairing (in the form of lecture and discussion)

vi) Lecture and practice on disassembly and assembly of diesel engine

vii) Lecture and practice for maintenance tools for the mobile maintenance team

Operation and management of power supply utilities

i) Analysis and evaluation of results of monitoring

ii) Evaluation of results of public announcement and articles of association

iii) Evaluation of the power tariff level and expenditures for maintenance and management (in the form of lecture and discussion)

iv) Evaluation of the tariff income and tariff collecting system (in the form of lecture and discussion)

v) Evaluation of management procedures for purchase of spare parts, procedures for requesting fault reaping, etc. (in the form of lecture and discussion)

(2) Works by Mongolian Side

In executing the soft component, the Mongolian side is to carry out the following works;

- Provision of sites for training and practice
- Supporting works related to training and practice
- Collection of monitoring sheet

3 - 2 Project Cost Estimation

The Mongolian side cost in case a grant aid from Japan being extended will be estimated as mentioned below. (Reference to Clause 7(4) of the Minutes of Discussion)

(a)	Removal and relocation of existing facilities	:	18,600,000 Tg.
(b)	Repairing work of power house	:	7,500,000 Tg.
(c)	Excavation for concrete foundation	:	7,000,000 Tg.
	Total	:	33,100,000 Tg.

Besides the above, Mongolia should bear the cost of works as mentioned in Sub-clause 3-1-7. To execute the Project, MOID and the objective Sum centers should have the necessary cost ready in advance, and the above works should be completed by June 2000.

3 - 3 Operation and Maintenance Plan

(1) Present Situation for Operation and Maintenance

(a) Transition of organizations for operation and maintenance

The organization for operation and maintenance of Sum center power supply utilities has experienced transitions during the economic structural transition from socialistic planned structure to market competition structure as chronologically mentioned below:

Up to 1988 : Management by cooperative organizations; each Sum center having one unit

1988 to 92 : Management by aimag

1992 : Commencement of transition to management by each Sum center

1995 : Completion of transition to management by each Sum center

At present the power supply business of a Sum center which is not grid connected is operated and maintained under the self-financing system and its representative is the Sum center chief. However, the management capability of each Sum center is not sufficient for proper execution of the activities, and there is a recent movement to shift again some portion of maintenance functions such as equipment maintenance to the execution by aimag.

(b) Functions of the country, aimags and Sum centers

The power supply activities of all aimag centers and of grid interconnected Sum centers are managed by the Energy Authority of MOID technically and financially. These activities have no direct relation with the aimag administration, however the organization consults with the aimag chief in deciding the chief of aimag power station.

While, the power supply activities of Sum centers not connected with grid, as objective Sum centers under the Project, are also under the management of MOID, however the actual operation is performed by the Sum centers. The payment of the power charges for Sum center's public installations by the Energy Development is the form of government subsidy to Sum centers. At each aimag center, one inspector of MOID is to station all the year round and to inspect generating facilities of each Sum center four times a year. The aimag chief appoints the inspector, the testing institute issues a certificate of the status for the inspector. The inspection items are to cover safety standards of facilities and operation of power stations, and inspection results are to be submitted to the inspection institute. However, this system was told to be not functioning properly.

(c) Training system

There is a regulation for training system in each power organization of aimag center to train operators once a year for 14 days. The method of training is to train operators by chief of each field, for instance an electrical chief engineer trains electricians, and a mechanical chief engineer trains mechanical workers. In principle, the chief of each shift gang must attend the technology training, and all operators must attend the safety training. Surely there was a regulation, however clear confirmation could not be obtained regarding whether this system has been functioning properly or not. While, there was no Sum center level training system.

(d) Operation and Maintenance of Facilities

The operation and maintenance of existing generating facilities is to be usually performed by the Sum center officers, not engineers for the engine. Therefore, the continuous management of the power business is not performed, there are no system to reserve of funds for procurement of the parts, the inspections and the repairs. As a result, in case of the serious trouble such as replacing the parts, the parts will be replaced from the other generating facilities, the facilities removed the parts will be left without operation.

