NO

BASIC DESIGN STUDY REPORT

ON

THE PROJECT

FOR

REHABILITATION FOR BALUCHAUNG NO.2

HYDRO POWER PLANT

IN

THE UNION OF MYANMAR

JANUARY 2002

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.
TOKYO ELECTRIC POWER CO.,INC.

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PREFACE

In response to a request from the Government of the Union of Myanmar, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of Baluchaung No. 2 Hydro Power Plant and entrusted the study to the Japan International Cooperation Agency (JICA).

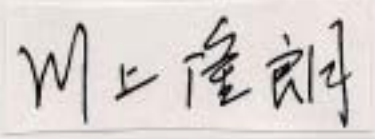
JICA sent to Myanmar a study team from August 9 to September 14, 2001.

The team held discussions with the officials concerned of the Government of Myanmar, 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 Myanmar 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 Myanmar for their close cooperation extended to the teams.

January 2002



Takaaki Kawakami

President

Japan International Cooperation Agency

January, 2002

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Rehabilitation of Baluchaung No. 2 Hydro Power Plant in the Union of Myanmar.

This study was conducted by the joint venture between Nippon Koei Co., Ltd. and Tokyo Electric Power Co., Inc. under a contract to JICA, during the period from July, 2001 to January, 2002. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Myanmar 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,

N. Matsushima
Noriaki Matsushima

Project manager,
Basic design study team on
The Project for Rehabilitation of
Baluchaung No. 2 Hydro Power Plant

The Joint Venture between
Nippon Koei Co., Ltd. and
Tokyo Electric Power Co., Inc.

Basic Design Study on the Project for Rehabilitation for Baluchaung No.2 Hydro Power Plant

LOCATION MAP

Baluchaung No.2 Hydro Power Plant

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Abbreviations

ACSR	:	Aluminum Conductor Steel Reinforced
CB	:	Circuit Breaker
CV	:	Cross-linked polyethylene insulated and polyvinyl chloride sheathed power cable
CVT	:	Cross-linked polyethylene insulated and polyvinyl chloride sheathed triplex power cable
CVV	:	Polyvinyl chloride insulated and sheathed control cable
DEP	:	Department of Electric Power
DS	:	Disconnecting Switch
MEPE	:	Myanma Electric Power Enterprise
GDP	:	Gross Domestic Product
GWh	:	Gigawatt-hour
IEC	:	International Electrotechnical Commission
JEC	:	Japanese Electromechanical Committee
JIS	:	Japanese Industrial Standard
MW	:	Megawatt
TR	:	Transformer

SUMMARY

As a result of economical renovations since 1988, the economic sector in Myanmar has shown a positive growing rate of GDP, which was 7% in average in the past 12 years between 1988 and 1999. Electric power demand has also been growing in pursuing the growth of GDP. The peak demand in the year of 2000 was grown at 2.5 times against that in 1987 and the growing rate was 8.5% per year. In August of 2001, a peak demand of 850MW in the whole country was recorded.

The generating facilities have been developed to cope with the increasing power demand. The total generating capacity in the year of 2000 was 976MW, of which hydropower 327MW(33%), gas turbine 475MW(49%) and steam turbine 174MW(18%) were composed.

However, available output of the generating facilities was 677MW, which was 69% of the whole capacity. As one of the major reasons, it was arisen that the output of gas turbines being shared a half of the generating facilities has been facing a difficulty of fuel supply and spare parts procurement.

The generated power has been transmitting through the national grid, which is composed of 230kV, 132kV and 66kV, towards 323 cities and 1,087 villages in 5 states and 6 districts. The total rated transmission capacity is considerably less than the total capacity of power generations because the development of the national grid has not been accompanied with that of the generating facilities. A considerable power loss is resulting from the overload transmission.

The electric power sector in Myanmar has been facing a power shortage since the 1980's. In a case, the power shortage was recorded at 250MW, which is 29% of the peak demand. To cope with this situation, a periodical power stoppage has been carried out in Yangon and Mandalay.

The Government of Myanmar has established the new 5 years development plan, in which the development of the electric power sector is in the highest priority as well as that of agriculture. As one of basic concepts in the development plan, increase of the capacity for power generation is given. The Ministry of Power Energy aim to increase the generated energy in 2005/06 with 3.6 times against that in 2001/02 by developing new generation.

Baluchaung No.2 hydro power plant is located at Baluchaung river at Lawpita in Kayah state and has a total capacity of 168MW (28MW x 6 units). Baluchaung No.2 has been providing a stable electric power towards the national grid under the continuous 24 hours operation since their initial operation (1960 for Units No.1-3 and 1974 for Units No.4-6). The generated energy in Baluchaung No.2 shares 24 % in that of the whole country as of the year 2000 and it means that Baluchaung No.2 is the largest and the most important power plant in Myanmar

However, due to the long-term operation, the rehabilitation of Baluchaung No.2 is urgently required to maintain the reliability and safety in order to keep its important role that is undertaken for a stable and reliable electric power supply in the country.

Under such circumstances, the Government of Myanmar requested a Grant Aid to the Government of Japan for the rehabilitation of Baluchaung No.2 hydro power plant. In response to the request from the Government of Myanmar, the Government of Japan decided to conduct a basic design study on the Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Myanmar a study team from August 9 to September 14, 2001. The study team held discussions with the officials concerned of the Government of Myanmar and conducted a field survey at the project site. This study aimed not only to formulate the contents and scope of work for the Project but also to ascertain the effect of the project and the eligibility for the Japan's Grant Aid program.

After the team returned to Japan, further studies were made. Then, a mission was sent to Myanmar from October 31 to November 10, 2001 in order to discuss a draft basic design.

This Japan's Grant Aid program is to provide non-reimbursable funds to procure the goods and services required for implementation of the Project for the rehabilitation of Baluchaung No.2 hydro power plant.

The objective of this Project is to rehabilitate Units No.1 to 6 with the associated substation equipment, which is essential to their operation, for restoration of their technical performances, reliability and safety to achieve their further long-term operation and to contribute a stable and reliable electric power supply in the country.

The generated power in Baluchaung No.2 has been sending together with that in Baluchaung No.1 for Mandalay and Yangon through the national grid, which is interconnected by of 132 kV transmission line for Mandalay and by 230 kV transmission line for Yangon.

The total transmission capacity is designed at 130 MW (40MW for 132 kV transmission line and 90 MW for 230 kV transmission line), which is considerably less than the total capacity of power generations of Baluchaung No.2 and No.1 (Total 196 MW). Under such situation, 150% over-load transmission has continuously been carried out in order to send fully the generated power to the consumers.

As for the 132 kV transmission line, the towers had been designed to install two (2) circuits of transmission line, but only one line was installed on the towers. This causes a complete stop of electric power supply during a fault or maintenance work of the transmission line, which lead a less reliability of power transmission for Mandalay. To cope with the present situation, the installation of additional 132 kV transmission line (2^{nd} line) is urgently required

The rehabilitation plan is formulated based on the following design policies.

a) Scope of the rehabilitation will be applied to the existing equipment of which the rehabilitation is highly essential and urgently required for keeping it in service consecutively to prevent a serious fault in near future, which will affect to the electric power supply in Myanmar.

b) In case that necessary replacement parts are no longer available in the market and/or the restoration to the original condition has no economic merit, the equipment will be renewed with current technology taking into consideration of technical level of operation and maintenance staff.

c) Layout and installation of the objectives will be designed to minimize a modification of the existing equipment.

d) The execution of installation works will be made by the present staffs in Baluchaung No.2 under the supervision of Japanese specialists to be provided by the manufacturers.

e) The rehabilitation works on site will be carried out during October to March, which is in the dry season and comparatively less affect to the electric power supply through the year.

Following the examination into the request from Myanmar, the plan of rehabilitation is formulated as follows:

Equipment	Extent of Rehabilitation
1. Excitation system	Modification of excitation system of Units 1-3 with a static type
2. Pressure oil supply system for governor	Replace of pressure oil pumps for Units 4-6
3. Compressed air supply system for turbine	Modification of compressed air supply system for Units 1-3 Replace of parts of compressed air supply system for Units 4-6
4. Cooling water supply system	Replace of cooling water pumps for Units 1-6
5. Oil lifter	Replace of control panel for Units 4-6
6. Inlet valve	Modification of inlet valve for Units 1-3
7. Metal seal of inlet valve	Replace of metal seal for Units 4-6
8. Control valve panel of inlet valve	Replace of control valve panel for Units 1-6
9. Needle and nozzle	Replace of needle chip and nozzle chip for Units 1-6
10. Deflector	Replace of chip and arm for Units 1-6
11. Water shelter	Replace of water shelter for Unit 5
12. Spare runner	Supply of spare runner
13. Control cables	Modification of control cables for Units 1-6
14. Control panels for generators	Repair of control panel for Units 1-3 Replace of control panel for Units 4-6
15. Main transformers	Replace for Units 4-6
16. 132kV current transformers	Replace
17. 132kV circuit breaker	Replace
18. 132kV disconnecting switches	Replace
19. Compressed air supply system for circuit breaker	Replace
20. Control panels of 132kV transmission lines	Repair of 132 kV transmission line control panel
21. Rectifier and battery	Replace of rectifier
22. Over head traveling crane	Replace of parts
23. 132kV transmission line (2^{nd} line)	Addition of 2^{nd} line
24. House drainage pumps	Modification of pump
25. Cooling water pump for booster transformer	Modification of pump
26. 11kV cable between main transformer and cubicle	Replace of 11kV power cable for Units 1-3
27. House transformer	Replace
28. 132 kV lightning arresters	Replace for Units 1-3
29. Lubricating oil system	Replace for Units 1-6
30. Turbine runner	Replace for Units 1-2

This Project will be completed in 46 months calculated from the conclusion of the Exchange of Notes (E/N) by both Governments. The implementation will be divided into three (3) phases. The schedule in each phase

includes 4.0 months for detailed design, bidding and conclusion of the contract (s), and 17.5 months for manufacturing, transportation, site rehabilitation works, site tests and transfer of technology.

The execution of this Project will have the following beneficial effects:

(1) Direct effects

a) The possibility of a fault and/or a trouble on the Units No.1 to No. 6 will be reduced and, as the results, the technical performance, reliability and safety of Baluchaung No.2 will be restored and maintained.

b) The Units No. 1 to No. 6 can be operated with high working ratio as they used to do before. This will come to restore and improve the reliability of electric power supply to the national grid and to reduce the maintenance cost.

c) Soft component will provide a guidance for proper operation and maintenance to maintain the equipment continuously and as a result the effects such as increase of the technical level and execution of periodrical inspection can be achieved.

d) Stable and continuous operation of Baluchaung No.2 contributes to a stable operation of Baluchaung No.1.

e) The transmission line capacity will be increased to 80MW, which is much effective to reduce the present over load condition.

f) Reliability of the electric power supply for Mandalay will be improved because a complete power stoppage for Mandalay can be eliminated since any of two (2) lines will send the electric power even if one line is shutdown.

g) Transmission loss will be reduced to half. In case 60MW is transmitted, the loss becomes 3.5MW against the present loss of 7.0MW, which is equivalent to increase of power generation 3.5MW.

