Ministry of Planning and International Cooperation
The Repiblic of Yemen

FINAL REPORT
OF THE PREPARATORY SURVEY
ON THE PROJECT
FOR
INTRODUCTION OF CLEAN ENERGY
BY SOLAR ELECTRICITY GENERATION SYSTEM
IN
THE REPUBLIC OF YEMEN

August 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

NEWJEC Inc.
JAPAN TECHNO Co., LTD.

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey on THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM in Republic of Yemen.

JICA sent to Yemen survey team headed by Mr. Masaru NISHIDA of NEWJEC Inc. and consist of NEWJWC Inc. and JAPAN TECHNO CO., LTD. from 11/7 to 23/7 and from 4/10 to 22/10, 2009.

The team held discussions with the officials concerned of the Government of Yemen, 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 Yemen in order to discuss a draft outline design, and as this result, the present report was finalized.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Republic of Yemen for their close cooperation extended to the teams.

August 2010

Kazuhiro YONEDA
Director General,
Industrial Development
Japan International Cooperation Agency

SUMMARY

Summary

I. Outline of the Recipient County

The Republic of Yemen is located in the southern end of the Arabia Peninsula, stretching 12 to 19 degrees latitude north, 43 to 54 degrees longitude north. Out of its territory of 555 thousand sq- km, 5.5% is forest and 34% agricultural land. Aden City is a port town facing the Gulf of Aden, with annual average temperature 29 degrees Celsius, and annual rainfall of 32mm is observed in two separate wet seasons (December to January and July), and the highest temperature reaches 40degrees in summer.

Yemen is classified as one of the least developed countries falling behind other Middle East countries. Gross National Product (GNP) per capital is US$965 (Central Statistics Office, 2007), the large proportion (approximately 30%) of which is generated by export of oil product, 90% of total export, started in 1980s. Between 2004 and 2007 GNP grew at 14.1% per annum, mostly due to world-wide hike of petroleum product prices and commodity prices in general. The reserve of oil is somewhat limited and the production has slowed down. Meanwhile, natural gas was found recently and exportation of LNG was started in 2009, as well as the use in a gas-turbine power plant.

The components of GNP are; agro-fishery 10%, manufacturing 10%, power and water 0.7%, distribution 16.4%, transport/communication 11.7%, finance and real estates 10.5%, and public sector 10%. Manufacturing and distribution have been expanding, while agro-fishery and mining including oil contracting.

Yemen has been making efforts to open up its economy, by joining Gulf Cooperation Council (GCC) and promoting economic fusion with other Arabic countries. The Government is also trying more stringent management of external debts and foreign reserves to prepare for the globalization of world economy. Further it is intending to develop its economy through liberalization of external trade, promotion of export, and inviting more FDI.

II. Background of the Project and its Outline

More than 50% of power production in Yemen comes from steam turbine power plants burning fuel oil, and the rest from diesel engine power plants. Thus the country is completely dependent on fossil fuel for its primary energy of electricity. The country is trying to shift the primary energy to natural gas from oil of which the reserve is limited. Use of renewable energy including solar power for rural electrification is being called for, and the Government has turned to introducing clean energy.

Renewable Energy Strategy and Action Plan published in June 2008 aims at realizing provision of power in rural areas, not reached by Public Power Corporation's transmission expansion plans, by off-grid sources such as solar energy and wind power/diesel hybrid. In April 2009, the Government

issued a republic law to establish the public rural electrification agency, which is given a task to study appropriate and cost effective methods of electricity provision including new-energy and renewable energy, and to select suitable methods that meet the needs and demand in rural areas.

The country decided to join "Cool Earth Partnership" and takes up as its policy priority reduction of GHGs emission and promotion of economic development, by the approach of adaptation and mitigation to climate change. In accordance with the initiative, Yemeni Government requested to the Government of Japan for Grant Aid in June 2009.

Having received this request, JICA conducted the first phase site survey between July 11th to 22nd in 2009, identified Sabaeen Hospital in the capital Sana'a and Al Wahda Hospital in Aden as candidate sites, and made into an agreement with the Recipient.

III. Outline of Study Result and the Content of the Project

Based on the results of the first phase study, the scale and efficiency of both site candidates have been reviewed in Japan, and Al Wahda Hospital was chosen as the Project Site. Subsequently JICA sent the Study Team for the second phase site survey between October 4th and 23rd to Yemen, to investigate the Site, collect related information and have discussion with the Recipient concerning the contents of the Project.

After coming back to Japan, the Study Team examined the necessity, effectiveness and appropriateness of the Project on the basis of the result of the site survey, and prepared a Basic Design Report. With the Basic Design Report in hand, JICA's Study Team visited Yemen again between April 10th and 16th 2010, explained and discussed the report, and signed the minute of meeting with the Government of Yemen.

Category	Content
Site and PV Capacity	Al Wahda Hospital: 300kW PV equipment − PV system shall be grid-interconnected − Surplus power shall not be sent back to the utility grid (no reverse current) − In the case of blackout, PV system shall restart in Stand-alone Mode to supply power to part of the Hospital
Procurement of Generating equipments and Installation Work	300kW PV modules Ancillary equipment and works for PV system - Junction box - Power conditioner cubicle - Meteorological observation device - Low voltage panel - Branch Switchers for Load (for stand-alone mode) - Materials for wiring and earthing - Electrical facility cubicle - Supporting structures for PV modules - Foundation of supporting structures for the PV system and electrical facility cubicle - Fences, gates, and grave surfacing - Cable connection for Electrical facility cubicle/interconnection point/display equipment/ connection to existing loads
Spare Parts and Tool Kits	Spare parts and tool kits for maintenances of equipment Manuals for O&M and implementation of O&M Guidance

The Project proposed is to provide Al Wahda Hospital with a photovoltaic system (PV system) of 300kW peak power and to supply electric power to the facility, as well as to give training programs covering topics like methods of operation and maintenance, and planning of solar power projects. The Responsible Organization is the Ministry of Planning and International Cooperation, and the implementing agency the Ministry of Public Health and Population. The outline of basic design of the PV equipment is shown in the table below.

IV. Project Implementation Cost and Period

The cost of this Project implemented under Japan's Grand Aid scheme includes expenses on Yemeni side approximately YR 3.7million for travel cost of participants to training programs.

The project period is planned to be five months for tendering stage, and fourteen months for the procurement of the Products and their installation.

V. Evaluation of the Project

The generating equipment procured in the Project is designed to be managed by the Site, Al Wahda Hospital, for its daily operation and maintenance, with supervision of the Ministry of Public Health and Population. The management of the equipment in the long run will also require technical assistance and input from the Ministry of Electricity and Energy.

At the implementation stage of the Project, a series of the training programs will be provided for operation and maintenance techniques and knowledge on solar generation and its planning and use. The training programs is planned with intentions to make effective and sustainable the operation and maintenance organization mentioned above, and to contribute to the promotion of solar energy use in Yemen.

The direct effect of this Project is expected to be the introduction of renewable energy source in Yemen which is dependent on fossil fuel for the primary energy of electricity, reducing fossil fuel consumption and the emission of the main cause of climate change, CO_2. The study estimates that the expected reduction in CO_2 emission due to the Project is 258 t-CO2 per year.

This Project will install the largest-scale solar generation system in Yemen with its population distributed over the territory and in need of solar energy in electrification of rural areas. The Project is expected to demonstrate the effectiveness of solar energy use to the wider public of the country, and will contribute to the promotion of its use in private sector.

Meanwhile, PV modules and power conditioners made by Japanese manufacturers have technical advantages over other countries in their efficiency, longevity, reliability, etc. in the market. As this Project is limiting the country of origin of this equipment to Japan, the Project will be able to offer advanced technology of Japanese products.

Adding up the discussions above, it is concluded that the Project planned herein is very effective and appropriate as a project implemented as Programme Grant Aid for Environment and Climate Change.

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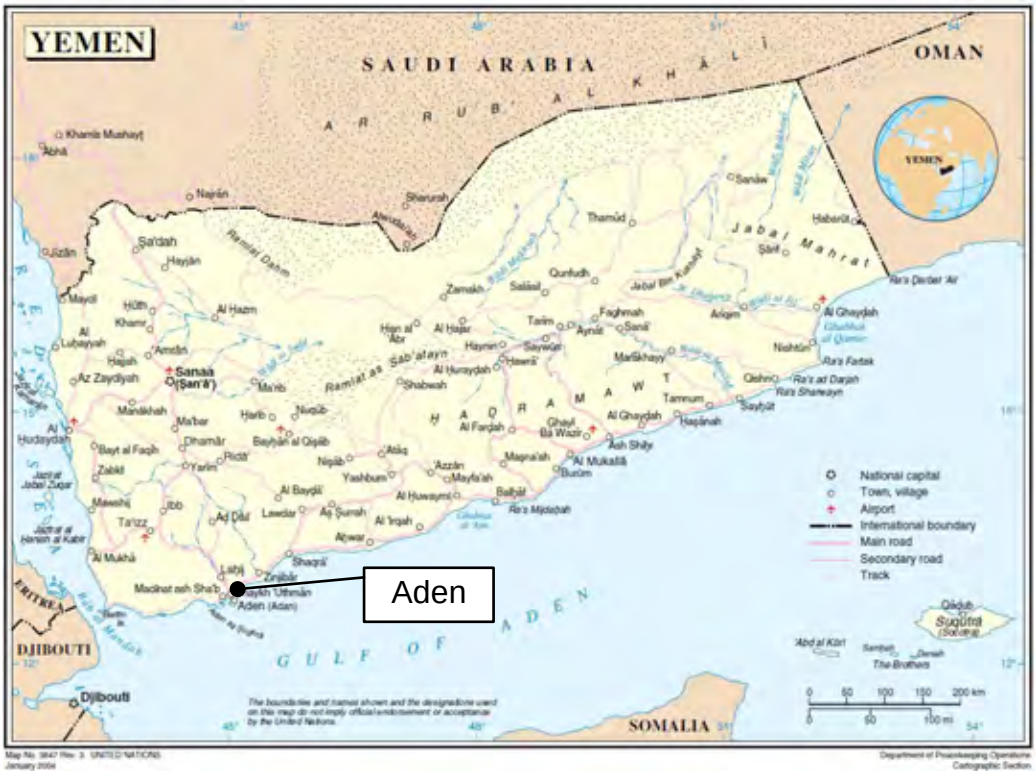

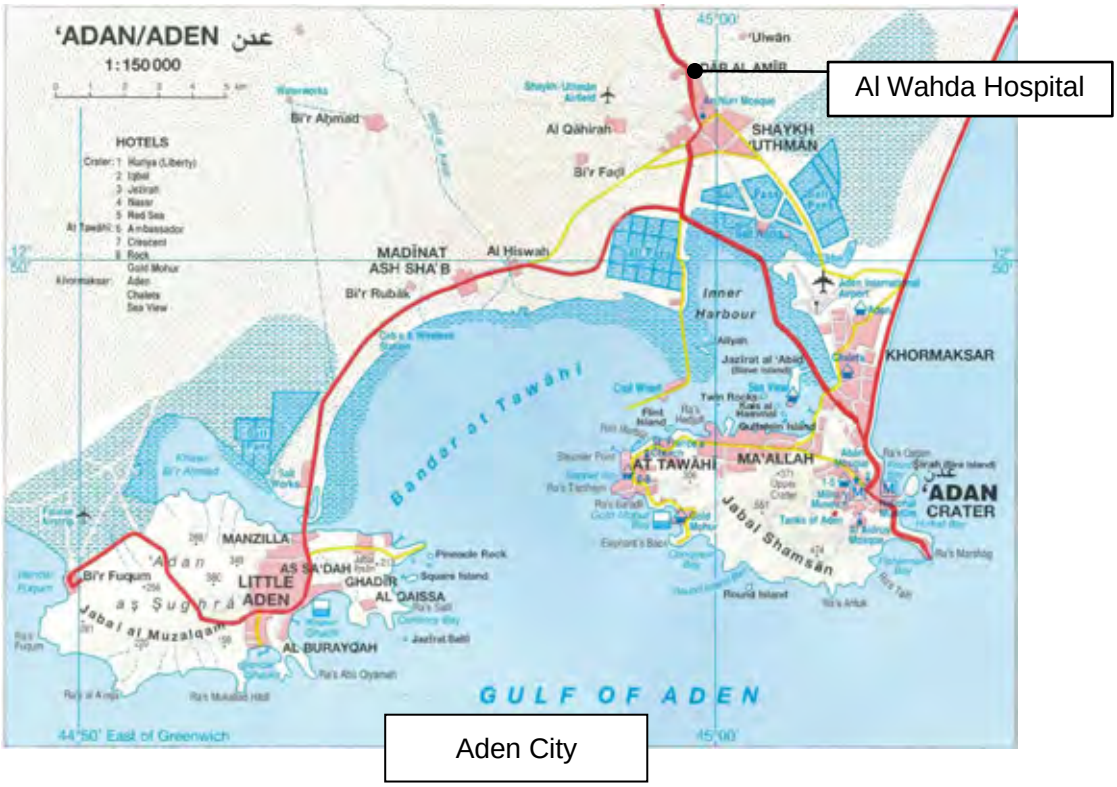

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Abbreviations

AC	Alternating Current
B/A	Banking Arrangement
CT	Current Transformer
DC	Direct Current
DEG	Diesel Engine Generator
EIA	Environmental Impact Assessment
EU	European Union
E/N	Exchange of Notes
GDP	Gross Domestic Product
GNI	Gross National Income
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
JCS	Japanese Electric Wire & Cable Makers' Association Standard
JEAC	Japan Electric Association Code
JEC	Japanese Electrotechnical Committee
JEM	Standards of Japan Electrical Manufacturer's Association
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
MCCB	Molded Case Circuit Breaker
MEE	Ministry of Electricity and Energy
MPHP	Ministry of Public Health and Population
MPIC	Ministry of Planning and International Cooperation
MWE	Ministry of Water and Environment
O&M	Operation and Maintenance
OJT	On the Job Training
PEC	Public Electricity Corporation
PCS	Power Conditioners
PV	Photovoltaic
PVC	Polyvinyl Chloride
SI	The International System of Units
VT	Voltage Transformer
XLPE	Cross-linked Polyethylene

CHAPTER 1

BACKGROUND OF PROJECT

Chapter 1 Background of Project

1-1 Background of the Study

Yemn has a chronic problem of shortage of generation capacity. Facilities of generation, power transmission, and power distribution are aging, and renewal or capacity enhancement of those facilities has not been catching up with the growth of demand. Due to the delay of network expansion, independent generation facilities have increased in regions, and expensive fuel is being consumed in less efficient manner.

Japanese government announced its policy initiative in Davos in January 2008 to assist developing countries which intend to contribute to mitigation of climate change by means of reduction of greenhouse gas emission without compromising their economic development. The initiative is called "cool earth partnership" and aims to support developing countries in their efforts to reduce energy consumption and emissions, and also to adapt to the change in climate. As one of measures, Japanese government set up "Programme Grant Aid for Environment and Climate Change ", a financial mechanism to support member countries which have difficulties in executing capabilities and funding.

Using this measure, Japanese government is seeking opportunities to employ its advanced technology of photovoltaics as a clean energy source in international cooperation. Ministry of Foreign Affairs of Japan has conducted needs surveys for Program Grant Aid for Environment and Climate Change using photovoltaic technology among member countries of Cool Earth Partnership, and Yemen Government responded with its candidate projects.

Requested Components for this Grant Aid project submitted in June 2009 is as follows.

Amount of request: US$5,000,000

Description of request: Arrangement of solar systems for following institutions.

a) Sabaeen Hospital
   Location: Al Sabaeen Plaza in center of Sana'a City,
b) Al Wahda Hospital
   Location: Al Sheikh Otham district in Aden City
c) Al Thawra Hospital
   Location: Al Thawra Street in Taizz City

Equipment and materials requested

a) Junction Box

b) Power conditioner
c) Circuit Breaker
d) Solar module
e) Cables
f) Equipment for data collection and display

Soft component (technical assistance) requested

a) Workshop for maintenance and management of operation
   Target: Technicians of PEC
   Period: Two weeks
b) Technical training for maintenance and management of operation
   Target: Senior technicians of PEC
   Period: One month
c) Preparation of manual for maintenance and management of operation
   (Experts will be dispatched)

In future:

d) Arrangement of systems for introduction of renewable energy (Technology cooperation)

Receiving thisrequest, technical issues such as potential of installation of photovoltaic module, etc. for the above sites were studied in the first phase site survey in July 2009. Then after the discussion with Yemeni side, Sabaeen Hospital and Al Wahda Hospital were identified as project site candidates in the Minutes of Discussion signed between Ministry of Planning and International Cooperation and other authorities in Yemen and JICA Preparatory Survey Team in August 14, 2009. After that, the scale and efficiency of both site candidates have been reviewed in Japan, and Al Wahda Hospital has been finally determined as the Project Site.

Al Wahda Hospital is a referral hospital combined with medical educational institution, to which patients come from Aden and its neighborGovernorates. Obstetrics and gynecology clinics, and pediatrics are the main services, and new building for kidney dialysis is under construction. Funding and management of the hospital is autonomous with assistance from the Aden Governorate.

In this Grant Aid project, photovoltaic power generation systems (PV systems) will be provided as part of assistance for mitigation measures of climate change in Yemen. A fraction of electricity in this country will be replaced by that from renewable energy source, which helps cope with both greenhouse gas emission and economic growth, by decreasing dependence on fossil fuel and the burden of electricity cost of a public facility.

1-2 Project Site and Surroundings

1-2-1 Related Infrastructure

(1) Status of Existing Electric Equipment in the Facility

The existing electric equipment in Al Wahda Hospital is composed mainly of thirty-year old Russian system. Part of the system has been renovated and some transformers were replaced with Korean-made ones in 2008. As-built drawings have been mostly lost, including a system-wide single line diagram. Many part of the system has been modified, whose records are only found in the memories of technicians of the facility. The outline of electric equipment in the facility is explained below.

There are two electrical rooms in the facility and four transformers of 11kV/400V, which receive power from the utility grid. Each electrical room houses two transformers and one low voltage panel (LVP). If one of these transformers breaks down, the other transformer can supply the power to the whole panel by an operation of switching device on the panel, although the switching device seems to have been out of order for many years.

Electricity comes through these transformers to the distribution panel of a building in multiple routes, to secure redundancy of the system in case of mechanical problems or maintenance works. For example, the main hospital ward (Building A2) is connected to both Transformers No.2 and No.3, which can be selected by switching on the distribution panel inside the building. However, the actual conditions of the equipment are with various problems, mostly arising from deterioration of equipment by age, breakages of breakers and insufficiency of cable capacities, etc.

The layout of major equipment in the hospital is shown in Figure 1-2-1-1, the schematic diagram of main power system in Figure 1-2-1-2, and outline specifications of transformers in Table 1-2-1-1.

There is one emergency diesel generator set (500kW capacity) in the hospital. The power generated by the set is supplied to Building A (main hospital ward), Building D (gynecology ward) and Building F (maintenance building), but not to Building B (administration).

Table 1-2-1-1 Outline Specifications and Capacities of Transformers

	Transformer #1	Transformer #2	Transformer #3	Transformer #4
Location	Electrical Room #2	Electrical Room #1	Electrical Room #1	Electrical Room #2
Capacity	1000kVA	1000kVA	630kVA	630kVA
Year	2008	2008	Before 1975	Before 1975
Origin	Korean	Korean	Russian	Russian
Remark			To be replaced soon	To be replaced soon

There is a power meter fixed at each of these transformers. In 2008, the total of reads of these meters, that is the annual energy consumption of the hospital, was 2,063,949kWh.