(e) Power tariff

Before the democratization of the government, the power utilities were operated with the government control and help of government subsidy, and there was no established power tariff system. After the shift to market economy, extensive assistance from the country was lifted and management of the power system was handed over to Sum centers as self-financing system. However, the government budget has been allocated to the power charge of public facilities as operating expenditure.

The power tariffs were calculated from necessary operating expenses of each month. The operating expenses comprise costs for fuel, repair and maintenance, salary of staff for operation and maintenance, management and others. Among these costs, the fuel cost occupies about 90% of the total cost.

According to an accounting policy of the Ministry of Finance, 12.5% of the main machine price of Sum center generating equipment is to be added to the power charge of each year, and this amount is to be expended toward maintenance expenses (procurement of spare parts, etc.) of facilities. If each Sum center decided power tariffs according to this principle, additional income would be effective for management and maintenance of the Sum center power system. However, no Sum center following this policy was

confirmed during the site investigation. The Ministry of Finance did not check regarding execution of this policy.

(2) Countermeasures for Long Term Operation and Maintenance of Facilities

The life of generators supplied from Japan under this Project is about 10 to 15 years in case of operating in Japan. However, in case of operating in Mongolia, the condition is too harsh to operate in long term.

To operate the new generating facilities in long term under such condition, it is important to execute the maintenance of the facilities as mentioned below, and necessary to work together MOID and aimag power station.

(a) Management of operation and maintenance manuals

There was a common problem that almost all the Sum centers had no operation and maintenance manuals. Manuals for supplied equipment are normally provided by the contractor under a contract, and these documents must be stocked properly in power stations so that the manuals can be conveniently referred to by operators in execution of operation and maintenance. Operators who are operating equipment, materials and facilities every day would be able to carry out daily operation and maintenance trouble free by preparing their own charts in Mongolian language and indicate operating procedures and maintenance methods in manners easily understandable to them. Also, regarding equipment construction it is required to prepare summary explanations in the Mongolian language to promote motivations of the operators. Especially, it is important to train re-operating procedures, maintenance of the battery and heating in the house, and to be thoroughly executed them so that the operation in very cold lead to the serious trouble

(b) Records of daily inspection and operation

One of the most important activities for continual operation and maintenance of power stations are daily inspection, diagnose and cleaning. These activities are especially important for the lubricant, fuel and cooling water systems. For instance, the oil leakage can be detected easily by carrying out daily cleaning regularly. A check list of daily inspection is prepared by suppliers, and it is required to arrange its contents well understood by operators and be carried out regularly. After inspection, the results need to be recorded and basic data for equipment maintenance are to be processed and stored properly. Analyzing and reviewing of the basic data as proper operation records make it possible to diagnose the abnormality.

(c) Management and procurement of spare parts

Though spare parts necessary for three years operation are obtained under this Project, it is essential for trouble-free operation of the power system to secure spare parts necessary after three years including items out of normal supply. Used and consumed spares and those may be worn in near future are known by carrying out regular inspection and overhaul, and necessary spare parts need to be supplemented for parts replacing when required.

(d) Execution of overhaul and periodical inspection

The periodical inspection of diesel engine needs to be executed after every 2,500 hours operation, and the fast overhaul after 10,000 hours operation. In case the both overhaul and periodical inspection are coincided, the overhaul having also functions of the periodical inspection has to be carried out. Necessary procedures, check items, parts to be replaced, etc. are mentioned in detail in manuals of suppliers, therefore it is required to arrange the operators and maintenance staff to understand the manuals clearly beforehand.

(e) Mobile maintenance team

Mobile maintenance team will be arranged at 3 Aimg centers (Khentii, Uvurkhangai and Dondgovi) under the Project taking into consideration the mobile maintenance teams to be established under the Second Phase Project. The teams is required to maintain the organization to make a regular inspection and/or stand-by to cope with request from a Sum center.

(f) Power tariff

With the recovery of stable power supply due to the rehabilitation of the generating facilities restarting of formerly operated manufacturing plants for wool and cashmere is expected. When the supply to various kinds of consumers are required, establishment of category-wise tariff system will become necessary. Therefore, from the mid-range view point, a study need to be commenced at the present stage to set up a tariff structure with differential tariffs according to consumer categories.