(2) Indirect effects

a) The implementation of the Project will reinforce the stable power supply to the national grid, which is essential to socio-economic development. This will prevent Myanmar nationals from suffering the electric power shortage more and lead to improvements in a living standard as well as in public services.

b) The restoration and improvement of the reliability of electric power supply will make a considerable contribution to progress of the national development plan, which is one of the main objectives of the Government of Myanmar.

c) MEPE can manage periodical overhaul and occasional inspection in case of emergency of the generating equipment. Especially, this Project will provide a greater opportunity for young engineers to learn the power plant equipment.

d) Similarly with the technology built up in Baluchaung No.2 hydro power plant to date, the technology provided by this Project will be transferred to the other power plants in the whole country. This will bring about the improvement of the technical level of MEPE.

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CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF PROJECT

Electric power demand in Myanmar has steadily been growing in pursuing the growth of GDP, which was 7% in average in the past 12 years between 1988 and 1999. The peak electric power demand in the year of 2000 was grown at 2.5 times against that in 1987 and the growing rate was 8.5% per year. In August of 2001, a peak demand of 850MW in the whole country was recorded.

The generating facilities consisting of hydropower, gas turbine and steam turbine have been developed to cope with the increasing electric power demand. The total generating capacity in the year of 2000 was 976MW and the share of power sources was hydropower 327MW(33%), gas turbine 475MW (49%) and steam turbine 174MW (18%). However, it is facing a problem of reduction of the available output of the generating facilities. The available output was 677MW in 2000, which was 69% against the whole installed capacity. As one of the reasons, it was arisen that the output of gas turbines being shared a half of the generating facilities has been reducing due to a difficulty of fuel supply and spare parts procurement.

From the above reason, the electric power sector in Myanmar has been facing a power shortage since the 1980's and a periodical power stoppage is obliged in Yangon and Mandalay.

On the other hand, the generated power has been transmitting through the national grid, which is composed of 230kV, 132kV and 66kV transmission lines, towards 323 cities and 1,087 villages in 5 states and 6 districts. The total rated transmission capacity is considerably less than the total capacity of power generations. Under such situation, a considerable power loss resulting from the overload transmission is one of the reasons for the shortage of power supply.

The Government of Myanmar has established the new 5 years development plan, in which the development of the electric power sector is in the highest priority as well as that of agriculture. As one of basic concepts in the development plan, increase of the capacity for power generation is given to cope with the current situation. The Ministry of Power Energy aims to increase the generated energy in 2005/06 with 3.6 times against that in 2001/02.

Baluchaung No.2 hydro power plant has a total capacity of 168MW (28MW x 6 units) and it is the largest power plant in Myanmar. Baluchaung No.2 has been providing a stable electric power towards the national grid under the continuous 24 hours operation since their initial operation (1960 for Units No.1-3 and 1974 for Units No.4-6). The generated energy in Baluchaung No.2 shares 24 % in that of the whole country as of the year 2000.

However, due to the long-term operation, the rehabilitation of Baluchaung No.2 is urgently required to maintain the reliability and safety in order to keep its important role that is undertaken for a stable and reliable electric power supply in the country.

Under such circumstances, the Government of Myanmar requested a Grant Aid to the Government of Japan for the rehabilitation of Baluchaung No.2 hydro power plant.

CHAPTER 2

CONTENTS OF THE PROJECT

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2.1 Basic Concept of the Project

Baluchaung No.2 hydro power plant is located at Baluchaung river at Lawpita in Kayah state and has a total capacity of 168MW (28MW x 6 units). The first three (3) units (Units No.1-3) were commissioned in 1960 under Japan's grant and the other units (Units No.4-6) were followed in 1974 under Myanmar own fund.

The renovation works for Baluchaung No.2 was carried out through 1992-1994 under Japanese fund as the objective was mainly for rehabilitation of Units No.1-3. As the result, mechanical and electrical performances of water turbine and generator for the units were restored and a reliable operation has been achieved.

However, renovation works for the remaining units (Units No.4-6) and other associated equipment such as main transformers, circuit breakers, disconnecting switches etc. have not yet done since their initial operation. In addition, aging and corrosion after the renovation has been observed even for Units No.1-3. Under such situation, number of annual shutdown due to a trouble of equipment was recorded in average 11 times per unit in the past five (5) years, especially in the year 2000 it was reported in 6.6 times.

Taking into consideration of the current situation in the electric power sector in Myanmar, it is essential and important issues to restore and maintain the function of Baluchaung No.2 hydro power plant in order to minimize an influence to the electric power supply of the national grid.

The objective of this Project is to rehabilitate Units No.1 to 6 and the associated equipment, which are essential to their operation, for restoration of their technical performances, reliability and safety so that they can achieve a further long-term operation.

In addition, the objective is to install 132 kV transmission line (2^{nd} line) between Baluchaung No.2 and Kalaw substation on the existing towers in order to improve a reliability of the transmission line, by which it is expected to secure the effect of the rehabilitation of Baluchaung No.2 hydro power plant.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

2.2.1.1 Basic Design Policy

The rehabilitation plan is formulated based on the following design policies.

(1) Scope of the rehabilitation will be applied to the existing equipment of which the rehabilitation is highly essential and urgently required for keeping it in service consecutively to prevent a serious fault in near future, which will affect to the electric power supply in Myanmar.

(2) In case that necessary replacement parts are no longer available in the market and/or the

restoration to the original condition has no economic merit, the equipment will be renewed with current technology taking into consideration of technical level of operation and maintenance staff.

(3) Layout and installation of the objectives will be designed to minimize a modification of the existing equipment.

(4) The International Electrotechnical Commission Standard (IEC) will be applied to the design, materials, manufacture, testing, inspection and performance of all electrical and electromechanical equipment. In case IEC can not be applied, the Japanese Industrial Standard (JIS) or the Japanese Electrotechnical Committee Standard (JEC) will also be acceptable.

2.2.1.2 Design Policy for Environmental Conditions

Baluchaung No.2 hydro power station is located at the altitude of 340m and meteorological conditions in the past 10 years at the project site are recorded as follows.

(1) Average maximum ambient temperature : 29.1℃
(2) Average minimum ambient temperature : 16.8℃
(3) Average yearly rainfall : 1,005mm
(4) Average relative humidities : 69%
(5) Maximum wind velocity : 7m/sec.

Taking the above data into consideration, the following environmental conditions, which had been applied for the past Baluchaung Projects, are able to apply for the design of equipment in this Project.

(1) Maximum ambient temperature : 40℃
(2) Altitude : 340m
(3) Averages relative humidity : 69%
(4) Seismic Coefficient : 0.15G
(5) Water temperature : 30℃

2.2.1.3 Design Policy for Procurement of Goods

Myanma Electric Power Enterprise (MEPE) requested to procure goods, which are the origin of Japan, for this Project because of their high reliability. Even if the goods are procured by Japanese company, manufacturing outside Japan is not acceptable. Under such request, all parts and/or equipment to be procured under this Project will be the origin of Japan.

2.2.1.4 Design Policy for Installation of Goods

MEPE has an enough number of staffs who are able to execute the installation works under this Project. The following staffs in Baluchaung No.2 will be assigned.

(1) Electrical staffs including the engineers, technician and workers : 46 persons
(2) Mechanical staffs including engineers, technician and workers : 50 persons
(3) Communication staffs including engineers, technician and workers : 6 persons
(4) Civil staffs including engineers, technician and workers : 8 persons

The above staffs (total 110 persons) have acquired their experiences on the installation works of generating equipment by participating the following Projects.

(1) Renovation works under OECF loan in 1992-1994
(2) Inspection and Overhaul for water turbines, generators, circuit breakers etc. with JICA experts in 2000

Having judged in the technical point of view, they have an enough capability for the execution of installation works. In this Project, therefore, the execution of installation works will be made by the present staffs in Baluchaung No.2 under the supervision of Japanese specialists to be provided by the consultant and manufacturers.

2.2.1.5 Policy for Capability of Executive Agency for Operation and Maintenance

Proper operation and maintenance of the rehabilitated equipment is essentially required to secure the desired effect of the rehabilitation for long time. Technical knowledge and skills has to be transferred to MEPE staffs to ensure that the equipment to be rehabilitated under this Project can be operated and maintained properly by them.
For the purpose, soft component to make the following technical guidance will be introduced during the implementation of this Project.

(a) Guidance and instruction for effective operation and maintenance on the overall hydropower station facilities/equipment.
(b) Guidance and instruction for recording of data such as daily inspection, operation, accident/malfunction and maintenance.
(c) Technical guidance for periodical inspection and overhaul (especially for water turbine, generator and main transformer)
(d) Guidance and instruction for managing of documents such as design drawings, instruction manuals and operation/maintenance manuals.
(e) Guidance and instruction for storing of spare parts and maintenance tools.
(f) Technical guidance for Operation and Maintenance on equipment newly installed

2.2.1.6 Policy for Scope and Grade of Works

(1) Design Policy in Continuous and Reliable Operation

The scope of rehabilitation works will be studied and determined to be suitable and sufficient for realizing the power generation continuously and reliably after the completion of the Project.
As for the re-used parts and equipment, an inspection will be given to them as far as possible to keep their functions and characteristics, during the rehabilitation works.

(2) Minimization of Existing Facility Modification

For minimizing a modification of the existing facilities, necessary coordination and interface with the existing ones will be incorporated in designing the rehabilitation works, such as base frames, foundations, cable holes, opening, etc.

In case of replacement of heavy equipment such as inlet valves and main transformers, new equipment will be installed on the same location of the existing one so as to keep the same design conditions on the existing structures.

(3) Attention for Other Units and Equipment

The rehabilitation works will be carried out one by one unit with its stoppage and under continuous operation of the other units. The implementation will be programmed so as not to interfere with the operation of other units and will be carried out with careful attention to the existing equipment and remaining parts that are not covered by this Project.

2.2.1.7 Policy for Procurement and Construction Schedule

(1) Policy for Procurement

In principle, a competitive bidding is applied for the procurement of goods under the projects of Japan grant aid program. However, taking into consideration of the particularity of this Project, which is the rehabilitation of the existing equipment, some goods are required to procure from the same manufactures as the origin.
Accordingly, the procurement of goods for this Project will be carried out by two contract packages for a direct negotiation and a competitive bidding.

(2) Policy for Construction Time Schedule

In order to minimize a disturbance of the electric power supply toward the national grid, the construction time schedule is carefully studied taking the execution of Japan grant aid program into consideration and the basic policies are given below.

(a) The rehabilitation works will be conducted by three (3) phases and the objective in each phase is given below.

First phase : Rehabilitation of water turbine auxiliary equipment (cooling water supply pumps and compressed air supply system) for Units No.1 to 6.
Installation of 2nd 132kV transmission line.

Second phase : Rehabilitation of generating equipment for Units No.4 to 6.