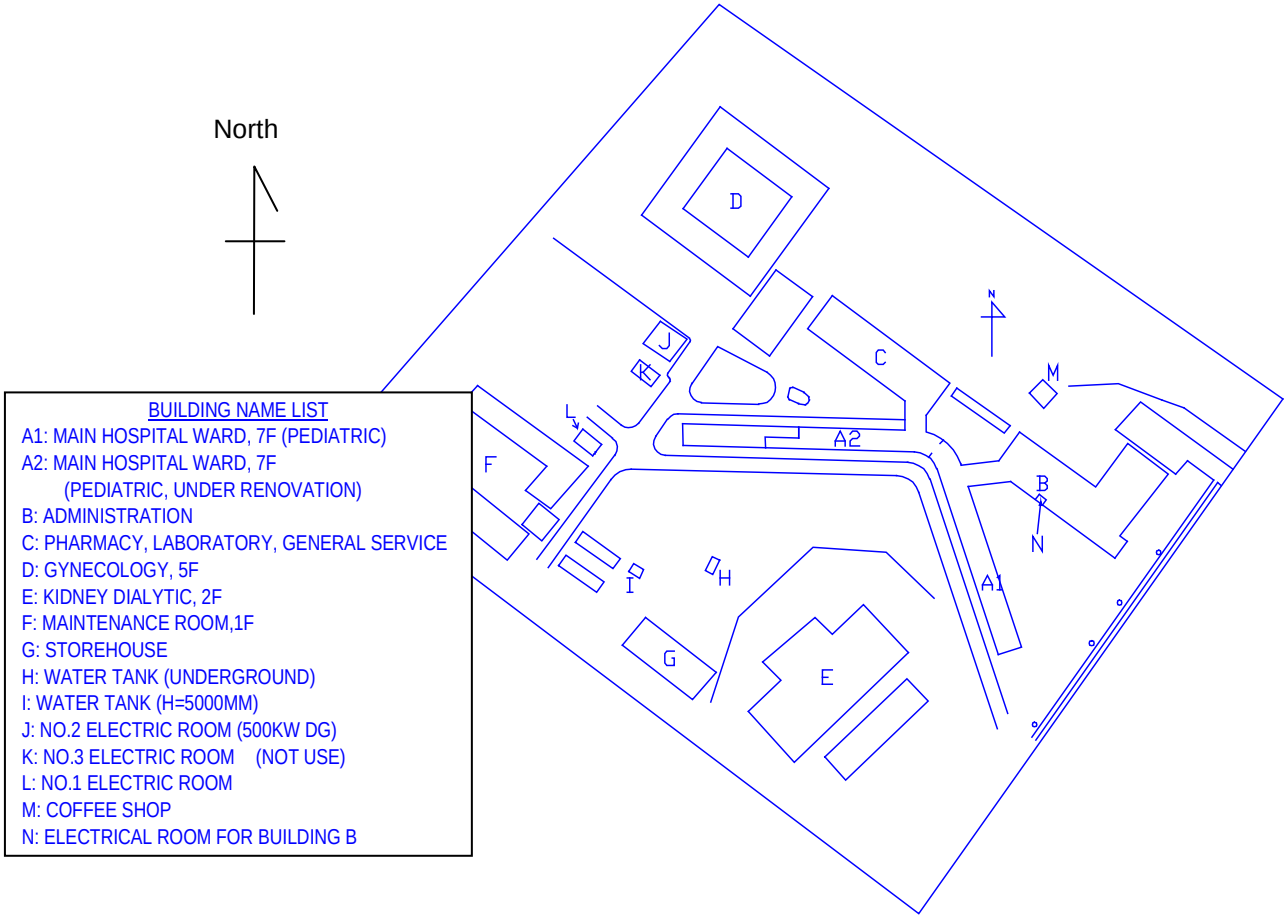


Figure 1-2-1-1 Layout of Major Equipment (existing)

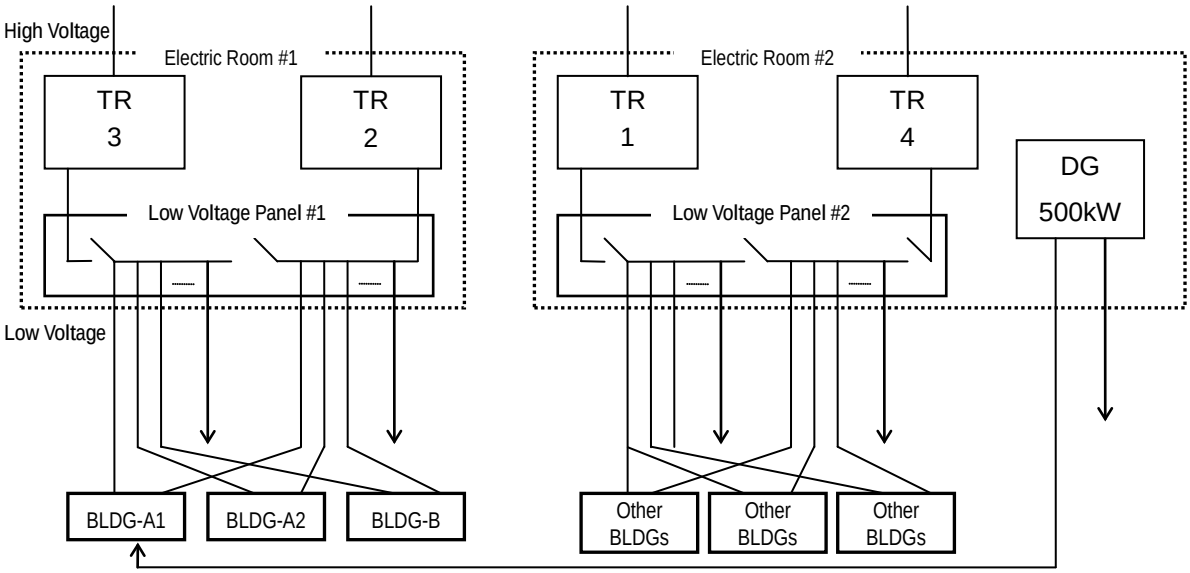


Figure 1-2-1-2 Schematic Diagram of Main Power System

(2) Status of Electricity Supply in the Region

In Yemen, supply capacity of electricity has been in shortage. Many electric equipment, such as transmission lines and switch gears, of the public utility, PEC, are old and deteriorated which also become causes of frequent blackout. The gap between demanded and supplied energy is large, hence the duration of blackout is long. The status of electricity supply is shown in Table 1-2-1-2 below. The shortage is estimated to be 15% of the demand, suggesting that on average there is two hour blackout every day.

As mentioned above, the hospital has an emergency diesel generator set supplying electricity to hospital buildings except Building B which houses the administration department and outpatient clinic. This has been a problem in outpatient consultations and hospital administration works.

With the abovementioned situations in the background, the hospital expressed to the JICA Team his strong willingness to have equipment capable of sending power even during blackouts. In response to this request, the Team decided to design the PV system with stand-alone function to be procured in this Project.

Table 1-2-1-2 Status of Electricity Supply in Yemen (June, 2009)

Description	Status	Remarks
Energy demanded	573.1 GWh	
Energy supplied	488.8 GWh	
Energy shortage	84.3 GWh (15% of the demand)	Shortage due to scheduled blackout and accidents, etc.
No of Connections	1,340,000 (Population 22.4mil.)	
Energy shortage per connection	Average daily energy consumption per connection is 14.3kWh, 15% (2.1kWh) of which is in short supply.	Assuming the size of the average consumer being 1kW, there can be blackout for two hours every day.

Source: PEC provide data edited by JICA Team

As the power utility, PEC, depends completely on fossil fuel for primary energy of the electricity generated and supplied, the power generated and consumed within the Site all contributes to the reduction of fossil fuel consumption.

1-2-2 Natural Condition

(1) Location and Topography of the Site

The Project Site, Al Wahda Hospital, is located in Aden City, the second largest city in Yemen. Aden is facing the Gulf of Aden which is leading to the Red Sea, and has been prosperous as a port town of maritime importance since ancient time.

Al Wahda Hospital is approximately 7 km away from Aden International Airport, built on a flat

land of approximately 300m by 300m rectangle. The perimeter of the premise is lined with fence made of concrete blocks. The PV system procured by the Project will be installed in the open, flat area in the southern part of the premise.

(2) Meteorological Conditions

The climate of Aden is classified as desert climate with annual rainfall of around 30mm, characterized by high temperature and humidity due to the monsoon from the coast and, especially during May to October, the temperature sometimes rises to 40 degrees Celsius.

Table 1-2-2-1 Climate Conditions of Aden

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature deg-C												
High	29.3	29.8	31.7	33.0	39.6	41.8	39.7	37.8	37.5	35.5	32.0	31.0
Low	22.0	20.0	17.3	21.0	24.0	27.0	26.0	26.0	25.8	23.5	20.0	23.0
Average	25.7	25.9	26.5	28.1	31.4	32.7	32.3	31.7	31.9	29.4	26.8	27.4
Humidity %	57	47	58	58	49	53	49	50	50	62	62	62
Rainfall mm	3	0	0	0	0	0	18	0	0	0	0	11
Wind Speed m/s	12.4	12.9	10.4	9.7	8.6	6.6	12.1	13.0	9.8	11.1	8.4	10.9
Wind Direction	E	E	E	E	SE	SE	SW	SW	SW	E	E	E

(3) Earthquake

Aden is located at the edge of the African Plate and prone to earthquakes, experienced one of magnitude 6.3 in 2007. The designing of structures for the Project should consider the earthquake countermeasures.

(4) Salinity

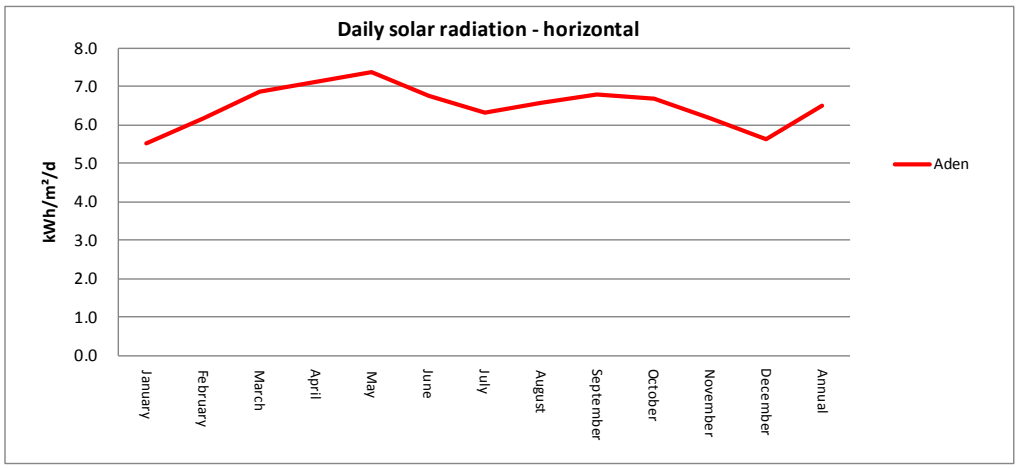
Al Wahda Hospital is located approximately 1 km away from the coastline. Therefore, the designing of equipment should consider the countermeasure against damages due to salinity.

(5) Irradiation

There has been no irradiation measurement data found for Aden or near around. According to RETScreen software published by Environment Canada, irradiation is highest in May at 7.36kWh/m^2/day, and lowest in January at 5.51 kWh/m^2/day. Annual average value is 6.49 kWh/m^2/day, which is very high in comparison with many other countries.

Source: RETScreen

Figure 1-2-2-1 shows the average monthly irradiation on horizontal plane in Aden.



Source: RETScreen

Figure 1-2-2-1 Average Monthly Irradiation on Horizontal Plane in Aden

1-2-3 Environmental and Social Considerations

The solar power generation system is understood to be a typical clean energy system due to its characteristics such as no emission of noise, vibration, exhaust and waste fluid in its power generating process. Therefore, the system can be considered to have no adverse impacts from environmental and social aspects.

As described in Chapter 2 in detail, the power generation system is designed to supply power by "Grid-interconnection" and "Stand-alone function" is also adopted to supply power to a limited demand during power failure in the grid. However, the use of batteries is not planned due to adverse impacts on the environment caused by lead contained in batteries when they are disposed. During the construction period, several adverse impacts caused by work can be expected. The emission of noise, vibration and exhaust by vehicles and machines for construction and the risk of accidents caused by the activities of those vehicles and machines also need to be assumed for the construction period. The volume and hazard of waste produced by the construction will not be significant but inappropriate management of waste can have risk of negative environmental and social impacts.

Al Wahda Hospital, the project site is a large general hospital located in the city of Aden with its premises isolated by a fence and containing many wards. The proposed site for installation of the PV modules is located to the south of the main building and is currently vacant. However, since several wards are found around the site, potential adverse impacts during the construction may need consideration. Also, since the hospital accommodates many inpatients and their families, and many outpatients visit the hospital as well, the risk of accidents caused by construction vehicles and unauthorized entry to the hazardous sites require consideration. In

addition, hindrance to surrounding traffic during the peak period for delivery of equipment, material and machinery can be assumed.

In order to mitigate the above mentioned adverse impacts during the construction period, appropriate mitigation measures which needs to be planned and implemented by the Contractor is required. Informing the work schedule and time table to the hospital staff, patients and neighbors in order for them to understand clearly the work procedures is also important to avoid the adverse impacts. As more concrete measures for security, the installation of temporary fencing to guard the site and arrangements for security guards will be required by the Contractor. Fencing around the system is planned to prevent electrical shock due to entry of unauthorized persons even after completion of the work.

The screening was carried out during the field survey to confirm the categorization of the project which was set as “C” according to JICA’s guidelines for environmental and social considerations (2004) at the beginning of the study. The following table shows the results of the screening. The items are listed in accordance with the scope of objects in JICA’s guidelines.

Table 1-2-3-1 Considerations for Environmental and Social Impacts

Item	Influence caused by the Project	Adaptation measure
Air pollution	None	
Water pollution	None	
Soil pollution	Medical waste dumped into the ground might be dug up during excavation works.	The Project area is located away from waste dump site.
Waste	Some waste will be generated during the construction period though there will be no waste after completion.	Necessary arrangements and supervision during the construction period should be provided.
Noise and Vibration	Noise and vibration will be generated during the construction period.	Necessary arrangements and supervision during the construction period should be provided.
Ground subsidence	None	
Offensive odors	None	
Geographical features	None	
Bottom sediment	None	
Biota and ecosystem	None	
Water usage	None	
Accidents	Risk of traffic accidents and electric shock during the construction period.	Necessary arrangements and supervision during the construction period should be provided.
Global warming	The project can be a part of efforts to mitigate the warming effect.	
Involuntary resettlement	None	
Local economy such as employment and livelihood etc.	None	
Land use and utilization of local resources	None, land for the Project is owned by the hospital	
Social institutions such as social infrastructure and local decision-making institutions	None	
Existing social infrastructure and services	None	
The poor, indigenous of ethnic people	None	
Misdistribution of benefits and damages	None	
Local conflict of interests	None	
Gender	None	
Children's rights	Visitors include many children, who are potential victims of aforementioned accidents during the construction period.	Necessary arrangements and supervision during the construction period should be provided.
Cultural heritage	None	
Infectious diseases such as HIV/AIDS	None	

As shown in the table, the impacts from the project will occur mostly during the construction period. Therefore, it is considered that long-term serious impacts, if any, can be avoided or mitigated through the execution of appropriate measures at the beginning stage of the project implementation. Based on the above procedure, the project was confirmed to be categorized as "C" again at the stage of site survey.

The Environment Protection Authority (EPA) is in charge of supervision of the environmental Impact Assessment (EIA) in Yemen, complying with the relevant provisions of the Environment Protection Law (1995). In accordance with the law, any project which might have adverse impact on the environment must be assessed by the EIA procedure. During the meeting with EPA, the Team explained about the outline of the Project and EPA suggested to the Team that negative impacts likely to be caused by the project would be quite limited due to the following reasons:

- Photovoltaic solar power planned for the project is regarded as clean energy.
- Size of the project can be considered as small scale.
- Site of the project is to be located on the land owned by the beneficiary.

The Team then resumed the consultation with EPA by explaining the results of the screening which indicated that the project would not be required to undergo the process of EIA in accordance with JICA's guideline for environmental and social considerations. The above was confirmed between EPA and the Team.

1-3 Global Issues

Global warming caused by greenhouse gas (GHG) emission including carbon dioxide is considered to be the main factor of the climate change, regarded as the global issue today. In particular, since the formation of United Nations Framework Convention on Climate Change, it is unanimously agreed that the reduction of CO_2 emission would be unattainable without a contribution from developing countries, as well as developed countries.

Solar generation is very effective in the reduction of CO_2 emission and the cost of energy production is not affected by fuel. Therefore, solar generation offers additional energy source and the reduction of CO_2 emission at a stable cost, and enables developing countries especially to contribute in the global community and to obtain energy for domestic development, at the same time.

This Project has been initiated by the participation of Yemen to Cool Earth Partnership. It is expected that the Project contribute to both the development of Yemen and alleviation of climate change as the global issue.

CHAPTER 2

CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Outline of the Project

In the Republic of Yemen, more than half of the electricity comes from steam turbine generators burning fuel oil, and the rest from diesel engine generators. It has been completely dependent on fossil fuel for primary source of electricity. The country has been seeking to diversify into natural gas, and also in rural electrification, clean energy sources including solar power.

Renewable Energy Strategy and Action Plan published in June 2008 aims to supply electricity in rural areas with off-grid solar, wind and their diesel-hybrid. In April 2009 the government of Yemen issued a republic law concerning a set up of the public rural electrification authority to plan and select appropriate low-cost energy supply schemes including those using new and renewable energy which best meet the energy needs in rural areas.

The country decided to join "Cool Earth Partnership" and takes up as its policy priority a reduction of GHGs emission and promotioin of economic development, by the approach of adaptation and mitigation to climate change.

This Project is to provide Al Wahda Hospital in Aden, Yemen with a photovoltaic system (PV system) of 300kW peak power and to supply electric power to the facility. The Project will contribute to the Yemeni policy of reduction of GHGs emission and the promotion of economic development, by supplying renewable energy to replace electricity generated by the conventional methods, and reducing the country's dependence on fossil fuel and relieving the burden of energy cost of the facility. The PV system works with the power from the utility grid (grid interconnection), but does not send its surplus power, if any, back to the grid. In the case of blackout of grid power the system can be re-started in “stand alone mode” by manual operation to send power to limited part of the facility.

This Project is conducted under the scheme the Programme Grant Aid for Environment and Climate Change and the tendering for the contract for the procurement of equipments and construction shall be held for Japanese companies. Among the various products to be procured for the Project, PV modules and power conditioners shall be limited to Japanese products. Site works including civil engineering works for foundations, installation of PV modules and electric works, is assumed to be undertaken and managed by the Japanese contractor employing private companies in the recipient country.

2-2 Basic Design of the Project

2-2-1 Design Policy

2-2-1-1 Design of the System

This Project is to procure and install a PV system (300kW) with grid interconnection to Al Wahda Hospital in Aden City.

Al Wahda Hospital is, being a referral hospital, one of the most important medical facilities in the southern region of the county, with its large scale, collecting users/patients from surrounding Governorates. As it is located in Aden City which is famous for its high temperature, the Hospital demands large amount of electricity during daytime for its inevitable air conditioning, which is suitable characteristics for photovoltaic power. Therefore, the Project will prove to be very effective and valuable, as a mitigation measure of climate change, to furnish the Hospital with a photovoltaic generation system.

The capacity of the PV system shall be determined taking into account the current electric power consumption and the future demand of main hospital wards which are currently under renovation. The provision of the system shall be confirmed to be free from any interference with other aid agency's activities and the installation area selected properly in view of the future land use of, and with approval from, the Hospital.

The PV system procured in the Project will be interconnected, as a prerequisite, to the power grid of Public Electricity Corporation of Yemen (PEC). It will be the first-ever experience for PEC to have a grid-interconnected renewable resource power generation, and there is no institutional/regulatory provisions in the country so far. PEC had understood the technical explanations provided by JICA Team and gave his judgment that he accepts the grid-interconnection of the PV system but not the reverse power flow[1] of the PV system, as there are no regulations concerning the matter. Therefore, the system is designed to produce power to be supplied to and consumed within the facility, and to suppress power production when it exceeds the consumption in the facility so that there will not be surplus power to be sent upstream to the grid.

The PV system shall be designed to shut down automatically when there is blackout of utility grid power. After having confirmed some predetermined conditions being met, the System shall be able to be restarted, disconnected from the utility grid, by manual operation to supply power to limited part of the facility. This function, called "stand-alone mode" is adopted in the design responding to the strong demand expressed by the Hospital. The Hospital is equipped with emergency diesel

[1] Reverse flow is the flow of power generated by PV system upstream to the utility grid.

generators for blackout situations. They supply power to parts of the Hospital but not to the administration and outpatient building due to the shortage of supply capacity, which led to the need for the power supply to the said building during the blackout.

The part of the facility to be supplied with power under stand-alone mode must be strictly without important loads[2] that require stable power supply, in particular those electric equipment that affect human lives, as power production of PV system alone is inherently unstable due to weather conditions and may stop anytime. The loads to be supplied with power under stand-alone mode should be limited to those dispensable, such as air conditioning and lighting, etc.

2-2-1-2 Natural Condition

(1) Air Temperature and Humidity

As mentioned in sub-section 1-2-2, the climate of Aden has high temperature and humidity throughout the year. Al-Wahda hospital is located relatively near the sea so that the equipments should be salinity resistant.

Power conditioners for the PV system procured in this Project shall be designed to be set in a container cubicle with air conditioning, which relieves the power conditioners of high air temperature outside.

Maximum temperature inside the cubicle shall be set at 27.5 degrees Celsius to protect semiconductors used in power conditioners from the heat. A space heater shall be furnished to the cubicle to prevent the dew condensation due to lowered temperature and high humidity inside the cubicle. Equipment to be installed outside the cubicle shall be designed to work in air temperature as high as 41.8 degrees Celsius. Also, a cubicle containing electric facilities of the system shall be designed with protection level IP 54.

Supporting structures for PV modules and junction boxes shall be designed to be salinity resistant as the site is located near the sea (main members of supporting structure shall comply with HDZ 55, of JIS H 8641 or equivalent, and junction boxes made of stainless steel).

(2) Lightning Strike

According to the interview to related parties of the Site, the Site is not considered prone to lightning strikes.

The countermeasures shall be that against inductive lightning, as the PV arrays are to be lying around two meter high at most, lower than surrounding buildings, and the Site is located within the development of the city, which implies low possibility of .direct lightning strikes. Specifically,

[2] Electric equipment that supports human lives, such as respirators.

junction boxes and power conditioners shall be fitted with arrestors.

(2) Rainfall and Wind

No special consideration is needed for rainfall and wind in the design of the system.

(3) Earthquakes

Aden is located at the edge of the African Plate, and has recently experienced the earthquake of Magnitude 6.3 scale. In the design of this Project, horizontal acceleration of 0.25G level shall be considered.

2-2-1-3 Local Conditions affecting the Works

In Yemen, all the local contractors are eligible to engage in the government's public works projects. However, there are no local contractors that have experiences in a similar project to this Project as this Project is the first-ever large-scale solar project in the country.

For construction equipment, local contractors hire equipment from local rental companies as needed. There are many rental equipment companies in Sana'a and the machines are in good condition. As for the experiences in solar system installation, there are some companies that have undertaken installation of electrical equipment for such facilities as antennas for mobile phone, pumping stations, schools and hospitals. These companies employ permanent engineers and technicians. Although they have sufficient capacity to carry out civil works, steel works and plant works in small scale, their ability to handle large scale works like this Project is still unseen.

Yemen is a Muslim country, and it is important to appreciate Muslim customs such as Ramadan in planning implementation schedules.

The Site is on the property of the hospital, easily accessible by general public including inhabitants of the area. Therefore, it is necessary to report to and discuss the contents and the schedule of the Works with people in charge at the hospital.

2-2-1-4 Application of Local Resource

(1) Utilization of Local Companies

It is assumed the Works at the Site will be managed by a Japanese company as a prime contractor who supervises the individual works sub-contracted and carried out by local companies. Local companies also are assumed to carry out, providing equipment and manpower, the installation works of electric equipment. The Works at the Site include; civil works (earth works, concrete

foundation works), steel works (fabrication of support structures for PV modules), equipment installation works (PV modules, electric boards and container cubicle), and electric works (laying cables). As the local companies do not have sufficient experiences in the similar projects, experienced engineer(s) will have to be sent from Japan or other countries to the Site for quality control, schedule control, safety control, assembling Supervision, testing and adjustment of equipment.

Rental large crane is available in the country and will be used to install the power conditioner cubicle transported from Japan. Local transporter's vehicle can carry 40 foot container by inland transportation.

(2) Utilization of Local Materials and Equipments

Most of construction materials such as aggregates, cement and reinforcement bars are available in the country. However, electric equipments and materials including PV modules, power conditioners, and cables are not available in the local markets.

