BASIC DESIGN STUDY REPORT

ON
THE PROJECT
FOR
REHABILITATION OF POWER PLANTS OF SUM CENTERS

PHASE II
IN
MONGOLIA

November 1998

JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD., TOKYO, JAPAN

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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 II and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Mongolia a study team from May 27 to July 1, 1998.

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. Then, a mission was sent to Mongolia in order to discuss a draft basic design, and as this result, the present report was finalized.

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

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

November 1998

Kimio Fujita

President

Japan International Cooperation Agency

November 1998

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 II in Mongolia.

This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from May 21, 1998 to December 10, 1998. 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,

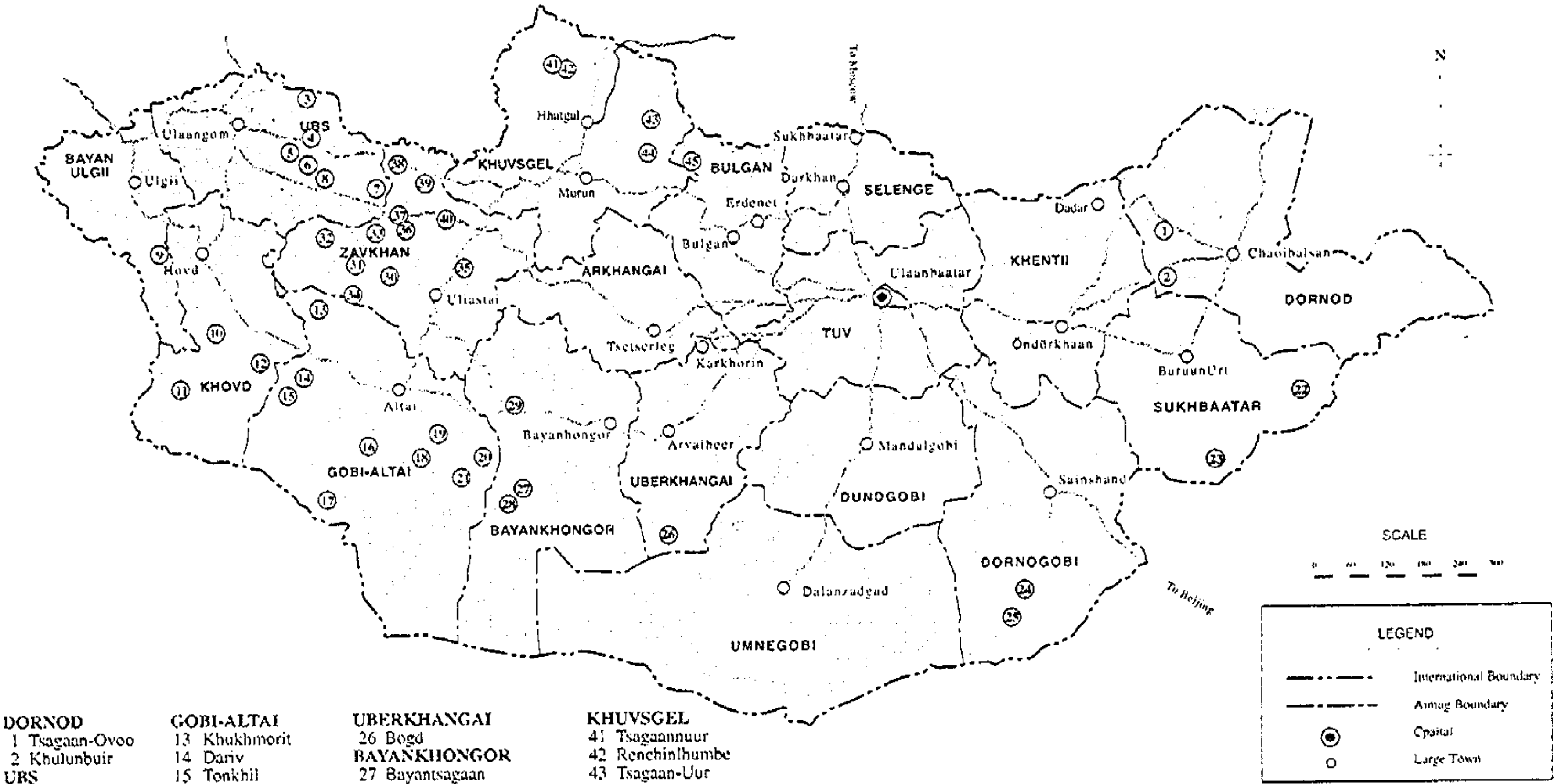
渡辺芳知.

Yoshitomo Watanabe

Project manager,

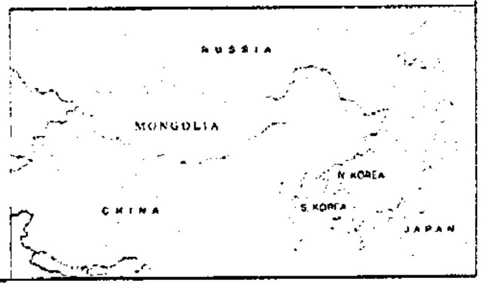
Basic design study team on
The Project for the Rehabilitation of
Power Plants of Sum Centers, Phase II

Nippon Koei Co., Ltd.



DORNOD	**GOBI-ALTAI**	**UBERKHANGAI**	**KHUVSGEL**
1 Tsagaan-Ovoo	13 Khukhmorit	26 Bogd	41 Tsagaannuur
2 Khulunbuir	14 Dariv	**BAYANKHONGOR**	42 Renchinlhumbe
UBS	15 Tonkhil	27 Bayantsagaan	43 Tsagaan-Uur
3 Tes	16 Tseel	28 Bayan-Under	44 Erdenebulgan
4 Zuungobi	17 Altai	29 Buutsagaan	**BULGAN**
5 Malchin	18 Tsogt	**ZAVKHAN**	45 Teshig
6 Hyargas	19 Biger	30 Erdenekhairkhan	
7 Zuunkhangai	20 Chandmani	31 Zavkhanmandal	
8 Tsagaankhairkhan	21 Erdene	32 Urgamal	
BAYAN-ULGII	**SUKHBAATAR**	33 Santmargats	
9 Deluun	22 Erdenetsagaan	34 Durveljin	
KHOVD	23 Naran	35 Ider	
10 Munhhairkhan	**DORNOGOBI**	36 Tsetsen-Uul	
11 Bulgan	24 Huvsgel	37 Songino	
12 Tsetseg	25 Khatanbulag	38 Tes	
		39 Asgat	
		40 Numreg	

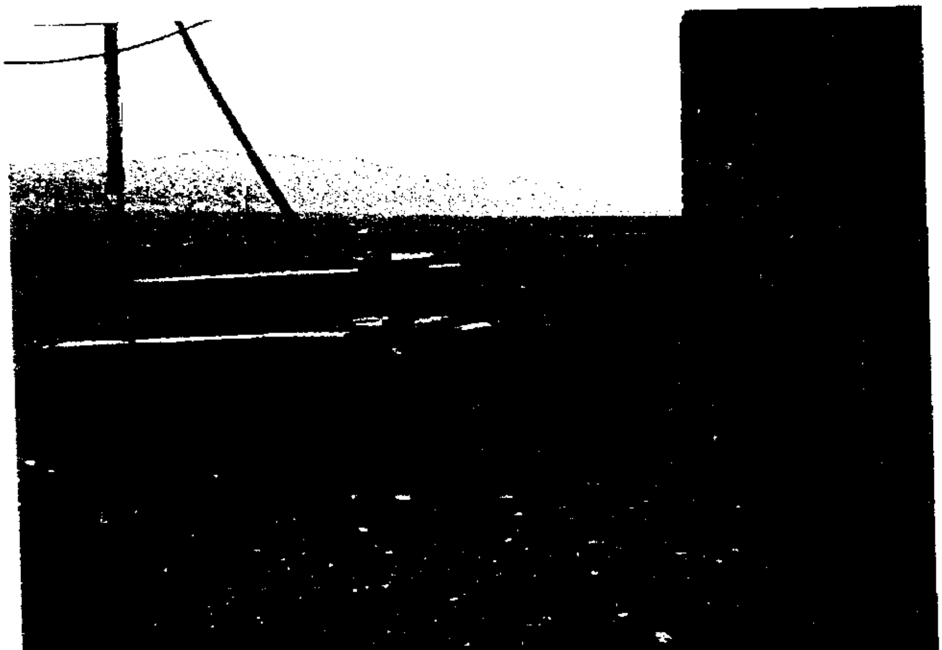
MAP OF MONGOLIA



Photographs of Site Investigation (1/4)

Site : Erdene (1/2)
Site No 21 on Location Map

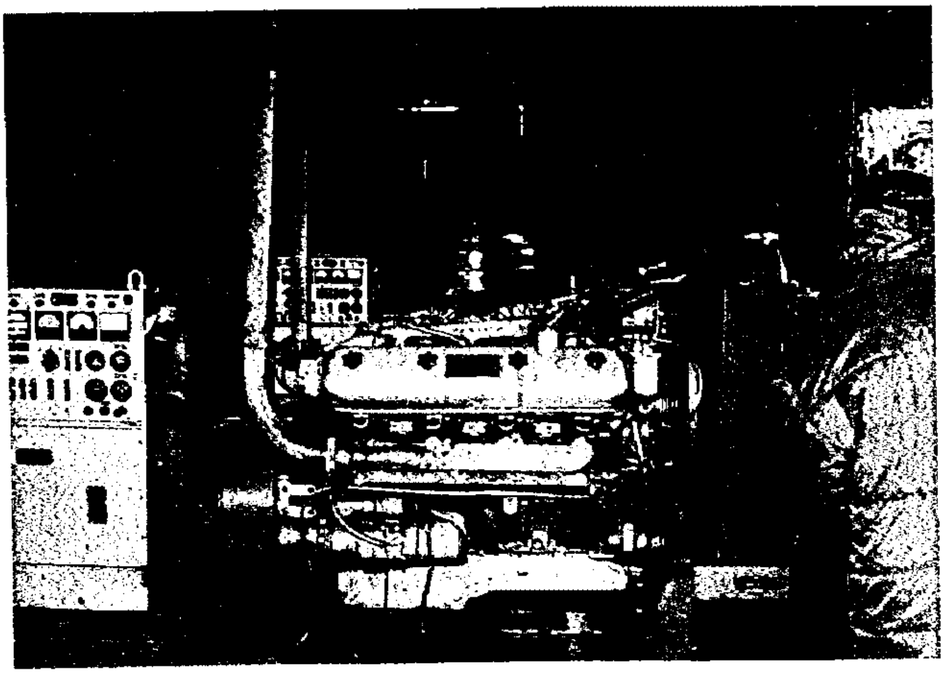
Existing Power House



Existing Fuel Tank

Photographs of Site Investigation (2/4)