Note : Manufacture and transportation of the turbine runners and the inlet valves, which are expected to take a long period for manufacturing, will be

included in the second phase.

Third phase : Rehabilitation of generating equipment for Units No.1 to 3.

(b) The rehabilitation works will be carried out for each unit with its stoppage by using a closure at the entrance of water turbine and two (2) months of the stoppage will be required for each unit.

(c) Three (3) units' stoppage and de-watering of the penstock line will be required to install the closure. The installation procedure is carefully studied so as to shorten the period and the stoppage of three units will be required at least 29 hours for Units No.1 to 3 and 32 hours for Units No.4 to 6.

(d) The existing 132kV transmission line will be required to stop for the period of seven (7) days during replacing of 132kV circuit breaker for the line, which is executed in the third phase.

(e) The rehabilitation works on site will be carried out during October to March, which is in the dry season and comparatively less affect to the electric power supply through the year.

2.2.1.8 Policy for 132 kV Transmission Line (2^{nd} line)

The generated power in Baluchaung No.2 together with that in Baluchaung No.1 has been sending for Mandalay and Yangon through the national grid, which is interconnected by 132kV transmission line for Mandalay and by 230kV transmission line for Yangon.

The total transmission capacity is accumulated at 130MW (40MW for 132kV transmission line and 90MW for 230kV transmission line), which is considerably less than the total capacity of power generations by Baluchaung No.2 and No.1 (total 196MW).

Under such situation, 150% over-load transmission has continuously been carried out in order to send the generated power fully to the consumers.

As for the 132kV transmission line, the towers had been designed to install two (2) lines of transmission line, but only one line was installed on the towers. This causes a complete stoppage of the transmission line during a fault or maintenance work, which lead a less reliability of power transmission for Mandalay. To cope with the present situation, the installation of 2^{nd} 132kV transmission line is urgently required.

The effects are expected as shown below.

(1) The transmission capacity will be increased to 80MW, which is much effective to reduce the present over load.

(2) Reliability of the electric power supply will be improved because a complete power stoppage for Mandalay can be eliminated since any of two (2) lines will send the electric power even if one line is stoppage.

(3) Transmission loss will be reduced to half. In case 60MW is transmitted, the loss becomes 3.5MW against the present loss of 7.0MW, which is equivalent to increase of power generation of 3.5MW.

On the other hand, MEPE has his own construction teams in particularly for the transmission lines. The teams are stationed at five (5) areas in the country and have an enough staff and material for installation works. Therefore, MEPE will assign his own staffs to be required for the installation of 132 kV transmission line.

Taking the above into consideration, necessary materials for the 2nd 132kV transmission line will be procured under this Project.

2.2.1.9 Policy for Cleaning inside Low Pressure Pipe Line and Penstock Line

According to the inspection carried out by JICA experts in 2000, it was reported that some materials were attached with its thickness of 20-30mm in the interior surface of low pressure pipe line and penstock line for Units No.1 to 3 over its full length of 2,200m.

Having taken a careful study, the cleaning work will not be included in this Project by the following reasons.

(1) The present situation does not give a serious influence to the power generation and an urgent action is not required at the moment.
(2) Three (3) units of No.1 to 3 have to be stopped simultaneously because de-watering of pipeline is required for the cleaning work.
(3) The cleaning work will be estimated to be take at least five (5) months taking the limited area (inside diameter of 2.8m) and a series work through the length (essential for safety reason) into consideration.
(4) The loss of power generation by stoppage of three units (84MW) for a period of 5 months will give a serious influence to the electric power supply in Myanmar.

2.2.2 Basic Plan

(1) Overall Plan

The results of study based on 2-2 Design Policy mentioned above are shown in table 2-1.

Table 2-1 Overall Plan

Requested Item	Executed Content
1. Excitation system (Units No.1-3)	Excitation system will be replaced with a static type since 1. Parts for repairing is difficult to provide due to the old type of excitation system. 2. Stability has become less since a spark is frequently occurred from the system.

2.Cooling water supply pipe line(Units No.1-6)	Replacement will not be done since it has been kept in good condition.
3. Pressure oil supply system for governor (Units No.1-6)	Partial renovation will be done since some parts are not functioned correctly. ・For Units No.1-3: Overhaul, cleaning and oil change will be done and Sump tank oil cooler / strainer will be replaced with new ones. (MEPE shall supply oil.) ・For Units No.4-6: Overhaul, cleaning and oil change will be done and Pressure oil pumps, Sump tank oil cooler /strainer will be replaced with new one. (MEPE shall supply oil.)
4. Compressed air supply system for turbine	・For Units No.1-3 (Common): Compressed air supply system will be completely replaced with air cooling type since the existing system is not functioned. ・For Units No.4-6 (Common): Compressors will be replaced with new ones.
5. Cooling water supply system (Units No.1-6)	Total 10 pumps will be replaced with new ones since the existing ones have a lot of water leakage. Two pumps, which were replaced in the renovation under OECF, will not be replaced since they have been kept good conditions. ・For Units No.1-3: 4-pump/6-control panel/6-foot valve will be replaced. ・For Units No.4-6: 6-pump/6-foot valve will be replaced.
6. Oil lifter (Units No.4-6)	Only control panel will be replaced.
7. Inlet valve (Units No.1-3)	Inlet valves will be completely replaced with new ones with metal seal type since the existing ones have a trouble of water leakage and they are too old to procure the parts for partial rehabilitation.
8. Metal seal of inlet valve (Units No.4-6)	Metal seals will be replaced with new ones because of their corrosion. The existing spare parts will be utilized for one unit.
9. Control valve panel of inlet valve (Units No.1-6)	Control valve panels will be completely replaced since water leakage is too much.
10. Needle and nozzle (Units No.1-6)	Only needle tips and nozzle tips will be replaced since wear and tear is found.
11. Deflector (Units No.1-6)	Only deflector tip/deflector arm will be replaced due to much wear and tear.

12. Water shelter (Unit No.5, B side)	New one will be installed since it has been lost.
13. Spare runner (Units No.1-6)	Two spare runners will be supplied (1 set for A side runner and the other for B side) in order to enable urgent response in case of runner broken.
14. Control cables (Units No.1-6)	・Control cables of outdoor switchyard will be replaced with new ones (No. 1-6) since they are extremely damaged. ・Indoor control cables will be replaced with new ones (No.4-6) since less reliability cables were installed.
15. Control panels for generators (Units No.1-6)	The following panels will be replaced with new ones since almost of mounted parts are deteriorated. ・Control desks (No. 1-6) ・Meter panels (No. 4-6) ・Protection relay panels (No. 4-6) Partial replacement will be done on the followings since some parts are not functioned correctly and then reliability has become less. ・Meter panels (No. 1-3) ・Protection panels (No. 1-3) ・Automatic control panels (No. 1-6)
16. Main transformers (Units No.4-6)	The existing transformers will be replaced with new ones since cooling efficiency has become low due to the deterioration of the coolers. Also the cooling water piping and 11kV power cables will be replaced with new ones.
17. 132kV current transformers (Units No.1-6)	The following 6 current transformers will be replaced with new ones because of oil leakage. ・T phase for northern line ・S phase for unit 2 ・T phase for unit 3 ・R/S/T phases for booster circuit bank B
18. 132kV circuit breaker	The following 5 circuit breakers, which are of air blast type, will be replaced with SF6 gas type. ・Northern line ・Units 1-3 ・Booster circuit bank B
19. 230kV circuit breaker	This item will not be included in this Project by the following reason: 230kV circuit breaker, which was supplied by the European manufacturer, has a trouble of gas leakage, but its situation is not so serious and then MEPE is requested to monitor and follow up.
20. 132kV disconnecting switches	One unit (booster circuit bank B) will be replaced with new one since it can not be operated.

21.Compressed air supply system for circuit breaker	Two AC air compressors will be replaced with new ones since air is leaking from some points.
22.132/33/11kV inter-bus transformer	This item will not be included in this Project since this transformer was replaced in the year of 2000 and the present conditions is good.
23. Control panels of 132kV transmission lines	The existing protective relay panel and control cables will be replaced with new ones since new protection relaying scheme is introduced for two circuits of 132kV transmission lines. Partial replacement will be done on the followings since some parts are not functioned correctly and then reliability has become less. ・Meter panel ・Control desk
24. Rectifier and battery	The existing rectifiers (No.1 and No.2) will be replaced with new ones since the condenser is removed and the transformer is overheated. One module of battery will be replaced with new one (No.1) since the module of No.1 battery is damaged.
25. Over head traveling crane	Replacement of aging and deterioration parts will be done.
26. 132kV transmission line (2^{nd} line)	Supply of materials for the 2^{nd} transmission line will be included in the scope of this Project.
27. Low and high pressure penstock	This item will not be included in the scope of this Project since a long period stoppage is needed for 3 units.
28. House drainage pumps	The existing pump will be replaced with new one since the capacity of the existing pump is not enough to drain a specified quantity.
29.Cooling water pump for booster transformer	The existing pump will be replaced with new one since the capacity of the existing pump is not enough to provide a specified quantity.
30. 11kV cable between main transformer and cubicle (Units No.1-3)	The existing power cables will be replaced with new ones since the existing cables have been deteriorated and a temporary cable has been using for Unit No.5 after damages by the ground fault.
31. 11kV power cable for house transformer (Units No.5 and 6)	This item will not be included in the scope of this Project since this circuit will not be required urgently.
32. House transformer	One of the 500kVA 11/0.4kV house use transformers will be replaced with new one due to the heavy oil leakage.
33. 132 kV lightning arresters (Units No.1-3)	Nine (9) units will be replaced with new ones since they are much deteriorated and seem not to be functioned.
34. Lubricating oil system (Units No.1-6)	Overhaul and Cleaning will be done. Not functioned relay and Lubricating oil will be replaced.
35. Turbine runner (Units No.1 and 2)	The existing Runners (1A, 2A and 2B) will be replaced with new ones since cracks on some backets are found.

(2) Equipment Plan

The specifications for the equipment in the Project are outlined in the table below.