2-2-1-5 Capability of Operation and Maintenance

Operation and routine maintenances of the PV system after the commissioning will be done by Al Wahda Hospital under the supervision of MPHP. As the facility owns and has been maintaining power receiving and distributing equipments over a long time to use, the facility is deemed to have reasonable capacity to maintain electric equipment in general. However, the status of existing equipment in the facility indicates inadequate practice and lack of knowledge about maintenances with preventive measures including routine inspections. Therefore, this Project should provide training program on O&M including important daily and periodic inspections, taught by Japanese specialist in two separate periods; one during the commissioning of the PV system, and the other a few months after the commissioning. Spare parts, tool kits, and Operation and Maintenance Manuals for maintaining the PV system should be supplied by the Project as well. In addition, to realize effective and efficient operation and maintenance, a suitable management organization for operations and maintenance should be proposed in the Project.

Some parts in the PV system need replacement in the long term and this may cost a significant amount. Such expenses may not be possible for the Facility (Al Wahda Hospital) to bear alone within one-fiscal year budget. It is important that the executing agency (MPHP) is aware of this and is prepared to make financial arrangement with the Facility. As the financial benefit of reduction of power purchase due to power generation is expected to be larger than the above cost, it is also possible to raise a fund from part of such benefit for future maintenance expenses.

2-2-1-6 Schedule of Procurement and Installation

As this Project is conducted in the scheme of the Programme Grant Aid for Environment and Climate Change, it must be conducted in as efficient manner as possible. To complete the Works and produce expected results by the specified time, the Works should be scheduled considering the sequence of inputs from both Japan and the recipient sides, and also, route, method of transportation, time for various official procedures necessary.

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

2-2-2-1 Design Condition

To design the capacity and specification of the PV system, various conditions described above are considered and consequently, the design conditions shall be set as shown below.

(1) Natural and Local Conditions

1. Outdoor air temperature	41.8 degrees Celsius (Maximum)
2. Electric room's temperature	27.5 degrees Celsius
3. Design relative humidity	Maximum 95%
4. Design wind velocity	40.0 m/s
5. Mean annual rainfall	50mm
6. Seismic force	to be considered (0.25G horizontal)
7. Elevation of the Site	about 2m
8. Load bearing capacity of the ground[3]	150kN/m^2
9. Salt damage	to be considered

(2) Applicable Standard

1. Japanese Industrial Standards (JIS)	: Industrial products
2. Japanese Electrotechnical Committee (JEC)	: Electric products
3. Standards of Japan Electrical Manufacturer's Association (JEM)	: Electric products
4. Japanese Electric Wire & Cable Makers' Association Standard (JCS)	: Cables
5. International Electrotechnical Commission (IEC)	: Electric products
6. International Organization for Standardization (ISO)	: Electric products
7 Technical Standard of Electric Equipment	: Electric products

(3) System of Unit

As a general rule, The International System of Units (SI) shall be used

[3] As the information was obtained through an interview with local construction company, it should be taken as reference only.

(4) Electric Mode

1 Nominal voltage (Low voltage)	380V (on-load)
2 Wiring system	3 phases-4 wires (connection point of existing equipments)
3 Frequency	50Hz
4 Earthing method	Direct grounding

2-2-2-2 Layout Plan of the PV System

The PV system procured by this Project is constructed on Al Wahda hospital's premises. Thus, the layout plan of the PV system shall be considered with not only convenience of operations and maintenances but also with following conditions.

- A layout to make the maximum use of solar power in limited space
- Efficiency and convenience of construction works
- Future land use of the Facility

After the discussion and consultation with the Hospital, it was found that the open area to the south of main building (Building A) is suitable for the installation area of PV modules. The layout of PV modules within the area was studied and the size of the installation was determined as 300kW maximum.

2-2-5-3 Outline of Basic Design

Considering the design policy, basic standard and layout plan described above, the outline of basic design in this Project is as shown Table 2-2-2-1

Table 2-2-2-1 Outline of Basic Design

Category	Content
Site and PV Capacity	Al Wahda Hospital: 300kW PV equipment − PV system shall be grid-interconnected − Surplus power shall not be sent back to the utility grid (no reverse current) − In the case of blackout, PV system shall restart in Stand-alone Mode to supply power to part of the Hospital
Procurement of Generating equipments and Installation Work	300kW PV modules Ancillary equipment and works for PV system - Junction box - Power conditioner cubicle - Meteorological observation device - Low voltage panel - Branch Switchers for Load (for stand-alone mode) - Materials for wiring and earth - Electrical facility cubicle - Supporting structures for PV modules - Foundation of supporting structures for the PV system and electrical facility cubicle - Fences, gates, and grave surfacing - Cable connection for Electrical facility cubicle/interconnection point/display equipment/ connection to existing loads
Spare Parts and Tool Kits	Spare parts and tool kits for maintenances of equipment Manuals for O&M and implementation of O&M Guidance

2-2-2-4 Outline of Equipment Plan

Elements of the PV system which will be installed at Al Wahda hospital are described below. Outline specification of the each equipment is shown in Table 2-2-2-7 and Table 2-2-2-8.

(1) Outline

1) Type of PV System

Type of the PV system is of grid interconnected without storage battery. Storage battery is not included as it would require large replacement cost and the disposition of used batteries may become environmentally hazardous.

2) Operation during the Power Failure

The PV system will be designed to shut down and the interconnection cut off automatically when there is blackout of utility grid power. After having confirmed some predetermined conditions being met, the System will be able to be restarted, disconnected from the utility grid in "stand-alone mode" by manual operation to supply power to limited part of the facility.

Conditions that have to be met to start, and that lead to the shutdown of, the stand-alone operation are as follows.

To start up

Necessary conditions: all the following conditions have to be met to start stand-alone mode;

1. Voltage of the grid has been nil for more than a pre-specified time,
2. Voltage of direct current generated by PV modules is above a pre-specified level,
3. The system control has been given permission to use the stand-alone mode,
4. "start button" has been pushed, or "automatic start" has been selected,
5. Other conditions specified by the manufacturer have been met.

Negative conditions: stand-alone mode does not run when any of the following conditions exist

1. Total load at the destination of stand-alone mode power exceeds the current output of the PV system,
2. Other conditions specified by the manufacturer exist.

Shutdown

Stand-alone mode is shut down when any of the following conditions exist

1. Voltage of the grid has been back to proper level for more than a pre-specified time,
2. Voltage of direct current generated by PV modules has fallen below a pre-specified level,
3. Operation hours of the day has been over,

4. "shutdown" button has been pushed at the control panel,
5. Other conditions or orders issued by the system controller (e.g., emergency shutdown).

The system will be designed to start and stop the stand-alone operation either manually or automatically. For some period after the commissioning of the system, it is highly recommended that this be done by manual operation, in order to facilitate the operators' understanding of the operation. Automatic operation should be wanted nevertheless, and can be activated on the condition that the operators and staff of the facility understand the pros and cons of the stand-alone operation. It is because the occurrence of blackout is frequent and unexpected, and manual operation of stand-alone mode can be too troublesome to the operators, which may eventually lead to the situation where the power is not properly supplied to the facility.

The choice of methods of starting/shutting down stand-alone mode does not affect occurrence of malfunctions or lifetime of the PV system. Also, the quality of power of stand-alone operation should not be an issue with respect to the damages to the electric equipment to be supplied thereby, as the protection relays shut down the PV system safely when the quality of power falls below the range of operation,

It should be noted that the PV system cannot be operated in interconnection with the diesel generator (500kW, 400V) existing at the facility during blackout.

Concerning "Stand-Alone" function of the PV system, there are important points that must be understood by the users and related parties of the Recipient side, which are shown below. This was repeatedly explained to the recipient during site surveys and there has been understanding established by the responsible and executing organizations.

A. Instability of PV system under stand-alone mode

The use of the stand-alone function of the PV system must be made with a good understanding that its output is unstable.

Specifically, the output of PV system varies due to irradiation. There is no power production during the night, and in rainy or cloudy weather, the output is lower than in sunny weather. Even on a fine day, the output may suddenly fall when a cloud casts a shadow on PV modules. The instant the output of the PV system falls below the power being demanded, the PV system automatically shuts down.

Although the specific operation of the shutting down depends on the design of the manufacturer, it will be generally as follows.

In stand-alone operation, inverters (power conditioners) run under "constant voltage" control. The power generated by PV modules is dependent on the radiation and may fall below the level demanded by the load. If this happens, inverters cannot maintain the voltage within the allowable range of the constant voltage control due to the lack of power. This drop of voltage triggers shutdown of the system, which is immediately followed by automatic opening of

conductors, and the system is cut off from the connection.

B. Inappropriate connection of important loads

The destination of power generated by the PV system under the stand-alone mode must not include important loads, such as medical equipment which support human lives (e.g., respirator) and those that affect assets and properties of people or enterprises (e.g., IT equipment of financial institutes) .

Such important loads are usually supported by multiple power sources, not by single source such as grid power only or diesel generator only, even in developed countries where utility grid power is much stable and reliable. Important loads should be furnished with UPS (Uninterruptible Power Supply) and/or other auxiliary power unit.

C. Limitation on the size of electricity consumption of connected equipment

Capacity of PV system under stand-alone mode is quite limited, maximum 20 to 30% of peak capacity. At the destinations of power generated by the PV system under the stand-alone mode, electricity consumption of equipment should be checked to make sure the total of such consumption does not exceed the limit.

<Case Study>

As an example, the actual recorded output of a 300kW grid-connected PV power plant is shown below. In the figure, vertical axis is for the output of PV system and the horizontal for the time. Output of PV in theory is like a sine curve taken for only positive side, and each peak in the chart corresponds to midday peak.

The output shown in the figure reveals that, in the stand-alone mode where weather-dependent PV is the only source of power, the capacity of the power source significantly fluctuates. Therefore, it becomes much more reliable to use the power for smaller load.

This gives the limitation to the total of the load that is supplied with power under stand-alone mode. The load must be examined and deliberately arranged.

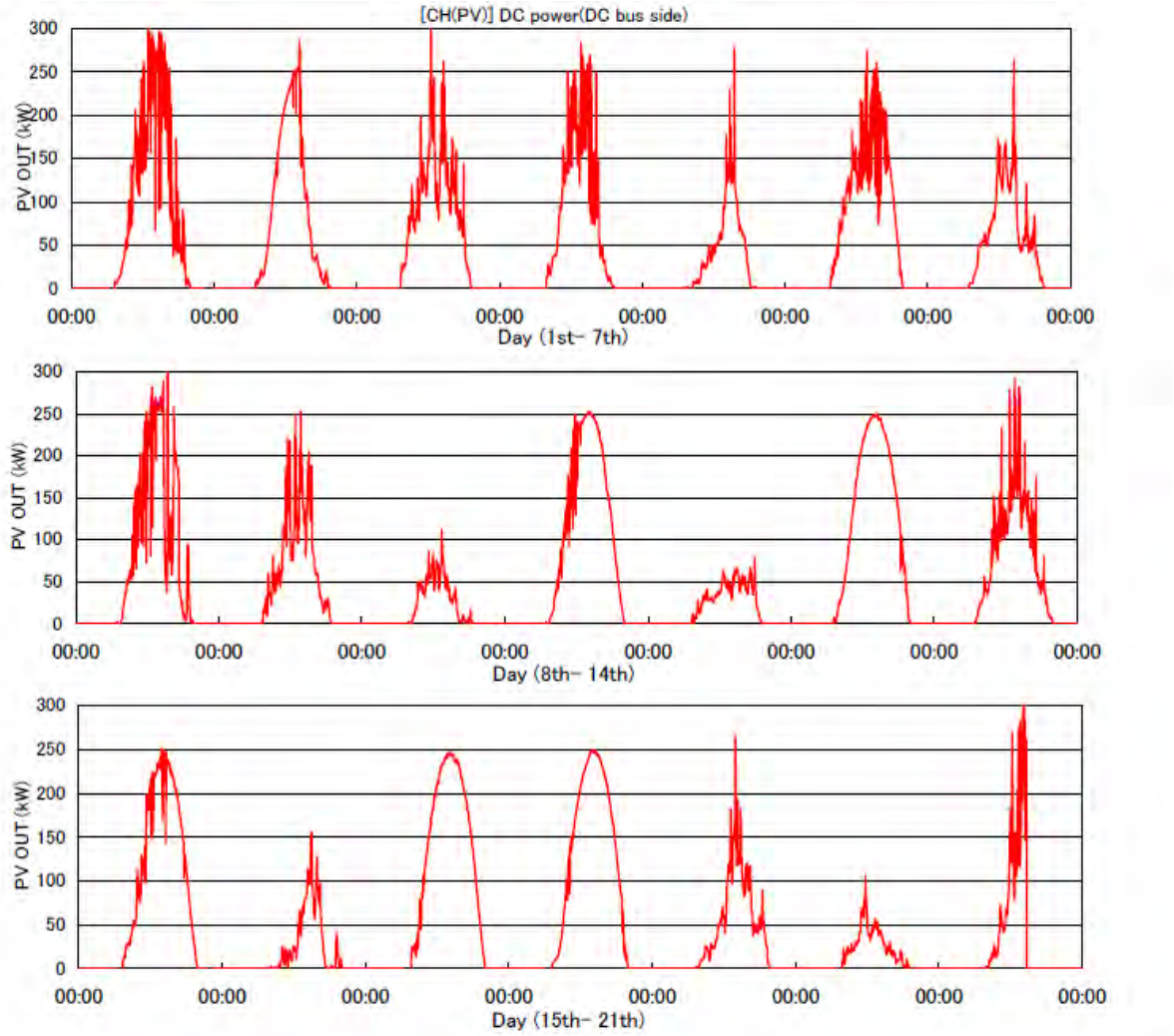


Figure 2-2-2-1 Example of PV Output from Actual Measurement

D. Switches for destination of PV generated power under stand-alone mode

At the destinations of power generated by the PV system under the stand-alone mode, one can choose the power source for a particular load from "Conventional (Diesel)" and "PV", using "Branch Switchers" equipment provided in this Project.

This equipment allows adjustment of the destinations, which may become necessary after changes in types and/or arrangement of electric equipment in the facility. Also, it is possible to set the circuits back to their original conditions (as there is no stand-alone function). The circuits and connections of the Branch Switchers are schematically shown in Figure 2-2-2-2andFigure 2-2-2-3.

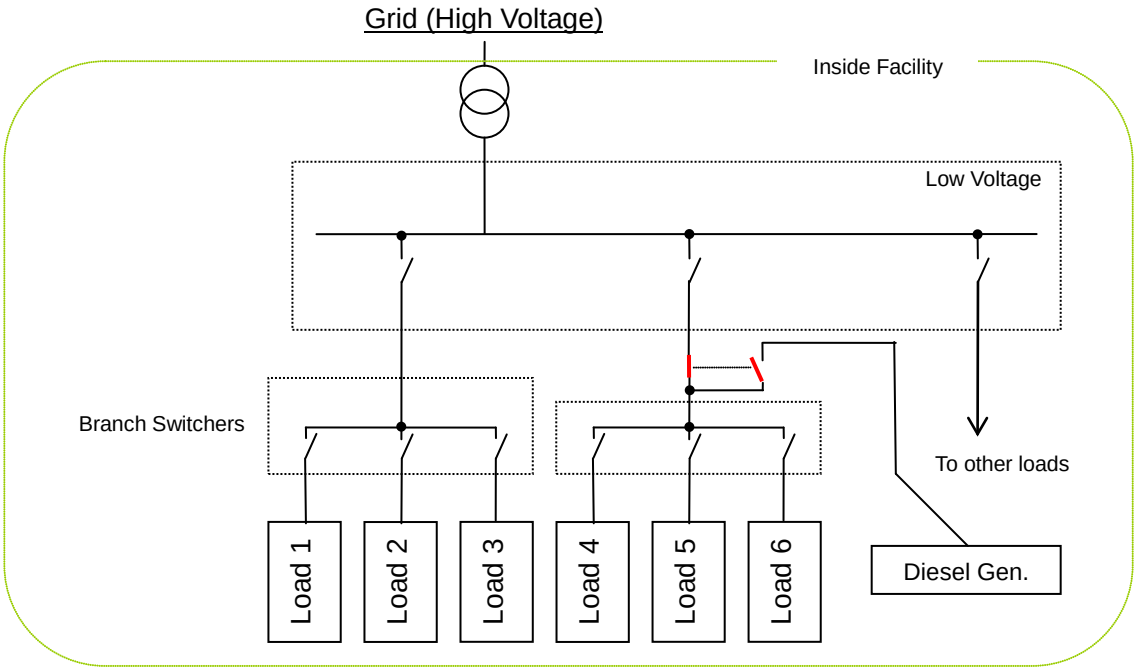
Branch Switchers for Load can be operated with inter-locked switchings provided inside the board.

The examples of electric equipment that are appropriate as stand-alone mode destinations are shown in Table 2-2-2-2.

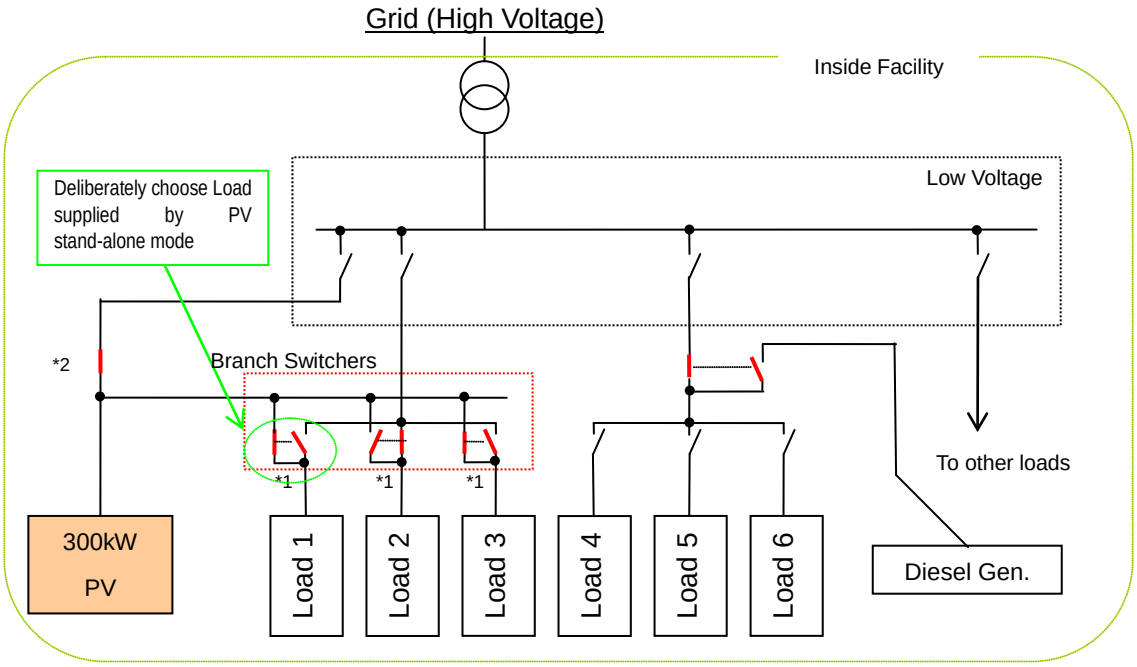
Table 2-2-2-2 Examples of Electric Equipment Appropriate for Stand-alone Mode

No.	Type of Equipment	Remarks
1	Lighting	
2	Air Conditioner	Excluding centrally controlled
3	Television, Radio	
4	Refrigerator	
5	Electric Cooker	
6	Mobile Phone Charger	
7	Portable Computers	With battery inside
8	Ventilator	
9	Water Pumps	5kWh or smaller recommendable

As Is without PV



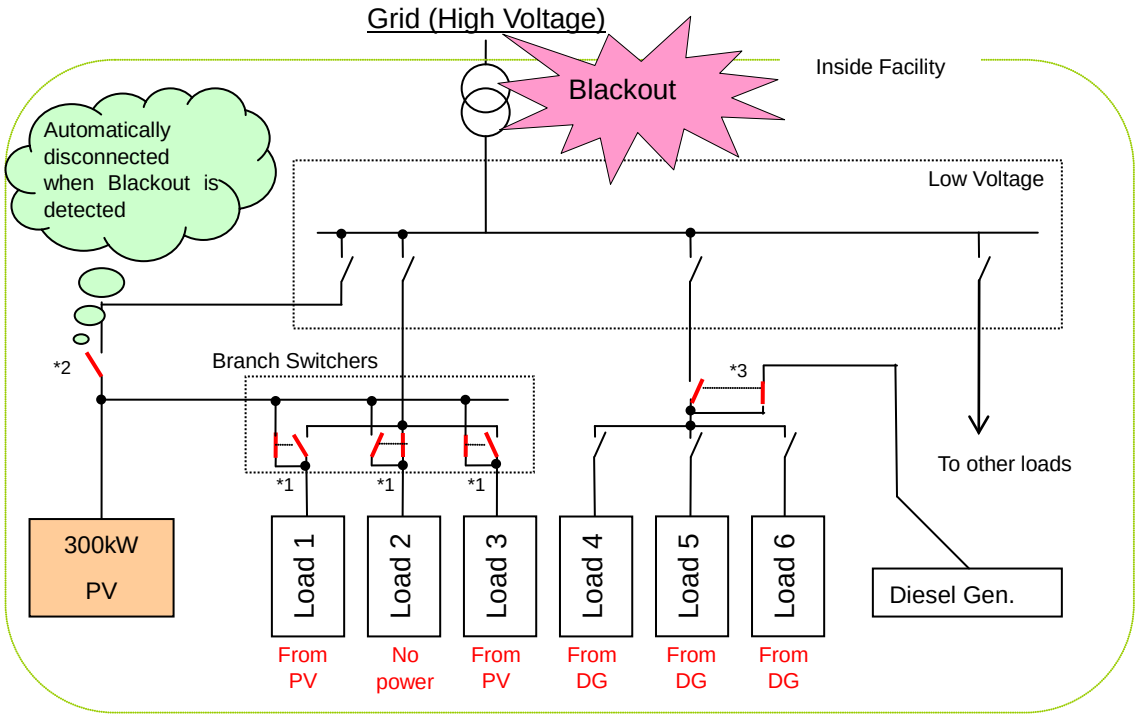
With PV



*1 : Mechanical Interlocking
*2 : Magnetic Conductor (automatic)
* : Load 1 to 3 represent Building B.