Site : Erdene (2/2)
Site No 21 on Location Map

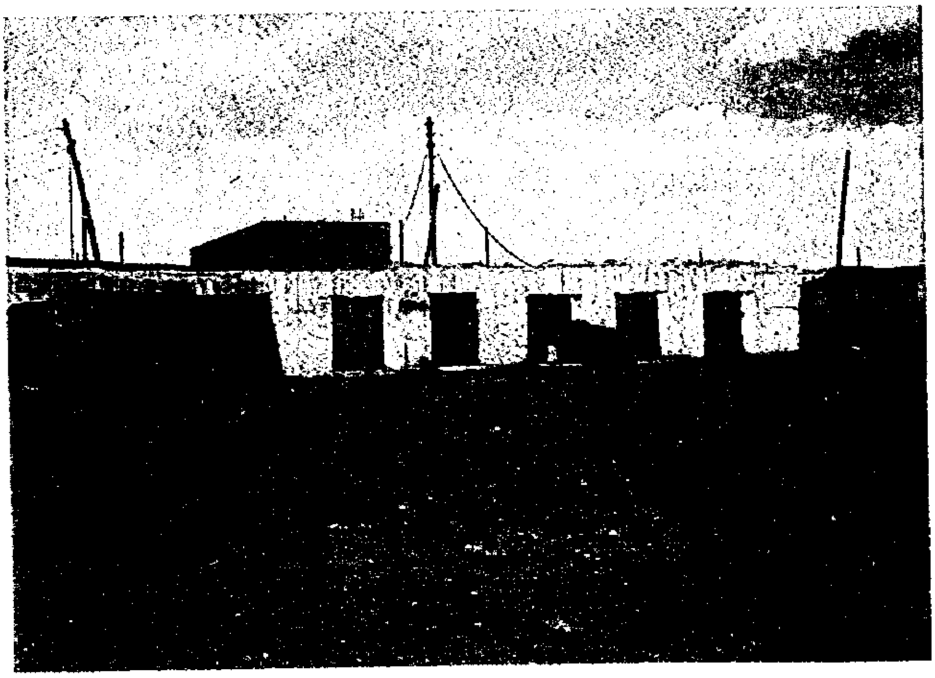


Existing Generator Supplied by the Former Soviet Union

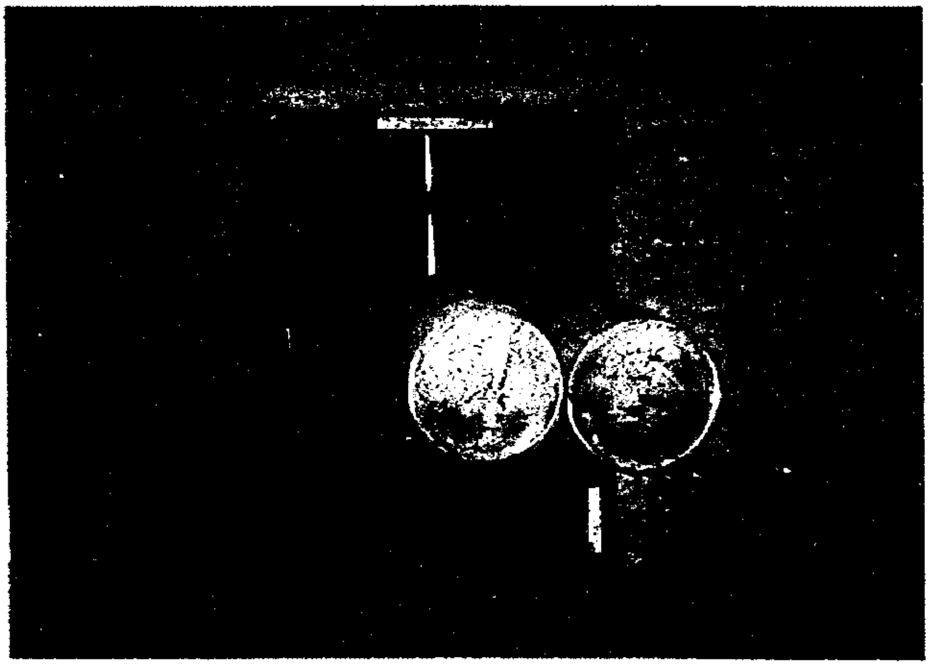
Remaining Tools and Parts

Photographs of Site Investigation (3/4)

Site : Bayantsagaan (1/2)
Site No 27 on Location Map



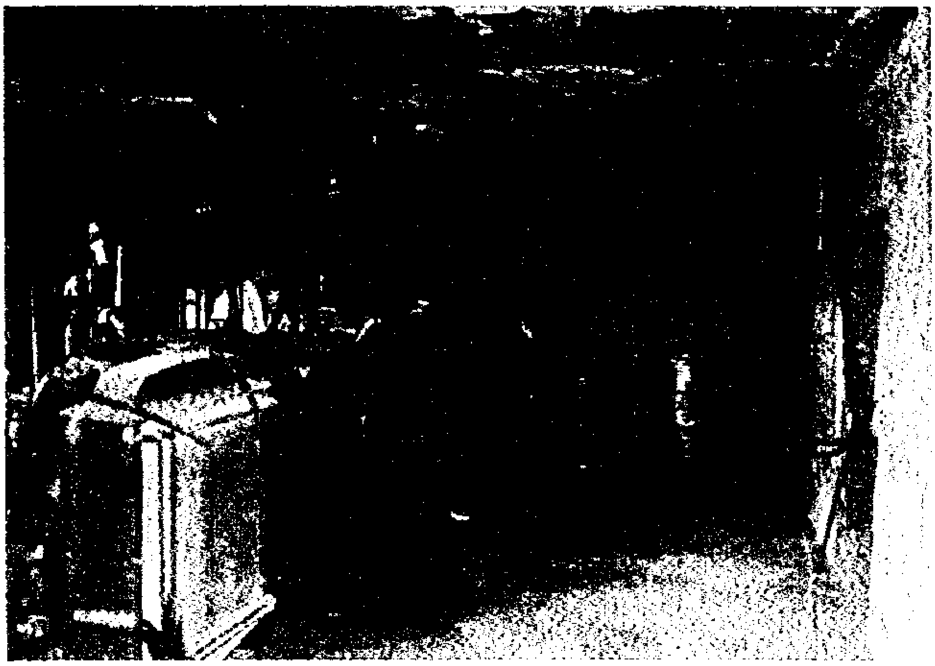
Existing Power House



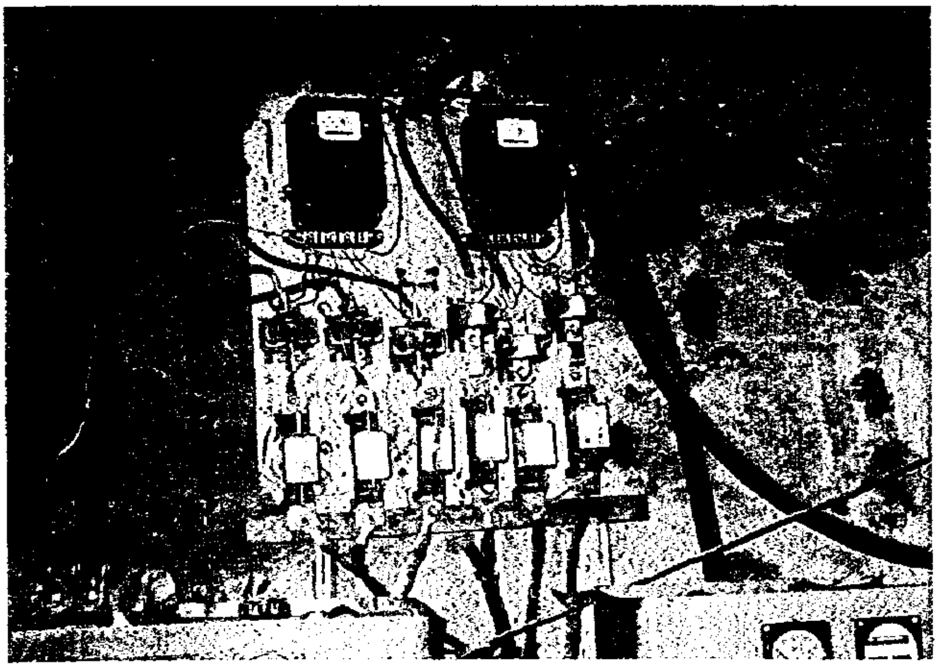
Existing Day Tank

Photographs of Site Investigation (4/4)

Site : Bayantsagaan (2/2)
Site No 27 on Location Map



Inside of Existing Power House



Existing Distribution Panel

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
OECF	:	Overseas Economic Cooperation Fund of Japan
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

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CHAPTER 1

BACKGROUND OF REQUEST FROM MONGOLIA

CHAPTER 1 BACKGROUND OF REQUEST FROM MONGOLIA

In 207 sums of Mongolia, the electric power is supplied by diesel generators installed at the sum centers. All of these diesel generators were manufactured in the former Soviet Union and most of them were installed in the years from 1963 to 1994. During the socialism period, Mongolia had depended on the former Soviet Union, as a member country of the Comecon economic group, on the aspects of essential living commodities, raw materials for industry, oil products etc. as well as the operation and maintenance of the diesel generators. After the collapse of the Soviet Union, the supply of generator spare parts has become difficult situation due to shortage of foreign currency and associated wide-range shortage in materials, which was resulted in stopping of diesel generators. Even the operating generators, their output has been decreased due to less efficiencies. Such situation is severely affecting to daily lives of sum inhabitants as well as social and economic activities of sums.

Under such a situation, the Government of Mongolia officially requested a grant financial assistance to the Government of Japan in 1996 for replacement of generating equipment of 74 sums among 207 sums, which are severely suffering from power shortage. Among these 74 sums, assistance from Japan has already been extended to 4 sums under a grass-roots grant in 1997 and 25 sums under the Project for the Rehabilitation of Power Plants of Sum Centers in 1997 (hereinafter called the First Phase Project). This Project aims to rehabilitate the remaining 45 sums and scope of work is summarized at table below.

1.	Objective sums	:	45 sums
2.	60 kW Diesel generators	:	92 units
3.	100 kW Diesel generators	:	42 units
4.	Total generators	:	134 units

The Japanese Government decided to execute a basic design study of the Project and JICA dispatched a mission to Mongolia from 27 May to 1 July, 1998. During the stay, the mission investigated site conditions and collected data associated with the rehabilitation of diesel generating equipment based on the discussion with MOID, who is the executing agency of the Project.

The list of members and inspection schedule of the mission, list of Mongolian personnel, minutes of meetings, collected data, 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 power supply to the objective sums are in terrible conditions by the background as mentioned Chapter 1. Problems related to the power supply to the objective sums are enumerated bellow:

(a) The supply of spare parts of Russian generating facilities has been stopped, and maintenance of equipment is difficult.

(b) As technical assistance to equipment maintenance is not available, it is not possible to repair damaged generating facilities.

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

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

The purpose of the Project is to provide new generating facilities to the remaining 45 sums among 74 sums, to try to achieve and maintain stable power supply to sums and to contribute to improvement and stability of sum.

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 Paragraph (9) the outline of plan.

(1) Relations with Upstream Plans of the Power Sector

The extensions of transmission and distribution line have been not planed to connect with national grid to the objective. However, In future, MOID has the plan to be enough for the electric supply in aimag centers by the extension and repairing of high-tension lines.

As the sums level, each sum has the extension plan, however the time is unfixed due to shortage of the budget and the stuffs. Under the situations, this Project has no relations to upstream plans.

(2) Aid Plans of Other Donors

All of the plans by other donors for the electric supply are not targets of the sums. In this Project, as the electric supply facilities at the sums are independence power resources, the connections of national grids should be left out of consideration.

To assist power sector development, four assistance activities are under execution, loan projects utilizing ADB and investigation and development planning under grant financial aids from TACIS and USAID. All of these activities are targets of Ulaanbaatar and major cities, out of scope of the Project, and coordination with these projects can be maintained.

(3) Present Conditions of Existing Generating Facilities at Each Sum

The operating conditions of the existing generating facilities at the times of site investigation, i.e. June 1998, were very bad as shown in Table 2.1. It was found as the result of site investigation that among 128 existing generators in the objective 45 sums 82 units are in inoperative conditions. Almost all of the sums 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 was not possible to estimate the potential demand from available operating records.

The major reasons of inoparativeness are super-aging. In all the investigated sums, many generating sets were damaged already and not possible to be repaired due to financial insufficiency and difficulty in obtaining spare parts of superannuated equipment, and most of the currently operating equipment will also become inoperative in near future. Also, there were difficulties in arranging necessary budget for operation and maintenance.

In repairing the existing diesel generators which can not be operated at present, machines need to be brought in to workshops, and this need considerable amount of cost. Moreover, the equipment are generally very old and manufacturing models have already been modified. Auxiliaries and spare parts are mostly out of stock, and purchase under special orders will result in high price and long supply period.

Even the generators which can be operated and are repairable at present will not be possible to continue operation to supplement generating capacity for long time under parallel operation with new equipment. The followings are basic ideas of the Project to solve such problems:

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

(b) Supplemental capacity addition of the existing generating facilities is not taken into account.