1. Excitation System (Units No.1-3)

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Static type exciting System			○	3 sets	For 28MW generator, with automatic voltage regulator
2) Exciter Transformer			○	3 sets	370kVA
3) Power Cable for flashing current			○	360 m	600V CV 38 mm^2 3-core
4) Power cable for Exciter Transformer			○	100 m 180 m	11kV CV 60 mm^2 3-core 600VCV500 mm^2 1-core
5) Control cables			○	1 set	CVV

3. Pressure Oil Supply System for Governor (unit No.1~6)

3-1 Unit No.1-3

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Oil cooler in oil sump tank		○		3 sets	Pump: 200 liter/min Motor:15kW,AC400V Sump tank: 3,000 liter Oil pressure tank: 3,000 liter, 19.5 ~ 21.0 kg/cm^2
2) Strainer		○		3 sets	
3) Cover packing		○		3 sheets	

3-2 Unit No.4-6

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Pressure oil pump set		○		3 sets	Pump:80liter/min,29kg/cm^2 Motor:7.5 kW, AC400V Sump tank: 1,600 liter Oil pressure tank: 1,550 liter 28-30 kg/cm^2
2) Oil cooler in oil sump tank		○		3 sets	
3) Strainer		○		3 sets	
4) Cover packing		○		3 sheets	

4. Compressed Air Supply System for Turbine

4-1 Unit No.1-3 (Common)

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Compressed air supply equipment			○	2 sets	Compressor: 1.0m^3/min, 23 kg/cm^2
2) Local control panel			○	1 panel	Motor: 15HP, AC 400V

4-2 Unit No.4-6 (Common)

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Compressed air supply equipment		○		2 sets	Compressor: 325liter/min 35 kg/cm^2
2) Local control panel		○		1 panel	Motor:3.7 kW, AC400V

5. Cooling Water Supply System (Unit No.1-6)

5-1 Unit No.1-3

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Cooling water pump set (A side)		○		2 sets	Pump: 6.6 liter/min, 25 m Motor: 45kW, AC 400V
2) Control panel for above		○		3 panels	
3) Cooling water pump set (B side)		○		2 sets	Pump: 6.6 liter/min, 25 m Motor: 45kW, AC 400V
4) Control panel for above		○		3 panels	
5) Foot valve		○		6 pcs	
6) Float switch in primary water supply tank		○		2 sets	

5-2 Unit No.4-6

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Cooling water pump set (A side)		○		3 sets	Pump: 6.6 liter/min, 25 m Motor: 45kW,AC 400V
2) Cooling water pump set (B side)		○		3 sets	Pump: 6.6 liter/min, 25 m Motor: 45kW, AC 400V
3) Foot valve		○		6 pcs	

6. Oil Lifter (Unit No.4-6)

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Control panel		○		3 panels	Pump: 21 liter/min, 136 kg/cm^2 Motor:7.5kW, AC 400V

7. Inlet Valve (Unit No.1-3)

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Inlet valve			○	6 sets	Rotary valve, 940mmdia
2) By-pass valve		○		6 pcs	Needle valve, 91mm dia.
3) Penstock drain valve		○		6 pcs	100A, 40K

8. Metal Seal of Inlet Valve (Unit No.4-6)

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Metal seal		◯		4 sets	Rotaryvalve, 880mm dia 2 set: use Spare part
2) By-pass valve		◯		6 pcs	Needle valve, 91mm dia
3) V packing		◯		6 sets	

9. Control Valve Panel of Inlet Valve (Unit No.1-6)

For six (6) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Control valve panel of inlet valve		◯		12 panels	
2) Strainer for above		◯		12 pcs	
3) Water pressure valve for control valve circuit		◯		36 pcs	

10. Needle and Nozzle (Unit No.1-6)

For six (6) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Needle tips		◯		24 pcs	
2) Nozzle tips		◯		24 pcs	
3)Leather washer for nozzle Pipe		◯		48 pcs	

11. Deflector (Unit No.1-6)

For six (6) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Deflector tips		◯		24 pcs	
2) Deflector arms		◯		48 pcs	

12. Water Shelter (Unit No.5, B side)

For one (1) unit

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Water shelter		◯		1 pc	

13. Spare Runner (Unit No.1-6)

For six (6) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) A side runner		◯		1 set	
2) B side runner		◯		1 set	

14. Control Cables

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) 600V CVV			○	2,200m	3.5mm^2 2-core
2) Ditto			○	20,400m	3.5mm^2 3-core
3) Ditto			○	16,600m	3.5mm^2 4-core
4) Ditto			○	1,500m	3.5mm^2 5-core
5) Ditto			○	1,900m	3.5mm^2 6-core
6) Ditto			○	11,900m	3.5mm^2 7-core
7) Ditto			○	600m	3.5mm^2 10-core
8) Ditto			○	1,900m	3.5mm^2 12-core
9) Ditto			○	2,800m	5.5mm^2 2-core
10) Ditto			○	1,000m	5.5mm^2 3-core
11) Ditto			○	3,000m	5.5mm^2 4-core
12) Ditto			○	500m	5.5mm^2 5-core
13) Ditto			○	500m	8mm^2 2-core
14) Ditto			○	200m	8mm^2 3-core
15) 600V CV			○	2,900m	8mm^2 3-core
16) Ditto			○	100m	14mm^2 2-core
17) Ditto			○	400m	14mm^2 3-core
18) Ditto			○	600m	22mm^2 3-core
19) Ditto			○	300m	38mm^2 2-core
20) 600V CVV-SB			○	1,500m	3.5mm^2 2-core
21) 600V IV			○	300m	3.5mm^2
22) Ditto			○	200m	5.5mm^2
23) Ditto			○	100m	8mm^2
24) Ditto			○	100m	14mm^2
25) Ditto			○	100m	22mm^2
26) Ditto			○	100m	38mm^2

15. Control Panel for Generators

15-1 Unit No.1-3

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Meter panel	○			3 panels	Meter 4 pcs Recorder for active power 3pcs Recorder for reactive power 3pcs Fault indicator 12 pcs
2) Protection relay panel	○			3 panels	Protection relay 8 pcs Recorder for voltage 3 pcs
3)Automatic control panel	○			3 panels	Auxiliary relay (use spare parts in P/S) 4 pcs
4) Control desk		○		3 panels	Desk type control panel, W900mm, H730mm

15-2 Unit No.4-6

For three (3) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Meter panel		○		3 panels	Self-supporting metal-enclosed control panel, W900mm, H2300mm
2) Protection relay panel		○		3 panels	Self-supporting metal-enclosed control panel, W900mm, H2300mm
3)Automatic control panel	○			3 panels	Auxiliary relay 12 pcs
4) Control desk		○		3 panels	Desk type control panel, W900mm, H730mm

16. Main Transformer(Units No.4-6)

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Main Transformer		○		10 pcs	10,333kVA,single phase incl. spare transformer
2) Bus Conductor		○		100 m	HDCC 200mm^2
3) Main Terminal		○		18 pcs	For Units 4-6
4) T-branch Clamp		○		18 pcs	For Units 4-6
5) Copper Bar		○		20 m	10mm×60mm
6) Cooling Piping		○		1 set	For Units 1-6
7) Flow Relay		○		6 pcs	For Units 1-6
8) 11kV Power Cable		○		650 m	For Units 4-6 : 11kV CV 600 mm^2 1-core
9) Cable Head		○		36 sets	For Units 4-6
10) Cleat		○		1 set	For Units 4-6

17. 132kV Current Transformers

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) 132kV Current Transformer		○		2 pcs	150/5 A
2) Bus Conductor		○		50 m	HDCC 200 mm^2
3) Main Terminal		○		12 pcs	

18. 132kV Circuit Breakers

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) 132kV Circuit Breaker		○		5 pcs	Rated Current : 800 A Rated breaking current : 25kA
2) Bus Conductor		○		300 m	HDCC 200 mm^2
3) Main Terminal		○		33 pcs	
4) T-branch Clamp		○		9 pcs	

5) PG Clamp		◯		6 pcs	

20. 132kV Disconnecting Switches

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) 132kV Disconnecting Switch		◯		1 pc	Rated Current : 800 A
2) Bus Conductor		◯		80 m	HDCC 200 mm^2
3) Main Terminal		◯		6 pcs	

21. Compressed Air Supply System for Circuit Breaker

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) AC Air Compressor		◯		2 sets	
2) Control Panel		◯		1 panel	
3) Piping Material		◯		1 set	
4) Pressure Gauge		◯		1 set	
5) Pressure Switch		◯		1 set	

23. Control Panels of 132kV Transmission Lines

23-1 132kV Transmission Line Control Panels

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Meter panel	◯			1 panel	Meter 4 pcs Recorder for voltage 1 pc Status indicator 1 pc Fault indicator 2 pcs Transducer 2pcs
2) Control desk	◯			1 panel	Control switches 10 pcs

23-2 Control Cable for 132kV Transmission Lines (Common)

Equipment	Classification			Q'ty [m]	Specification
	Repair	Replace	Modification		
1) 600V CVV			◯	800m	3.5mm^2 2-core
2) Ditto			◯	6,500m	3.5mm^2 3-core
3) Ditto			◯	4,200m	3.5mm^2 4-core
4) Ditto			◯	1,400m	3.5mm^2 6-core
5) Ditto			◯	300m	3.5mm^2 10-core
6) Ditto			◯	200m	5.5mm^2 2-core
7) Ditto			◯	1,100m	5.5mm^2 3-core
8) 600V CV			◯	500m	5.5mm^2 2-core
9) Ditto			◯	3,000m	5.5mm^2 3-core

10) Ditto			◯	300m	5.5mm^2 4-core
11) Ditto			◯	900m	8mm^2 3-core
12) 600V IV			◯	100m	3.5mm^2
13) Ditto			◯	100m	5.5mm^2
14) Ditto			◯	100m	8mm^2

24. Rectifier and Battery (Common)

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Rectifier		◯		2 sets	Type : Thyristor Rated supply voltage : 3 phase AC400V Rated output voltage : DC 230V Rated DC current : 100A
2) Battery	◯			1 pc	Type : CS290

25. Over Head Traveling Crane

For two (2) units

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Resister for traveling		◯		2 sets	
2) Resister for traversing		◯		2 sets	
3) Resister for main hoist		◯		2 sets	
4) Resister for auxiliary hoist		◯		2 sets	
5) Brake liner and shoe For traveling		◯		2 sets	
6) Ditto for traversing		◯		2 sets	
7) Ditto for main hoist		◯		2 sets	
8) Ditto for auxiliary hoist		◯		2 sets	
9) Slip ring for traveling		◯		2 sets	
10)Slip ring for traversing		◯		2 sets	
11)Slip ring for main hoist		◯		2 sets	
12)Slip ring for auxiliary		◯		2 sets	
13)Collector wheel For traveling		◯		8 pcs	
14) Collector wheel For traversing		◯		66 pcs	
15) Wire for main hoist		◯		2 sets	
16)Wirefor auxiliary hoist		◯		2 sets	

26. 132kV Transmission Line (2nd line)

26-1 Transmission line

(a) Insulator Strings

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		

1)Single Tension Insulator Strings (Normal type) with 9 discs	◯			532 sets	E&M strength: 120kN, Ball-socket type
2)Single Tension Insulator Strings (Inverted Type) with 9 discs	◯			26 sets	ditto
3) Single Suspension Insulator Strings with 8 discs	◯			1,122 sets	ditto
4) Single Suspension Insulator Strings (for jumper support) with 8 discs	◯			4 sets	ditto
5) Single Tension Insulator Strings (Tie-down for transposition) with 8 discs (Normal single tension for upper side)	◯			2 sets	E&M strength: 80kN, Ball-socket type
6) Single Tension Insulator Strings (Tie-down for transposition) with 8 discs (Inverted single tension for lower side with turnbuckle)	◯			2 sets	ditto
7) Tension rod (length: 1,060 mm)	◯			3 sets	Mechanical strength : 120kN