Figure 2-2-2-2 Diagram of Power Circuit including Branch Switchers (1)

In Stand Alone Mode (Load 1 & 3 supplied by PV, and 4 to 6 by DG)



*1 : Mechanical Interlocking, *2 : Magnetic Conductor (automatic), *3 : Interlocking
Load 1, 2, 3 are within Building B.

Advantage of Use of Branch Switchers

1 *Destinations of power from PV under stand-alone mode can be selected load by load. The selection can be changed according to future changes in loads (types and power demand of electric equipment to be connected),*

2. *Restricting further the loads supplied by stand-alone PV at the destinations, operation of stand-alone PV can be adjusted to be more continuous even under changing solar irradiation (countermeasure to output fluctuation),*

3. *If the use of stand-alone function becomes unnecessary or undesirable (due to changes in loads, etc.) in the long run, the circuits and wirings can be switched back to the original (before PV installation) conditions.*

Figure 2-2-2-3 Diagram of Power Circuit including Branch Switchers (2)

(2) Contents of Basic Design

1) Verification of Design Capacity or PV System

The PV system will be connected to one of four existing transformers for the grid interconnection. The transformer is selected from considering the following matters.

- Ages of transformers as older transformer may be replaced sooner
- Distance to the PV system as longer distance means higher transmission loss

- Balance between the load connected to the transformer and the peaking capacity of the PV system, as the surplus power is not allowed to be sent to the utility grid.

Transformer No.2 meets most the conditions above and should be selected as the interconnection point.

Next, capacity of the PV system is considered. The main loads of Transformer No. 2 are as shown below.

- Building A (Main hospital ward; 7 storeys)
- Building B (Administration, out-patient clinic, X-ray; 2 storeys)
- Building F (Maintenance and operation section; one storey)
- Own load of the electrical room

The actual electric power consumption measured of the Transformer No.2 was about 222kW at maximum. But, the loads connected to Transformer No. 2 are expected to increase in the future by the following factors.

♦ Completion of renovation of Building A
Western half portion of Building A is currently under renovation. This renovation will be finished around 2011 and the loads are expected to increase for about 4000 sq meters of floor area (13.6 m × 61.0 m × 5 storeys). Expected types of loads are electric lights and some equipment with large electric consumption, such as air conditioners. If an air conditioner is installed at every room, the increase of loads will be about 180kW (25 rooms × 5 floors × 1.5kW per air conditioner). Another X-ray scanner made in Japan has been installed in Building A after the site study. Power consumption of this additional scanner is about 100kVA.

♦ Replacement of wiring and the low voltage panel at Building B
There are two lines of wiring to Building B; from Transformer No. 2 and Transformer No. 3. Power sent from these transformers to Building B is both about 100kW. These loads are limited due to the shortages of capacities of cables and of capacities of breakers the low voltage panel in Building B. For example, two X-rays equipped in Building B are not able to work at the same moment because of these limitations.
Therefore, the renewal of some equipment derived from this Project will increase the load of Building B.

The loads of Building B are listed in Table 2-2-2-3. Present capacity of installation in Building B in total is about 370kW. Al Wahda Hospital technicians estimate the increase of electric power demand by renewal of equipment about 100kW in the future.

Table 2-2-2-3 Load List of Building B

Name	Light	Air conditioner	X-ray1	X-ray2	Fans	Refrigerator	Others	Computer	Device of dental clinic
Capacity	80W	10A	100A, 3ph	60A, 3ph	100W	1.5A	6A	-	-
Number of load(s)	200	57	1	1	70	14	4	10	2
Operating day/hours	8:00-13:00	8:00-13:00	24 hour stand-by	24 hour stand-by	8:00-13:00	24 hour	8:00-13:00	8:00-13:00	8:00-13:00

In summary, electric power consumption of Transformer No. 2 is estimated to increase at maximum to around 600kW; 222kW (present energy consumption), about 280kW (due to renovation of Building A plus new CT scanner), and about 100kW (due to renewal of Building B).

As mentioned before, the installation area gives the upper limit of the installation size. Meanwhile the judgment of no reverse flow demands that the electricity generated should be consumed within the facility as much as possible. Considering these conditions, the capacity of 300kW of the PV system in this Project was found appropriate.

As there was no actual insolation measurement data for the Site available to the Team, the annual energy production was estimated using software called RETScreen, developed and distributed by Natural Resources Canada. The result shows that 500MWh of energy is expected from the system. This energy is approximately 25% of annual power consumption of the Hospital. However, in reality, the energy produced will be smaller than this potential: when the demand is smaller than the production possible the output will be suppressed, and during the blackout of the grid power the system will send power to the limited part of the Hospital under Stand-alone mode. Therefore, the production of 500MWh of energy should be considered theoretical maximum.

The size of the PV equipment of the Project is finally determined, with due consideration of the budgetary size assumed at the earlier stage of the Study and the effective size and shape of installation area for PV modules.

2) Type of PV Module

There are various types of solar cells depending on semiconductors used. Main types of solar cells are silicon and compound. Silicon type has been and is the majority in the market. Silicon type is further classified into crystal and thin film types. Silicon type is made of once melted and molded matrix sliced into thin wafers. Thin film type is made of extremely thin silicon film developed on a sheet of glass by plasma. Although thin film has the advantage of larger production scale, it still has a performance issues to be solved.

With regard to the conversion efficiency, a recent technical report shows that thin film yields higher efficiency measured in annually produced energy, a few percentage points higher, than

silicon type due to the atmospheric temperature and conversion efficiency relationship: the higher the temperature the lower the efficiency. The disadvantage of thin film is that it requires about 1.4 times larger installation area than silicon type.

After the discussion with the Site, the installation area of PV modules was located in the open area to the south of Building A. The size of the available area is, after deducting spaces for Power Conditioner Cubicle and the existing structures, and considering the layout of sub-arrays, less than 3,800 sq-m in effect. Meanwhile, 300kW PV modules of thin-film type would, considering the allowance for maintenance work, etc., require as large an area as 4,200 sq-m. Therefore, for this Project, PV module should be of silicon type.

3) Destination of Electric Power in Stand-alone Mode

The PV system is designed to shut down automatically when there is blackout of utility grid power. After having confirmed some predetermined conditions being met, the System will be able to be restarted, disconnected from the utility grid in "stand-alone mode" by manual operation to supply power to limited part of the facility.

The part of the facility to be supplied with power under stand-alone mode should be strictly without important loads that require stable power supply, in particular those electric equipment that affect human lives, as power production of PV system alone is inherently unstable due to weather conditions and may fall below the demanded level anytime. The loads to be supplied with power under stand-alone mode should be limited to those dispensable, such as air conditioning and lighting, etc.

Those buildings and their parts connected to Transformer No. 2 are considered as candidates to be supplied with under stand-alone mode.

- West side of Building A (hospital's main ward, 7 storeys, under renovation)
- Building B (administration department, out-patient clinic, with X-ray, 2 storeys)

West side of Building A

Building A is seven storeyed and its western half is currently under renovation. Main use of this building is as shown below.

Table 2-2-2-4 Uses of Each Floor of Building A

Floor	Main application	Remark
Ground	Emergency department	
1st	Blood department	Transfusion equipment
2nd	Inpatients' rooms	
3rd	Isolation ward (Dysentery, etc)	
4th	Inpatients' rooms (Cancer, etc)	
5th	Inpatients' rooms (Cancer, etc)	
6th	Operating room, dentist	

Main use of Building B is administration, library, classroom, and outpatient department. Main loads are air conditioners, lights, two X-ray scanners, and dental units.

Building A is judged difficult to be supplied with electric power under stand-alone mode as it has important loads. Currently, a diesel generator of the Hospital supplies part of loads of Building A with electric power. If the PV system is connected under stand-alone mode during blackout instead of the diesel generator, reliability of power supply may decrease in some situations.

Meanwhile, there are no important loads in Building B which concern human lives directly such as life support systems and the diesel engine generator does not supply Building B with electric power. Therefore, if the PV system is connected to Building B under stand-alone mode, backup power supply during blackout will be realized.

Consequently, Building B is selected as the destination of electric power supply under stand-alone mode.

During the stand-alone operation, maximum 90kW of power is expected from the PV system (maximum output 100kW less system's own consumption 10kw). It should be noted that this output is highly dependent on the weather.

4) Electric Equipment

a) PV Module

Type of PV module is silicon. Capacity of total PV modules is over 300kW using the 10kW unit (only as a guide) sub-arrays. PV modules are connected to junction boxes by special cables.

Spare parts of PV modules are 3% of installed number (decimal place is cutoff).

PV module specifications, number and unit of sub-arrays must satisfy the following conditions.

- To lay out PV modules without significant change in the design fence and gate alignment,
- To match the input voltage of power conditioners with PV output,
- To design sub-array rectangular and use dummy modules if there are sub-arrays with uneven number of modules in order to look coherent,
- To use cables with allowable voltage drop less than 2% to connect the output terminals of PV modules to power conditioners,

Layout of equipment is and fence and gate alignment are shown in basic design drawing No.03.

b) Junction Box

Each series circuit of PV modules is connected to both positive and negative terminals of a junction box.

One junction box collects approximately 10kW of PV module output in nominal term. Junction

boxes are equipped with a circuit breaker, anti- reverse flow diode, and arrester for each input.

c) Power Conditioner Cubicle

Outline

Power Conditioner shall consist of four main equipment shown below. These equipment shall be encased in one or a few boards.

- Power Conditioner
- Low Voltage Switchboard
- Branch Switchers for PV Array
- System Controller

All the boards shall be furnished with space heaters inside.

<*Power Conditioner*>

This equipment converts direct current collected from PV modules, supply the load with alternate current in connection with the utility grid power supply.

Direct current circuit is designed to operate under inflow voltage of 500V or higher.

AC circuit is designed to synchronize the PV generated power to the utility grid power by Maximum Power Point Tracking (MPPT) method.

Power Conditioners are equipped with a stand-alone function which enables providing power to limited part of the Facility, up to the power being produced by PV modules under other constraints, during the period of the power from the utility grid being suspended (blackout).

Power Conditioners shall be installed in multiple units, added by an extra stand-by unit. The stand-by unit shall be placed inside Electrical Facility Cubicle. The system shall be designed in a way that when some units are broken down, remaining unit(s) shall work within the capacity then available. This design is to ensure the maximum lifetime of the system.

<*Low Voltage Switchboard*>

Low Voltage Switchboard connects AC output of power conditioners to the utility grid at the low voltage side of the existing transformer via a rotable phase-adjusting transformer. It also has the distribution function to supply electric power to selected loads where individual loads can be switched by breakers.

This equipment should also be designed to have a couple of magnetic circuit breakers at grid-connection side, so as to enable both manual and automatic operations of starting stand alone mode when the main power from the utility grid is out (blackout).

An AC 3 phase arrester is installed at the grid-connection point. This equipment is also furnished with transformers and distributors for the System's own use.

< Branch switchers for PV arrays>

Branch Switchers for PV Array equipment is equipment that collects output of PV modules. Output from sub-arrays through collection boxes all converges at this board.

MCCB (Molded Case Circuit Breaker) is equipped inside the board for each junction box input.

An arrester is equipped inside the board for each junction box input. Main DC circuits are designed for applied voltage of DC500V or over.

<System Controller>

This equipment embodies various functions such as sequences and inter-locks, to operate the photovoltaic system properly and safely. The functions included are shown below.

- Start and stop of the PV system
- Interlock
- Protection
- Suppression of reverse current
- Monitoring function
- Display function
- Recording function

Display function shall be realized by display devices set up at the Site to show the function and effect of the PV equipment to users and visitors to the Hospital. In the Hospital, the most suitable place for the display device is the side of the main entrance where most people are expected to notice. As the installation area is somewhat away from this main entrance shielded by the main building, there should be second display device set up at the installation area which gives the information to people who are just facing the PV installation. These locations are shown in Basic Design Drawing No.03.

Components of this equipment are shown in the table below.

Table 2-2-2-5 List of Components (System Controller)

No.	Device	Specification	Quantity
1	System Control Panel		Complete set
2	Display Equipment(outside)	Display of generating power (current output, cumulative energy generated and CO^2 reduction, etc.)	2 complete set

d) Meteorological Observation Device

Meteorological Observation Device includes such instruments as a solar irradiation meter and thermometer to observe and record the climate conditions of the photovoltaic module installation area.

Components list

Components of this device are shown in Table 2-2-2-6.

Table 2-2-2-6 List of Components (Meteorological Observation Device)

No.	Component	Specification	Quantity
1	Pyrheliometer (Outside installation)		1
2	Thermometer (Outside installation)		1
3	Transducer (Outside storage box)	For each of 1 and 2 above	2 sets

e) Low Voltage Panel (in Electrical Room No. 1)

The low voltage panel of Electrical Room No.1 will have to be replaced by this Project as the existing panel has been significantly deteriorated in function of due to the aging and corrosions which prevents safe connection of the PV system.

The Low Voltage Panel distributes electric power received from the utility power grid through the transformer to each load including the PV system. The single line diagram of the panel is shown in Drawing No.01.

Volt-Current Transformer and Transducer (VCT) is installed inside the panel.

Outline of VCT

Volt-Current Transformer and Transducer should be equipped to the Panel at the interconnection point in order to monitor the reverse current which is not allowed.

This device consists of VCT and a converter and sends the effective power calculated by the converter to the System Controller Equipment.

f) Branch Switchers for Load

This equipment shall function as a distributor of the loads and a switcher of two power source; utility grid power and photovoltaic power.

This board shall have a couple of breakers with mechanical inter-locking for each distribution line to load to select either the transformer or PV system for power source.

The single line diagram of Branch Switcher Board is shown in Drawing No.04

g) Electrical Facility Cubicle

Electrical Facility Cubicle of the PV System encloses the equipment below the cubicle is furnished with air conditioning system to keep the equipment inside from overheating.

- Power Conditioner
- Low Voltage Switchboard
- Branch Switchers for PV Array
- System Controller

h) Support Structure for PV modules

A Support Structure for PV module sets up a sub-array of PV modules arranged in series and in parallel to attain required voltage of sending power. The Support Structure is furnished with fittings for environment monitoring instruments and Junction Boxes to be attached to the Support Structure.

The material is finished with hot dip zinc galvanizing. For the fastening used in the cradle, a countermeasure shall be taken against larceny.

Type of installation: ground installation
Direction and Slope: south, 12 degrees
Materials: steel
Coating: Hot Dip Zinc galvanized with salinity resistance

i) Materials of Wiring and Earthing

Wiring

Exterior cables are of armored type and directly buried underground. Materials of cables are copper, which has large allowable power and flexibility in installation. For insulation general-purpose cross-linked polyethylene is used.

Exterior cable route was designed and decided, considering the information on the existing cables obtained from the Facility, confirmed in-situ with technicians and the director in charge of maintenances, so as not to interfere with the existing cables and future expansion plans of buildings, etc. Cable layout is shown in Basic Design Drawing No.05.

Earthing

Following earthing fixtures are installed in this Project.

- Earthing of metal objects and electrical equipment to prevent the electric shock
- Earthing of fences and gates
- Independent earthing of control panels and meteorological observation devices, as required

Earthing resistance shall be less than 10 ohm.

j) Fence, Gate and Gravel Surfacing

♦ Fence and Gates

Al Wahda Hospital is surrounded by walls and there are security guards 24 hours a day which makes the risk of burglary relatively low. However, there are patients and visitors including children walking around in the hospital who must to be kept away from the PV system safely.

Therefore, the fence surrounding the PV system, with safety measures including anti-electric shock function, shall be constructed by the Project. Considering the environment in the hospital, obtrusive materials such as barb-wire should not be used.

The alignment of the fence should be designed considering the shade it makes on PV modules, a space for maintenance works, and tamperproof from outside. Also, it should not enclose unnecessarily large plot of land to make it out of use for the facility.

There should be two sets of gates; smaller one is for everyday use of operators, the larger one for periodical maintenance allowing the entrance of motor vehicles.

Layout of fence and gates is shown in Basic Design Drawing No.03.

♦ Gravel surfacing of PV module area

PV module area should be gravel-surfaced in order to stabilize the surface, control the growth of weeds and facilitate the maintenance works. Before the placement of gravel, surface soil should be removed for approximately 10cm in depth and replaced by gravel layer. The area will be enveloped with curbstones or similar concrete blocks to keep gravels within the area. Gravels should be of the size of 20 to 40mm, strong enough to withstand the use of long years.

k) Concrete Foundation of Equipment

The foundations of supporting structures, electric facility cubicle, fences and gates are constructed.

♦ Excavation for placing foundations

There is some water related structure buried underground of the PV installation area. Unfortunately there is no definite information available. The structure is in use and must be preserved. Therefore, the excavation work at the area must be done with utmost care, employing hand excavation method as required.

♦ Foundation type

As mentioned elsewhere, there is some water related structure buried underground of the PV installation area which calls for the use of shallow foundations for the supporting structure for PV modules. Therefore, the foundations are assumed to be of U-shaped type, a horizontal member connecting two vertical members.

(3) Outline Specification of Main Facilities

Table 2-2-2-7 Specification of Main Equipments (1)

Equipment	Outline Specification	Quantity
PV Module	Capacity of PV modules: 300kW peak output or higher Type: mono/poly-crystal silicon, on-ground type (public/industrial use presumed) Conversion efficiency: around 14% presumed Unit capacity of a module: around 210W presumed	1 complete set
Junction Box	Circuit breaker, anti-reverse flow diode, arrester for each input.	1 complete set
Power conditioner	AC rated voltage: Three-phase three-wire system 400V (line-to-line voltage) or 200V ±10% AC rated voltage in Stand-Alone Mode: 380 Vrms (line-to-line voltage, with load) AC rated frequency: 50Hz ±3% AC rated output : over 300kW DC voltage range: DC0V ~ 500V or higher DC control voltage range: DC320V (or lower) to 400V (or higher) Conversion efficiency : 93% or higher (Rated operation) Harmonic current: Distortion Factor total 5% or less, at each order 3% or less (Rated operation) External communication: equipped Operation mode 1. Normal operation (Maximum power point tracking for grid connection) 2. Blackout operation (Constant AC voltage control for stand-alone mode)	1 complete set
Branch switchers for PV arrays	MCCBs for each junction box input Arrester for each junction box input Main DC circuits with applied voltage DC500V.or higher	1 complete set
Low voltage switchboard	MCCB (for interconnection point, load, PCS, board's own use) Magnetic conductor (for interconnection point) Uninterrupted power supply (UPS) Grid-connection protection relays Over Current Relay (OC) Over Voltage Relay (OV) Under Voltage Relay (UV), Over Frequency Relay (OF) Under Frequency Relay (UF) Islanding detector both active and passive type detection functions.	1 complete set

Table 2-2-2-8 Specification of Main Equipments (2)

Equipment	Outline Specification	Quantity
System controller	Main functions - Start and stop of PV system - Interlock - Protection - Suppression of reverse power flow - Monitoring function - Display function - Recording function	1 complete set
Meteorological observation device	Irradiation meter (exterior) 1 unit Thermometer (exterior) 1 unit Transducers(in storage box for exterior use) one for each of above meters	1 complete set
Low voltage panel	MCCB Energy Meter; 2 units for receiving power - Type: normal energy meter (testing not necessary - Three-phase three-wire system	1 complete set
Branch switchers for load（For stand-alone operation）	MCCB Mechanical interlock: 1 set	1 complete set
Electrical facility cubicle	With air conditioning (AC units shall be supplied with power from Low Voltage Switchboard either in grid-interconnection or stand-alone modes.)	1 complete set
Support structure for PV modules	Hot dip zinc galvanized and salinity resistance fittings for meteorological devices fittings for junction boxes	1 complete set
Materials of wiring and earthing	Wiring Form: low voltage 2-4core copper cable, XLPE insulation, PVC sheath Applicable standard: IEC Accessory: material for terminal dressing	1 complete set
Fence, gate and gravel surfacing	Fence Height: 2m Gate Height: 2m Gravel surfacing, grain size: about 2-3cm Gravel layer thickness: 10cm or more	1 complete set

XLPE:cross-linked polyethylene , PVC: polyvinyl chloride, MCCB: molded-case circuit breaker

2-2-3 General Drawing

Number	Title
NO. 01	SINGLE LINE DIAGRAM
NO. 02	SINGLE LINE DIAGRAM (PV SYSTEM)
NO. 03	GENERAL LAYOUT PLAN
NO. 04	BRANCH SWITCHERS FOR LOAD
NO. 05	CABLE LAYOUT PLAN
NO. 06	EQUIPMENTS LAYOUT (NO. 1 ELECTRIC ROOM)
NO. 07	EQUIPMENTS LAYOUT (BUILDING B ELECTRIC ROOM)

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy / Procurement Policy

(1) Procurement Policy

This Project is implemented by Japan's Programme Grant Aid for Environment and Climate Change with a procurement agent. The Government of Yemen shall employ the agent for the procurement of products and services, following the exchange of notes between the two governments concerning the Programme Grant Aid. The Consultant and the Contractor shall provide their services and products on contract with the Agent.

The organization chart of the Project is shown in the figure below.