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

Table 2.1 Inventory of Existing System(1/3)

Aimag	Sum	Capacity	Production Year	Type	Operating Condition	Voltage	Number of Revolutions
BULGAN	Teshig	100 kW	1984	AD-100S-T400R	impossible	400-230V	1500rpm
		60 kW	1987	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1987	AD-60S-T400R	impossible	400-230V	1500rpm
BAYAN-ULGII	Deluun	100 kW	1985	AD-100S-T400R	impossible	400-230V	1500rpm
		60 kW	1982	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1988	AD-60S-T400R	**possible**	400-230V	1500rpm
		60 kW		AD-60S-T400R	impossible	400-230V	1500rpm
UBS	Zuungobi	60 kW	1984	AD-60S-T400R	**possible**	400-230V	1500rpm
		60 kW	1984	AD-60S-T400R	impossible	400-230V	1500rpm
	Zuunhangai	100 kW	1984	AD-100S-T400R	impossible	400-230V	1500rpm
		60 kW	1983	AD-60S-T400R	**possible**	400-230V	1500rpm
		60 kW	1987	AD-60S-T400R	impossible	400-230V	1500rpm
	Malchin	60 kW	1974	AD-60S-T400R	**possible**	400-230V	1500rpm
	Tes	315 kW	1973	CG.D13-42-12	impossible	400-230V	500rpm
		315 kW	1973	CG.D13-42-12	impossible	400-230V	500rpm
		200 kW	1973	CG.D13-42-12	impossible	400-230V	500rpm
		200 kW	1973	CG.D13-42-12	impossible	400-230V	500rpm
	Tsagaanhairkhan	100 kW	1984	AD-100S-T400R	impossible	400-230V	1500rpm
		60 kW	1984	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1983	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1983	AD-60S-T400R	impossible	400-230V	1500rpm
	Hyargas	60 kW	1984	AD-60S-T400R	**possible**	400-230V	1500rpm
KHOVD	Tsetseg	100 kW	1989	AD-100S-T400R	**possible**	400-230V	1500rpm
		100 kW	1989	AD-100S-T400R	impossible	400-230V	1500rpm
	Bulgan	100 kW	1989	AD-100S-T400R	**possible**	400-230V	1500rpm
		60 kW	1987	AD-60S-T400R	**possible**	400-230V	1500rpm
		60 kW	1987	AD-60S-T400R	impossible	400-230V	1500rpm
	Munkhkhairkhan	100 kW	1988	AD-100S-T400R	impossible	400-230V	1500rpm
		60 kW	1990	AD-60S-T400R	**possible**	400-230V	1500rpm
		60 kW	1983	AD-60S-T400R	impossible	400-230V	1500rpm
BAYANKHONGOR	Buutsgaan	100 kW	1980	AD-100S-T400R	impossible	400-230V	1500rpm
		60 kW	1983	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1983	AD-60S-T400R	impossible	400-230V	1500rpm
	Bayan-Undur	60 kW	1988	AD-60S-T400R	**possible**	400-230V	1500rpm
		60 kW	1987	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1986	AD-60S-T400R	impossible	400-230V	1500rpm
	Bayantsagaan	100 kW	1985	AD-100S-T400R	impossible	400-230V	1500rpm
		60 kW	1989	AD-60S-T400R	**possible**	400-230V	1500rpm
		60 kW	1963	AD-60S-T400R	impossible	400-230V	1500rpm
GOBI-ALTAI	Altai	60 kW	1988	AD-60S-T400R	**possible**	400-230V	1500rpm
		60 kW	1980	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1982	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW		AD-60S-T400R	impossible	400-230V	1500rpm

Table 2.1 Inventory of Existing System(2/3)

Aimag	Sum	Capacity	Production Year	Type	Operating Condition	Voltage	number of revolutions
GOBI-ALTAI	Biger	60 kW	1989	AD-60S-T400R	possible	400-230V	1500rpm
		30 kW	1982	AD-30S-T400R	impossible	400-230V	1500rpm
		30 kW	1988	AD-30S-T400R	impossible	400-230V	1500rpm
	Tonkhil	100 kW	1987	AD-100S-T400R	impossible	400-230V	1500rpm
		100 kW	1987	AD-100S-T400R	impossible	400-230V	1500rpm
		60 kW	1980	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW		AD-60S-T400R	impossible	400-230V	1500rpm
GOBI-ALTAI	Khukhmorit	60 kW	1988	AD-60S-T400R	possible	400-230V	1500rpm
		60 kW	1989	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1989	AD-60S-T400R	impossible	400-230V	1500rpm
		30 kW		AD-30S-T400R	impossible	400-230V	1500rpm
	Dariv	60 kW	1984	AD-60S-T400R	possible	400-230V	1500rpm
		60 kW	1990	AD-60S-T400R	impossible	400-230V	1500rpm
	Chandmani	60 kW	1974	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1981	AD-60S-T400R	possible	400-230V	1500rpm
		60 kW	1974	AD-60S-T400R	impossible	400-230V	1500rpm
	Tsogt	60 kW	1981	AD-60S-T400R	possible	400-230V	1500rpm
		60 kW	1973	AD-60S-T400R	impossible	400-230V	1500rpm
	Tseel	60 kW	1987	AD-60S-T400R	possible	400-230V	1500rpm
		60 kW	1988	AD-60S-T400R	impossible	400-230V	1500rpm
	Erdene	100 kW	1987	AD-100S-T400R	possible	400-230V	1500rpm
		100 kW	1987	AD-100S-T400R	impossible	400-230V	1500rpm
		60 kW	1985	AD-60S-T400R	impossible	400-230V	1500rpm
DORNOGOBI	Khubsgul	100 kW	1987	AD-100S-T400R	possible	400-230V	1500rpm
		60 kW	1987	AD-60S-T400R	impossible	400-230V	1500rpm
	Khatanbulag	60 kW	1976	AD-60S-T400R	possible	400-230V	1500rpm
		60 kW	1976	AD-60S-T400R	impossible	400-230V	1500rpm
ZAVKHAN	Tsetsen-Uul	60 kW	1971	AD-60S-T400R	possible	400-230V	1500rpm
		60 kW	1986	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1971	AD-60S-T400R	impossible	400-230V	1500rpm
		50 kW	1971	AD-50S-T400R	impossible	400-230V	1500rpm
	Erdenehairhan	100 kW	1980	AD-100S-T400R	impossible	400-230V	1500rpm
		60 kW	1980	AD-60S-T400R	possible	400-230V	1500rpm
	Songino	100 kW	1989	AD-100S-T400R	possible	400-230V	1500rpm
		60 kW	1983	AD-60S-T400R	possible	400-230V	1500rpm
		30 kW	1987	AD-30S-T400R	impossible	400-230V	1500rpm
	Numrug	60 kW	1986	AD-60S-T400R	possible	400-230V	1500rpm
	Zavhanmandal	60 kW	1985	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1990	AD-60S-T400R	impossible	400-230V	1500rpm
		60 kW	1990	AD-60S-T400R	possible	400-230V	1500rpm
	Santmargats	100 kW	1990	AD-100S-T400R	impossible	400-230V	1500rpm
		60 kW	1987	AD-60S-T400R	possible	400-230V	1500rpm
		60 kW	1985	AD-60S-T400R	impossible	400-230V	1500rpm

Table 2.1 Inventory of Existing System(3/3)

Aimag	Sum	Capacity	Production Year	Type	Operating Condition	Voltage	number of revolutions
ZAVKHAN	Urgamal	60 kW	1978	AD-60S-T400R	possible	400-230V	1500rpm
ZAVKHAN	Urgamal	60 kW	1974	AD-60S-T400R	impossible	400-230V	1500rpm
ZAVKHAN	Urgamal	60 kW	1974	AD-60S-T400R	impossible	400-230V	1500rpm
ZAVKHAN	Durvuljin	100 kW	1989	AD-100S-T400R	impossible	400-230V	1500rpm
ZAVKHAN	Durvuljin	100 kW	1994	AD-100S-T400R	possible	400-230V	1500rpm
ZAVKHAN	Durvuljin	60 kW	1985	AD-60S-T400R	impossible	400-230V	1500rpm
ZAVKHAN	Ider	100 kW	1989	AD-100S-T400R	impossible	400-230V	1500rpm
ZAVKHAN	Ider	60 kW	1989	AD-60S-T400R	possible	400-230V	1500rpm
ZAVKHAN	Tes	100 kW	1989	AD-100S-T400R	possible	400-230V	1500rpm
ZAVKHAN	Tes	60 kW	1986	AD-60S-T400R	impossible	400-230V	1500rpm
ZAVKHAN	Tes	320 kW	1969	CG.D13-42-12	impossible	400-230V	500rpm
ZAVKHAN	Tes	320 kW	1969	CG.D13-42-12	impossible	400-230V	500rpm
ZAVKHAN	Tes	315 kW			impossible	400-230V	500rpm
ZAVKHAN	Asgat	315 kW	1987	CY2-85-45-12	impossible	400-230V	500rpm
ZAVKHAN	Asgat	315 kW	1987	CY2-85-45-13	impossible	400-230V	500rpm
ZAVKHAN	Asgat	60 kW	1988	AD-60S-T400R	possible	400-230V	1500rpm
UBURKHANGAI	Bogd	100 kW	1979	AD-100S-T400R	impossible	400-230V	1500rpm
UBURKHANGAI	Bogd	60 kW	1980	AD-60S-T400R	possible	400-230V	1500rpm
UBURKHANGAI	Bogd	60 kW	1980	AD-60S-T400R	possible	400-230V	1500rpm
SUKHBAATAR	Erdenetsagaan	100 kW	1990	AD-100S-T400R	possible	400-230V	1500rpm
SUKHBAATAR	Erdenetsagaan	60 kW	1984	AD-60S-T400R	impossible	400-230V	1500rpm
SUKHBAATAR	Erdenetsagaan	60 kW	1984	AD-60S-T400R	impossible	400-230V	1500rpm
SUKHBAATAR	Naran	60 kW	1988	AD-60S-T400R	possible	400-230V	1500rpm
SUKHBAATAR	Naran	60 kW	1989	AD-60S-T400R	possible	400-230V	1500rpm
DORNOD	Tsagaan-Ovoo	100 kW	1990	AD-100S-T400R	possible	400-230V	1500rpm
DORNOD	Tsagaan-Ovoo	60 kW	1975	AD-60S-T400R	possible	400-230V	1500rpm
DORNOD	Tsagaan-Ovoo	100 kW	1980	AD-100S-T400R	impossible	400-230V	1500rpm
DORNOD	Tsagaan-Ovoo	100 kW	1980	AD-100S-T400R	impossible	400-230V	1500rpm
DORNOD	Tsagaan-Ovoo	200 kW	1980	AD-200S-T400R	impossible	400-230V	500rpm
DORNOD	Khulunbuir	30 kW	1972	AD-30S-T400R	possible	400-230V	1500rpm
DORNOD	Khulunbuir	60 kW	1981	AD-60S-T400R	possible	400-230V	1500rpm
DORNOD	Khulunbuir	60 kW	1981	AD-60S-T400R	impossible	400-230V	1500rpm
KHUVSGUL	Tsagaaannuur	100 kW	1989	AD-100S-T400R	possible	400-230V	1500rpm
KHUVSGUL	Tsagaaannuur	60 kW	1990	AD-60S-T400R	impossible	400-230V	1500rpm
KHUVSGUL	Tsagaan-Uur	100 kW	1988	AD-100S-T400R	possible	400-230V	1500rpm
KHUVSGUL	Tsagaan-Uur	60 kW	1984	AD-60S-T400R	impossible	400-230V	1500rpm
KHUVSGUL	Renchinlhumbe	60 kW	1984	AD-100S-T400R	possible	400-230V	1500rpm
KHUVSGUL	Renchinlhumbe	60 kW	1984	AD-60S-T400R	impossible	400-230V	1500rpm
KHUVSGUL	Erdenebulgan	315 kW	1985	CG.D13-42-12	impossible	400-230V	500rpm
KHUVSGUL	Erdenebulgan	315 kW	1984	CG.D13-42-12	impossible	400-230V	500rpm
KHUVSGUL	Erdenebulgan	60 kW	1985	AD-60S-T400R	possible	400-230V	1500rpm
KHUVSGUL	Erdenebulgan	60 kW	1984	AD-60S-T400R	impossible	400-230V	1500rpm

(4) Power Demand Forecast of Each Sum

The power demand of each sum was forecasted using historical power demand data of each category as shown in Table 2.2 and considering true power demand estimated taking into account the installed capacity of each sum and assumed operating hours. As demand varies according to season and area, these factors are taken into account in demand forecasting. The unrestricted maximum demand is also estimated from the installed capacity and assumed operating hours.

(a) Basic Data for Power Demand Forecast

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

For each sum, any significant increase in population and economic development can not be expected, and the following available data were analyzed:

- Maximum generated power of each sum
- Annual energy which is able to be delivered
- Annual and daily load curves

From the category-wise power demand data obtained in site investigation the category groups were classified as follows:

(i) General demand

(ii) Public demand

(iii) Civilian demand

In calculating the maximum demand of each sum, the same idea as that of the First Phase Project, "peak of general demand does not coincide with peak of public and civil demand", was followed. To improve accuracy of estimation, the daily load pattern* of five years in future was assumed as mentioned in this Clause, and the maximum demand was worked out.

(b) Population and Electrification Ratio

According to the result of hearing investigation at each sum, the average annual population growth rate of a sum under the Project is 2 to 3%. This rate differs sum by sum, and the growth of general demand is estimated using the national average of 1.7%.

The electrification ratio differs sum by sum, but this is mainly caused by shifting of inhabitants looking for the chance of employment and use of private generators for ghels. The present electrification ratios are assumed to be kept unchanged and significant improvement is not assumed.

(c) Power Loss and Distribution Capacity

There are two methods of 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 sums under the Project, reliable data for consumed energy can not be obtained due to lack of proper energy meters, and loss values are calculated by the above theoretical method.