(b).Conductor

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		
1) Conductor	◯			500 km	ACSR 397.5MCM, Ibis
2) Mid-span Joint Sleeve	◯			250 pcs	For ACSR
3) Repair Sleeve	◯			50 pcs	For ACSR
4) Armor rod	◯			1,122 pcs	For ACSR
5) Vibration damper	◯			4,818 pcs	For ACSR 10 lbs.
6) T-brunch sleeve	◯			3 pcs	Main: ACSR 397.5 MCM Brunch:Al 400mm^2 ×2-bundle

(c) Ground wire

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		
1) Ground wire		◯		167 km	Galvanized Steel Wire (7/No9 SWG)
2) Tension clamp		◯		188 sets	For GSW
3) Suspension clamp		◯		375 sets	For GSW
4) Mid-span Joint Sleeve		◯		84 pcs	For GSW
5) Repair Sleeve		◯		20 pcs	For GSW
6) Vibration damper	◯			1,606 pcs	For GSW, 3 lbs

26-2 Baluchaung No.2 Hydro Power Station（The 2nd T/L: New）

(a) Transmission facilities（power station）

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		
1) Circuit breaker	○			1 set	Rated voltage:145 kV Rated short-current breaking: 25 kA SF6 Gas type
2) Disconnecting switch	○			3 sets	Rated voltage:145 kV、Rated current:800A Manual operation
3) Capacitor voltage transformer	○			1 set	Ratio:132kV/$\sqrt{3}$/110V/$\sqrt{3}$
4) Lightning arrester	○			3 sets	Highest system voltage:145 kV、Rated voltage:120 kV
5) Tension fitting set with 12 discs	○			6 sets	Boll-socket type
6) Suspension fitting set with 12 discs	○			4 sets	ditto
7) Tension rod	○			9 sets	Mechanical strength:120kN
8) Conductor	○			363 m	HDCC 200 mm^2
9) Ground wire	○			90 m	Cu 150 mm^2
10) T-type compression terminal	○			3 pcs	Main: ACSR 397.5 MCM Brunch: HDCC 200 mm^2
11) T-type compression terminal	○			3 pcs	Main: HDCC 200 mm^2 Brunch: HDCC 200 mm^2
12) T-type compression terminal	○			6 pcs	Main: HDCC 325 mm^2 Brunch: HDCC 200 mm^2
13) C-type clamp	○			10 pcs	Cu 150 mm^2
14) C-type clamp	○			20 pcs	HDCC 200 mm^2

(b) Protective device

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		
1) Line protection system	○			1 set	Digital type Distance protection

26-3 Kalaw substation（2nd line: New）

(a) Transmission facilities（Substation）

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		
1) Circuit breaker	○			1 set	Rated voltage:145 kV Rated short-current breaking: 25 kA SF6 Gas type
2) Disconnecting switch	○			1 set	Rated voltage:145 kV Rated current:800 A Motor operation
3)Capacitor voltage transformer	○			3 sets	Ratio:132kV/$\sqrt{3}$/110V/$\sqrt{3}$
4) Lightning arrester	○			3 sets	Highest system voltage :145 kV Rated voltage:120 kV
5) Conductor	○			335 m	Al 400 mm^2

6) Ground wire	○			120 m	Cu 150 mm^2
7) Flat-type compression terminal	○			24 pcs	Al 400 mm^2×2-bundle
8) T-type compression terminal	○			3 pcs	Main: ACSR 397.5 MCM Brunch:Al 400mm^2 ×2-bundle
9) C-type clamp	○			15 pcs	Cu 150 mm^2
10) C-type clamp	○			12 pcs	Al 400 mm^2
11) Spacer	○			30 pcs	Al 400 mm^2 ×2-bundle
12) Station post insulator	○			3 sets	Station post insulator:BIL650 kV

(b) Protective device

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		
1)Line protection system	○			1 set	Digital type Distance protection

(c) Control panel

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		
1) MW meter	○			2 pcs	CT: 500/5 PT:132kV/ √ 3: 110V/ √ 3 1.5 class
2) Mvar meter	○			2 pcs	CT: 500/5 PT: 132kV/ √ 3: 110V/ √ 3 1.5 class
3) A meter	○			2 pcs	CT: 500/5 1.5 class
4) kV meter	○			2 pcs	PT: 132kV/ √ 3: 110V/ √ 3 1.5class
5) Fault indicator	○			2 pcs	10 indicaters type
6)ON/OFF control switch （for CB, DS）	○			8 pcs	With signal lamps
7) ON/OFF witch （for DC supply）	○			2 pcs	
8) Terminal block	○			12 pcs	12 terminals type
9) mimic bus	○			10 m	

(d) Distribution Board

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		
1) NFB	○			8 pcs	2p-type AC/DC230V
2) Terminal block	○			2 pcs	12 terminals type 5.5 mm^2
3) Flexible metal conduit	○			50 m	Flexible type
4) Saddle for ditto	○			20 pcs	
5) Bushing for ditto"	○			10 pcs	

(e) Control cable

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		
1) 600V CVV	○			1,900 m	5.5mm^2 4-core
2) Ditto	○			1,200 m	3.5mm^2 8-core
3) Ditto	○			100 m	3.5mm^2 2-core
4) Ditto	○			100 m	3.5mm^2 4-core
5) Ditto	○			800 m	5.5mm^2 2-core

26-4 Kalaw substation（Existing line）

(a). Transmission facilities（Substation）

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		
1)Circuit breaker	○			1 set	Rated voltage:145 kV Rated short-current breaking: 25 kA SF6 Gas type
2)Disconnecting switch	○			1 set	Rated voltage:145 kV Rated current:800 A Motor operation
3)Capacitor voltage transformer	○			1 set	Ratio 132kV/$\sqrt{3}$:110V/$\sqrt{3}$
4) Lightning arrester			○	3 sets	Highest system voltage 145 kV Rated voltage:120 kV
5) Conductor	○			335 m	Al 400 mm^2
6) Ground wire	○			120 m	A 150 mm^2
7)Flat-type compression terminal	○			24 pcs	Al 400 mm^2 x 2-bundle
8)T-type compression terminal	○			3 pcs	Main: ACSR 397.5 MCM Brunch:Al 400mm^2 ×2-bundle
9) C-type clamp	○			15 pcs	Cu 150 mm^2
10) C-type clamp	○			12 pcs	Al 400 mm^2
11) Spacer	○			30 pcs	Al 400 mm^2 ×2-bundle
12) Station post insulator			○	3 sets	Station post insulator:BIL650 kV

(b) Control cable

Equipment	Classification			Q'ty	Specification
	Addition	Replace	Modification		
1) 600V CVV	○			1,900 m	5.5mm^2 4-core
2) Ditto	○			1,200 m	3.5mm^2 8-core
3) Ditto	○			800 m	3.5mm^2 2-core

28. House Drainage Pumps

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Drainage pump set			○	2 sets	Pump: 7.5HP, 20m 0.5 m^3/min Motor: 5.5kW,AC 400V

29. Cooling Water Pump for Booster Transformer (Bank No.1)

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Water supply pump set			○	2 sets	Pump: 3.7kW 12m 1.25 m^3/min Motor: 3.7kW AC 400V
2) Control panel for above			○	1 panel	

30. 11kV Power Cable between Main Transformer and Cubicle (Unit No.1-3)

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) 11kV Power Cable		○		700 m	11kV CV 600mm^2 1-core
2) Cable Head		○		36 sets	
3) Cleat		○		1 lot	

32. House Transformer

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) House Transformer		○		1 pc	500kVA ONAN
2) 11kV Power Cable		○		100 m	11kV CV 60mm^2 3-core
3) Cable Head		○		2 sets	

33. 132kV Lightning Arrester (Unit No.1-3)

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) 132kV Lightning Arrester		○		9 pcs	
2) Bus Conductor		○		50 m	HDCC 200mm^2
3) T-branch Clamp		○		9 pcs	
4) Main Terminal		○		9 pcs	

34. Lubricating Oil System (Unit No.1-6)

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) No fuse breaker		○		1 pc	For Unit No.4-A
2) Oil flow relay		○		5 pcs	69Q for Unit No.1-A,2-B, 3-A, 4-B&5-B
3) Cooling water flow relay		○		4 pcs	69W for Unit No.2, 3, 4 &5
4) Water infiltration detector		○		1 pc	

35. Turbine runner (Unit No.1-2)

Equipment	Classification			Q'ty	Specification
	Repair	Replace	Modification		
1) Runner, Unit No.1, B side		○		1 set	
2) Runner, Unit No.2, A side		○		1 set	
3) Runner, Unit No.2, B side		○		1 set	

2.2.3 Basic Design Drawing

Basic design drawings for the Project is shown in table 2-2 and attached in DRAWINGS.

Table 2-2 Basic Design Drawing

No.	Drawing No.	Title
1	BAC-02-0001	Single Line Diagram
2	BAC-02-0002	Power Station System Diagram
3	BAC-02-0003	House Service Diagram
4	BAC-02-0004	House Service Diagram
5	BAC-02-0005	Plan of Baluchaung No.2 HPS
6	BAC-02-0006	Elevation of Baluchaung No.2 HPS
7	BAC-02-0007	Section of Baluchaung No.2 HPS
8	BAC-02-0008	Layout Drawing of Control Room
9	BAC-02-0009	Longitudinal Section of Switch Gear Room and Control Room
10	BAC-02-0010	Front View of Meter Panel, Sloping Panel and Vertical Panel for Unit No.1 – No.3
11	BAC-02-0011	Front View of Meter Panel, Sloping Panel and Vertical for Unit No.4-No.6
12	BAC-02-0012	Front View of Relay Panel for Unit No.1-No.6
13	BAC-02-0013	Front View of Automatic Control Panel for Unit No.1-No.6
14	BAC-02-0014	Front View of Panels for 132kV Transmission Line
15	BAC-02-0015	Front View of New 132kV T/L Relay Panel
16	BAC-02-0016	Outdoor Switchyard Panel Diagram
17	BAC-02-0017	Outdoor Switchyard Cross Section A – A
18	BAC-02-0018	Outdoor Switchyard Cross Section B – B
19	BAC-02-0019	Outdoor Switchyard Cross Section B – B
20	BAC-02-0020	Outdoor Switchyard Cross Section C – C
21	BAC-02-0021	Outdoor Switchyard Cross Section C – C
22	BAC-02-0022	Outdoor Switchyard Cross Section D – D
23	BAC-02-0023	Outdoor Switchyard Cross Section D – D
24	BAC-02-0024	Outdoor Switchyard Cross Section E – E
25	BAC-02-0025	Outdoor Switchyard Plane Diagram around House Service Transformer
26	BAC-02-0026	Water and Air Piping System (Unit No.1-3)
27	BAC-02-0027	Water and Air Piping System (Unit No.4-6)
28	BAC-02-0028	Oil Piping System (Unit No.4-6)
29	BAC-02-0029	Lubricating Oil Supply and Grease Lubricating System
30	BAC-TL-0001	Single Line Diagram of Kalaw Substation
31	BAC-TL-0002	Ground Plan of Kalaw Substation
32	BAC-TL-0003	Elevation of Lawpita 1L of Kalaw Substation
33	BAC-TL-0004	Elevation of Lawpita 2L of Kalaw Substation
34	BAC-TL-0005	Floor Plan of Control Room of Kalaw Substation
35	BAC-TL-0006	Installation Location of Switching Board

2.2.4 Implementation Plan

2.2.4.1 Procurement Plan

This Project is to rehabilitate the existing equipment that was supplied by Japanese manufacturers. The equipment and parts thereof to be supplied under this Project are required to completely make a technical interface with the existing equipment from both structural and functional point of view.