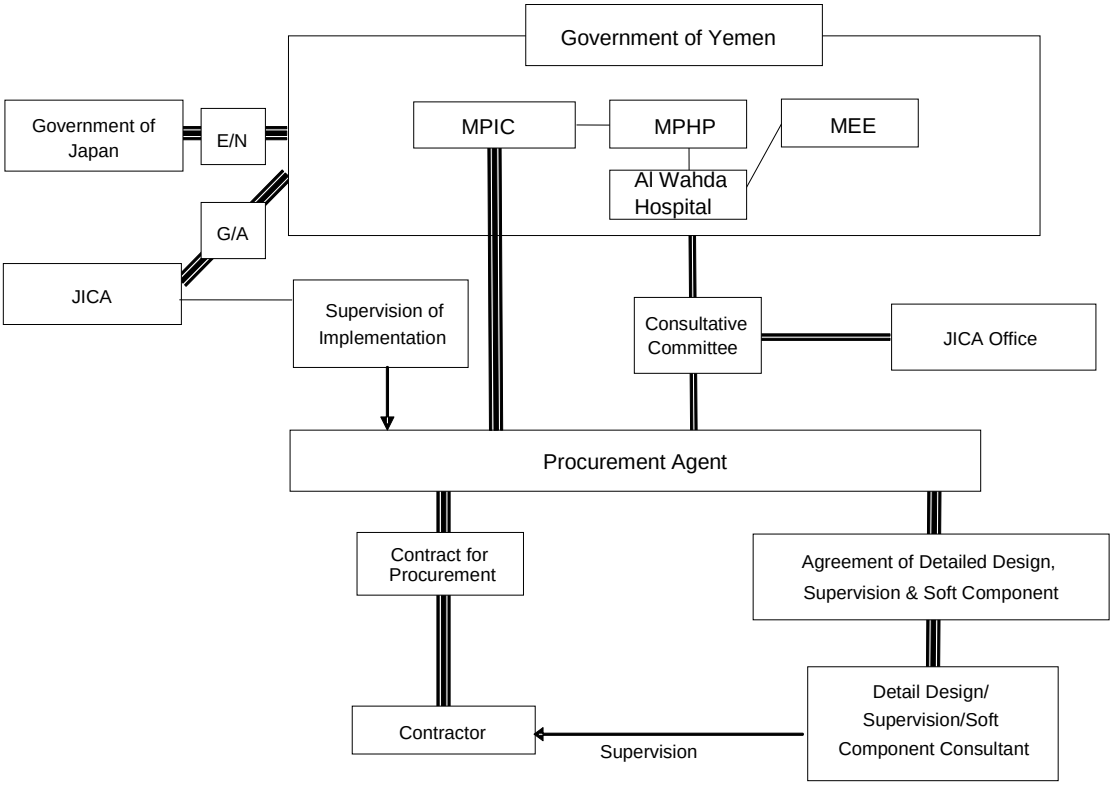


Figure 2-2-4-1 Organization chart of Implementation

1) The Organization of Recipient Side

The organization of recipient side is; Ministry of Planning and International Cooperation as a responsible organization, Ministry of Public Health and Population as a executing agency, and Al Wahda Hospital as the Site. Also, Ministry of Electricity and Energy gives technical assistance to the Project.

2) The Procurement Agent

On Japan's side, it is the procurement agent who will make into the agent agreement with the recipient to undertake tendering, contracting and manage the whole procurement business. In addition the agent will implement the settlement for consultants and the contractor and fund administration on behalf of Recipient side.

3) Consultants

The Consultant will assist the procurement agent in his undertaking of tendering, supervise the works of the Contractor, issue certificates for taking over after the completion of procurement/installation works and for the end of defect liability scheduled one year after the taking over. He also will provide training to people concerned so that the equipment will be properly operated and managed.

4) The Contractor

The Contractor, according to the contract made into with the Agent, designs, manufactures and transports the products, installs and commissions the products, and gives guidance to operators for the operation and maintenance of the products. From a perspective of quality and reasonable implementing policy, the Contractor will implement the procurement of equipment and installation on the package.

(2) Implementation Policy

For installation works, local contractors will be able to handle the works under Japanese prime contractor. The main works for the Project are; civil works (earthworks and concrete foundation works), steel works (assembling of support structure of PV modules) and electrical works (electrical wirings and installation of solar modules and other equipment).

In principle, Japanese standards are applicable in this Project since the PV system is one of the first of its kind to be built in Yemen. However, adequate methods normally used in the country may be utilized for the installation works.

In principle, the construction methods normally practiced in the Yemen can be utilized for the installation works. Local contractors will be utilized as much as possible in the works under Japanese prime contractor. It is difficult to reduce the number of Japanese engineers if the Contractor is to keep both the quality of works that meets the required standards in the Japanese grant aid projects, and with a suitable management. However, the number of engineers can be as small as possible, without compromising with the quality of the work, by adopting the local standards for the design and specification where possible.

2-2-4-2 Procurement/Installation Conditions

(1) Construction Business in the Recipient Country

Although there is no local company that has engaged in PV projects with large capacity, some electrical contractors such as the ones from Dubai have experiences of the similar large-scale electrical project and have their office in Aden. These contractors are expected to be able to handle works that meet the required standards in Japanese Grant Aid programmes.

There are some companies dealing with rental of construction machines in Aden, and it is confirmed that the machines necessary for the Project can be hired from those companies.

(2) Installation Conditions

Considering the climate at the Site and the types of installation, extra care must be taken during the installation works, as follows.

- The climate in Aden is characterized by high temperature with low humidity throughout the year and the maximum temperature reaches beyond 40 degrees between May and July. Therefore, for the hot season, installation works especially concrete works should be given special attention, possibly avoiding these works.

- Some underground structures have been identified at the PV installation area. However, the detailed information such as the exact locations and the depths are unknown since the drawings are unavailable. Therefore, shallow foundations will be used, and extra attention should be paid during the earthwork in order not to damage the existing underground structures.

- As the Site is in a hospital, keeping good communication, especially about the schedule and the contents of the works, with the hospital side is important, especially when the electricity in the hospital has to be cut off for the works such as electrical rooms and distribution boards. The timing and duration of the cut off should be considered in drawing up the schedule. Also, if the electricity from the utility grid is expected to be cut off for a prolonged period, alternative source of power such as the use of diesel generators must be considered to shorten the periods of power-less situation.

2-2-4-3 Scope of Work

The work demarcation between the Japanese and the Yemen sides is as follows.

Table 2-2-4-1 Allocation of Chief Responsibility

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure land		●
2	To clear, level and reclaim the site when needed urgently		●
3	To construct gates and fences in and around the site		●
4	To construct a parking lot if necessary		●
5	To construct roads		
	1) Within the site	●	
	2) Outside the site and Access road		●
6	To construct the facility and install the equipment	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities if necessary:		
	1) Electricity		
	a. The power distribution line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer for the site	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for conveying storm water, sewage, etc. from the site)		●
	b. The drainage system within the site (for sewage, ordinary waste, storm water, etc.)	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
8	To bear the following commissions applied by the bank in Japan for banking services based upon the Bank Arrangement (B/A):		
	1) Payment of bank commission		●
9	To ensure all the expense and prompt execution of unloading and customs clearance at the port of disembarkation in the recipient country		
	1) Marine or air transportation of the products from Japan or third countries to the recipient	●	
	2) To ensure all the expense and prompt execution of unloading, tax exemption and customs clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
10	To accord Japanese nationals and / or nationals of third countries, including persons employed by the agent whose services may be required in connection with the Components such facilities as may be necessary for their entry into recipient country and stay therein for the performance of their work.		●
11	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the Components and to the employment of the Agent will be exempted by the Government of recipient country		●
12	To maintain and use properly and effectively the facilities that are constructed and the equipment that is provided under the Grant.		●
13	To bear all the expenses, other than those covered by the Grant and its accrued interest, necessary for the purchase of the Components as well as for the agent's fees.		●
14	To ensure environmental and social consideration for the Programme.		●

2-2-4-4 Consultant Supervision

This Project will be started according to the rules of Japan's Programme Grant Aid, after the exchange of notes (E/N) between the two countries which follows the design carefully considered on the basis of the basic design, and its assessment for the appropriateness by the Government of Japan. During the installation works, synchronized with the progress of civil and electric works, the Consultant will send at least one resident engineer for the management of schedule, quality and safety of the Works. The Consultant also witnesses shop and pre-shipment inspections of equipments and materials procured in Japan to avoid any problems from happening, which may appear after the equipment from Japan have arrived at the Site.

(1) Basic Policy on Supervision of the Installation Works

The Consultant shall look after the progress of the works and ensure that the works be finished within a given time-frame. He shall also supervise and guide the Contractor to ensure both the quality of the Works as the Contract Documents stipulate, and the safety of the Works. To attain this objective, the Consultant sends two construction supervisors, one an electric equipment specialist and the other a civil engineer, to the Site coordinated with the progress of the Works.

The main important points in installation work supervision are shown below.

1) Schedule Control

The consultant will compare the implementation schedule originally prepared by the prime Contractor with the progress of the work in terms of the following items every month and every week. If the progress of the work is considered behind the original schedule, the consultant will issue warning and request remedy plans to the Contractor to complete the installation works within a given time-frame.

- confirmation of quantity of work done,
- confirmation of arrivals of equipment and materials,
- comparison between planned and actual turn-out of engineers, technicians and laborers.

2) Quality Control

The consultant will carry out the following inspections to determine whether the qualities of the equipment stipulated in the Contract Documents (Technical Specifications, Drawings) are secured by the Contractor. If the qualities of the works are questionable, the Consultant will request the Contractor remedies, changes and/or adjustments.

- checking shop drawings and specifications of the equipment and materials,
- witnessing shop inspection or verifying the test reports,
- checking installation procedure statement, site test, adjustment and site inspection procedure statement, and shop drawings,
- supervising the installation work and witnessing test run, adjustment and inspection,

- verifying the shop drawings,
- checking the finished work against the shop drawings. .

3) Safety Control

The consultant will supervise the Contractor through frequent meetings and cooperation to prevent accidents and hazards at the Site from happening.

As PV modules produce electricity while they receive sunlight, countermeasures to avoid incidents of electrical shocks are particularly important.

The following safety aspects are to be focused on in this project.

The main important points in safety control at the Site are shown below.

- setting up safety rules and appointment of safety managers,
- conducting regular inspections of construction machines to prevent accidents,
- pre-planning routes for heavy vehicles and construction equipment and transportation, enforcing maximum speed role
- promoting welfare measures for workers and observe working schedule with holidays.
- practice countermeasures to avoid incidents of electrical shocks

(2) Project Implementation System

Organization and relationships between parties related to the Project including the installation supervision are shown in the figure below.

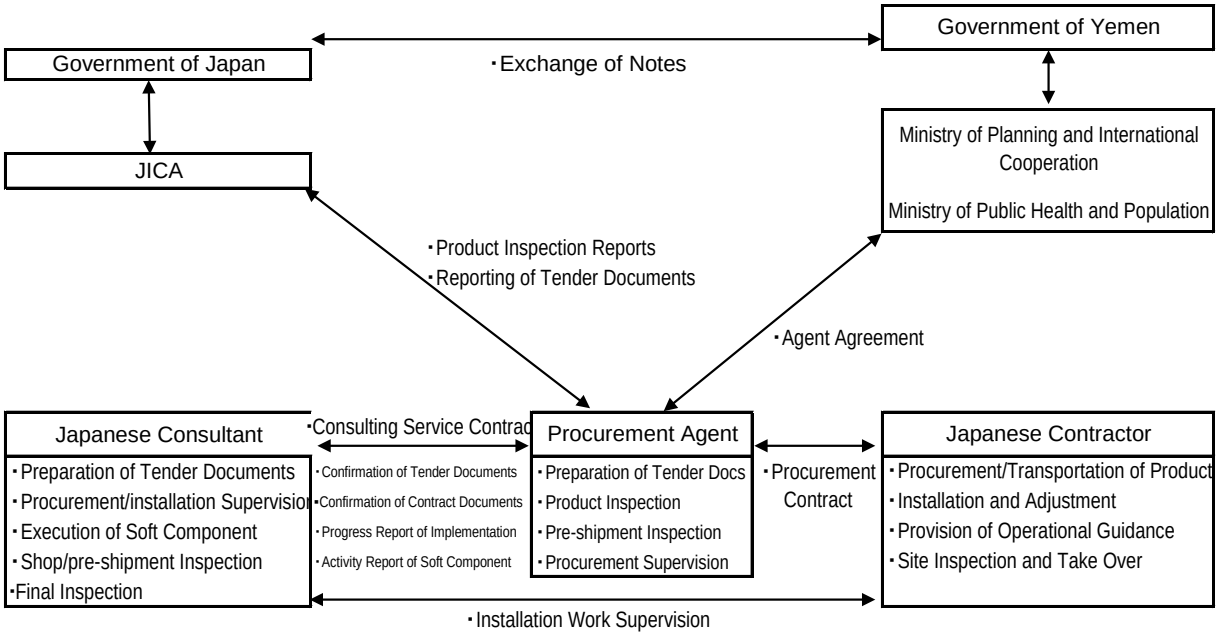


Figure 2-2-4-2 Project Implementation System Chart

2-2-4-5 Quality Control Plan

The Installation work supervisor of the Consultant conducts the supervision by the items shown below to confirm whether the quality of equipment and installation satisfies the relevant stipulations in the Contract Documents (Technical Specifications and Drawings, etc.). If the qualities of the works are questionable, the Consultant will request the Contractor remedies, changes and/or adjustments.

- checking shop drawings and specifications of the equipment and materials,
- witnessing shop inspection or verifying the test reports,
- checking installation procedure statement, site test, adjustment and site inspection procedure statement, and shop drawings,
- supervising the installation work and witnessing test run, adjustment and inspection, verifying the shop drawings, checking the finished work against the shop drawings. .

2-2-4-6 Procurement Plan

(1) Procurement in Japan

Among various items of the Products to be procured in the Project, PV modules and power conditioners shall be of made in Japan.

(2) Transportation Plan

The PV related electric equipment and materials procured in Japan will arrive at the biggest port in Yemen, Aden Port. The port is an international port which covers an area some 14.5km east-west and 5.6km north-south with the depth of between 5m and 16m. The maximum capacity of bulk silos are 50,000ton. The maximum capacity of the mobile crane is 50ton, which are well beyond the needed capacity of 20ton for this Project. The target site, Al-Wahda Hospital, is located relatively near to the port, about 10km. Also, there are many experienced transport companies in Aden and the access roads from the port to the Hospital are well maintained. Therefore, there is no concern related to the local transport of the materials from Japan.

2-2-4-7 Operational Guidance Plan

(1) Objectives

Operational Guidance shall be given to those engineers and technicians who will be in charge of operation and maintenance of the PV system so that the system, which is the first case of this size, will be operated and maintained properly, even under emergency situations.

There has been no experience and knowledge of grid-connection of renewable resources such as

PV systems in Yemen, and technical information and data concerning the quality of electricity of the grid to which the PV system will be connected are not available. Under these circumstances, adjustment of PV equipment for the commissioning should be finalized with careful observation of the actual connection for a certain time. Meanwhile, the state of maintenance of the existing electrical equipment in the Hospital is not quite up to the standard required for the PV system. Other local conditions such as high temperature, dusty site etc., are also negative factors in long-term maintenance of PV equipment which uses sensitive components such as semiconductors. Considering these, it is proposed that the Contractor conduct inspection of the PV equipment three month after the commissioning.

(2) Planning of Operational Guidance

When designing specifications and the grade of PV system, the current technical level of practices in the Recipient country and the knowledge and experiences of people in charge of generating equipment in the Facility are assessed and taken into consideration. There are some differences between PV system equipments and the existing generating equipments, like a diesel engine generator. In addition, as this is first opportunity to introduce the grid connected PV system in Yemen, related parties should not be considered to have capacities for operation and maintenance of PV systems of this scale. Therefore, the Contractor is obliged by the Contract to provide operational guidance to related people concerning the operation and maintenance of the PV system during installation works and a certain period after the commissioning.

1) Plan for Guidance of Operations and Maintenances during Installation Works

The program is outlined below

a) Time and Location of Guidance
Lectures and exercises : approximately one week (at the Site)

b) Instructors
The engineer(s) in charge of supervising installation works, pre-commissioning and adjustment, dispatched by the manufacturer of the PV system are assumed to be the instructor(s) of the guidance.

c) Trainees
The trainees who receive the guidance are mainly technicians in charge of operations and maintenances at the Site after the commissioning. The implementing organization appoints trainees specifically before the installation works start.

Table 2-2-4-2 Organization Control of Operations and Maintenances

Person in charge		number	Main role
Control technician		1	Responsible official and decision making
Operation	Electric technician	1	Management of PV system based on technical knowledge of electric equipment and PV system
	Electric technician	About 2	Normal operation
Maintenance	Electric technician	1	Handling of PV system in troubles based on technical knowledge of electric equipment and PV system
	Electric technician	2	Daily inspection
	Sanitation worker	Few persons	Cleaning of PV modules

d) Contents of Guidance

i) Lectures

Using Operation and Maintenance Manuals, lectures on basic knowledge of the PV system will be given.

- Explanation of Operation and Maintenance Manuals
- Basic Knowledge of Operation and Maintenance (operation scheduling, control, basic knowledge of preventive maintenance, functions of the system, basic knowledge of malfunctions and their handling, spare parts and tools, management of drawing and documents)

ii) Exercises at the Site

During the period of installation works and pre-commissioning, following items will be taught at the Site.

- Methods of start up and shut down of the system
- Explanations on meters on the boards and parts
- Methods of emergency shutdown of the system
- Methods and subjects of observations and inspections
- Methods of cleaning of cables, etc.
- Methods of maintenance of electric equipment (including cleaning of PV modules)

2-2-4-8 Proposal on Training Program

(1) Background

For Yemen, this Project will be the first-ever experience to have a PV system with grid interconnection, although Yemen has a number of cases of independent off-grid solar systems, those for medical facilities and schools, etc. Therefore, it is important to train those Al Wahda hospital technicians who will be actually operating and maintaining the equipment. At the same

time, it is also important to inform officers in the Ministry of Electricity and PEC, and other people who will be involved in the Project, regarding the technical features and institutional issues relevant to PV systems and their interconnection to the utility grid, to prepare them to handle renewable projects in the future.

Operational guidance provided by the Contractor, as explained in the previous section, aims to furnish operators at the Site with practical methods of operation and maintenance of the PV system. On the other hand, the training program discussed here is planned with the objectives to transfer technical knowledge behind the operation methods, building a foundation among the operators and other people concerned for better judgment and application of basic knowledge in the various situations of the management of the PV system, with expectations of development in future projects of a similar kind.

In particular, as the PV system is designed to be equipped with "stand-alone function" to supply power to part of the facility during blackouts, the program should put some emphasis on the importance of understanding of the limitations and issues of the function for proper use of the function.

Further, as pointed out in 2-2-4-7, due to lack of experience of grid connection of renewable power in the country and that of technical data concerning quality of grid power, it is proposed that the Contractor conduct an inspection three month after the commissioning. The second series of training program will be carried out at the same time, in order to reinforce the training and ensure consolidation and sustainability of the knowledge transferred.

(2) Objectives of Training Program

The aims are to enable the receipt country stakeholders to do things as shown below.

For operations and maintenances technicians at the Site;

- To operate and maintain PV system under normal and emergency conditions, with sufficient knowledge of the function of PV system in connection with the existing electric equipment in the facility,
- To deal with the daily and periodical inspection and maintenance, fully understanding their meaning and importance, and also to change and procure the spare parts and consumables,
- To consider routine activities of operation and maintenance and prepare an operation and maintenance management plan,
- To manage selection and arrangement of electric equipment at the destination of "stand-alone mode" power.
- To have basic knowledge that empowers them to give trainings to novice operators within and outside the facility,
- To explain the system to the visitors using publicity leaflets prepared in the program.

For officials in governments and electric utility company

- To understand the PV system theories, technical characteristics, and institutional issues,
- To have technical knowledge relevant in preparing agreements between private owners of power generators and the electric utility company,
- To acquire the knowledge for the development and guidance of new operations and maintenances staff,
- To promote the use of PV using the publicity leaflets prepared in the program.

(3) Outcome of Training Programs

- The operation and maintenance management plan has been established, and the PV system procured is operated and maintained autonomously and sustainably,
- The stand-alone function is used properly with the adequate arrangement of electric equipment at the destination,
- Technical officers at the Ministry of Electricity and PEC are equipped with knowledge on the method of planning and on the institutional provisions for interconnection of renewable power generation systems,
- Use of PV is being promoted using the publicity leaflets prepared in the program.

(4) Confirmation and Evaluation of Outcomes

Most tangible outcome will be the operation and maintenance management plan. As discussed below, the training programs are divided into two periods, the first during the commissioning of the equipment and the other three months after the commissioning. The operation and maintenance management plan will be drafted in the first-period program and revised in the second, taking into account the actual experiences in three months. Publicity Leaflet will be designed and prepared in the programs, with due consideration to the current status of renewable energy use in the recipient country, to be used and distributed to public in order to introduce the PV system procured in the Project and to promote the use of renewable energy.

Other outcomes in the first-period program will be evaluated in the following manners at the beginning of the second-period program. The whole program will also be evaluated with the materials presented at the Work Shop to be held at the end of the programs, further supplemented by questionnaires.

- Evaluation of operation records and daily check sheets for three months,
- Evaluation of problem-response records for three months,
- Evaluation of communication and discussions in Trouble Shooting sessions in the second-period program,
- Evaluation of knowledge acquisition concerning the system-wide management, through Exercises, Workshop and its handouts prepared,
- A questionnaire conducted at end of the training programs

(5) Planning of Training Program

1) Content

Training program is planned to consist of a series of lectures, exercises, and OJTs led by Japanese consultants. The program is to be carried out in two separate periods; one during the commissioning of the equipment, and the other three months after the commissioning.

There will also be an operational guidance provided by the Contractor. During this period, the consultant will coordinate with the Contractor and plan the details of his training program so that the necessary techniques and knowledge are effectively transferred to the participants of the program. Those training items with a symbol (*) below are the ones presumably provided by the Contractor. The consultants will provide additional information for such items, if necessary, to make them more relevant, not just "how to operate", in the context of understanding of PV systems.

Before commissioning (approximately starting 4 weeks before commissioning)

Lectures on basic knowledge

- Basic theory of photovoltaic generation
- Utilization of photovoltaic generation
- Grid-interconnection and its planning
- Understanding surplus and reverse current
- Supply of power to the facility from the grid
- Power demand and loads in the facility
- Workings of PV equipment during blackout
- Stand-alone operation and protection functions
- Load management at the destination of Stand-alone mode power
- Planning PV systems
- Arrangement between PV owner and power utility

Lectures on construction planning

- Installation of PV system
- Power distribution in the facility (with exercises)
- Electric equipment in the facility and connection of PV system
- Scheduling works
- Work supervision and inspection, take-over

OJT program

- Witnessing connection works
- Witnessing pre-commissioning/commissioning tests

After commissioning of PV system (continued from "before commissioning" program)

Reinforcement of Guidance of Contractor

- Starting, stopping, restarting the system (*)
- Daily inspection and maintenance (*)
- Periodical inspection and maintenance (*)
- Consumables and replacement work (*)
- Occurrence of faults and actions (*)
- Activation of Stand-alone mode(*)

Planning O&M works on the basis of Operation Manuals (exercises)

- Making daily check sheet/log sheet forms,
- Making failure/accident record forms,
- Methods of maintaining PV equipment in a good condition,
- Management of Stand-alone operation and responses to problems,
- The results of the above will be compiled and made into the operation and maintenance management plan.