While, the distribution capacity can be obtained by a calculation based on number of circuits, conductor size, route length, etc. The distribution loss is not significant in spite of small conductor size applied as the distribution distance is short and sending power is small. The calculation results for power loss and distribution capacity are presented in Table 2.3.

(d) Demand Forecast

The power demand of sums was estimated based on assumptions mentioned in the above Paragraphs (a), (b) and (c).

(i) General demand

The general demand occupies 40 to 60% of the total demand. A specific feature of the seasonal pattern of power consumption is that the power consumption is considerably larger in winter than that in summer and also the duration of use is longer. Therefore, the demand forecast is performed only for the winter demand.

As for the winter general demand, individual room heating and lighting are assumed to be sustained for almost 24 hours. The peak demand appears in the period of 17: 00 to 23: 00, and the demand in other times of day is estimated to be about 10% of the peak demand.

(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 new addition plans of public facilities at most of sums, and there is no possibility of significant growth of public demand. Thus, growth of public demand is not taken into account.

(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 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.

(iv) Overall demand of sum

The overall demand of each sum is estimated based on the conditions in the above Paragraphs (i), (ii) and (iii). Distribution power loss and station power consumption are taken into account. The power demand of 5 years in future is estimated, and generating facilities to meet the maximum power demand of five years in future, i. e. 2003, are assumed to be objectives of supply under the Project. Maximum demand (kW), required generating output (kW) and generating energy (kWh) of each sum in winter are tabulated in Table 2.4. The daily load pattern and number of operating generators of each sum in the winter season are shown in Figures 2.1-1 through 2.1-12.

* <u>The method of preparing daily load pattern</u>

(a) General demand: The obtained load at site is assumed to increase at a rate of 1.7% per annum corresponding to the population growth rate. The 8.8% increased demand 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 %

(b) Public demand: The hospital and room heating loads are assumed to be 24 hour loads, and other demands are distributed for the period of 8 to 18 o'clock as given below:

8~11hr	12~13 hr	14~17 hr	18 hr
100 %	50 %	100 %	30 %

(c) Civil demand: This demand is distributed in the period of 8 to 18 o'clock in the same manner as the other demand of the public demand.

The total of above (a) to (c) is determined as the estimated demand of each hour.

Table 2.2 Power Demand Data of Each Category (kW)

Aimag	Sum	General Demand	Public and Civilian Demand: Total	Public Office	School	Kindergarten	Hospital	Veterinary Hospital	Communication	Heating	Cooperative Society	Filling Station	Culture Center	Bank	Library, Public Hall	Factory	Others	Power Loss
BULGAN	1 Teshig	206.8	162.5	4.5	15.0	0.5	6.0	1.5	1.5	30.0	4.0	7.0	1.5	0.5	0.5	90.0	0.0	17.9
BAYAN-ULGII	2 Deluun	167.7	56.6	1.4	2.5	0.3	7.3	0.2	0.6	0.0	21.0	1.8	0.3	0.2	0.2	10.7	10.1	8.5
UBS	3 Zuungobi	70.0	103.8	4.3	5.0	2.5	7.0	1.0	5.0	15.0	30.0	1.0	2.5	3.0	0.5	25.0	2.0	10.7
	4 Zuunkhangai	160.8	62.4	0.8	5.0	0.5	0.8	0.1	0.2	22.0	10.0	1.0	2.5	0.5	1.0	18.0	0.0	9.9
	5 Malchin	70.0	110.7	6.8	8.2	3.2	7.3	2.4	6.5	34.0	3.2	2.6	1.8	1.4	0.8	20.5	12.0	5.7
	6 Tes	145.4	93.2	2.0	30.0	1.0	32.0	0.5	0.2	2.0	0.0	1.0	0.0	0.5	4.0	20.0	0.0	0.1
	7 Tsagaankhairkhan	124.2	109.0	4.0	26.0	4.0	20.0	2.0	2.0	10.0	10.0	10.0	9.0	0.0	0.0	12.0	0.0	8.3
	8 Hyargas	102.6	82.0	2.0	5.0	3.0	2.0	4.0	5.0	34.0	2.5	1.0	1.0	1.0	0.5	21.0	0.0	4.8
KHOVD	9 Tsetseg	92.1	51.0	5.0	12.0	6.0	10.0	2.0	5.0	0.0	0.0	2.0	2.0	1.0	0.0	4.0	2.0	10.0
	10 Bulgan	226.8	106.3	2.2	14.4	5.4	3.3	1.5	0.9	4.1	38.4	2.5	10.8	1.6	0.0	9.0	12.2	12.7
	11 Munkhkhairkhan	80.1	63.0	5.0	12.0	6.0	10.0	2.0	5.0	8.0	2.0	4.0	2.0	0.0	0.0	5.0	2.0	3.5
BAYANKHONGOF	12 Buutsagaan	100.5	161.9	9.5	20.0	8.0	12.0	3.0	3.6	30.0	2.3	5.0	2.0	3.5	3.3	41.7	18.0	7.1
	13 Bayan-Undur	120.0	211.9	7.6	10.0	2.0	15.0	1.2	4.0	35.0	2.0	4.0	6.0	2.5	1.0	100.0	21.6	12.3
	14 Bayantsagaan	225.3	18.5	1.0	3.5	1.5	1.2	0.1	1.5	5.2	1.0	1.5	2.0	0.0	0.0	0.1	0.0	19.7
GOBI-ALTAI	15 Altai	115.7	52.6	0.3	2.3	4.3	2.7	2.0	1.0	18.5	2.0	2.0	1.0	1.0	0.0	12.0	3.5	3.2
	16 Biger	87.4	49.0	1.0	6.0	1.0	5.0	0.5	3.0	0.0	6.0	6.0	0.5	0.5	0.5	4.0	15.0	5.1
	17 Tonkhil	108.1	81.5	3.5	14.0	3.0	10.0	2.0	6.0	19.0	0.0	6.0	3.0	1.0	0.0	12.0	2.0	7.0
	18 Khukhmorit	101.9	59.9	1.2	12.0	1.5	6.0	0.1	3.5	25.0	0.0	2.0	2.5	0.1	0.0	6.0	0.0	6.6
	19 Dariv	80.0	118.4	10.4	26.3	6.5	12.5	5.0	6.5	25.0	4.0	2.0	3.0	4.0	0.0	12.0	1.2	5.1
	20 Chandmani	226.6	58.6	2.0	5.0	1.0	4.0	0.8	2.0	24.5	4.0	1.0	3.5	0.8	2.0	8.0	0.0	24.0
	21 Tsogt	115.0	185.1	8.0	27.0	13.0	17.0	6.0	5.0	30.0	8.0	6.0	9.0	5.0	6.0	30.0	15.1	14.0
	22 Tseel	115.0	57.5	0.2	3.5	0.5	0.9	0.8	4.0	21.0	0.9	3.0	3.5	0.8	0.4	16.0	2.0	3.4
	23 Erdene	170.6	100.2	3.8	17.0	4.0	4.8	0.0	1.3	23.9	1.0	2.0	3.0	0.8	1.8	26.4	10.4	15.4
DORNOGOBI	24 Khuvsgul	127.0	43.1	1.5	3.0	1.1	5.9	0.3	6.0	8.0	0.5	1.7	2.6	0.3	0.2	10.0	2.0	12.0
	25 Khatanbulag	179.9	52.8	1.5	3.1	1.3	6.9	0.6	1.6	10.0	1.0	1.7	3.0	0.6	0.2	20.0	1.2	7.2
ZAVKHAN	26 Tsetsen-Uul	150.1	136.6	11.2	9.1	8.2	11.2	6.9	14.8	16.5	0.0	14.0	10.7	12.4	0.0	21.6	0.0	44.3
	27 Erdenekhairkhan	138.1	94.0	2.6	17.0	3.0	20.0	2.1	2.3	35.0	2.1	2.0	3.0	0.9	0.0	4.0	0.0	5.6
	28 Songino	70.3	191.1	17.5	14.3	7.8	17.6	10.5	8.4	37.6	10.3	12.5	11.6	15.6	0.0	27.4	0.0	25.6
	29 Numrug	90.0	143.7	8.0	18.0	5.0	12.0	5.0	2.5	32.0	0.0	5.2	8.0	1.0	2.0	40.0	5.0	9.6
	30 Zavkhanmandal	144.0	70.5	1.5	10.0	4.0	6.0	2.0	3.0	25.0	6.0	2.0	5.0	1.5	0.0	1.5	3.0	12.6
	31 Santmargats	118.5	68.6	27.6	2.7	0.2	2.6	0.3	2.4	25.0	0.4	2.0	1.6	0.4	0.0	1.0	2.4	8.5
	32 Urgamal	173.6	45.0	2.5	13.0	2.0	4.0	3.0	2.0	0.0	0.0	4.0	5.0	1.0	0.5	6.0	2.0	6.2
	33 Durvuljin	169.0	71.0	3.0	7.0	1.0	3.0	1.0	1.0	15.0	10.0	1.0	2.0	1.0	1.0	25.0	0.0	8.3
	34 Ider	120.4	56.7	9.7	13.8	0.1	10.4	0.9	0.2	0.0	0.9	0.2	4.5	0.2	0.2	2.1	13.5	6.9
	35 Tes	120.0	256.9	20.4	23.0	25.5	30.0	18.3	38.4	9.8	10.0	12.3	17.0	10.0	0.0	42.2	0.0	13.3
	36 Asgat	119.0	50.5	0.8	5.0	7.0	0.8	0.8	0.8	15.1	2.0	15.0	0.8	0.8	0.8	0.8	0.0	8.2
UVURKHANGAI	37 Bogd	197.0	118.7	1.2	45.0	5.0	7.5	0.1	3.0	20.0	20.0	3.0	3.0	0.1	0.8	10.0	0.0	13.3
SUKHBAATAR	38 Erdenetsagaan	144.1	75.8	2.0	14.5	1.0	10.0	1.0	4.5	37.5	2.0	0.5	0.5	0.3	0.5	0.5	1.0	9.3
	39 Naran	110.6	30.0	1.0	2.0	1.0	2.0	2.0	3.0	15.0	0.0	0.0	3.0	0.0	0.0	1.0	0.0	16.3
DORNOD	40 Tsagaan-Ovoo	156.9	131.0	11.0	31.5	5.0	20.0	5.0	13.0	13.5	8.0	6.0	10.0	3.0	5.0	0.0	0.0	12.0
	41 Khulunbuir	68.9	51.2	1.0	3.0	0.8	3.0	0.2	0.4	0.2	0.0	0.0	2.0	0.2	0.2	40.2	0.0	0.6
KHUVSGUL	42 Tsagaan-Uur	81.0	135.6	12.8	19.0	4.1	19.6	3.7	4.1	15.0	2.2	2.0	8.2	4.1	0.0	24.6	16.2	11.9
	43 Tsagaannuur	128.2	79.0	1.0	12.0	0.5	2.5	1.0	3.0	39.0	15.0	0.0	2.0	0.0	0.0	3.0	0.0	17.6
	44 Renchinlhumbe	114.4	36.6	2.1	7.2	0.2	2.1	2.0	4.0	0.0	3.0	1.0	2.0	1.0	2.0	10.0	0.0	5.5
	45 Erdenebulgan	136.3	106.2	1.5	13.0	0.5	1.5	0.4	2.5	30.0	15.0	3.5	2.5	0.4	0.4	35.0	0.0	11.2