(3) Operation and Maintenance Cost

At present, the power supply activities of each Sum center are basically operated with the self-financing principle. The necessary cost for operation and maintenance of the new generating facilities must be included in yearly budget and be secured by each Sum center. The running cost for total 25 Sum center centers with the present electric power supply is estimated as shown in Table 3.3.

Table 3.3 Operation and Maintenance Cost (annual)

Item	Q'ty	Unit	Unit price	Amount
(a) Fuel	411,652	Ltr/year	265 Tg/Ltr	109,087,000 Tg
(b) Operators	25	Sum center	348,000 Tg/year	8,700,000 Tg
(c) Spare parts	25	Sum center	635,000 Tg/year	15,875,000 Tg
(d) Regular inspection by maintenance team	25	Sum center	55,000 Tg/year	1,375,000 Tg
合 計				135,037,000 Tg

Note: Fuel cost is estimated under the condition of present power generation(18:00 to 23:00 in winter season)

Power charge is collected by consumers of household as well as the public and civilian companies, and the share of income is about 70% of the household. As the result of site investigation, the average power tariff for household is calculated at 4,228 Tg per month. Therefore, the total income by sold power energy is estimated in Table 3.4

Table 3.4 Annual Income

Item	Tariff	Monthly rate	House	Amount
(a) Household	4,228	Tg/house	4,079	206,952,000 Tg
(b) Public and Civilian				88,693,000 Tg
Total				295,645,000 Tg

According to the above tables, the balance for total 25 Sum center centers is obtained as shown in Table 3.5.

Table 3.5 Balance for Total 25 Sum centers

Item	Amount
(a) Operation & Maintenance	135,037,000 Tg
(b) Income	295,645,000 Tg
Balance	+ 160,608,000 Tg

As the result, it is concluded that the running of the generating facilities can be continuously made in the long term against the present level of power generation.

On the other hand, the capacity of power generation increase at 2.5 times against the existing one and consequently the running cost is expected to grow up as shown in Table 3.6.

Table 3.6 Operation and Maintenance Cost (annual)

Item	Q'ty	Unit	Unit Price	Amount
(a) Fuel	1,173,944	Ltr/year	265 Tg/Ltr	311,095,000 Tg
(b) Operators	25	Sum center	348,000 Tg/year	8,700,000 Tg
(c) Spare parts	25	Sum center	1,778,360 Tg/year	44,459,000 Tg
(d) Regular inspection by maintenance team	25	Sum center	55,000 Tg/year	1,375,000 Tg
Total				365,629,000 Tg

Income after 5 years is also expected to increase as shown at Table 3.7 with assumption of the growth of household at rate of 1.7 % per year.

Table 3.7 Annual Income

Item	Tariff	Monthly rate	House	Amount
(a) Household	4,228	Tg/house	4,438	225,166,000 Tg
(b) Public and Civilian				96,499,000 Tg
Total				321,665,000 Tg

From the Tables 3.6 and 3.7, it is supposed that the balance will be minus 44,000,000 Tg per year if the power tariff is not corrected according to the increased power generation.

To overcome the situation, the power tariff is required to correct at 13.7 %. However it is expected that the generating facilities can be continuously operated and maintained because all Sum center centers have an intention to pay the tariff corresponding to the expansion of power generation.

CHAPTER 4

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATIONS

4 - 1 Project Effect

The Project aims to install new diesel engine generators at the 25 objective Sum centers for stable power supply to the Sum centers. Problems being arising at present for the generating facilities in the objective Sum centers of the Project and countermeasures to be executed under the Project are mentioned blow:

Problems

(a) The power supply capacity has gone down against the requirement of demand, and becomes to interfere with the life in Sum centers.

(b) Only one generator can be operated in a Sum center and then a stable power supply is not maintained.

(c) The existing generators are of old type and deteriorated with aging. Therefore, the fuel consumption rate is high and high energy rate is derived due to low energy generation efficiency.