For promotion of renewable energy use

- Design and preparation of publicity leaflet

It is very often experienced, in Japan and in other countries as well, that initial setting of the equipment and/or the lack of familiarity of operation lead to malfunction or unsatisfying performance of the equipment. Therefore, it is necessary to carry out revisory training program a certain period after the commissioning. This revisory training program is proposed to consider three month experience of actual operation and maintenance of PV equipment, operation issues unique in the implementation and in Al Wahda Hospital circumstances, to discuss problems and questions arose, and to revise the operation and maintenance management plan. This process aims for the establishment of more pragmatic and steady method of operation.

On top of these, the records of power generation and power suppression to prevent reverse flow are to be analyzed to provide exercise materials for more advanced operation planning and brief financial assessment, in order to build a capability for planning and management of PV systems in wider applications. The three month inspection carried out by the Contractor engineer will be video-recorded and be used later or outside the facility. This aims at the promulgation of Project's positive effect in time and in space, resulting in the realization of initial objectives of the Project.

The following contents are being considered.

Three months after the commissioning

Evaluation of Establishment of Techniques

- Evaluation of knowledge of basic operation methods

- Evaluation of knowledge of basic maintenance works

Revision of Operation and Maintenance Activities

- Evaluation of 3 month experience of operation and maintenance (as input)
- Trouble shooting sessions (by questionnaire, Q&A session, discussion)
- Confirmation of records of Stand-alone operation and consideration on necessary change in rules,
- Revising daily operation and check sheets (exercise)

Improvement of Operation and Maintenance Methodology for Long-run

- Planning operation with considerations on seasonal changes (to consider changes in output of PV system by seasons and resulting operation methods)
- Witnessing three month inspection (there will be demonstration of replacement of parts, such as fuses by manufacturer's engineer)
- Recording the three month inspection (video-taped and recorded on DVD media)

Preparation of Trouble Shooting Manual

- Discussion on the problems experienced and responded in three months, finding better responses and solutions, compiling information into " Trouble Shooting Manual ",

Support for establishing advanced organization for operation and maintenance

- Brief financial assessment of the generation equipment (comparison of income and expenses)
- Improvement of management of equipment for better financial performance of the equipment,
- Planning better use of PV system responding to the increase in power demand,

Round up Exercises

- Revising the operation and maintenance management plan
- Questionnaire

Workshop

- Presenting revised operation and maintenance management plan and Trouble Shooting Manual,
- Reporting results of brief financial assessment and operation records.

2) Participants

Candidate participants to the training sessions are as follows.

Al Wahda hospital technicians:	Those who will be actually operating the PV system
PEC officers:	in distribution, power purchasing or power plant management related departments, with engineering background (preferably having a degree in electric engineering)

Al Wahda hospital technicians:	Those who will be actually operating the PV system
MEE, MPHP officials:	in regulatory planning, facility management or facility planning related departments, preferably with engineering background
Other	If there are requests from other ministries or organizations, they may appoint persons in charge of public facility planning and/or its maintenance to join the program.

Preliminary assignment for these participants are shown in the table below.

Table 2-2-4-3 Program Contents and Participants

Activities	Technicians (3-4person)	PEC (2-3person)	Ministries (2-3person)	others (2-3person)
Before commissioning				
Lectures on basic knowledge	○	○	○	○
Lectures on construction planning	○	○	○	
OJT program	○	○	○	
For promotion of renewable energy use	○	○	○	
After commissioning				
Reinforcement of Contractor Guidance	○	○		
Planning O&M works	○			
Three month after commissioning				
Establishment of Techniques	○	○		
Revision of O&M Activities	○			
Improvement of O&M for Long-run	○			
Preparation of Trouble Shooting Manual	○	○		
Advanced Organization for O&M	○		○	
Round up Exercises	○	○	○	○
Workshop	○	○	○	○

3) Schedules

The schedule for the abovementioned program is shown below.

Table 2-2-4-4 Training Program before/after Commissioning

		-4w	-3w	-2w	-1w	0w	1w	2w	3week
Activities	Preparation								
	Basic knowledge lectures								
	Construction exercise								
	OJT								
	Reinforce Contractor Guidance								
	O&M Management Planning								
	Promotion Material								
Participant	Hospital technicians								
	PEC officers								
	Ministry Officials								
Lecturers	Consultant (leader)								
	Consultant (assistant)								
	Interpreter								

Table 2-2-4-5 Training Program Three Months after Commissioning

		1w	2w	3w	4w
Activities	Establishment of Techniques				
	Revision of O&M Activities				
	Improvement of O&M for Long-run				
	Preparation of Trouble Shooting Manual				
	Advanced Organization for O&M				
	Round up Exercises				
	Workshop				▼
Participant	Hospital technicians				
	PEC officers				
	Ministry Officials				
Lecturer	Consultant (leader)				
	Consultant (assistant)				
	Interpreter				

(6) Resources for the Training Program

As already mentioned, this PV system with grid interconnection is first-ever experience in Yemen. Therefore, Japanese consultants are assumed to undertake the implementation of training programs. Consultants to be assigned should have adequate experiences in planning of PV system with grid interconnection.

There will be two Japanese consultants, one leader and one assistant, to be lecturers to the programs of both periods. National consultants are not considered as the recipient country does not have an experience in similar projects.

As the official foreign language of the country is Arabic, and the participants may not be good at speaking English, translation/interpretation service is necessary. But Arabic-English interpretation service available in the country will have problems in technical terms and expressions. If consultants give a lecture in English and an interpreter translates to Arabic, it is most likely to cause confusion and misunderstanding. Therefore, the translation between Japanese and Arabic is more desirable, and the interpreter should be sought in Japan. Hiring Japanese-Arabic interpreter has some other advantages; such as translating additional materials obtained from the Contractor to use in the lectures, which are very likely written in Japanese.

(7) Schedule of Training Programs

Work schedule of training programs is as shown below, assuming that the agreement between procurement agents and contractors will be concluded in December 2010.

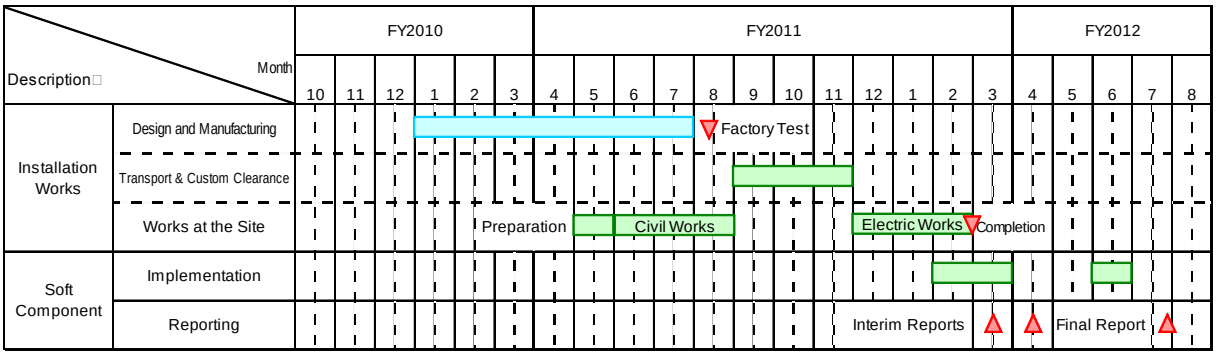


Figure 2-2-4-3 Training Program Implementation Schedule

(8) Products of Training Programs

Products of training programs are outlined below.

- A training program textbook prepared by the Consultant
- Output of Exercises (A single line diagram of the facility, etc.)
- Publicity Leaflet

- Progress reports
- Visual record (DVD) of Periodical Inspection (three month inspection)
- Operation and Maintenance Management Plan (with revision)
- Trouble Shooting Manual
- Workshop materials
- Results of questionnaires
- Final report (including evaluations of operation records and trouble shootings)

(9) The Responsibility of Receipt Country

As Al Wahda Hospital is located in Aden, transportation expenses, accommodation costs, and allowances of participants should be borne by their affiliations in the case of participation from outside Aden.

It is important that participants take part in the training programs in full for the achievement of program objectives, which, however, requires the participants of being away from their work places for weeks. Therefore, there must be an official designation as a participant given by the section/department management who appreciates the usefulness of the programs. It is also important that government agencies appoint persons who will be in charge of PV and renewable energies in the future.

2-2-4-9 Implementation Schedule

In making up the implementation schedule, it is necessary to take the grant aid cooperation into full consideration and set up a proper project implementation system with the work schedule.
The execution schedule is as follows:

(1) Exchange of Notes (E/N)
(2) Consultant Agreement
(3) Tender document preparation
(4) Tendering and signing of contract with the selected contractor
(5) Manufacture and procurement of materials and equipments
(6) Installation of PV equipment
(7) Implementation of soft component
(8) Completion and hand-over

The project will be implemented in about 30 months upon conclusion of the E/N. In Yemen a law stipulates maximum 48-hour workweek with a maximum 8-hour workday. Friday is the weekly day of the rest and the total numbers of official public holidays is 15 days a year. In making up the implementation schedule, it is necessary to consider Ramadan, during which efficiency of works is expected to decline, in order to make a workable and manageable schedule. The whole period of

implementation of the Project consists of design and manufacturing, transportation, foundation work, installation work, pre-commissioning and adjustment. The foundation work can be conducted while the electric equipment is being manufactured in Japan. It is reported by a local construction company that curing concrete is difficult during summer in southern Yemen because of the high temperature. Therefore, the concrete works are scheduled to be implemented in relatively low temperature seasons, before May.

Based on the grant aide scheme of Japan, preliminary implementation schedule is drawn up as shown below.

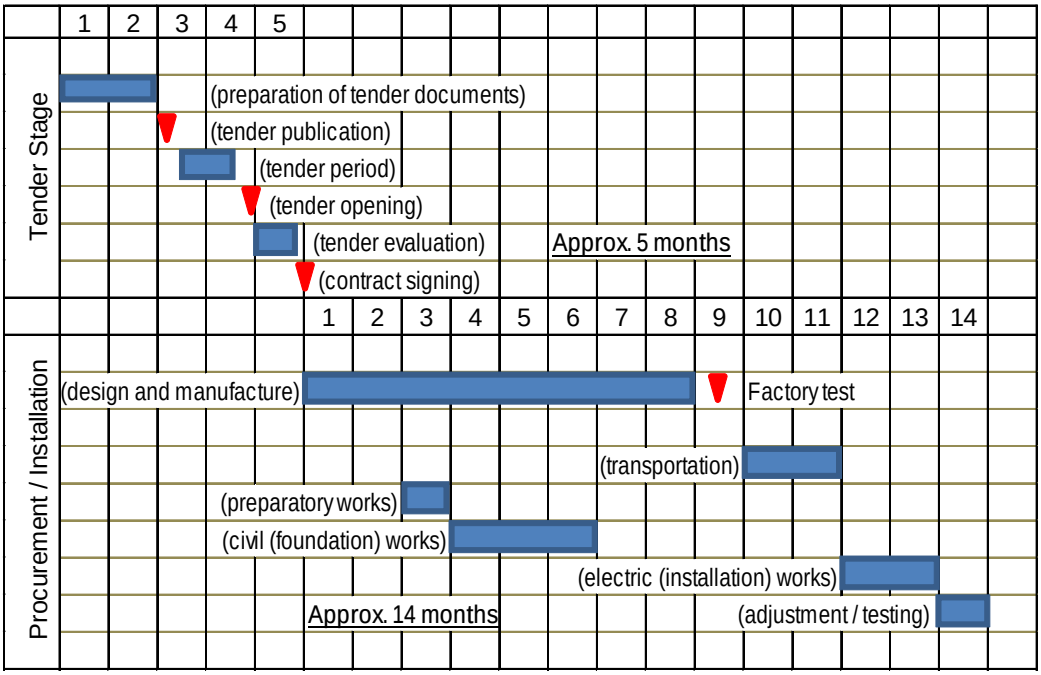


Figure 2-2-4-4 Implementation Schedule of the Project

2-3 Obligations of Recipient Country

Undertakings required of the Recipient Country had been confirmed by the minuets of discussion concluded in First Phase Study of the Project. The specific items required for implementation are listed below.

- To secure the land (done)
- To clear and level the area for PV module installation
- To install fence and gate to PV system installation space
- To conclude a bank arrangement with Japanese bank and pay commission
- To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the Components and to the employment

of the Agent will be exempted by the Government of recipient country
- To accept the personnel of our country in charge of this project
- To do required procedure for construction of the electric generating equipment
- To ensure the personnel and financial resource for the operation and maintenances of PV system in the future
- To select and send adequate persons for training program, from the Ministry of Electricity, PEC, other relevant government organizations

2-4 Project Operation Plan

2-4-1 Basic Concept of Operation and Maintenance of Generating Equipment

The generating equipment procured in the Project is designed to be managed by the Site, Al Wahda Hospital, for its daily operation and maintenance. In the long term, the management of the equipment will require assistance and input from the executing agency of the Project, the Ministry of Public Health and Population, and also from the advisor to the Project, the Ministry of Electricity and Energy. PEC should also be involved in the agreement necessary for the grid-interconnection and reverse current.

The recipient is expected to implement the preventive measures and proper maintenances of the generating equipments to keep the performance, function, and continuous supply of power, on the basis of improvement of reliability, safety, and efficiency.

Basic concept of maintenance is shown in the figure below.

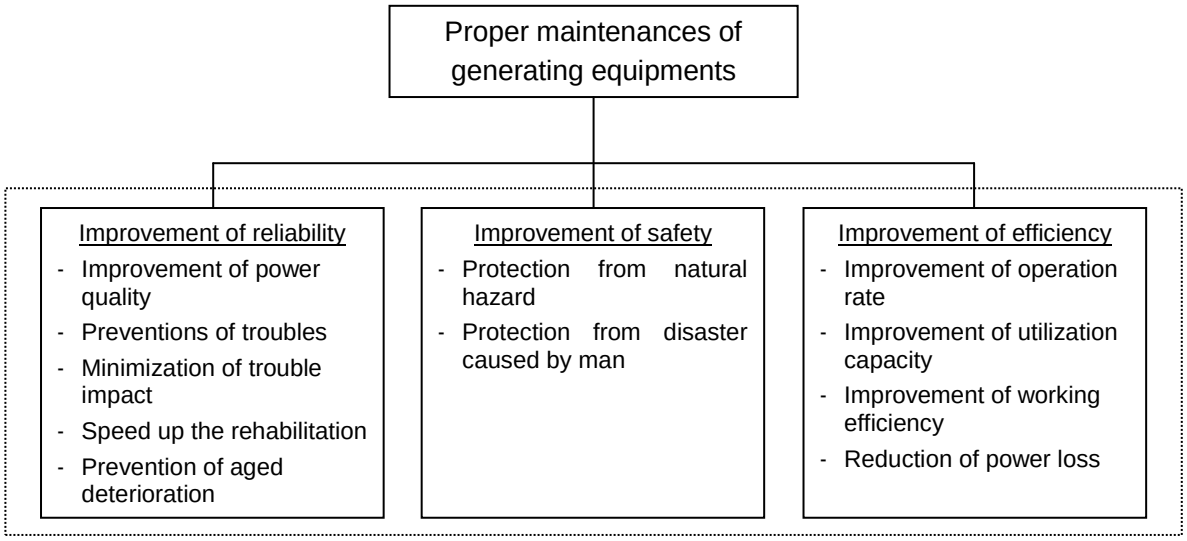


Figure 2-4-1-1 Basic Concept of Generating Equipments Maintenances

Keeping the basic concept in mind, the recipient country should operate and maintain the PV system, utilizing the O&M techniques transferred during the Contract through OJT by Contractor's experts and through training programs by the Consultant, and according to Operation and Maintenance Manuals.

2-4-2 Periodical Inspection

Relevant parties in the Recipient country should draw up an O&M Plan for the PV system on the basis of the standard daily and periodic inspection lists shown in tables below and O&M Manuals presented by the Manufacturer, and execute the O&M works efficiently meeting the power demand.

(1) Daily Inspections

Daily inspections are mainly visual inspections conducted daily. Recommended inspection items are shown in Table 2-4-2-1. In the case of any anomalies detected, consult with a responsible engineer of the Facility.

Table 2-4-2-1 Standard Daily Inspection Items and Findings

Category	Items		Findings
PV array	Visual	a) Surface of arrays	Stain and damage
		b) Support stands	Corrosion and rust
		c) Connecting cable	Damage
Junction box	Visual	a) Boxes	Corrosion and rust
		b) Connecting cables	Damage
Power Conditioner Cubicle	Visual	a) Outside boxes	Corrosion and rust, energized part being covered
		b) Connection cables	Damage
		c) Vent hole (air shaft, filters etc)	Aeration, Filter clogging
		d) Condition	Abnormal sound, vibration, odor, and overheating
		e) Control panel	Signal of errors
		f) Power generating	Errors of power generating condition on control panel

(2) Bi-monthly Inspections

Bi-monthly inspections are advisable to be conducted once every two months. Recommended inspection items are shown in Table 2-4-2-2.

Table 2-4-2-2 Standard Bi-monthly Inspection Items and Findings

Category	Items		Findings
PV Sub-array[4]	Visual and touch	Earthing wires and grounding terminals	Junction with Earthing wires Loose screws
Junction box	Visual and touch	a) Boxes	Corrosion and damage
		b) Connecting cables and terminals	Anomaly in wiring Loose screws
		c) Earthing wires and connecting terminals	Anomaly in wiring Loose screws
	Measurement and test	a) Insulating resistance	<PV − Earthing wires> 0.2MΩ[5] or over, measured voltage DC500V (Measure all circuits) <Output Terminals − Earthing wires> 1MΩ or over Measured voltage DC500V
		b) Open circuit voltage	Specified voltage, Polarity （Measure all circuits）
Power conditioner Cubicle	Visual and touch	a) Outside boxes	Corrosion and damage
		b) Connecting cables and terminals	Anomaly in wiring Loose screws
		c) Earthling wires and connecting terminals	Anomaly in wiring Loose screws
		d) Vent hole (air shaft, filters etc.)	Aeration, Filter clogging
		e) Condition	Abnormal sound, vibration, odor, and overheating
		f) Control panel	Signal of errors
	Measurement and test	a) Insulating resistance (Power conditioner - Earthing)	1MΩ or over Measured voltage DC500V
		b) Control panel	Operation checks (Display and power generating)
		c) Re-starting Timer	Confirmation of automatic start-up
Switch for PV	Visual and touch	a) Connecting terminals of switch	Loose screws
	Test	a) Insulating resistance	1MΩor over Measured voltage DC500V

2-4-3 Long term Operation and Maintenance

Although the expected operation life of PV modules and power conditioners, the main components of PV system, varies by manufacturers, generally PV modules[6] are considered to work for 20 years and power conditioners[7] are considered to work for 15 years under the proper

[4] PV modules should be checked for the following points
- Smudges on the surface, cracks and discolorations on the surface, etc,
- Deformation of support structure, rust, loosened bolts, etc.

[5] Allowable Insulating resistance
0.4MΩ or over for Insulating resistance of 300V or over.

[6] "Photovoltaic Power Generation System, 3rd edition", September 2006, Japan Photovoltaic Energy Association.

[7] Based on the interviews to manufacturers.

O&M and favorable environment. Actual operation life, however, depends on the execution of inspections and daily operation/maintenance conditions. There are some parts inside the equipment that have to be replaced before operation life of the equipment.

Those maintenances including the replacement of major worn-out parts are generally called "full-scale maintenance", "detailed maintenance" or overhaul, in this Project defined as "long term maintenance". Frequency of long term maintenance is once every five to seven years.

Long term maintenance can be the most expensive maintenance work related to PV system, because major parts may have to be purchased and replaced, and in some unfortunate cases a dispatch of manufacturer's engineers have to be requested. Therefore, unlike regular maintenances and periodic inspections, some special provision for long term maintenance is needed. Regular maintenances and periodic inspections are assumed to be implemented by the technicians and on the current operation budget at the Facility. Long term maintenance, therefore, requires, among others, financial support from the implementing/responsible ministries/agencies of the government. Also, there are some cases which requires the involvement of electricity utility company as the PV system is interconnected to the utility grid.

Table 2-4-3-1 Organization Control of Long Term Maintenance

	Responsible organization	Periodical and Daily Inspection	Long Term Maintenance
Project site:	Al Wahda Hospital	Operation of PV system Planning and implementation	Planning and implementation
Implementi-ng Agency:	MPHP	Monitoring of operation and effect on PV system	Financial support
Electric Utility	PEC	Monitoring of grid interconnection and reverse power flow condition	Technical support

It is desirable for sustainable supply of electric power by the PV system to have a proper supporting program especially targeting long term maintenance. Within this Project, the following measures are proposed.

1. Provision of spare parts needed up to the first long term maintenance
2. Provision of a dedicated section in O&M Manuals that explains how to use spare parts

As specification of spare parts and maintenances varies by manufacturers, detailed lists are proposed by bidders and finally will be fixed after tendering.

2-4-4 Spare Parts

Spare parts for the PV system are classified into two categories; standard components for periodic replacements and components for unscheduled replacements. Owners of the PV system have to purchase these parts for periodic inspections and maintenances.

It is planned that the spare parts necessary up to the first long term maintenance are procured by this Project. The Recipient country himself has to meet subsequent needs for spare parts. The lists of spare parts and tools proposed to be procured in the Project are shown in the table below.

Table 2-4-4-1 Spare Part and Tool List for PV System

No.	Item	Quantity
Spare parts		
(1)	Periodic replacement	
	1) Low-tension circuit fuses	200%
	2) Lamps	200%
	3) Indication Lamps	200%
	4) Flour lamps, Glow lamps	200%
	5) Lightning arrester	200%
(2)	Unscheduled replacement	
	1) MCCBs	1 complete set
	2) Relays	1 complete set
	3) Capacitors	200%
	4) Funs	200%
	5) PV modules	3%
	6) Power Conditioner (stand-by unit)	1 set
Tool kits		
(1)	Measuring equipments	
	1) AC clamp meter	1 unit
	2) Insulating resistance tester 500V	1 unit
	3) Simple resistance meter	1 unit
	4) Phase indicator	1 unit
	5) Voltmeter for low voltage	1 unit
	6) Digital multimeter	1 unit
(2)	Tools	
	1) Flathead screwdrivers	2 pcs
	2) Philips screwdrivers	2 pcs
	3) Nippers	2 pcs
	4) Pinchers	2 pcs
	5) Crimp contact pinchers	2 pcs
	6) Card Circuit tester	1 pc
	7) Wire Stripper	2 pcs
	8) Cable cutters	2 pcs
	9) Torque Wrench	1 pc

2-5 Cost Estimation of Project

2-5-1 Cost of Procurement of Products and Services

The cost for the Project born by the Recipient is estimated to be YR 3.7 million as explained below

(1) The Cost of Yemen Side

The obligations of the Recipient side were discussed in section 2-3 of this report, among which the following items may require explicit expenditures.