Table 2.3 Power Loss and Capacity of Distribution Line

Aimag	Sum	Generator Capacity (kW)	No. of Circuit (cct)	Size of Conductor (mm2)	Continuous Allowable Current (A)	Distribution Capacity (kW)	Max. Demand (kW)	Average Power (kW)	Load Current (A)	Power Loss (kW)
BULGAN	1 Teshig	300	6	HA16	1089.0	603.6	278.9	167.3	301.9	17.92
BAYAN-ULGII	2 Deluun	200	3	HA16	544.5	634.2	198.3	71.4	128.8	8.5
			2	HA35	599.7			47.6	85.9	
UBS	3 Zuungobi	200	2	HA16	363.0	201.2	124.6	74.8	134.9	10.7
	4 Zuunkhangai	300	6	HA16	1089.0	603.6	207.7	124.6	224.8	9.9
	5 Malchin	180	2	HA16	363.0	407.9	126.6	50.6	91.4	5.7
			1	HA50	373.0			25.3	45.7	
	6 Tes	200	2	ACSR70	959.7	7978.9	192.3	115.4	13.9	0.02
	7 Tsagaankhairkhan	180	5	HA16	907.5	503.0	173.4	104.0	187.7	8.31
	8 Hyargas	180	3	HA35	899.6	498.6	152.4	91.4	165.0	4.8
KHOVD	9 Tsetseg	180	2	HA16	363.0	201.2	120.2	72.1	130.1	9.99
	10 Bulgan	300	5	HA25	1199.6	664.9	266.9	160.1	288.9	12.7
	11 Munkhkhairkhan	120	3	HA25	719.8	398.9	108.6	65.2	117.6	3.5
BAYANKHONGOR	12 Buutsagaan	200	3	HA35	899.6	498.6	183.9	110.3	199.1	7.1
	13 Bayan-Undur	300	3	HA25	719.8	565.1	243.9	109.8	198.0	12.3
			1	HA35	299.9			36.6	66.0	
	14 Bayantsagaan	300	2	HA25	479.9	432.2	271.2	108.5	195.7	19.7
			1	HA35	299.9			54.2	97.9	
GOBI-ALTAI	15 Altai	180	1	HA25	239.9	753.2	150.3	22.5	40.7	3.2
			3	HA50	1118.9			67.6	122.0	
	16 Biger	120	3	HA16	544.5	301.8	105.2	63.1	113.9	5.1
	17 Tonkhil	180	3	HA25	719.8	398.9	153.6	92.2	166.3	7.0
	18 Khukhmorit	180	3	HA25	719.8	398.9	148.5	89.1	160.8	6.6
	19 Dariv	180	2	HA16	363.0	467.2	134.4	40.3	72.7	5.1
			2	HA25	479.9			40.3	72.7	
	20 Chandmani	300	1	HA35	299.9	372.9	299.0	89.7	161.8	24.0
			1	HA50	373.0			89.7	161.8	
	21 Tsogt	300	3	HA25	719.8	398.9	216.6	130.0	234.5	14.0
	22 Tseel	180	6	HA25	1439.6	797.9	150.4	90.2	162.8	3.4
	23 Erdene	300	1	HA16	181.5	433.0	229.7	45.9	82.9	15.4
			2	HA35	599.7			91.9	165.8	
DORNOGOBI	24 Khuvsgul	180	2	HA25	479.9	266.0	164.1	98.5	177.6	12.0
	25 Khatanbulag	300	6	HA25	1439.6	797.9	219.9	131.9	238.0	7.2
ZAVKHAN	26 Tsetsen-Uul	300	2	HA16	363.0	201.2	253.3	152.0	274.2	44.3
	27 Erdenekhairkhan	300	5	HA35	1499.3	831.0	210.9	126.5	228.3	5.6
	28 Songino	300	3	HA16	544.5	301.8	235.8	141.5	255.3	25.6
	29 Numrug	200	4	HA16	726.0	402.4	166.8	100.1	180.6	9.6
	30 Zavkhanmandal	300	2	HA35	599.7	332.4	200.3	120.2	216.8	12.6
	31 Santmargats	180	2	HA35	599.7	332.4	165.0	99.0	178.6	8.5
	32 Urgamal	200	4	HA35	1199.4	664.8	199.1	119.5	215.5	6.2
	33 Durvuljin	300	2	HA35	599.7	539.1	210.2	84.1	151.7	8.3
			1	HA50	373.0			42.0	75.8	
	34 Ider	180	3	HA16	544.5	434.8	148.3	66.7	120.4	6.9
			1	HA25	239.9			22.2	40.1	
	35 Tes	300	4	HA16	726.0	8712.3	294.0	117.6	212.2	13.3
			2	HA35	599.7			58.8	4.2	
	36 Asgat	180	4	HA16	726.0	402.4	153.6	92.2	166.3	8.2
UVURKHANGAI	37 Bogd	300	1	HA16	181.5	599.2	255.1	38.3	69.0	13.3
			3	HA35	899.6			114.8	207.1	
SUKHBAATAR	38 Erdenetsagaan	300	1	HA16	181.5	599.2	213.6	32.0	57.8	9.3
			3	HA35	899.6			96.1	173.4	
	39 Naran	200	2	HA16	363.0	201.2	153.6	92.2	166.3	16.3
DORNOD	40 Tsagaan-Ovoo	300	4	HA16	726.0	535.4	216.2	103.8	187.2	12.0
			1	HA25	239.9			25.9	46.8	
	41 Kholunbuir	120	2	HA50	746.0	945.4	78.8	23.6	42.7	0.6
			2	ACSR70	959.7			23.6	42.7	
KHUVSGUL	42 Tsagaan-Uur	180	3	HA16	544.5	301.8	160.5	96.3	173.7	11.9
	43 Tsagaannuur	200	2	HA25	479.9	266.0	198.6	119.2	215.0	17.6
	44 Renchinlhumbe	200	2	HA35	599.7	332.4	132.1	79.3	143.0	5.5
	45 Erdenebulgan	200	2	HA16	363.0	3525.7	191.0	76.4	137.8	11.2
			1	HA25	239.9			38.2	2.8	

Table 2.4 Max. Demand, Max. Generating Output and Generating Energy

Aimag	Sum	Maximum Demand (kW)	Maximum Generating Output (kW)	Generating Energy (kWh/day)
BULGAN	1 Teshig	278.9	300.0	4,900
BAYAN-ULGII	2 Deluun	198.3	200.0	3,100
UBS	3 Zuungobi	124.6	200.0	2,600
	4 Zuunkhangai	207.7	300.0	3,200
	5 Malchin	126.6	180.0	2,460
	6 Tes	192.3	200.0	3,800
	7 Tsagaankhairkhan	173.4	180.0	3,240
	8 Hyargas	152.4	180.0	2,820
KHOVD	9 Tsetseg	120.2	180.0	2,340
	10 Bulgan	266.9	300.0	4,700
	11 Munkhkhairkhan	108.6	120.0	2,280
BAYANKHONGOR	12 Buutsagaan	183.9	200.0	4,000
	13 Bayan-Undur	243.9	300.0	4,400
	14 Bayantsagaan	271.2	300.0	3,700
GOBI-ALTAI	15 Altai	150.3	180.0	2,760
	16 Biger	105.2	120.0	1,980
	17 Tonkhil	153.6	180.0	2,820
	18 Khukhmorit	148.5	180.0	2,760
	19 Dariv	134.4	180.0	2,520
	20 Chandmani	299.0	300.0	3,900
	21 Tsogt	216.6	300.0	4,200
	22 Tseel	150.4	180.0	2,820
	23 Erdene	229.7	300.0	4,600
DORNOGOBI	24 Khuvsgul	164.1	180.0	2,340
	25 Khatanbulag	219.9	300.0	3,700
ZAVKHAN	26 Tsetsen-Uul	235.3	300.0	4,700
	27 Erdenekhairkhan	210.9	300.0	4,100
	28 Songino	235.8	300.0	4,800
	29 Numrug	166.8	200.0	4,000
	30 Zavkhanmandal	200.3	300.0	3,400
	31 Santmargats	165.0	180.0	2,820
	32 Urgamal	199.1	200.0	3,100
	33 Durvuljin	210.2	300.0	3,400
	34 Ider	148.3	180.0	2,640
	35 Tes	294.0	300.0	4,900
	36 Asgat	153.6	180.0	2,640
UVURKHANGAI	37 Bogd	255.1	300.0	4,700
SUKHBAATAR	38 Erdenetsagaan	213.6	300.0	3,900
	39 Naran	153.6	200.0	3,000
DORNOD	40 Tsagaan-Ovoo	216.2	300.0	4,200
	41 Khulunbuir	78.8	120.0	1,680
KHUVSGUL	42 Tsagaan-Uur	160.5	180.0	2,940
	43 Tsagaannuur	198.6	200.0	3,100
	44 Renchinlhumbe	132.1	200.0	3,000
	45 Erdenebulgan	191.0	200.0	3,800

(5) Adequate Installed Generating Capacity and Number of Units of Each Sum

In selecting the unit generator output and number of units for each sum, the criterion that the generation pattern can follow the load pattern of five years in future in a most economical manner was reviewed as the most important condition.

In estimating the daily load pattern of five years in future, the patterns before 1990 were referred to. As mentioned in Sub-clause (1) above, the demand is suppressed due to the present insufficiency in generating capability and the present load pattern does not represent the true pattern based on requirement. Therefore, the load pattern before economic corruption when the demand was not restricted was referred to.

A load allocating device is required for the parallel operation of 60 kW and 100 kW generators. In one sum, diesel generators of the same capacity are installed to minimize the initial investment cost and be easy of operation and maintenance.

The adopted selection procedures for generator output and number of units are shown below:

Preparation of daily load pattern in 2003 (5 years in future)

↓

Selection of generator output and number of units to meet peak load

↓

Finalization of generator output and number of units taking into account of available space for new sets in the existing power station

The installed capacity of diesel generators and number of units which satisfy the maximum demand (kW) of each sum which are most economic in operation were selected by the above method. The selected generator output and quantity of units for each sum are presented in Table 2.6, and summarized in Table 2.5.

Table 2.5 Selected Generator Unit Capacity and Number of Units

	Unit Output		100 kW	60 kW	Total
(i)	Requested No. of Units	(Units)	42	92	134
(ii)	Results of Analysis	(Units)	74	48	122
(iii)	(i) - (ii)	(Units)	+ 32	- 44	- 12

Table 2.6 Selected Generator Capacity and Quantity of Units

Aimag		Sum	Maximum Demand (kW)	Required No. of Units		Result of Analysis		Fluctuation	
				100kW	60kW	100kW	60kW	100kW	60kW
BULGAN	1	Teshig	278.9	2	1	3	0	1	-1
BAYAN-ULGII	2	Deluun	198.3	1	2	2	0	1	-2
UBS	3	Zuungobi	124.6	1	2	2	0	1	-2
	4	Zuunkhangai	207.7	1	2	3	0	2	-2
	5	Malchin	126.6	1	2	0	3	-1	1
	6	Tes	192.3	2	1	2	0	0	-1
	7	Tsagaankhairkhan	173.4	1	2	0	3	-1	1
	8	Hyargas	152.4	1	2	0	3	-1	1
KHOVD	9	Tsetseg	120.2	1	2	0	3	-1	1
	10	Bulgan	266.9	2	2	3	0	1	-2
	11	Munkhkhairkhan	108.6	0	2	0	2	0	0
BAYANKHONGOR	12	Buutsagaan	183.9	1	2	2	0	1	-2
	13	Bayan-Undur	243.9	1	2	3	0	2	-2
	14	Bayantsagaan	271.2	1	2	3	0	2	-2
GOBI-ALTAI	15	Altai	150.3	1	3	0	3	-1	0
	16	Biger	105.2	1	2	0	2	-1	0
	17	Tonkhil	153.6	1	2	0	3	-1	1
	18	Khukhmorit	148.5	0	3	0	3	0	0
	19	Dariv	134.4	1	2	0	3	-1	1
	20	Chandmani	299.0	1	2	3	0	2	-2
	21	Tsogt	216.6	1	2	3	0	2	-2
	22	Tseel	150.4	1	2	0	3	-1	1
	23	Erdene	229.7	2	1	3	0	1	-1
DORNOGOBI	24	Khuvsgul	164.1	1	2	0	3	-1	1
	25	Khatanbulag	219.9	1	2	3	0	2	-2
ZAVKHAN	26	Tsetsen-Uul	235.3	0	3	3	0	3	-3
	27	Erdenekhairkhan	210.9	0	3	3	0	3	-3
	28	Songino	235.8	0	3	3	0	3	-3
	29	Numrug	166.8	1	2	2	0	1	-2
	30	Zavkhanmandal	200.3	1	2	3	0	2	-2
	31	Santmargats	165.0	0	3	0	3	0	0
	32	Urgamal	199.1	0	3	2	0	2	-3
	33	Durvuljin	210.2	1	2	3	0	2	-2
	34	Ider	148.3	1	2	0	3	-1	1
	35	Tes	294.0	3	0	3	0	0	0
	36	Asgat	153.6	2	2	0	3	-2	1
UVURKHANGAI	37	Bogd	255.1	1	2	3	0	2	-2
SUKHBAATAR	38	Erdenetsagaan	213.6	1	2	3	0	2	-2
	39	Naran	153.6	0	2	2	0	2	-2
DORNOD	40	Tsagaan-Ovoo	216.2	1	2	3	0	2	-2
	41	Khulunbuir	78.8	1	2	0	2	-1	0
KHUVSGUL	42	Tsagaan-Uur	160.5	1	2	0	3	-1	1
	43	Tsagaannuur	198.6	0	2	2	0	2	-2
	44	Renchinlhumbe	132.1	0	2	2	0	2	-2
	45	Erdenebulgan	191.0	1	2	2	0	1	-2
				42	92	74	48	32	-44
				134		122		-12	
Total Capacity (kW)				9,720		10,280			

(6) Special Design Based on Natural and Geographical Conditions at Site

The objective sums of the Project lie in an inland country and there is a large temperature difference between summer and winter. In winter, temperature goes down below - 40 degree in many sums. In the west, there are many sums lying at a high altitude to the highest of 2640 m. There are frequent thunderstorms during seasonal transition from April to summer, which cause many damages to electrical facilities. The southeastern area of the county is in the desert area. Strong wind blows except for summer season of June to July, and sand storm is frequent due to strong wind.