The equipment and parts, which are essential by only the original manufacturers with the following reasons, will be procured by direct negotiation with them:

(a) The equipment and parts for the rehabilitation cannot be designed without detailed data and information on the existing equipment such as design drawings, specifications, performances, materials and detailed dimensions. Only the original manufacturer possesses these detailed data.

(b) These detailed data will not be disclosed or given to the third parties because they include the manufacturer's own technical know-how.

(c) The third party has no way of collecting such detailed data other than an extra field investigation. This investigation will be carried out by disassembling the turbines and generators, so it will require stoppage of the units. Thus, the extra field investigation by the third party will cause great inconvenience to Myanmar side.

(d) The third party is requested to prepare various design drawings subsequently to the extra field investigation. This will be expensive in loss of time for delivery of the equipment.

(e) Japanese manufacturers will not repair the equipment supplied by the third parties from his business practice except in special circumstances. This is the reason why they cannot take responsibility on the performances of the equipment rehabilitated by them and they cannot indemnify any loss caused by their rehabilitation works.

(f) No manufacturer other than the original manufacturer can take over the responsibility of the existing equipment after the rehabilitation works.

(g) No manufacturer other than the original manufacturer can make successful and reliable coordination for the desired performances with the existing parts to be re-used.

Besides, the equipment and parts, for which any manufacturer is available even if the technical specification is given, will be procured under competitive bidding procedure.

Accordingly, the procurement of the goods for this Project will be carried out by two contract packages for direct negotiation and competitive bidding. The equipment and parts will be grouped into two contract packages as shown in table 2-3.

Table 2-3 Procurement Plan

Equipment/Parts		Contract		Reason of Contract Method
		Bidding	Direct Nego.	
1	Excitation system (Unit No.1-3)		○	Design coordination with the existing generator is required.
3	Pressure oil supply system for governor (Unit No.1-6)		○	Partial rehabilitation of the existing system.
4	Compressed air supply system for turbine		○	Partial rehabilitation of the existing system.
5	Cooling water supply system (Unit No.1-6)		○	Partial rehabilitation of the existing system.
6	Oil lifter (Unit No.4-6)		○	Partial replace of the existing system
7	Inlet valve (Unit No.1-3)		○	Design coordination with the existing turbine is required.
8	Seals of inlet valves (Unit No.4-6)		○	Partial replace of the existing inlet valves
9	Control valve panels of inlet valves (Unit No.1-6)		○	Partial rehabilitation of the existing system
10	Needle tips and nozzle tips (Unit No.1-6)		○	Partial replace of the existing turbine
11	Deflectors (Unit No.1-6)		○	Partial replace of the existing turbine
12	Water shelter (Unit No.5, B side)		○	Partial replace of the existing turbine
12	Spare runner (Unit No.1-6)		○	Design coordination with the existing turbine is required.
14	Control cable	○		Any bidder is available if specification is given.
15	Control panels for generators (Unit No.1-6)		○	Partial rehabilitation of the existing system
16	Main transformers (Unit No.4-6)	○		Any bidder is available if specification is given.
17	132kV current transformers	○		Any bidder is available if specification is given.
18	132kV circuit breakers	○		Any bidder is available if specification is given.
20	132kV Disconnecting switches	○		Any bidder is available if specification is given.
21	Compressed air supply system for circuit breaker	○		Any bidder is available if specification is given.
23-1	Control panel of 132kV transmission panel		○	Partial rehabilitation of the existing system
23-2	Ditto (control cable)	○		Any bidder is available if specification is given.
24-1	Rectifier	○		Any bidder is available if specification is given.
24-2	Battery		○	Partial replace of the existing batteries
25	Over head traveling crane		○	Partial rehabilitation of the existing crane
26	132kV transmission line (2^{nd} line)	○		Any bidder is available if specification is given.
28	Drainage pump	○		Any bidder is available if specification is given.

29	Cooling water pump for booster transformer	○		Any bidder is available if specification is given.
30	11kV power cable between main transformer and cubicle	○		Any bidder is available if specification is given.
32	House transformer	○		Any bidder is available if specification is given.
33	132kV Lightning arresters	○		Any bidder is available if specification is given.
34	Lubricating oil system (Unit No.1-6)		○	Partial rehabilitation of the existing system
35	Turbine runner (Unit No.1-2)		○	Design coordination with the existing turbine is required.

2.2.4.2 Implementation Policy

The rehabilitation works under this Project will be made under the operation of Baluchuang No.2 hydropower station. The extent of rehabilitation works cover almost all the equipment related to Unit No.1 to No.6, and 132kV transmission line. Prior to the commencement of the works, optimum rehabilitation method and work sequence will be studied for executing the rehabilitation works smoothly and effectively without hindrance to generating operation of other units.

The basic concept and important notice for the implementation of the Project are shown as below.

(1) Executive Agency

The executive agency of Myanmar side is Myanma Electric Power Enterprise (MEPE) and MEPE is in charge of the Project operation and execution.

For implementation of the Project, Myanmar side is requested to pay careful attention to the following three items and to assign personnel in charge of the Project for smooth execution including enough staff to install all renovated equipment and 132kV transmission line.

(a) Coordination and arrangements for unit stoppage during the rehabilitation works

In implementation of this Project, one unit is requested to stop its operation for a period of two (2) months. The operation of the other units should be arranged so that the stoppage of the unit will not interfere with the continuous electric power supply to the national grid.

(b) Preparation of budget and assignment of personnel for proper execution of the works allocated to Myanmar side

Myanmar side is requested to take a share in the site rehabilitation works. The works shared to Myanmar side should be carried out timely in close coordination with the implementation schedule of the Project. Necessary budget and personnel should be allocated for smooth and efficient execution of the shared works.

(c) Transfer of Technology

A sufficient number of MEPE staffs are requested to participate directly in the site rehabilitation works. One of objective of their participation in the site works is to transfer to them technical skills for dismantling and reassembling of the turbine and generator through the soft component so that periodical overhaul can be managed by them.

(2) Consultant

In accordance with Japan's Grant Aid Procedure, the Government of Myanmar will make a contract with Japanese consulting firm who execute the consulting services such as preparation of bid document for procurement of equipment/parts and supervision of rehabilitation works.

The major work items for the consultant to be responsible are listed below.

Pre-Construction Stage

(a) Preparation of bid documents for procurement of equipment, parts, and services for rehabilitation works
(b) Bidding and evaluation of bids
(c) Contract negotiation
(d) Approval of drawing/documents
(e) Witness of shop inspection before shipping
(f) Issue of inspection certificate
(g) Reporting and explanation to the parties concerned

Construction Stage

(a) Progress control of transportation, rehabilitation works, site inspections and tests, etc.
(b) Coordination of work schedule among the contracts
(c) Safety control at site
(d) Witness of site inspections and tests
(e) Evaluation of site test results
(f) Preparation of monthly report regarding the transportation, rehabilitation works, site inspections and tests
(g) Issue of payment certificates
(h) Preparation of completion report on site works such as transportation, rehabilitation works, site inspections and tests
(i) Final inspection for one year after taking over
(j) Periodical reporting to the parties concerned

(3) Contractor

For the rehabilitation works under the Project, a qualified high technique and experience are required by the following reasons:

(1) The stoppage period for each unit is expected to be two (2) months for disassembly, repairing, replacing, reassembling, testing, and so on.
(2) It is inevitable for some works to be carried out in the same time and parallel because almost all the equipment is installed in the same place,
(3) Since the equipment are related to each other, it is essential to make the necessary coordination of the work schedule and sequence.

Therefore, it is necessary for some specialists dispatched from the Contractor to execute the technical instructions, quality control, progress control, etc. during the site installation works and tests.

The scope of rehabilitation is almost all the equipment for Units No.1 to No.6 and 132 kV transmission line. Accordingly the following specialists for the respective special fields will be dispatched to site for successful and smooth execution of the Project.

(a) Technical specialists for installation works

First Phase	Four (4) persons (Cooling water supply system, compressed air supply system,, transmission line, control panel for transmission line)
Second Phase	Eight (8) persons (turbine auxiliary, inlet valve, water turbine, control panel, control cable, overhead crane, transformer, switchgear)
Third Phase	Eight (8) persons (turbine auxiliary, inlet valve, water turbine, control panel, control cable, excitation system, 11 kV power cable, switchgear)

(b) Technical specialists for testing

First Phase	One (1) person (control panel for transmission line)
Second Phase	Three (3) persons (Water turbine, control panel, commissioning test)
Second Phase	Four (4) persons (Water turbine, control panel, commissioning test, excitation system,)

The Contractor will execute the work pursuant to the specification prepared by the consultant, such as designing, manufacturing, supply, shop test, packing for shipping, transportation, and the instruction on site works and site tests. The equipment rehabilitated will be taken over after testing at site and confirming the required function. The Contractor is requested to carry out transfer technology to MEPE staff during the execution of site works.

2.2.4.3 Implementation Conditions

(1) Communication System

A reliable communication system for both overseas and domestic is essential for collection of information and urgent reactions against any kind of problem.

The existing communication system in the site is in a difficulty for overseas communication and the system is less reliable even in a domestic line.
Under such situation, the international communication system will be established during the installation works of the Project so as to make a safety and smooth execution of the Project.

(2) Safety Control

The safety control is essential for the Project taking into account the relocation of heavy

equipment/parts, working at heights and narrows, parallel work at the same place and time, etc.

Prior to the commencement of every work, Tool Box Meeting (TBM) is requested to be carried out as far as possible so as to confirm the safety execution of work and safety measures. Especially it is important for allover workers on electrical circuit to check the switched off condition, lock the switches, ground the circuit, confirm the stoppage area, to avoid the accident due to operation errors.

(3) Preparation Works

Since almost works will be executed during the stoppage of operation for each Unit, the access and method of handing in/out for the equipment should be studied sufficiently by the Consultant, the Contractor and MEPE mutually so as to carry out the works smoothly.

(4) Consideration to the operation of the other units

When the rehabilitation works are carried out for one unit, the remaining five units are under operating. Taking such operation of power station in consideration, the implementation plan should be studied without hindrance to the power generation.

Especially, since 132 kV bus is used as common for all the units, the complete shut down of 132kV transmission line is inevitable when the rehabilitation of equipment relating to the 132kV transmission line are made. Some countermeasures should be considered for this equipment so as to minimize the time of total shut down.