(d) The procurement of spare parts and the maintenance of equipment become difficult. Therefore the repairing is not possible even minor troubles.

(e) The operators in Sum centers can not perform overhaul and daily inspection of the facilities because of no inspection tools and they do not have enough knowledge and skill.

(f) Operation and maintenance of the facilities is under the difficult conditions because power tariff and collecting methods are not securely established.

Countermeasures

(a) Required capacity is to be restored by installing new generators so as to meet the demand, and at the same time the reliability is to be improved by carrying out operation control so as to satisfy the requirement.

(b) More than one generator are to be installed and the parallel operation is to be conducted to satisfy to the requirement of demand.

(c) Turbochargers are to be furnished on new diesel engine generators to obtain a higher efficiency and then the decrease of operation cost is to be attempted by recovering discharging pressure and keeping high temperature of the fuel system.

(d) Consumed spare parts for 3 years and standard maintenance tools are to be supplied together with the generating unit and the method of daily operation and maintenance are to be trained for the operators in Sum centers.

(e) A maintenance car, measuring instruments and tools for inspection and repairing are to be supplied for the mobile maintenance team to be established at 3 Aimag centers. And the training of the operation and maintenance for new diesel engine generators manufactured in Japan will make it possible to judge some troubles before being serious with performing overhaul and inspection.

(f) The setting of power tariff and the methods of collecting system are to be trained to obtain a basic knowledge on business operation.

The execution of this Project will produce the direct benefits under-mentioned as 1), 2) and 3). The Project will contribute to the rural inhabitants of Mongolia by solving the problem of power shortage which has constituted a bottleneck in leveling up the living standards as mentioned below. The number of population which will directly benefit by the Project will corresponds to the total population in the objective Sum centers and will be 23 thousand.

1) The situation that most of Sums may become non-electrified Sums in several years can be avoided.

2) New facilities can satisfy latent demands by the extension of daily supply duration and increase in the maximum generating output.

3) Reliability of power supply will be raised and quality of power supply will also be improved by stability of supply voltage and frequency.

The total output capacity of new generating facilities to be installed at the objective Sum centers is 4,800 kW. This capacity corresponds to about 2.5 times the total capacity of the existing generators in Sum center (1,920 kW) which can be operated in 1999. This will significantly contribute to the improvement of present situation that the movement toward market economy and economic restoration have been hampered due to the shortage in power supply. As fuel consumption is expected to be improved by about 25 % for 60kW and 18 % for 100kW, fuel can be saved and the operation cost can be curtailed by installation of new high efficiency generators replacing old and inefficient generators. By converting these saved costs to maintenance and management, the continual operation of power supply will be

effectively promoted. From the above-mentioned effects, the Project is considered to contribute to improvement of inhabitants' lives and restoration of public services.

As mentioned above, the Project is judged to be adequate for execution under a grant aid program from Japan.

4 - 2 Recommendation

The Project produce to provide significant effects as mentioned above, and at the same time will contribute to leveling up of the basic human needs. Therefore, it is judged that the Project is appropriate for execution under grant aid from Japan. However, there are problems as mentioned below, and the Project will not be executed smoothly and effectively without solving the problems.

(1) Though the power supply activities of each Sum center are operated with the self-financing principles, basic knowledge on business operation is not sufficient and continual management and maintenance are difficult. The fundamental knowledge can be obtained by the execution of soft component. However, subsequently MOID is required to carry out inspection and guidance on the management technology to the staff and person in charge for sound and continual management of power utility. Especially, guidance on optimization on the power tariff collection system and business management will be essential.

(2) Knowledge on new equipment to be supplied under this Project is not sufficient in each Sum center. Technical guidance is conducted under the soft component. As follow-up after the soft component, the Energy Authority is required to periodically carry out a training together with manufacturers under instructions of MOID to the operation and maintenance technicians of each Sum center so as to maintain proper operation and maintenance of new equipment. Especially, through introduction of technologies for minimization of fuel consumption rate, fault diagnosis through periodical inspection and overhaul, etc., methods for continual business operation and maintenance are to be guided.