Under such site conditions, the following factors need to be taken into account in design of electrical equipment:

(a)	Altitude	:	800 m to 2,640 m
(b)	Ambient temperature	:	Minimum - 45 °C
		:	Maximum + 32 °C
(c)	Annual frequency of lightning hit	:	20 times

Natural and geographical conditions of the sums affect design of diesel generating facilities. Especially, the engine output decreases due to altitude and temperature must be taken into account in estimating site output. Each manufacturer has a standard series of engine output and adequate engine type is usually selected from this series without designing special type to suite site conditions. For continual management, operation and maintenance of equipment, air heating facilities for operation of diesel engines in winter, dust prevention or filtering facilities, etc. need to be taken into account.

Guessing from the observation records of thunder storms at sums, considerable frequency of annual lightning hits are anticipated and actually many examples of generator faults, especially of windings were reported. Such damages seem to be caused by lightning as distribution lines are of high overhead construction. To avoid damages due to lightning strokes, provision of proper grounding of equipment and facilities, installation of insulation transformers between generator circuits and distribution lines and lightning arresters on incoming line poles, etc. are planned to be designed.

Mechanical damages and burning of bearings were observed at many sums. This seems to be caused by insufficient lubricating effects as lubricating oil does not circulate properly the friction surfaces due to very 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.

(7) Transportation to the Site

Almost all of the roads have not been paved except Ulaanbaatar city, and the roads are very bad conditions caused by insufficient maintenance. Under the situation, it is very difficult to transport the facilities supplied by the Project, to the sites of 45 sums in all over the country. As width of the roads from aimag center to the sums become narrower, 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 thoroughgoing putting emphasis on inland transportation.

(8) Execution Schedule

The weather condition should be taken notice to plan the schedule of installation at site. It is very cold in winter, it is impossible to carry out the erection under the temperature which goes down below -30 °C. The installation of the new generators must be completed in December due to supply the electric power to central heating facilities.

The erection and installation are carried out simultaneously by 5 parties due to completion of the works at 45 sums in 12 aimags all over the country during this limited period, been ahead of the north and western mountainous areas which become cold from September.

(9) Outline of the Plan

Based on the result of the above analyses, the project outline of the 45 sums are as given below:

(a) Purchase of diesel generating facilities

(b) Arrangement of concrete foundations for equipment

(c) Execution of equipment installation

(d) Commissioning tests prior to taking over

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

(f) Countermeasure to produce warm air in restarting

(g) Supply of maintenance tools and a vehicle for the traveling maintenance team established in 6 aimags

(h) Execution of the Soft Component Program

During the commissioning tests, diesel generators will be operated continuously for five hours under attendance of the contractors. For the warm air counter measures for engine restarting, air-heating facilities for machine rooms using simplified stoves burning animal dung, coal or other fuel need to be arranged.

The matters of the traveling maintenance team were discussed thoroughly with MOID, It is judged that the supply to 6 aimags is reasonable, in consideration of good use of the tools.

So that the sum 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.

2 - 3 Basic Design

2 - 3 - 1 Design Concept

(1) Meteorological Conditions

(a) Temperature and Humidity

The ambient temperature varies site by site. The relative humidity is generally low and there is not much variation among values of various locations. In design of the Project, the criteria in the First Phase Project will be applied basically, but for the lowest temperature in the winter period the result of site investigation will be applied:

Minimum average ambient temperature	:	-45 °C
Maximum average ambient temperature	:	+32 °C
Maximum relative humidity	:	70 %

(b) Wind Velocity and Sandstorms

The recorded maximum wind velocity at each sum ranges in 20 to 30 m/sec. Especially, in the Gobi desert area in the south to southeast of the country 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 equipment design in these areas. In the Project, the design maximum 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, equipment is of indoor use and will not be much affected by rainfall and snowfall.

(d) Lightning

A lot of thunderstorms are recorded in the mountainous areas in the west. Especially, during from April to summer there are a lot of lightning hits and many records of damages to electric facilities are reported.

(2) Geographical Conditions and Water Quality

The output of diesel engine goes down with increase in elevation due to thin air. Therefore, to obtain required output, increase of engine output or adoption of engine with one class higher output is required. In this project, to furnish engines with turbo-chargers will augment the engine output, and larger engines were adopted at high altitude areas.

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 generators and auxiliary facilities to be provided to each sum power station.

(a) Specifications of equipment

Basic specifications of equipment are as follows:

Table 2.7 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 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 outputs 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 reinforcement plan of sum generating facilities under the Project is explained below.

(1) Utilization of Existing Facilities

At the objective sums, power stations with some diesel generators constructed with the former Soviet aid are still under operation. Therefore, these power houses, distribution lines, etc. can be used for the Project. However, the houses shall be required some repairs so that they are very old and partly damaged.

The design under the Project is based on the assumption that the new facilities are to be installed after removal of all unusable items in the existing power stations. Each sum has an intention to utilize old equipment in the existing power stations as far as possible, but the parallel operation with new equipment is not considered in the Project. It is planned to use the removed generators for room heating with own arrangement by sums.

The existing 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 2.2 - 1 through 2.2 - 4 show single line diagrams of the existing power stations in sums.

(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 2.3 - 1 through 2.3 - 45.

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.

(3) **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	:	74 sets	48 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	

(4) **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	:	74 sets	48 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	

(5) Auxiliary Equipment and Accessories

(a) Protection and control board

i)	Installing 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	:	150 AH x 2 pcs 2 sets
iii)	Battery voltage	:	12 V
iv)	Rectifier output voltage	:	24 V
v)	Rectifier rated current	:	25 A
vi)	Installing place	:	Indoor, generator room
vii)	Preheating system	:	Air heating and space heater

(d) Low tension distribution board

i)	Board type	:	Indoor, self supporting type
ii)	Board ratings	:	600 V, 600 A, 12.5 kA
iii)	Bus capacity	:	600 A
iv)	Installing place	:	Indoor, generator room
v)	Main circuit breaker	:	SF6 gas circuit breaker
vi)	Main circuit breaker type	:	600 V, 600 A, 12.5 kA
vii)	Drawout circuit breaker type	:	Air fuseless type
viii)	Drawout circuit breaker ratings	:	600 V, 225 A, 6.3 kA
ix)	Instrument PT ratings	:	400/110 V, 100 VA
x)	Instrument CT ratings	:	300/5 A, 25 VA 150/5 A, 25 VA

(e) Insulation transformers

i)	Type	:	Oil-filled type
ii)	Rated capacity	:	450 kVA 250 kVA 160 kVA
iii)	Rated voltage	:	Input 400 - 230 V / Output 400 - 230 V
iv)	Connection vector	:	Dyn 11
v)	Cooling system	:	Oil-filled, self-cooled

(6) Operating Methods

For operation system, the manual system which is same as those of the grassroots grant and the First Phase Project is adopted. The manual system has merits in view of compactness in construction, easiness in operation and easiness in 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

(7) 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 indicator or lamp indicator (3 elements of frequency, voltage and phase difference)

(b) Load allotting equipment : Simplified, contact-less, automatic load allotting equipment, with load limiter

(c) Installing place : Indoor

(d) Number of units controlled : 2 to 3 units

(8) Spare Parts

Spare parts are essential to maintenance of generating equipment. Consumption parts for about 2 years are to be supplied together with each generating unit as standard spare parts, and replacement parts for serious trouble are to be supplied for the traveling maintenance team separately as special spare parts. A list of special spare parts is shown in Table 2.8.

Table 2.8 List of Special Spare Parts

No.	Parts	Q'ty
1	Fuel injection pump assembly	1 set
2	Water pump assembly	1 set
3	Oil pump assembly	1 set
4	Piston ring assembly	6 pcs
5	Gasket kit	1 set

(9) 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 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.

(10) 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) Diesel generator

(d) Auxiliary equipment and accessories

(e) Insulation transformer

(f) Protection and control equipment

(g) Low tension distribution board

(h) Distribution materials

(i) Installation materials

(j) DC source equipment

(k) Spare parts

(11) 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) Fuel pipings and valves

(d) Conduit pipes and fittings

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

(f) Pedestals, hangers, supports, etc.

(12) Materials for Connecting with Distribution Lines

The generated energy is to be delivered to consumers through the existing distribution lines. The existing power cables have already been deteriorated due to very old 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 generator low tension panels and the existing first poles, and connecting clamps, power cable protecting pipes, cable fittings and bands, etc. will be included in supply items. 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 aluminum conductor cable
ii)	Rated voltage	:	600 V
iii)	No. of cores and size	:	3-core x 150 mm^2 + 1-core x 100 mm^2

(b) Connecting clamps

i)	Type	:	PG clamp
ii)	Material	:	Hard aluminum
iii)	Connecting sizes	:	16 to 50 mm^2 - 150 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

(13) Materials for Connecting with Existing Generators

As mentioned in Paragraph (5) of Sub-clause 2-2, rehabilitation of existing generating facilities will not be conducted under the Project and parallel operation with the existing generators is not considered. Therefore, connecting materials are not required.

(14) Air Heating Facilities

In the project areas, the minimum winter temperature goes down to below - 40 °C in the mountainous region. 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 2.4 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.

(15) 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 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 can be attained, fabrication period can be shortened, and lower overall cost can be attained.

Detailed construction of pre-fabricated foundation is shown in Figure 2.5, 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

(16) Maintenance and Repairing Tools

On site investigation of 12 aimags for supply of maintenance and repairing tools to the traveling maintenance team, requested by Mongolia, 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 at sums 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 is planed on 12 aimags, but on 14 aimags if a grass-roots assistance and the First Phase Project are included. The number of the generators supplied from Japan by a grass-roots assistance and the First Phase Project and planed by this Project are shown in Table 2.9. It is judged that the supply to 6 aimags is reasonable, in consideration of good use of the tools. Selected aimags and covered aimags and sums by the traveling maintenance team established in each aimag are shown below:

	Selected Aimags	Covered Aimag(s)	Number of Sums
(a)	GOVI-ALTAI	GOVI-ALTAI	9
(b)	BAYANKHONGOR	BAYANKHONGOR UVURKHANGAI UMNUGOVI	15
(c)	KHUVSGUL	KHUVSGUL BULGAN	13
(d)	ZAVKHAN	ZAVKHAN	11
(e)	SUKHBAATAR	SUKHBAATAR DORNOD DORNOGOVI KHENTII	11
(f)	KHOVD	KHOVD UVS BAYAN-ULGII	15

The tools supplied to each traveling maintenance team under this Project are shown as below. The details are shown in Table 2.10.