(5) Coordination between the works

Almost all the equipment to be rehabilitated is concentrated in the narrow space in the power station. The works such as removal, installation, painting, test, etc will be carried out in same and parallel. It is necessary to make the interface and responsibility of works clear, and to realize the safety for personnel/equipment and the control of quality.

(6) Coordination with Baluchaung No.1

Water discharge from Baluchaung No.1 is fully drawn down to No.2 power station and the volume of water is balanced. During the implementation, one unit will be stopped for its rehabilitation, which means the discharge from No.1 is surplus and has to be drain out after the tailrace of No.1. In order to drain the surplus water, a temporary stop log using wooden blocks will be made at the downstream of No.1, by which the tailrace water level become high and then the surplus discharge can be flowed toward the intake of No.2.

This method has been adopted in several times for the maintenance works of Baluchaung No.2 and then no additional discharge way is required during the implementation.

2.2.4.4 Consultant Supervision

Under the Japan's Grant Aid Scheme, the Consultant shall execute smoothly the consulting services by organizing a project team for construction supervision, with a full understanding of the Basic Design.

(1) Basic Policy for Construction Supervision

The Consultant is requested to give to the Supply's contractor and MEPE at any time instructions which may be necessary for the execution of the Works and to manage the Supply contractor's and MEPE's activities to finish all the Works safety and positively within the scheduled time for completion. The basic policy for construction supervision is the following three items.

(a) Progress control

i) To monitor the progress of manufacturing, transportation and site works for each item of equipment.
ii) To monitor the progress of installation works and site tests to be executed by Myanmar side.
iii) To arrange a coordination meeting for project management and progress control, from time to time during the implementation of the Project. Such a coordination meeting will be held weekly during the period of the site rehabilitation works and daily during the period of commissioning.

(b) Safety control

i) To enforce a safety check before setting out the works.
ii) To make necessary protection for the other facilities/equipment so as not to give damage
iii) To avoid complication of some works at a place.
iv) To provide a safety man at handling equipment and at working near the energized parts
v) To take necessary safety precaution at working near the floor openings or the energized.

(c) Quality control

i) To review the Supply contractor's design drawings for all major equipment to check the conformity with the requirements specified in the specifications.
ii) To witness factory tests to check whether the equipment is manufactured in compliance with the approved drawings and the specifications.
iii) To verify the results of the rehabilitation works through site test. All the tests necessary to prove and demonstrate that all guarantees and technical particulars for the rehabilitated equipment have been satisfied.

(2) Consultant Engineer in Charge

To smoothly execute all different types of consultant services, it is required to assign a competent Project Manager who has ample experience in similar projects and fully understand the contents of the Project. At the same time, the Consultant establish a competent organization by appointing proper staff in charge for preparation of the Bid Documents, technical review of the Contractor's drawings, factory inspection, construction supervision and commissioning tests.

(a) Project Manager (1 person)

The Project Manager will manage overall implementation of the Project. He will give instructions, suggestions and necessary advice to other engineers in charge.

In the site construction stage, he will check working methods, safety, and progress control of whole works and to formulate site organization for construction supervision. He will also be responsible for evaluation of the Project effect.

(b) Engineers in Charge of Bid Documents (4 persons)

The engineers are responsible for preparation of Bid Documents, bidding procedures including bid announcement, attendance to Bid Opening, Bid evaluation, assistance to the Contract Negotiation and the conclusion of the Contract.

Considering the specialties required for these activities, four engineers; one mechanical engineer, two electrical engineers and one transmission engineer are required for this assignment.

(c) Engineer in Charge of Drawing Review and Factory Inspection (2 persons)

The engineers are responsible for technical review of the contractor's drawings for approval and witnessing the factory tests for the purpose of quality control of the equipment and materials to be supplied under the Project.

Considering the specialties required for these activities, four engineers; one mechanical engineer, two electrical engineers and one transmission engineer are required for this assignment.

(d) Engineers in Charge of Construction Supervision (4 persons)

The resident engineers at site will be in charge of progress control and safety control in the whole period of the site rehabilitation works.

Considering the specialties required for these activities, four engineers; one mechanical engineer, two electrical engineers and one transmission engineer are required for this assignment.

(e) Soft Component Engineers (2 persons)

The technical transfer will be made to maintain the effect of rehabilitation works continuously for long period and to execute the necessary operation and maintenance works effectively by the engineers.

Considering the specialties required for these activities, two engineers; one is a mechanical engineer and another is an electrical engineer, are required for this assignment.

2.2.4.5 Procurement Plan

(1) Procurement of Equipment

This Project is to rehabilitate the existing equipment that was supplied by Japanese manufacturers. Therefore, the equipment and parts thereof to be supplied under this Project are required to be technically interfaced with the existing equipment from both structural and functional point of view.

Such equipment and parts are not available in Myanmar will be procured in Japan.

(2) Policy of Spare Parts Supply

The spare parts such as lamps, fuses and recording papers, etc. to be required for normal operations will be supplied in this Project. Parts which is important and required in urgently in case of a failure of part, such as turbine runner, needle tips and nozzle tips etc. will be supplied under this Project.

(3) Concept of Defects Liability

The defects liability will be requested to all the equipment rehabilitated in the Project for one year after taking over. Even if the defects arise on the part out of scope of the Project, it shall be included in the part to be liable in case of such defects caused by Project execution.

The defect liability period is one (1) year after taking over.

As for the totally replaced facilities/equipment and unit/parts of which the function can be measured, the function guarantee for such will be requested.

2.2.4.6 Implementation Schedule

The implementation schedule for this Project will be executed in the following three (3) phases and the overall implementation schedule is shown in Table 2-4.

(1) First Phase

(a) Purpose : Function restoration for Units No.1-6 turbine auxiliaries
Installation of 132kV transmission line

(b) Major Scope
- Modification of Compressed air supply equipment for Units No.1-3 and Replace for Units No.4-6
- Replace of Cooling water supply equipment for Units No.1-6.
- Installation of 132kV transmission line

(c) Overall period : Twenty-one and half (21.5) months

(2) Second Phase

(a) Purpose : Function restoration for Units No.4-6 generating equipment

(b) Major Scope
- Metal seal replace of inlet valves (including control valve panel)
- Overhaul of water turbine (including needle tip, nozzle tip and deflector and water shelter setting only for Unit No.5-B side).
- Replace of control panels and control cables
- Replace of main transformers
- Overhaul of overhead traveling crane

(c) Overall period : Twenty-one and half (21.5) months

(d) Stoppage : Stoppage of generator is required for 2 month each unit
Three units' stoppage is required for de-watering and setting of closure at the maximum 32 hours.

(e) Soft component : Guidance for operation and maintenance of power plant

(3) Third Phase

(a) Purpose : Function restoration for Units No.1-3 generating equipment

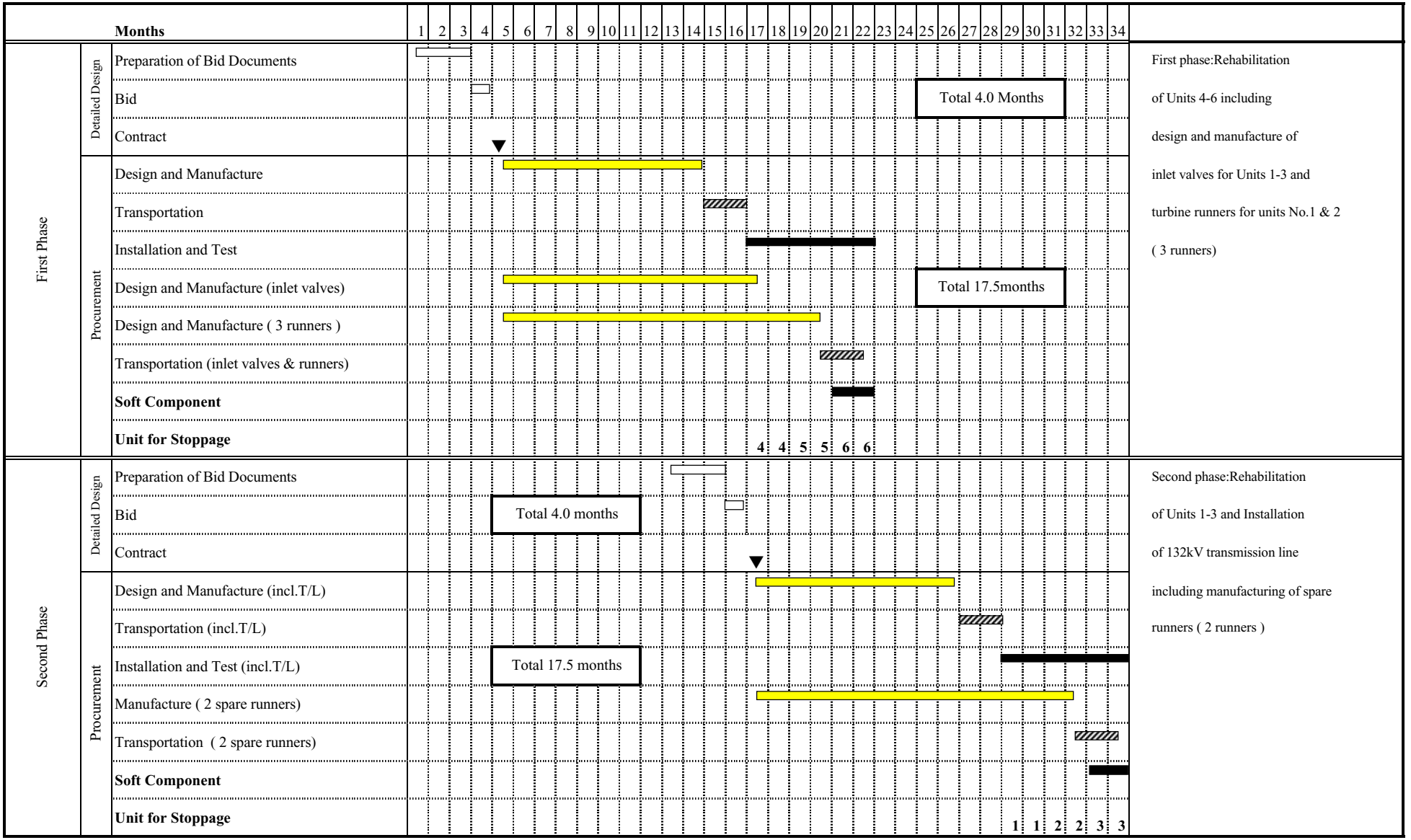
(b) Major Scope
- Replace of inlet valves (including control valve panel)
- Overhaul of water turbine (including needle tip, nozzle tip and deflector replace)
- Replace of excitation system
- Replace of control cables
- Replace of turbine runner
- Replace of switchgear

(c) Overall period : Twenty-one and half (21.5) months

(d) Stoppage : Stoppage of generator is required for 2 month each unit
Three units' stoppage is required for de-watering and setting of closure at the maximum 29 hours.