- Clearing and leveling of the Site
- Sending trainees of Ministries and PEC to the Training Programs to be held in Aden

As for the clearing and leveling, the Site is at the moment open and flat, and does not specifically require such works. At the Second Phase Study of JICA Team, the Team requested the hospital management to keep the area unoccupied and open. As long as the area should be kept as it is now, there would be no significant cost incurred for the purpose.

Meanwhile, the Training Program is scheduled to be held at the Site in Aden. If trainees should be sent from Sana'a or any other cities, there would be expenses for travel, accommodations, and per diem, etc. Such expenses are estimated, on the basis of the plan discussed in section 2-2-4-8, as shown in the table below.

Table 2-5-1-1 Expenses for Trainees sent to Training Programs

			Travel Air fare Sana'a-Aden		Accommodation, per diem		
Trainees	Base	number	rate	amount	rate	day	amount
Program before and after commissioning							
Operators	Aden	6				49	0
PEC participants	Sana'a	0	158	0	100	0	0
	Aden	3			0	35	0
MPHP participants	Sana'a	2	158	316	100	21	4,200
	Aden	0			0	0	0
MEE participants	Sana'a	2	158	316	100	21	4,200
	Aden	0			0	0	0
total		13		632			8,400
Program three months after commissioning							
Operators	Aden	6			0	28	0
PEC participants	Sana'a	0	158	0	100	0	0
	Aden	3			0	14	0
MPHP participants	Sana'a	2	158	632	100	14	2,800
	Aden	0			0	0	0
MEE participants	Sana'a	2	158	316	100	14	2,800
	Aden	0			0	0	0
Total		13		948			5,600
Workshop							
Conference(25persons, handout, drinks, etc)							2,500
Grand Total							18,080

(Unit : US Dollar)

$18,080 × 96.53 [JPN/US$] / 0.471 [JPN/YR] = YR 3,705,000

(2) Condition of Calculation

1.	Time of calculation	October, 2009
2.	Exchange rates of foreign currencies	US$ 1 = JPN 96.53 YR(Yemen Rial) 1 = JPN 0.471
3.	Time of the Event	as shown in Figure 2-2-4-4
4.	Remarks	Calculation is done according to the rules for Japan's Grand Aid Programmes

2-5-2 Cost of Operation and Maintenance

(1) Estimation of Cost of Operation and Maintenance

The following cost factors are considered here.

1. Cost for daily operation
2. Cost for personnel in operation and maintenance
3. Cost for spare parts to be required
4. Cost for renovation

Cost estimation in this section does not consider unlikely, but still possible, breakdown of equipment and resulting repair cost. Also, repair cost after vandalism or sabotage is not considered. Further, the cost of requesting Japanese manufacturer's engineers to be present at the Site for repair and/or diagnosis works is not considered.

1) Cost for Daily Operation

As a PV system does not consume any fuels, there would be very few expenses under this category. To be very precise, there are expenses for water used in cleaning of PV modules, electricity for system monitoring and air conditioning during not-generating hours of the day, which are small enough to be negligible.

2) Cost for Personnel in Operation and Maintenance

The PV system to be procured in the Project can be, and will be operated and maintained by the existing maintenance staff of the facility. Therefore, operating and maintaining the PV system does not require additional persons to be employed by the facility.

Meanwhile, part of working hours of the maintenance staff will be taken up by operation and maintenance activities, it is converted to monetary terms for reference purpose. (Daily cost of a person is assumed to be $22.86.)

- Daily inspection (modules and cubicle) 0.5 hours per day
  0.5hr/8hr [daily working hrs] times $22.86 = $1.37 per day
- Cleaning of modules (1hr per month per kW of modules) 30hours per month

30hrs/30days/8hr [daily working hrs] times $22.86 = $2.97 per day

Adding these two, we get daily cost at $4.34. To convert this to annual cost,

$4.34 times 365＝$1,584.1
$1,584.1 times 96.53[JPN/US$] / 0.471[JPN/ YR] YR 324,000 per year

3) Cost for Spare Parts to be required

A PV system to be procured in this Project is in general considered to have an expected operation life of ten to twenty years. PV modules require little maintenance cost as they have no moving parts, hence less possibility of break down. In particular, Japanese made PV modules have reputation of lower rate of deterioration of conversion efficiency compared to products of other countries. On top of this, there will be a few per cent extra modules to be procured in the contract as spare parts. There will be no spare parts of PV modules to be purchased by the Recipient in the future, leaving necessity of purchasing only those parts related to power conditioners.

As discussed in Section 2-4-3, the procurement contract for the Project is planned to include provision of spare parts to be necessary up to the first long-term maintenance work. This will relieve the recipient from the expenses of purchasing spare parts until the first long-term maintenance work. The first long-term maintenance work will take place, with some variation among manufacturers, about seven years after the commissioning of the equipment.

There is an exception to the above, the parts related to air conditioners is not included in the list of spare parts provided by the Contractor.

In summary, the cost of spare parts will be for those for air conditioners until the first long-term maintenance, which will be added with those for power conditioners thereafter. Roughly speaking, and on average, these costs are estimated as in the table below.

Table 2-5-2-1 Expenses for Spare Parts

	Aggregate for a period of Long-term Maintenance	Average Annual cost
Power Conditioner related (applicable only after the First Long-term Maintenance)	Approx. 3,150,000	Approx 450,000
Air Conditioner related	Approx. 1,050,000	Approx 150,000
Total (after the First Long-term Maintenance)	Approx. 4,200,000	Approx 600,000

(Unit: Japanese Yen)

Remarks : As mentioned before, these costs do not include that for dispatch of engineers from abroad. These costs are subject to large variation due to the environment and conditions of operation and maintenance.

Converting these figures into Yemen Rials, we have the expected purchase cost of spare parts as below.

Before the First Long-term Maintenance

JPN150,000/0.471[JNP/ YR] = YR 318,000 per year

After the First Long-term Maintenance

JPN 600,000/0.471[JNP/ YR] ＝YR 1,373,000 per year

4) Cost for renovation

As mentioned in the previous section, PV modules have long expected life with slow deterioration rate. Therefore, PV modules do not require replacement during the lifetime of the whole PV system.

The power conditioners on the other hand are just like ordinary equipment in the power utility industry and some of their parts have statutory service lives. Those parts that have been deteriorated should be, on occasions of periodical and/or long-term maintenance, replaced with the spare parts considered in the previous section. Beyond this, overall replacement of the equipment or renovation is considered out of scope of this Project.

(2) Financial Resources for operation and Maintenance

A financial benefit of having PV equipment accrues to a party who pays electricity bills. As Al Wahda Hospital is not paying electricity bills, the hospital will not be financially benefited from the Project. Further, considering the limited budget of the hospital it would be too much a burden for the hospital to bear the cost of maintenance discussed in the previous section.

Here, it makes more sense to assume that the governments who are paying the bill are also liable to pay the cost of operation and maintenance of the PV system.

The financial value of the electricity generated by the PV system will be, although difficult to estimate accurately as there may be some energy produced but wasted due to the balance of supply and demand (no reverse flow), calculated on the basis of the expected annual production of energy 500MWh. Assuming this energy is all consumed in the Hospital and contributes to the reduction of electricity bills, using current electricity tariff of the Hospital, YR 30 per kWh, we obtain the financial value of the power as below.

500MWh ×YR30/kWh＝YR 15,000,000

As this value is much larger than the aforementioned operation and maintenance cost, the Project will prove to put no additional financial burden to the Recipient

2-6 Other Relevant Issues

(1) Handling of Reverse Current

In this study, the PV system is designed in a way that reverse current to the utility grid is not permitted even when there is surplus power generated, due to the decision of the public electricity company, PEC. Al Wahda Hospital is presently under the large scale rehabilitation works and when the works are complete, the consumption of electricity at the hospital is expected to be much larger than the level measured at the Site in this study. The surplus power will not be produced that much for the design capacity of the PV system. However, considering the possibility that the country may have similar kind of projects in the future, this Project may have provided a timely opportunity the related authorities to consider rules and regulations for the handling of reverse current. The design of the PV system to be provided in the Project has added to an ordinary, with-reverse current system a control to suppress the occurrence of reverse flow. And this control can be cancelled by the operation on the control panel of the System (when there is a surplus power).

In the training programs (soft component) to which officials of the Ministry of Electricity and PEC are encouraged to participate, the reverse current issue should be taken up to prepare them for the similar projects in the future and to prompt these officials to engage in the discussion on the issue.

(2) Operation and Maintenance Organization

For this Project, the Ministry of Public Health and Population will be the executing agency, and Al Wahda Hospital will be taking care of daily operation and maintenance. Staff of maintenance department of the Hospital has been in charge of managing electric facilities of the Hospital including a diesel generator unit, and they are well capable of handling the PV system, provided that they have been given knowledge and training for the new equipment. In particular, as the long-term maintenance works demand technically higher level of knowledge, PEC who are very much experienced in electric equipment and its supervisor, the Ministry of Electricity, are expected to provide support.

(3) Use of Stand-alone Function

This Project is designed, on the basis of the request from the Hospital, to furnish the PV system with the stand-alone function. In order to utilize this function safely and effectively, the mechanism of photovoltaics and the working of PV equipment, characteristics of electric instruments on the demand side (destination of stand-alone power) and their arrangement, must be fully understood and managed.

Therefore, it is not only those technicians who will be directly in charge of operation and

maintainance of the PV system, but also engineers and researchers who are using electric equipment in the Hospital, that have to acquire accurate and sufficient understanding of the stand-alone function, through an attendance to the training program or any other means.

CHAPTER 3

PROJECT EVALUATION AND RECOMMENDATIONS

Chapter 3 Project Evaluation and Recommendations

3-1 Recommendations

3-1-1 Prerequisite to Project Implementation

There are prerequisites for the Project to be implemented without impediments, which are shown below.

(1) Handling of Reverse Current

Although the reverse current is not permitted in this Project, in the training programs (soft component) to which officials of the Ministry of Electricity and PEC are encouraged to participate, the reverse current issue should be taken up to prepare them for the similar projects in the future and to prompt these officials to engage in the discussion on the issue.

(2) Operation and Maintenance Organization

For this Project, the Ministry of Public Health and Population will be the executing agency, and Al Wahda Hospital will be taking care of daily operation and maintenance. Staff of maintenance department of the Hospital will be well capable of handling the PV system, provided that they have been given knowledge and training for the new equipment. In particular, as the long-term maintenance works demand technically higher level of knowledge, PEC and its supervisor, the Ministry of Electricity, are expected to provide support.

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3-1-2 External Conditions to Achievement of Project Objectives

Yemen side should work on the following things for the Project's to take effects sustainably.

(1) Expectations on the Ministry of Electricity

In this Project, the implementation agency is the Ministry of Public Health and Population, and the

Ministry of Energy is given a position of an advisor. The reason behind this arrangement may have been that the grid-interconnected PV system provided by the Project did not appear directly to meet the energy policy of the country in which the use of solar energy is to be advanced in the field of rural electrification.

The Ministry of Electricity has separated the rural electrification business using solar energy from the public electricity company, and is seeking to promote private investment in the field, with the supervision by the newly established rural electrification agency. There seems to be not much information available concerning renewable energy resources which is needed by private investors in their decision making and managing the risks involved. Having the records of power production and that of long-term operation and maintenance in this Project publicized can provide information very useful in planning the solar projects with certain size. This kind of utilization of technical knowledge obtained with the Project is not the work expected for the Ministry of Public Health and Population, but for the Ministry of Electricity.

(2) Technical Assistance, Cooperation with Other Donors

As mentioned above, the Ministry of Energy is promoting the use of solar energy in the field of rural electrification, seeking private investment in mini-grid in remote areas. Meanwhile GTZ of Germany has withdrawn from the energy sector, very likely leaving the solar uses to individual independent solar systems for schools and medical facilities in rural areas away from the national power network.

Considering the technical advantages of Japan, what Yemen would demand Japan to provide in the form of technical assistance are;

1) to prepare necessary institutions and markets to promote private investment in rural electrification,
2) to improve planning, installing, operating and maintaining single/grid-interconnected solar facilities,
3) to use and interconnect other renewable resources together with solar generation.

Among them, 1) has been already established in the policy documents with an assistance from GTZ. Therefore, Japanese assistance is desired in 2) and 3) above.

Yemeni Government should take a lead, with cooperation from Japanese side, to realize assistance projects mentioned above.

3-2 Project Evaluation

3-2-1 Validity of the Project

The Project is considered valid on the basis of following points.

(1) Reduction of Fossil Fuel Consumption and Carbon Dioxide Emission

Yemen depends completely on fossil fuel for the primary energy for electric generation. Therefore, energy generated by the PV system of this Project will all contribute to the reduction of consumption of fossil fuel, hence the emission of CO2. This Project is considered appropriate as it will deliver the direct effect as follows,

Reduction of fossil fuel consumption
Reduction of carbon dioxide emission
Reduction of the Country's dependence on imported fossil fuel

(2) Consistency with Higher Policy

The energy policy and climate change mitigation measures of Yemen, while the government is aware of the abundant endowment of solar potential in the country, focuses on its use in independent, isolated use (e.g. SHS) in rural areas. Villages with a certain scale are, if away from the national power grid, planned to be electrified by mini-grid using solar power, realized by private investments. On the other hand the policy has been seeking to harness solar thermal and wind energy for the renewable energy to be connected to the national grid. This Project, to have PV system interconnected to the national grid, is something that the policy has not been aware of.

Aden City, where the chosen Site situates, has an advantage in terms of climate conditions for the utilization of solar power. If this Project can demonstrate the effectiveness of PV use in Yemen, it will have a good impact on the energy policy of Yemen. At the same time it will have a good impact on the promotion of private investment in PV uses.

It should be also pointed out that Al Wahda Hospital is situated in the southern part of Yemen. The Yemeni government is committed to balanced development of northern and southern parts of the Country. This Project will be welcomed in that it helps balance the flow of development assistance to parts of Yemen

In this manner, the Project is compatible with the energy policy of Yemen and considered appropriate.

(3) Operation and Maintenance Capacity at the Site

Facility maintenance staff of Al Wahda Hospital, although does not seem to have education in

advanced electric engineering, has been managing the electrical facilities of the Hospital which are getting older, and securing power even for the most advanced medical equipment, on the basis of their experience. Therefore, they are considered well capable of operating and maintaining the PV system to be installed, once they have been given necessary knowledge and adequate management tools.

The Site chosen for the Project is considered appropriate for the reasons given above.

(4) Financial Weight of Operation and Maintenance

The energy expected to be produced by the PV system of the Project can be valued on the basis of electricity tariff charged to the Hospital to be approximately YR 15 million, which is much larger than the long-term cost of operation and maintenance. Therefore, the Project will not put a burden on, but contribute to, the finance of the Country.

(6) Socio-Environmental Considerations

The photovoltaic generation system to be installed by the Program will work to reduce the consumption of fossil fuel, leading to reduction of emission from thermal power plants locally, and that of CO_2 emission globally.

Meanwhile, it is pointed out that the Contractor should plan the installation works carefully so that there would be no significant impact on environment or accidents during the works.

(7) Benefit from Advanced Technology of Japanese Products

PV equipment consists mostly of PV modules, power conditioners and their peripherals. Especially, PV modules and power conditioners made by Japanese manufacturers have technical advantages over other countries in their efficiency, longevity, reliability, etc. in the market. As this Project is limiting the country of origin of this equipment to Japan, the Project will be able to offer advanced technology of Japanese products.

3-2-2 Effectiveness of the Project

(1) Overall Effect

By the introduction of the photovoltaic generation system, the Recipient country can reduce the consumption of fuel oil and diesel oil, or do without additional consumption of such fossil fuel, resulting in the reduction of CO_2 emissions. This will contribute to the climate change mitigation policy of the Recipient country. On top of this, to install a photovoltaic generation system of the largest scale in the second largest city of the Recipient country, we could expect demonstration and educational effects of clean energy use including solar power on the wider public within the

country and outside. If the Project proves that very efficient solar generation is possible in Aden City with its climatic advantage, it may accelerate private investment and/or foreign assistance in the field in Yemen.

There are secondary effects such as economic effect of less domestic consumption of fossil fuel that can be turned to exportation, and diversification of sources of power, as the country has been completely dependent on the fossil fuel. Although Al Wahda Hospital does not himself take the cost of electricity, the reduction of purchased energy from PEC will contribute to the finance of the government.

(2) Quantitative Effects

Among the effects mentioned above, those that can be quantified are described below.

1) Generated Energy

As mentioned before, the generated power expected from the PV system to be installed by the Project is approximately 500MWh per year, though it should be considered as theoretical maximum. This amounts to be a quarter of the annual electricity consumption of Al Wahda Hospital (2,064MWh in 2008), and 0.01% of the annual sales of PEC (4,083.8GWh in 2007) over the country.

2) Financial Benefit

If all the generated energy is to reduce the consumption of PEC electricity, in financial term, it will be a reduction in YR 15 million per year.

3) Reduction of CO_2 Emission

Unit emission of CO_2 [8]

The effect of CO_2 emission reduction is calculated here in the following manner,

- To apply the method of CDM, which in the first place assumes the Baseline, and considers the change from the baseline of CO_2 emission with the PV system to be the reduction in CO_2 emission,
- The baseline is defined by the alternative generation method without the PV system.
- The alternative generation method should be of approximately the same scale, and practically possible power plant or generator in the country.
- CO_2 emission of the alternative power plant or generator above for the estimated energy generation of the Project is considered as the reduction of CO_2 emission by the Project.

For a small scale generation unit below 15MW, UNFCCC/CDM has its rule to use a diesel engine generator for the baseline. However, Yemen has oil and gas resources for power

[8] UNFCCC Web Page (http://cdm.unfccc.int/index.html)

generation. Therefore, we can assume either diesel generator or gas generator (gas engine) to be the baseline for the analysis.

Unit CO_2 emission of a diesel generator and a gas generator can be calculated using "Guideline for Calculation of Greenhouse Gas Emission (March/2007)" published by the Ministry of Environment, Japan as below;

For diesel generator

Specific gravity of diesel fuel	0.86
Mass of diesel fuel for 1L	860g
Fuel consumption of diesel generator	0.235g/kWh
Generation for diesel fuel 1 L	3.66kWh/L（0.860g/L / 0.235g/kWh）
Unit CO_2 emission by combustion of diesel fuel	2.62kg-CO_2/L
Unit CO_2 emission per kWh	0.716kg-CO_2 (2.62kg-CO_2/L / 3.66kWh/L)

For gas generator, we compare the thermal values of diesel fuel and natural gas,

Thermal value of natural gas	54.5 Mj/kg
Thermal value of diesel fuel:	44.4Mj/kg
Unit consumption of natural gas	0.235kg/kWh × (44.4/54.5)=0.191 kg/kWh
Unit CO_2 emission of combustion of natural gas:	2.7kg-CO_2/kg
Unit CO_2 emission per kWh	(2.7kg-CO_2/kg × 0.191 kg/kWh) = 0.516kg-CO_2/kWh

Among two sources of energy, we use natural gas to estimate the CO_2 emission reduction for the conservativeness of the analysis. Using unit CO_2 emission of natural gas, and multiplying with the theoretical maximum annual generated energy 500MWh, we obtain the estimation of annual CO_2 reduction of the Project,

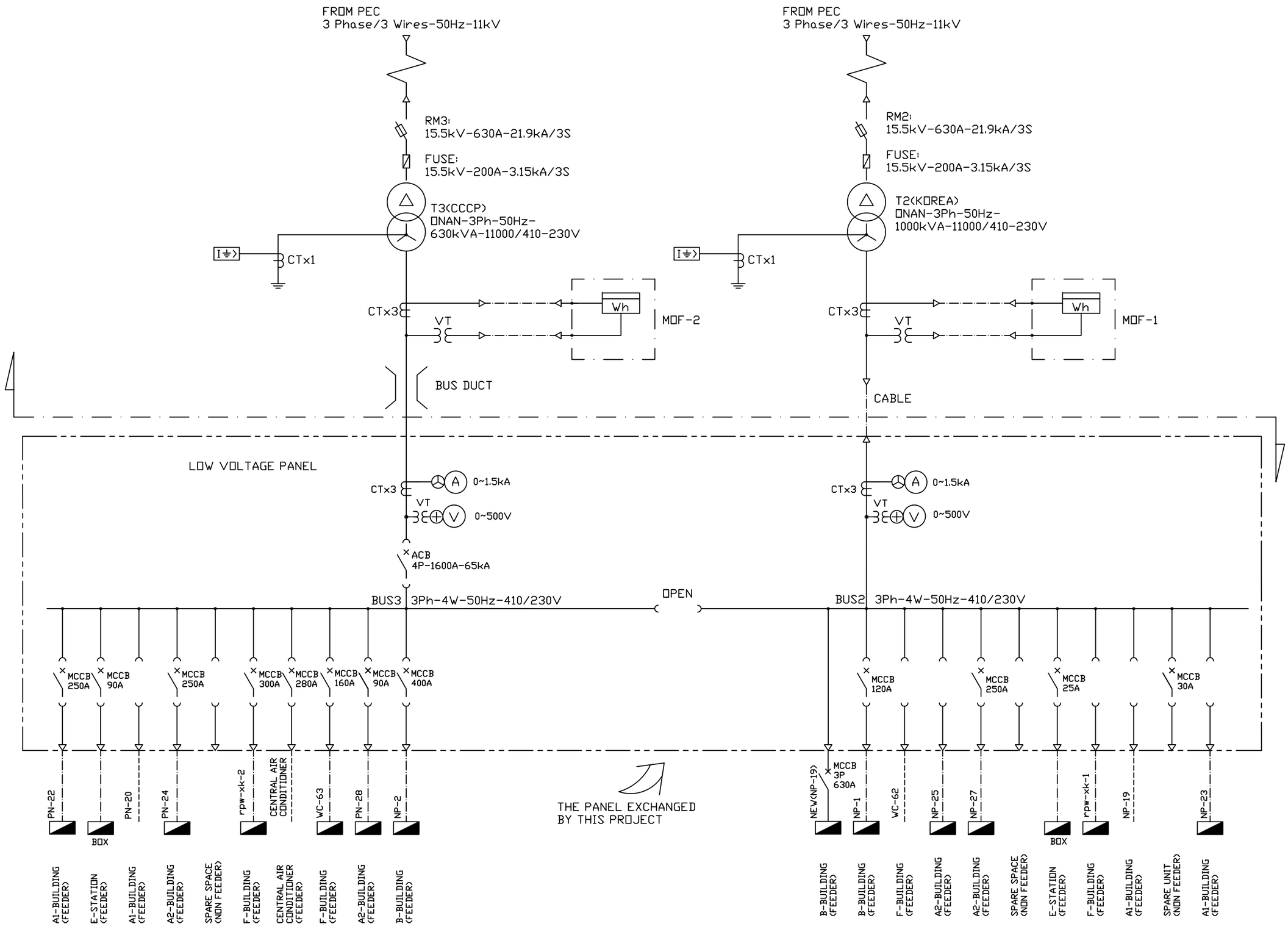
Annual CO_2 emission reduction by the Project can be at maximum