(a) Truck type vehicle with roof : 1 set

(b) Measuring instruments and meters : 1 set

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

Table 2.9 Number of Installed Generators of Each Project (1/4)

Almag		Sum	Glassroots Grant 100kW	Glassroots Grant 60kW	First Stage 100kW	First Stage 60kW	Second Stage 100kW	Second Stage 60kW
1 UMNUGOVI	1	Bajandalai						
	2	Bajan-Ovoo						
	3	Bulgan						
	4	Gurvantes						
	5	Mandal-Ovoo			-	2		
	6	Manlai	-	3				
	7	Noyon						
	8	Nomgon						
	9	Sevrei			-	2		
	10	Khanbogd						
	11	Tsogt-Ovoo						
	12	Khlmroen						
	13	Tsogttsetii						
		Sub-total	0	3	0	4	0	0
		Number of Sums	1		2		0	
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
		Number of Sums	0		0		9	
3 BAYANKHONGOI	32	Shinejinst			-	2		
	33	Bajan-Under					3	0
	34	Bajanlig			-	2		
	35	Bajangov						
	36	Bogd						
	37	Jinst						
	38	Baansagaan			-	3		
	39	Bajantsagaan					3	0
	40	Khureemaral			-	3		
	41	Gurvanbulag						
	42	Jargalant			3	-		
	43	Galuut			-	3		
	44	Erdenesogt	1	2				
	45	Bajan-Ovoo						
	46	Bajan-Bulag			-	2		
	47	Buutsagaan					2	0
	48	Bumbugur						
	49	Ulziit						
	50	Zag						
		Sub-total	1	2	3	15	8	0
		Number of Sums	1		7		3	

Table 2.9 Number of Installed Generators of Each Project (2/4)

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

Table 2.9 Number of Installed Generators of Each Project (3/4)

Aimag	Sum	Glassroots Grant 100kW	Glassroots Grant 60kW	First Stage 100kW	First Stage 60kW	Second Stage 100kW	Second Stage 60kW
10 KHUVSGUL	96 Jargalant			-	3		
	97 Galt			-	2		
	98 Shine-Ider			-	3		
	99 Tumurbulag						
	100 Burentogtokh						
	101 Tsetserleg						
	102 Arbulag			-	2		
	103 Bayanzurkh			-	2		
	104 Chandamani-Undur			-	2		
	105 Tsagaan-Uur					0	3
	106 Tsagaan-Uul						
	107 Ulaan-Uur			-	2		
	108 Renchinlhumbe					2	0
	109 Tunel						
	110 Tosontsengel						
	111 Alag-Erdene						
	112 Khatgal	1	2				
	113 Tsagaannuur					2	0
	114 Erdenebulgan					2	0
	Sub-total	1	2	0	16	6	3
	Number of Sums	1		7		4	
11 ARKHANGAI	115 Khangai						
	116 Tariat						
	117 Tsahir						
	Sub-total	0	0	0	0	0	0
	Number of Sums	0		0		0	
12 ZAVKHAN	118 Shiluustei						
	119 Durvuljin					3	0
	120 Jaruu						
	121 Erdenekhairkhan					3	0
	122 Zavkhanmandal					3	0
	123 Urgamal					2	0
	124 Santmargats					0	3
	125 Tsetseen-Uul					3	0
	126 Ider					0	3
	127 Ikh-Uul						
	128 Tes					3	0
	129 Tsagaanchuluut						
	130 Tsagaankhairkhan						
	131 Telmen						
	132 Tudevtei						
	133 Songino					3	0
	134 Otgon						
	135 Numrug					2	0
	136 Asgat					0	3
	137 Bayankhairkhan						
	138 Bulnai						
	Sub-total	0	0	0	0	22	9
	Number of Sums	0		0		11	
13 BULGAN	139 Tesig					3	0
	Sub-total	0	0	0	0	3	0
	Number of Sums	0		0		1	

Table 2.9 Number of Installed Generators of Each Project (4/4)

Almag	Sum	Glassroots Grant		First Stage		Second Stage	
		100kW	60kW	100kW	60kW	100kW	60kW
14 UBS	140 Undurkhangai						
	141 Tsagaankhairkhan					0	3
	142 Zuunkhangai					3	0
	143 Khyargas					0	3
	144 Baruuntruun						
	145 Malchin					0	3
	146 Zuungobi					2	0
	147 Bukhmurun						
	148 Zavkhan						
	149 Tes					2	0
	Sub-total	0	0	0	0	7	9
	Number of Sums	0		0		6	
15 KHOVD	150 Miangad						
	151 Zereg			-	2		
	152 Darvi			2	-		
	153 Altai						
	154 Uiench						
	155 Bulgan					3	0
	156 Tsetseg					0	3
	157 Must			2	-		
	158 Munkkhkhairkhan					0	2
	159 Mankhan						
	160 Chandmani			-	2		
	161 Khovd						
	162 Buyant						
	163 Durgun						
	Sub-total	0	0	4	4	3	5
	Number of Sums	0		4		3	
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
	Number of Sums	1		0		1	
	Total Number of Generators	3	9	12	46	74	48
	Total Number of Sums	4		25		45	

Table 2.10 Tools and Materials for Maintenance Car (1/2)

No.	Item	Q'ty
Tool/Material		
1	Polyethylene Jug 2L	1 pc
2	Polyethylene Funnel	1 pc
3	Drum Pump (Manual)	1 set
4	Oil Jug	1 pc
5	Oilier 180cc	2 pcs
6	Grease Gun Lever Type	1 pc
7	Nozzle Tester	1 set
8	Compression Gauge	1 set
9	Cylinder Gauge 50-150mm	1 set
10	Digital Tachometer 60-3000rpm	1 set
11	Maintenance Tool Set for Diesel Engine (75 Items	1 set
12	Piston Ring Compressor	1 set
13	Piston Filler Gauge 230mmL, 0.05-0.38mm	1 set
14	Piston Ring Tool Max. 135mm	1 set
15	Bearing Puller Set	1 set
16	Oil Jack 3ton	2 set
17	Convex Rules 5m	1 pc
18	Rasp 5 Sets	2 set
19	Bow-shaped Saw 250mm	2 pcs
20	Hand Light	2 set
21	Cord Reels 220V, 30m	1 set
22	Polyethylene Tank 20Ltr	1 pcs
23	Wire Brush	2 pc
24	Paint Brush	4 pcs
25	Torque Wrenches 2-20kgf.m	1 pc
26	Torque Wrenches 10-85kgf.m	1 pc
27	Vernier Calipers, 300mm	1 pc
28	Micrometer 100-125mm	1 pc
29	Micrometer 125-150mm	1 pc
30	Dial Gauge	1 pc
31	Magnet Stand for Dial Gauge	1 pc
32	Thickness Gauge	2 pcs
33	V-Block	2 pcs
34	Straight Scale	1 pc
35	Test Pump, 50kg/cm^2	1 pc
36	Chain Block, 3 ton	2 pc
37	Wire Rope 10mm 3L	4 pcs
38	Pliers, 200mm	1 pc
39	Extractor (6, 8, 10, 12M)	2 sets
40	Tap dies (6, 8, 10, 12M)	2 sets
41	Tap dies (handle)	1 pc
42	Scraper 25mm W	2 pcs
43	Digital Maltimeter	1 pc
44	Clamp Ammeter	1 set

Table 2.10 Tools and Materials for Maintenance Car (2/2)

No.	Item	Q'ty
45	Electric Drill ,13mm	1 pc
46	Electric Drill Head,6.0-13.0mm	1 set
47	Soldering Iron (220V,200W) with Solder (1kg)	1 pc
48	Megatester	1 pc
49	Pliers for Compression Connector	1 pc
50	Phase Meter	1 pc
Consumables		
1	Grease (No. 6) 1kg	2 pcs
2	Penetration Spray (CR-5), 480ml	5 pcs
3	Color Checker (6 cans)	5 sets
4	Liquid Packin, 200g	10 pcs
5	Insulation tape 20m, Black	10 pcs
6	Insulation Tape 20m, Red	10 pcs
7	Insulation Tape 20m, Yellow	10 pcs
8	Insulation Tape 20m, Green	10 pcs
9	Compression Connector 3.2, 4.3, 5.3, 6.4, 8.4mm/set	5 set
10	Compression Connector 14, 22, 30, 38	5 set
11	Sand Paper ##100, 10 sheets	20 case
12	Blade for Bow-shaped Saw 250mm	20 pcs
13	Wiping Clothes	10 pcs
14	Work Gloves	10 pair
15	Rubber Gloves	5 set

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 sums which are receiving new facilities under the Project. Up to the present, MOID has not yet prepared detailed execution plan. While, each sum 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 level.

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

(a) Preparatory works for installation works

Before commencing site installation works, contractors will carefully inspect the access for transport and whether removal or relocation of existing facilities 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 for proper execution of the preparatory works.

(b) Installation works

As the installation works will take long time if the equipment are installed following 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 not to cause faults and accidents by mis-wiring and mis-connection. During this period, the contractors are required to train sum operators for operation and maintenance of 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 generating facilities to the sums should be confirmed by the Consultant/Client with reviewing check lists to be entered in by representatives of both contractors and sums. The trial operation is very important to confirm properties 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 contractors 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 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 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

(2) Works by Japanese Contractors

Contractors 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 sums, 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 generators	(Low tension generator itself)
- Low tension insulation transformers	(Indoor, oil-filled transformer)
- Low tension generator panels	(Indoor, low tension, enclosed panel)
- Low tension control panels	(Indoor, low tension, enclosed panel)
- Power cables	(3-phase, 4-wire cables for outgoing circuits)
- Existing distribution lines	(First poles 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 scopes of works for supply of equipment and materials and installation works are mentioned below.

(a) Piping materials necessary to branch from the piping of the existing fuel storage tank, and site works for connection and installation

(b) Power cables and terminal processing materials for connection between low tension panel and the existing distribution lines (first pole of line) or the stepup 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 and the First Phase Project, and is planning to carry out necessary works only by informing execution policies to concerned sums. However, for the Project the number of sums are as many as 45, 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 sums 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. for which Japanese prices are very high 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 sums. 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)	Diesel generators (main bodies)	100 kW x 74 sets 60 kW x 48 sets	Japan
2)	Auxiliaries (starting equipment, exhausting equipment)	1 lot for 45 sums	Japan
3)	Room heating facilities	1 lot for 45 sums	Local
4)	Protection, control and synchronizing panels	1 lot for 45 sums	Japan
5)	low tension panels	1 lot for 45 sums	Japan
6)	DC supply panels, batteries and chargers	90 sets	Japan
7)	Insulation transformers	1 lot for 45 sums	Japan
8)	Power and control cables	1 lot for 45 sums	Japan
9)	Pipes and valves	1 lot for 45 sums	Japan
10)	Grounding materials	1 lot for 45 sums	Japan
11)	Prefabricated foundations	122 sets	Local
12)	Connecting materials with existing lines (including lightning arresters)	1 lot for 45 sums	Japan
13)	Construction equipment and tools	1 lot for 45 sums	Japan
14)	Tools for traveling maintenance team	6 sets	Japan
15)	Spare Parts and consumption materials	1 lot for 45 sums	Japan
16)	Replacement parts	14 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 summer time only. For project execution, 13 months in total will be required; 2 months for working design, 2 months for bidding and conclusion of contract, 3 months for manufacturing of equipment and materials, and 6 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

Items / Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Detailed Design																	
Site Investgation and Meeting	■																
Detail Design	□	□															
Final Meeting for Design			■														
2. Tender & Contract																	
Tender Announcement			▲														
Tendering				▲													
Tender Evaluation				□													
Award of Contract					▲												
3. Implementation																	
Design and Manufacturing						□	□	□									
Transportation to Ulaanbaatar								□	□	□							
Foundation Manufacturing						■	■										
Transportation and Installation of Foundation							■	■	■								
Inland Transportation of Generating System										■	■	■	■				
Installation, Adjustment and Test										■	■	■	■				
Handing Over														▲			
4. Soft Component																	
Preparation of Lecture, Lecture and Practice									■	■	■						
Evaluation											□						
Collecting of Monitoring Sheets and Data															■		
Analyzing and Evaluation of Data, Lecture, Site Visit															■	■	
Evaluation																	□

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 Appendix 4 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 45 sums, however the operators in sums 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 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 (Summer session) : July to September 1999 (3.0 months)
- Second session (Winter session) : January to February (2.0 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 sums
  - iii) Operation and management of power supply utilities

- Mongol 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 chief or deputy		O
ii) Power station chief and operators of sums	O	O
iii) Power utility engineers of district (members of mobile repairing gangs)	O	O
iv) MOID staff in charge		O

(d) Contents of works

- First Session

  Operation and maintenance of generating facilities

  - 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 on methods of preparing and entering in monitoring formats

vii) Preparation of basic manuals for operation and maintenance

<u>Operation and management of power supply utilities</u>

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

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

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) Inspection of sum sites

<u>Operation and management of power supply utilities</u>

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)

vi) Inspection of sum sites

(2) Works by Mongolia Side

In executing the soft component, the Mongol 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 as mentioned below. (Reference to Appendix 5 of the Minutes of Discussion)

(a)	Repairing work of power house	:	24,790,000 Tg.
(b)	Removal and relocation of existing facilities	:	23,400,000 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 sums should have the necessary cost ready in advance.

3 - 3 Operation and Maintenance Plan

(1) Present Organization for Operation and Maintenance

(a) Transition of organizations for operation and maintenance

The organization for operation and maintenance of sum 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 having one unit
1988 to 92	:	Management by aimag
1992	:	Commencement of transition to management by each sum
1995	:	Completion of transition to management by each sum

At present the power supply business of a sum which is not grid connected is operated and maintained under the self-financing system and its representative is the sum chief. However, the management capability of each sum 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 sums

The power supply activities of all aimag centers and of grid interconnected sums 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 sums not connected with grid, as objective sums under the Project, are also under the management of MOID, however the actual operation is performed by the sums. The payment of the power charges for sum's public installations by the Energy Development is the form of government subsidy to sums. At each aimag center, one inspector of MOID is to station all the year round and to inspect generating facilities of each sum 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 level training system.

(d) Power tariff

According to an accounting policy of the Ministry of Finance, 12.5% of the main machine price of sum 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 decided power tariffs according to this principle, additional income would be effective for management and maintenance of the sum power system. However, no sum following this policy was confirmed during the site investigation. The Ministry of Finance did not check regarding execution of this policy.