(e) Soft component : Guidance for operation and maintenance for new equipment and monitoring for the guidance executed in the second phase.

Table 2-4 Implementation Schedule



2.3 Obligations of Recipient Country

2.3.1 Works to be executed by Myanmar Side

In the implementation of this Project, Myanmar side is requested to execute their activities in accordance with the Minutes of Discussions on August 17, 2001 as the obligations of the recipient country. The site rehabilitation works shall be carried out in active collaboration with Myanmar side and the following activities are essential for successful and smooth execution.

(1) Participation in Rehabilitation Works

(a) Stoppage of generator for the rehabilitation works, and coordination and arrangement to cover the electric power in the national grid during the stoppage.

(b) Safety control during the implementation.

(c) Operation and adjustment of generating equipment including substation during the rehabilitation works.

(d) Installation works and site tests for the rehabilitated equipment and 2nd 132kV transmission line

(2) Proper Storage and Disposal of Unnecessary and Waste Articles of the Existing Plant

Myanmar side shall be responsible for proper storage and disposal of all unnecessary and waste articles of the existing plant. Myanmar side plans to store such unnecessary articles at the stockyard and warehouse on site.

Especially the following items must be paid attention to prevent an environmental pollution.

(a) Insulating oil of main transformers for Units No.4-6

Myanmar side prior to the replacement of the new ones shall undertake the removal and storage of the existing transformer oil. The transformer oil shall be purified after removal and stored in the existing oil tanks. The quantity of oil for one phase transformer is estimated at 6,000 liter, namely in total 54,000 liter.

(b) Disposal of existing lead acid battery

One cell of lead acid battery will be replaced with new one under this Project. The waste lead acid battery shall be carefully stored at the storage in the power station.

(3) Floor Finishing Work

In relation to the removal of the existing equipment, floor-finishing work will be required to repair the floor surfaces. Myanmar side as well as supply of necessary mortar cement and floor tiles shall carry out such finishing works.

(4) Construction of Cable Duct in Switchyard

In relation to the replacement of outdoor cables, the cable duct will newly be required because the existing cable duct is fully occupied. In addition to the cable duct, the modification of the existing window at the control room will be required for making the cable route between the switchyard and the control room.

(5) Construction of Foundations in Switchyard of Baluchaung No.2 and Kalaw substation

In relation to the installation of 2nd 132 kV transmission line, foundations for the outdoor switchgears such as circuit breakers, disconnecting switches, current transformers etc. will newly be required in the switchyard of Baluchaung No.2 and Kalaw substation.

(6) Temporary Foundations for the existing Main Transformers Units No.4-6

At the replacement of the existing main transformers, temporary foundations will be required for their storage after removal. Myanmar side shall make the construction of foundation at latest before one month of the replacement.

(7) Preparation of Accommodations for Japanese personnel in Baluchaung No.2

2.3.2 Project Cost Estimation

In order to execute all the above mentioned works as undertaking obligations by Myanmar side, the cost to be borne by Myanmar side has estimated as follows:

i) Remuneration of staff for rehabilitation	13,465,000 Kyat	(19,800 US$)
ii) Remuneration of staff for 2nd 132kV Transmission line	6,570,000 Kyat	(9,660 US$)
iii) Construction of cable duct	669,300 Kyat	(980 US$)
iv) Construction of foundations at Baluchaung No.2	989,000 Kyat	(1,457 US$)
v) Construction of foundations at Kalaw substation	1,932,000 Kyat	(2,843 US$)
	Total : 23,625,300 Kyat	(34,740 US$)
	Exchange Rate: 1 US$=680Kyat	

To smoothly implement this Project, Myanmar side should have the necessary cost ready in advance and the works in the above (4), (5), (6) and (7) must be completed at latest before one (1) month of the commencement of rehabilitation works.

2.4 Project Operation Plan

Baluchaung No.2 Hydropower Station has been operated for over 40 years by MEPE staffs. The power station has a sufficient number of operators and maintenance crews who have experiences for operation and maintenance of the power station. Therefore, they can manage the customary operation and maintenance of the power station without the need of modification of their organization. However, their technical knowledge is not sufficiently satisfied and it is needed to give a guidance in order to maintain the effectiveness of this Project and to achieve further long-term operation of Baluchaung No.2. The operation and maintenance of the power station need to be improved in the following manner.

(1) Improvement of Periodical Maintenance Works

(a) Ordinary inspection

The ordinary inspection has been carried out periodically to confirm and maintain the performance of the respective equipment. Maintenance tools and testing equipment have been kept in Baluchaung No.2, but additional maintenance tools and testing instruments to be required for handling of new equipment introduced by this rehabilitation will be supplied. The contractor will instruct the maintenance crews of the power station how to use these items in their works.

(b) Detailed inspection

The detailed inspection is essentially required to achieve the long-term operation of the generating units in good conditions.

The technical skills for dismantling and re-assembling of the turbines and generators will be transferred to the maintenance crews through on-the-job-training so that they can manage periodical overhaul and occasional inspection in case of emergency.

(2) Improvements in Recording Operational Data and Events

The operation data have been recorded hourly or half-hourly. The event recording is limited to heavy faults/troubles and major maintenance works. However, there are no satisfactory records on light faults/events, replacement of spare parts and consumables.

These operation data, faults/troubles and maintenance results are essentially required to monitor the operating conditions of the respective equipment. Accordingly, these data and events shall be recorded properly and compiled as a database for the operation management and scheduling of the future maintenance plans.

Therefore, the Consultant will provide the technical guidance for improvements in data recording to the operators and maintenance crews at site.

(3) Proper Replacement of Consumables and Wearing Parts

To enable continuous operation after the completion of this Project, consumables and wearing parts shall be replaced properly and timely in accordance with maintenance schedule to be formulated carefully. Necessary budget shall be prepared for proper replacement of these items.

2.5 Other Relevant Issues

2.5.1. Soft Component

Baluchaung No.2 power Station has been operating and maintaining over 40 years by MEPE under the difficult conditions such as shortage of parts. The operation and maintenance has been carried out well so far and it has to be continued after this Project.

Under such understanding, soft component, which provide a guidance for proper operation and maintenance to maintain continuously the effect achieved by this Project, will be adopted in the implementation stages.

The soft component will be carried out to the staff in Baluchaung No.2 hydro power plant in the following aspects.

(1) Guidance and instruction for effective operation and maintenance on the overall hydropower station facilities/equipment.

(2) Guidance and instruction for recording of data, such as daily inspection, operation, accident, mal-function and maintenance.

(3) Technical guidance for periodical inspection and overhaul (specially for water turbine and generator)

(4) Guidance and instruction for keeping of documents such as design drawings, instruction manuals and operation/maintenance manuals.

(5) Guidance and instruction for storing of spare parts and maintenance tools.

(6) Technical guidance for Operation and Maintenance on equipment newly installed

CHAPTER 3

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

3.1 Project Effect

The objective of this Project is to rehabilitate the Unit No. 1 to Unit No. 6 for restoration of their technical performances, reliability and safety to the original conditions to realize a stable supply of electricity. The implementation of this Project will have the beneficial effects as shown in Table 3-1.

Table 3-1 Effects by Implementation of This Project

Present Issues	Measures by this Project	Effect after Implementation
1. The existing Units No. 1 to No. 3 have been operated for over 40 years and 25 years for Units 4 to 6 since their commissioning. Their operating performances have deteriorated due to aging and corrosion under full power operation.	The Units No. 1 to No. 6 and the substation equipment will be rehabilitated to restore them to the original conditions.	The possibility of faults and troubles on the Units No.1 to No. 6 will be reduced. As the result, the technical performance reliability and safety of Baluchaung No.2 will be restored and maintained for further long -term operation.
2. Baluchaung No.2 has been continuously operated to provide the electric power to the national grid and its generated energy share 24 % in that of the whole country. If Baluchaung No. 2 are left as they are, it will have an adverse effect on stable power supply.		The Units No. 1 to No. 6 can be operated with high working ratio as they used to do before. This will come to restore and improve the reliability of power supply to the national grid.
3. Baluchaung No.2 has been operating by using discharge water from Baluchaung No.1, which is located upstream of No.2, and the water volume is balanced. It means that a stoppage of Baluchaung No.2 cause failure of operation of No.1.		Stable and continuous operation of Baluchaung No.2 contributes to stable operation of Baluchaung No.1.
4. Capacity of transmission lines can not cover the whole generated power of Baluchaung No.2 and No.1. The generated power is transmitted to Mandalay area with 150% overload of 132kV transmission line.	The second 132kV transmission line will be installed and then 2 circuits of 132kV transmission lines will be available.	Reliability of power transmission for Mandalay area will be improved due to double circuits of transmission line. Even one transmission line is failure, the electric power can be sent by the other line. The capacity of 132kV transmission line will be increased double and then power loss can be reduced half. Present power loss 7.0MW is expected to be 3.5MW.

5. Documents which are essential for operation and maintenance of the equipment, such as drawings, manuals etc. are not properly utilized.	The desired management will be transferred to the operation and maintenance crews of the power station through the soft component.	They can manage a proper management for the drawings, manuals, operation and maintenance records and they can refer to the documents for periodical inspection
6. MEPE staffs have no technical skills for planning of the periodical inspection and execution of dismantling and reassembling of the turbine and generator.	The desired technical skills will be transferred to the maintenance crews of the power station through the soft component.	They can manage periodical overhaul and occasional inspection in case of emergency of the turbines and generators. Especially, this Project will provide a greater opportunity for young engineers to learn the generating equipment.

The implementation of this Project will also have the following indirect effects:

(1) The implementation of the Project will reinforce the stable power supply to the national grids, which is essential to socio-economic development. This will prevent Myanmar nationals from suffering the electric power shortage more and lead to improvements in a living standard as well as in public services.

(2) The restoration and improvement of the reliability of power supply will make a considerable contribution to progress of the national development plan, which is one of the main objectives of the Government of Myanmar.

(3) Similarly with the technology built up in Baluchaung No.2 hydro power plant to date, the technology provided by this Project will be transferred to the other power plants in the whole country. This will bring about the improvement of the technical level of MEPE.

3.2 Recommendations

A sufficient and proper maintenance is essentially required to maintain the effectiveness of this Project and to achieve further long-term operation of Baluchaung No.2 hydro power plant. The maintenance works for Baluchaung No.2 need to be improved as described in Clause 2.4, Project Operation Plan. In particular, the following two items are the most important subjects to achieve successful long-term operation of Baluchaung No.2 Hydro Power Plant.

(1) Preparation of Necessary Budget

The extension of the service life can be achieved on assumption that the consumables and wearing parts should be replaced properly and timely in accordance with maintenance schedule to be formulated carefully. Therefore, MEPE is recommended to prepare necessary budget for proper replacement of these items.

(2) Execution of Periodical Maintenance Works

MEPE is recommended to execute the desired periodical maintenance works including overhaul to maintain the performance of equipment, to detect any trouble in its early stage and to prevent faults and accidents.