(2) Operation and Maintenance of Facilities

The operation and maintenance of existing generating facilities is to be usually performed by the sum 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. And so the quality of fuel and lubricating oil in Mongolia is not so good, It is very important to replace consumption materials frequent such as fuel filter and to inspect periodically. And the very cold condition will cause that the cooling water and the solution of the battery are frozen, fuel is became sherbet form, the lubricating oil is lost viscosity, will lead to the serious trouble for the engine.

The life of generators supplied from Japan under this Project is about 15 years in case of operating in Japan, standard operation period is 8 years at the longest. 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 sums 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) Securing maintenance budget

At present, the power supply activities of each sum are basically operated with the self-financing principle. As additional cost is required for operation of new generating facilities, the necessary cost must be included in yearly budget and be secured. As guarantee of necessary budget has close relation with the operation of power utility and power selling organization, details will be discussed in the following paragraphs. An example of rough idea of necessary budget for operation and maintenance of generating facilities under the Project is estimated as shown in Table 3.3.

Table 3.3 Example of Rough Idea of Necessary Budget for Operation and Maintenance

Aimag: Zavkhan   Sum : Santmargats

Install Generators
100 kW 0
60 kW 3

Fuel Consumption Rate
100 kW 20.9 Ltr/h
60 kW 17.4 Ltr/h

Load Pattern of Santmargats in Winter

Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Load	40.1	40.1	40.1	40.1	40.1	40.1	40.1	93.6	93.6	81.1	81.1	73.1	73.1	81.1	81.1	81.1	131.2	165.0	152.7	152.7	152.7	152.7	152.7	40.1
Output Power	60	60	60	60	60	60	60	120	120	120	120	120	120	120	120	120	180	180	180	180	180	180	180	60
100 kW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60 kW	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	1
Fuel Consumption	17.4	17.4	17.4	17.4	17.4	17.4	17.4	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8	52.2	52.2	52.2	52.2	52.2	52.2	52.2	17.4

According to above table, quantity of fuel consumption in one winter day is 817.8 Ltr/day.

Quantity of fuel consumption in winter (6 months) is

6 momths x 30 days x 817.8 Ltr/day = 147,204 Ltr/0.5 month

In other 6 months, generators are operated only 4 hours in 1 day

147,204.0 x 4 hr ÷ 24 hr = 24,534.0 Ltr/0.5 month

Therefore, quantity of annual fuel consumption is

147,204.0 + 24,534.0 = 171,738.0 Ltr/Year

① Fuel Cost

According to site investigation, fuel cost in Santmargats is 256 Tg/Ltr.
Therefore, annual fuel cost is

171,738.0 Ltr/Year x 256 Tg/Ltr = 43,964,928 Tg/Year

= 52,339.2 US$/Year (1US$ = 840 Tg)

② Manning Cost

According to site investigation, avarage monthly income of operators is 30 US$/month.
Therefore, annual manning cost for three operators is

30 US$/month x 12 months x 3 Men = 1,080.0 US$/Year

③ Spare Parts

Rough estimation of spare parts cost for 1 yeay is 4400.0 US$/Year.

Therefore, Necessary annual budget for operation and maintenance is (①+②+③)

52,339.2 + 1,080.0 + 4400.0 = 57,800.0 US$/Year.

(= 48,552,000 Tg. Year)

(3) Management of Power Utilities and Organization for Power Sales

(a) Power tariff system

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 sums as self-financing system. However, the government budget has been allocated to the power charge of public facilities as operating expenditure.

From the balance sheet in 1996, 1997 and up to May of 1998, income and expenditure are almost balanced for most of sums as the self-financing system is adopted. The depreciation expense against Russian diesel generators provided under aid from the former Soviet Union was not counted by any of sums. 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. An example of balance sheet is shown in Table 3.4.

In a power tariff system, generally a power tariff is grouped by each consumer category. This is because the required capacity changes according to consumer category, and the unit power delivery cost from the power station to consumers differs according to consumer category. The category-wise tariff system has not been established and the power tariff changes according to difference of payment pattern in the objective sums.

At present, consumers of each sum can be classified into the three groups of general, public and civil consumers. There are no industry consumers with large power. Under such a situation, a differential tariff system will not be required so far as the present consumption pattern is maintained.

On the other hand, 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.

Table 3.4 Example of Balance Sheet

Aimag: Gobi-Altai

Sum: Chandmani

Item	Unit	1996	1997	1998 (Jan.-May)
1. Output Energy	(kWh)	63,200.0	26,700.0	31,620.0
2. Selling Energy	(kWh)	56,880.0	24,030.0	28,450.0
3. (2.) ÷ (1.)	(%)	90.0	90.0	90.0
4. Average Unit Price per kWh	(Tg)	60.0	98.0	107.0
5. Total Selling Income	(10^3Tg)	2,871.5	2,352.6	3,056.0
6. Other Income	(10^3Tg)	-	-	-
7. Sub-total	(10^3Tg)	2,871.5	2,352.6	3,056.0
8. Operating Cost	(10^3Tg)	3,371.6	2,491.9	2,906.7
1) Fuel Cost	(10^3Tg)	2,871.6	2,251.9	2,671.2
2) Maintanance Cost	(10^3Tg)	200.0	150.0	80.0
3) Wagws	(10^3Tg)	240.0	90.0	155.5
4) Management Cost	(10^3Tg)	-	-	-
5) Others	(10^3Tg)	60.0	-	-
9. (7.) - (8.)	(10^3Tg)	▲ 500.1	▲ 139.3	149.3
10. Repayment	(10^3Tg)	-	-	-
11. Interest	(10^3Tg)	-	-	-
12. Grant of Goverment	(10^3Tg)	-	-	-
13. Income	(10^3Tg)	-	-	-
14. Cash Flow (10.+13)	(10^3Tg)	-	-	-

(b) Security of impartiality

The power tariff varies according to unit rates of fuel, generated energy and other factors. At present, a systematic power tariff system has not yet been established for the objective sums in Mongolia, and the amount of claim for power charge differs based on whether energy consumption is measured by energy meters or fixed rate. The fact that different charges are claimed in spite of same quality of power is supplied in the same area will create a long-term problem in view of impartiality. Further, though there are no firm data, unacceptable illegal use of power is also observed. It is required to try to install watt-hour meters to all consumers and charge to use of power impartially according to energy consumption.

In the long run, such impartiality problems must be solved, and for this purpose it is required not only improvement of the sum tariff structure but also how the power supply system and power tariff system shall be reorganized are required to be reviewed.

(c) Collection of power charges

As mentioned in the foregoing paragraph, the power charge has been claimed to all consumers of each sum based on actual operating cost of each month. By such a power utility operation based on running operation, any preparation or insurance against unforeseen failures or accidents can not be arranged and necessary investment to future facilities will not be possible. This seems to be caused by the lack of ideas that the power supply is a very important factor to support sum economy and social lives and to make payment against the value added. The change of social consensus is very important for this case.

Along with such reforms, improvement of the setting and collecting systems for power charge are required. The fuel consumption rates of Japanese generators will be significantly lower than rate of Russian generators. Though there is difference according to operating pattern, the operating expense will be able to be reduced by about 25% for 60 kW units and about 18% for 100 kW units, and power tariff will be able to be lowered accordingly.

While, according to the result of site investigation the willingness to pay against power consumption is same as the present rate or higher (refer to Table 3.5). As the desire of consumers to power supply is strong, the all or part of power tariff reducing effect by the improved fuel consumption rate is required to go to the procurement of spare parts, improvement of facilities and investment for future addition. By taking such measures, sustainable management of operation and maintenance will be attained.

Table 3.5 Willingness to Pay against Power Consumption

Aimag	Sum	Present Rate (Tg/month)	Willingness (Tg/month)
BULGAN	1 Teshig	2,500	3,000 ~ 3,500
BAYAN-ULGII	2 Deluun	3,250	3,250
UBS	3 Zuungobi	4,000	3,500
	4 Zuunkhangai	3,500	5,000
	5 Malchin	3,500	3,500
	6 Tes	4,000	4,000
	7 Tsagaankhairkhan	3,700	4,700
	8 Hyargas	2,800 ~ 3,500	3,500
KHOVD	9 Tsetseg	3,400	2,500 ~ 2,800
	10 Bulgan	4,500	2,500 ~ 5,100
	11 Munkhkhairkhan	3,700	3,500
BAYANKHONGOR	12 Buutsagaan	3,600	4,800
	13 Bayan-Undur	4,500	5,000
	14 Bayantsagaan	5,000	6,500
GOBI-ALTAI	15 Altai	3,400	3,400
	16 Biger	4,000	4,000
	17 Tonkhil	5,000	5,000
	18 Khukhmorit	2,500 ~ 3,500	3,500
	19 Dariv	3,600	3,300
	20 Chandmani	4,300	4,500
	21 Tsogt	4,000 ~ 4,500	4,000
	22 Tseel	4,200	7,000 ~ 7,200
	23 Erdene	3,500	4,500
DORNOGOBI	24 Khuvsgul	5,300	5,300
	25 Khatanbulag	5,800	6,800
ZAVKHAN	26 Tsetsen-Uul	4,150	3,600
	27 Erdenekhairkhan	3,800	4,000 ~ 4,500
	28 Songino	4,000 ~ 4,400	4,400
	29 Numrug	4,000 ~ 4,300	4,000
	30 Zavkhanmandal	5,500 ~ 6,500	7,000
	31 Santmargats	4,500	6,500
	32 Urgamal	4,800 ~ 5,500	5,500
	33 Durvuljin	4,250	5,000 ~ 6,000
	34 Ider	4,500	2,500
	35 Tes	4,950 ~ 5,800	5,000
	36 Asgat	3,000 ~ 3,500	3,500
UVURKHANGAI	37 Bogd	3,500	4,300
SUKHBAATAR	38 Erdenetsagaan	9,700	7,799
	39 Naran	3,400	2,900
DORNOD	40 Tsagaan-Ovoo	4,500	4,500
	41 Khulunbuir	4,720	5,000
KHUVSGUL	42 Tsagaan-Uur	2,700 ~ 3,200	3,000 ~ 3,500
	43 Tsagaannuur	4,443	5,000
	44 Renchinlhumbe	5,500	6,000
	45 Erdenebulgan	3,200 ~ 3,500	3,800 ~ 4,500

CHAPTER 4

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATIONS

4 - 1 Project Effect

The Project aims to install new diesel generators at the 45 objective sums for stable power supply to the sums. Problems evident at present for the generating facilities in the objective sums of the Project and countermeasures to be executed under the Project are mentioned blow:

Problems

(a) The power supply capacity has gone down further below the requirement of demand, and becomes to interface with the life in sums.

(b) Only one generator can be operated in one sum, and stable power supply is not possible.

(c) The existing generators are of old types 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 a difficult. Therefore the repairing is not possible even slight troubles.

(e) The operators in sums can not perform overhaul and daily inspection of the facilities so that they have no inspection tools, they have also not enough the knowledge and the skill.

Countermeasures

(a) Necessary supply capacity is to be restored by installing new generators so as to satisfy the demand, and at the same time the supply 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 possible to satisfy to the requirement of demand by increasing the number of units in parallel.

(c) Turbochargers are to be furnished on new diesel generators, and improvement of energy efficiency and decrease of operation cost is to be attempted by recovering discharging pressure and keeping high temperature of the fuel system.

(d) Consumption parts for about 2 years and standard maintenance tools are to be supplied together with generating units, and the method of daily operation and maintenance are to be trained for the operators in sums.

(e) A maintenance car, measuring instruments and tools of inspection and repairing are to be supplied for each traveling maintenance team established at 6 aimag centers. And the training of the operation and maintenance for new diesel generators manufactured in Japan will make it possible to judge some troubles before being serious with performing overhaul and inspection.

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 sums, and will be 151 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 equipment to be installed at the objective sums is 10,280 kW. This capacity corresponds to about 3.2 times the total capacity of generators in each sum (3,170 kW) which can be operated in 1997. 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. Though the values are affected about 20% 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 are operated with the self-financing principles, basic knowledge on business operation is not sufficient and continual management and maintenance are difficult. Therefore, MOID is required to carry out guidance on management technology to management staff and person in charge for sound and continual management of power utility, periodically together with its inspection. Especially, guidance on optimization on the power tariff collection system and business management will be essential.

(2) Knowledge on new Japanese equipment supplied under this Project is not sufficient in each sum. Therefore, it is necessary to conduct technical guidance to operation and maintenance technicians of each sum on proper operation and maintenance of new Japanese equipment. At the same time the Energy Authority is required to periodically carry out training together with manufacturers under instructions of MOID. 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.

(3) Each sum authority is required to fully understand the contents proposed in the "Operation and Maintenance Plan" in Clause 3-3, and try to improve its capability with its own efforts.