= 500MWh x 0.516kg-CO2/kWh=258 t-CO2

DRAWINGS

DRAWINGS

Number	Title
NO. 01	SINGLE LINE DIAGRAM
NO. 02	SINGLE LINE DIAGRAM (PV SYSTEM)
NO. 03	GENERAL LAYOUT PLAN
NO. 04	BRANCH SWITCHERS FOR LOAD
NO. 05	CABLE LAYOUT PLAN
NO. 06	EQUIPMENTS LAYOUT (NO. 1 ELECTRIC ROOM)
NO. 07	EQUIPMENTS LAYOUT (BUILDING B ELECTRIC ROOM)



DRAWING NO. 01 SINGLE LINE DIAGRAM (AL WAHDA HOSPITAL)

TOTAL 300KW PV SYSTEM

POWER CONDITIONER CUBICLE
(ELECTRICAL FACILITY CUBICLE OF THE PV SYSTEM)

(NEW) LOW VOLTAGE PANEL(LVP) IN NO.1 ELECTRIC ROOM

SUB ARRAY 1
JUNCTION BOX NO.1

SUB ARRAY 15
JUNCTION BOX NO.15

SUB ARRAY XX
JUNCTION BOX NO.**

GRID-CONNECTION PROTECTION RELAYS
I> ID
V> V<
F> F<
RPR

RPR:REVERSE POWER RELAY

FOR BACK UP

SOLAR IRRADIATION AND THERMOMETER
TD BOX
TD
TD
DISPLAY EQUIPMNET 1
*3
*1
*2
DISPLAY EQUIPMENT 2

SYSTEM CONTROLLER
*4,*5
*6,*7

*4 TD V< Wh TD *5
*6 V< TD Wh I> TD *7

*5,*6(*7,*8:
TO SYSTEM CONTROLLER
FOR REVERSE FLOW PROTECTION CONTROL

SPARE
SPARE
DISPLAY SYSTEM 2 (*2)
DISPLAY SYSTEM 1 (*1)
TD BOX (*3)
POWER OUTLET IN CUBICLE
AIR CONDITIONER
LIGHTING IN CUBICLE

No.1,4,BOX IN ROOM
NO.2,PN-22(BUILDING A1)
NO.3,PN-20(BUILDING A1)
NO.4,PN-24(BUILDING A2)
NO.5,PN-28(BUILDING A2)
NO.6,NP-2(BUILDING B)
NO.7,WC-63(BUILDING F)
NO.8,rpw-xk-2(BUILDING F)
NO.9,SPARE
NO.10,,SPARE
NO.11,,SPARE
NO.12,,SPARE
No.20,PV SYSTEM
No.21,17,BOX IN ROOM
NO.22,PN-19(BUILDING A1)
NO.23,PN-23(BUILDING A1)
NO.24,NEW(PN-19)(BUILDING A1)
NO.25,PN-25(BUILDING A2)
NO.26,PN-27(BUILDING A2)
NO.27,NP-1(BUILDING B)
NO.28,rpw-xk-1(BUILDING F)
NO.29,,SPARE
NO.30,,SPARE
NO.31,,SPARE
NO.32,,SPARE

BRANCH SWITCHERS FOR LOAD (BSL)
IN BUILDING B

DMM

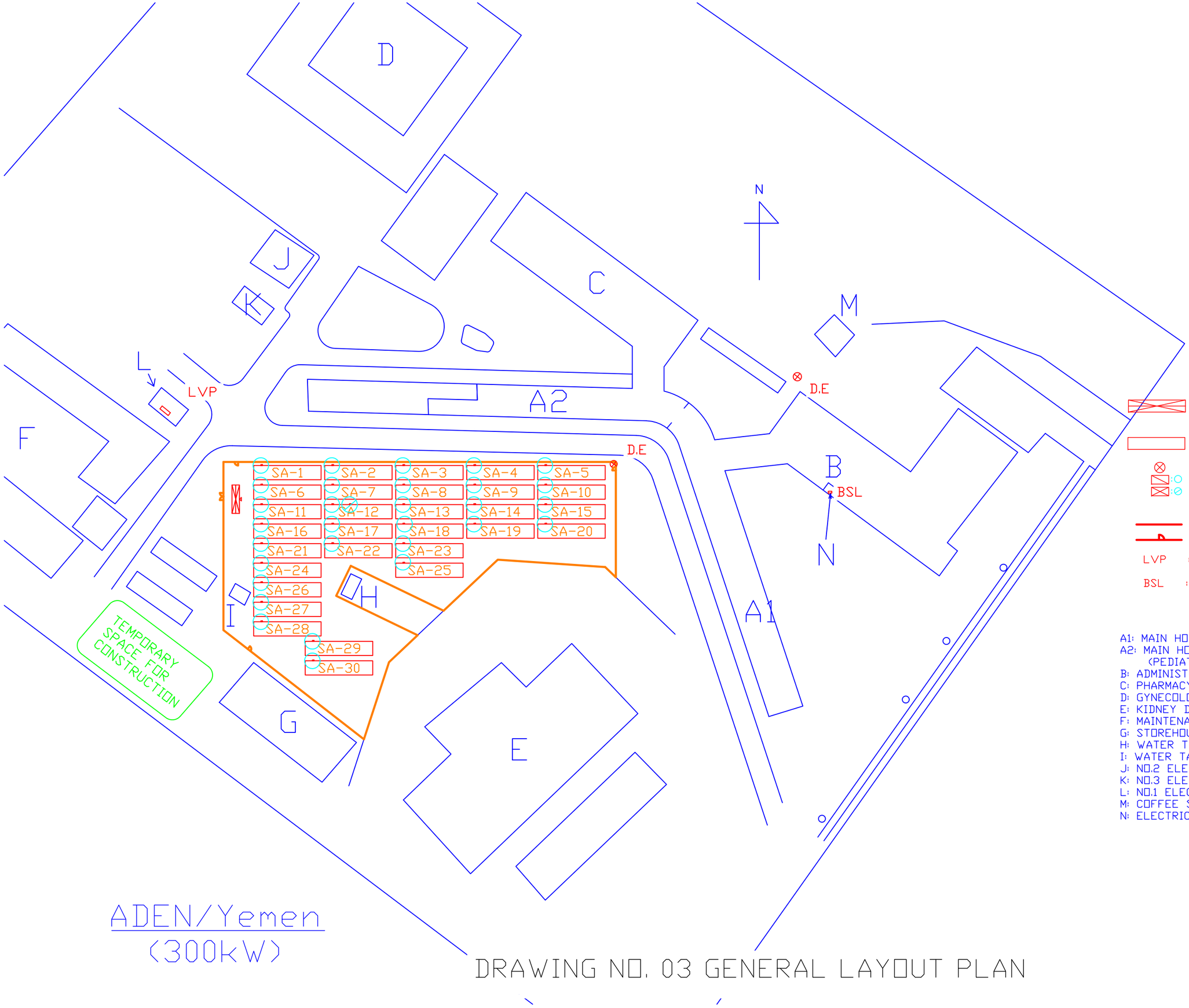
GENERAL LOAD

TOTAL 19 CIRCUITS

: SCOPE OF THE PROJECT

DMM:DIGITAL MULTI-METER
M.INT.LOCK:MECHANICAL INTERLOCK
THE CONTRACTOR SHALL CARRY OUT NECESSARY SURVEY ABOUT THE EXISTING ELECTRICAL FACILITIES.

DRAWING NO. 02 SINGLE LINE DIAGRAM (PV SYSTEM)



LEGEND

- : ELECTRICAL FACILITY CUBICLE OF THE PV SYSTEM [E.C.FOR PV]
- : PV SUB ARRAY (APPROPRIATE 10kW) [SA]
- : DISPLAY EQUIPMENT[D.E]
- : JUNCTION BOX [J.B.]
- : TRANSDUCER BOX FOR METEOROLOGICAL OBSERVATION [T.D. BOX]
- : FENCE
- : GATE

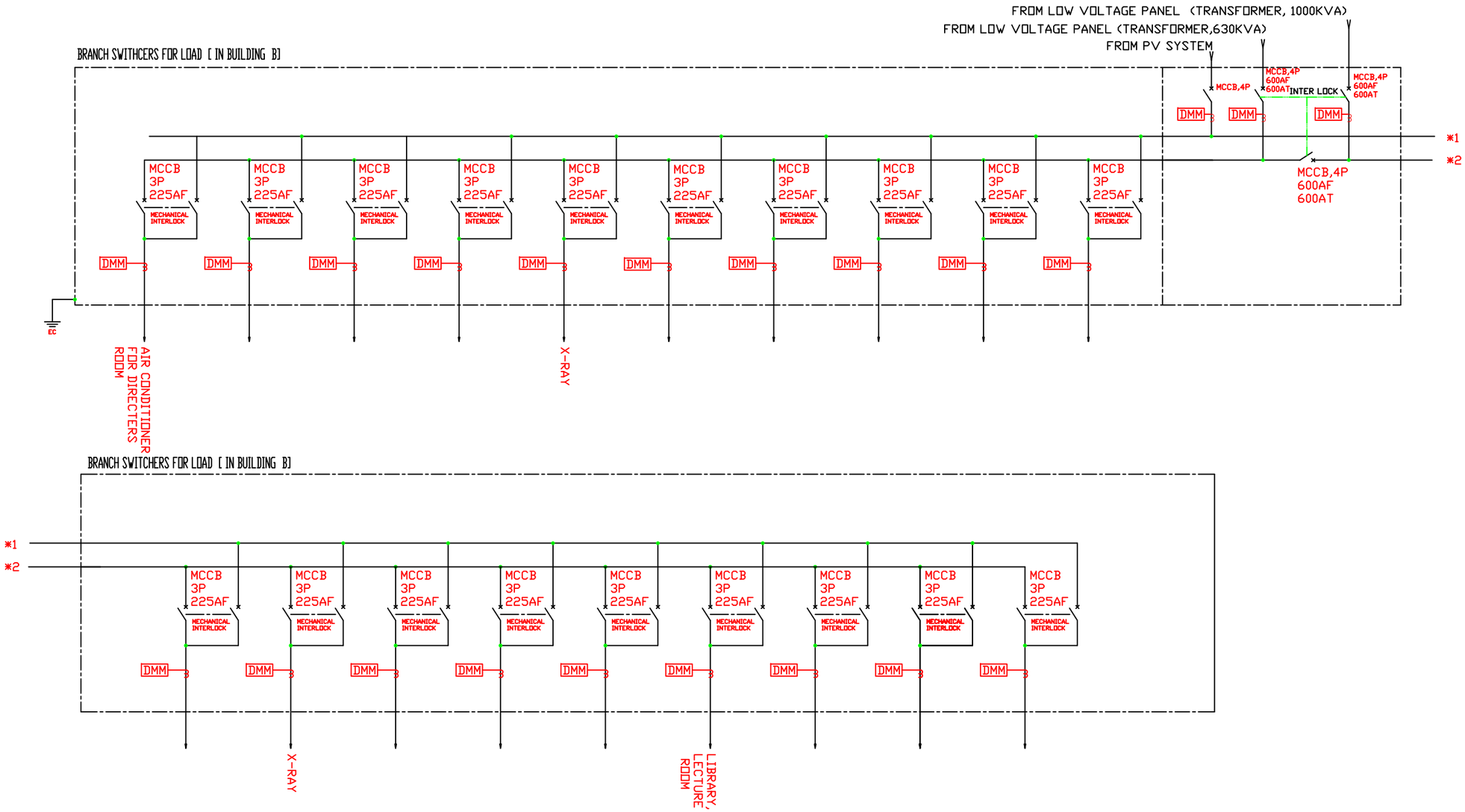
LVP : LOW VOLTAGE PANEL IN EXISTING ELECTRICAL ROOM 1
BSL : BRANCH SWITCHERS FOR LOAD IN BUILDING B

BUILDING NAME LIST

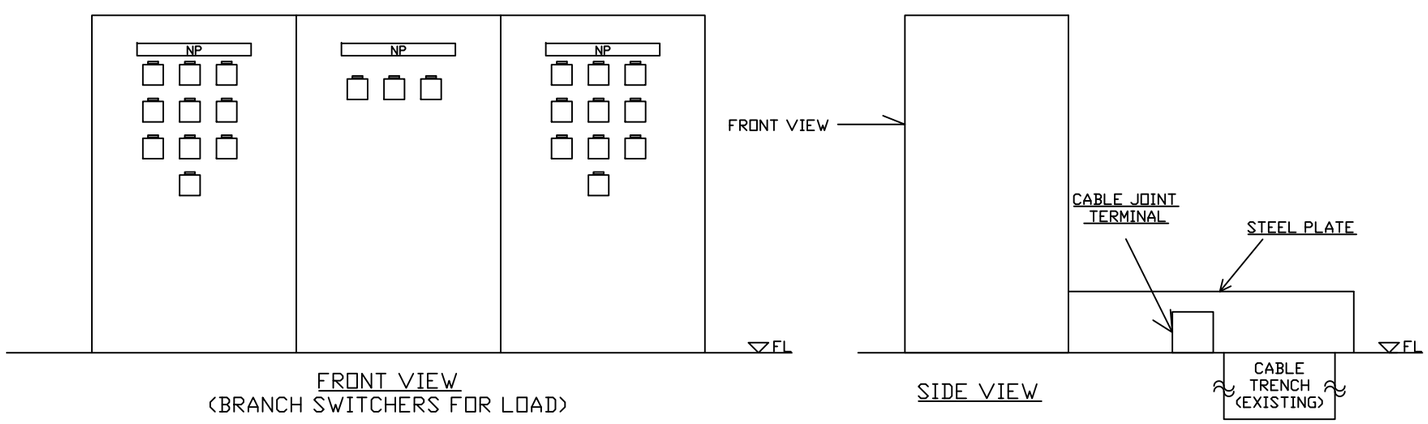
A1: MAIN HOSPITAL WARD,7F (PEDIATRIC)
A2: MAIN HOSPITAL WARD,7F (PEDIATRIC,UNDER RENOVATION)
B: ADMINISTRATION
C: PHARMACY, LABORATORY, GENERAL SERVICES
D: GYNECOLOGY,5F
E: KIDNEY DIALYTIC,2F
F: MAINTENANCE ROOM,1F
G: STOREHOUSE
H: WATER TANK(UNDERGROUND)
I: WATER TANK (H=5000MM)
J: NO.2 ELECTRIC ROOM (500KW DG)
K: NO.3 ELECTRIC ROOM (NOT USE)
L: NO.1 ELECTRIC ROOM
M: COFFEE SHOP
N: ELECTRICAL ROOM FOR BUILDING B

ADEN/Yemen
(300kW)

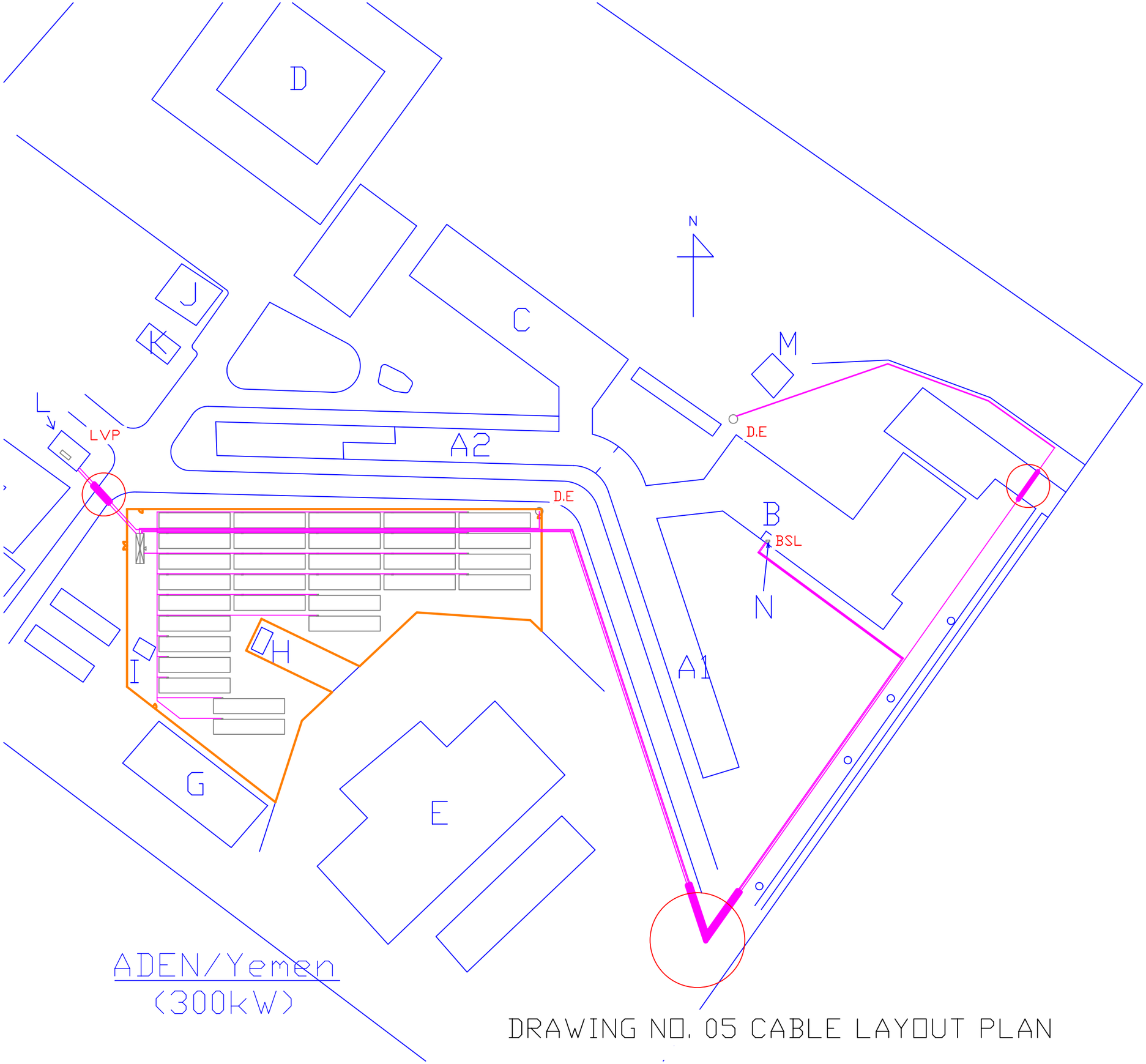
DRAWING NO. 03 GENERAL LAYOUT PLAN



DMM: DIGITAL MULTI-METER



DRAWING NO. 04 BRANCH SWITCHERS FOR LOAD



LEGEND

: ELECTRICAL FACILITY CUBICLE OF THE PV SYSTEM [E.C.FOR PV]

: PV SUB ARRAY (APPROPRIATE 10kW) [SA]

: DISPLAY EQUIPMENT[D.E]

: JUNCTION BOX [J.B.]

: TRANSDUCER BOX FOR METEOROLOGICAL OBSERVATION [T.D. BOX]

: FENCE

: GATE

LVP : LOW VOLTAGE PANEL IN EXISTING ELECTRICAL ROOM 1

BSL : BRANCH SWITCHERS FOR LOAD IN BUILDING B

BUILDING NAME LIST

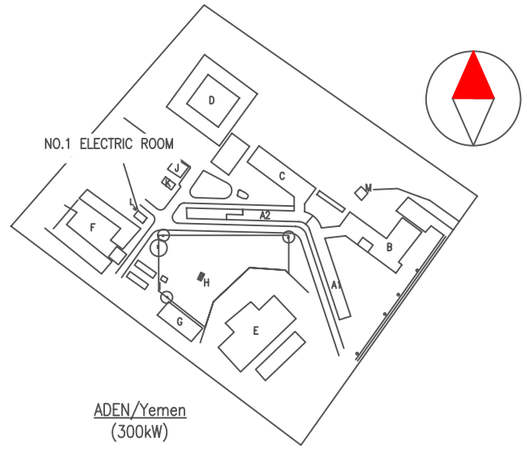
A1: MAIN HOSPITAL WARD,7F (PEDIATRIC)
A2: MAIN HOSPITAL WARD,7F (PEDIATRIC,UNDER RENOVATION)
B: ADMINISTRATION
C: PHARMACY, LABORATORY, GENERAL SERVICES
D: GYNECOLOGY,5F
E: KIDNEY DIALYTIC,2F
F: MAINTENANCE ROOM,1F
G: STOREHOUSE
H: WATER TANK(UNDERGROUND)
I: WATER TANK (H=5000MM)
J: NO.2 ELECTRIC ROOM (500KW DG)
K: NO.3 ELECTRIC ROOM (NOT USE)
L: NO.1 ELECTRIC ROOM
M: COFFEE SHOP
N: ELECTRICAL ROOM FOR BUILDING B

NOTE:
DEPTH FROM THE GROUND SURFACE TO THE CABLE WHICH IS UNDER THE ROAD OF AL WAHDA HOSPITAL SHALL BE
> MORE THAN 1200MM (WITH FEP PIPE):
SHOWN IN BOLD LINE(ASPHALT AREA):O

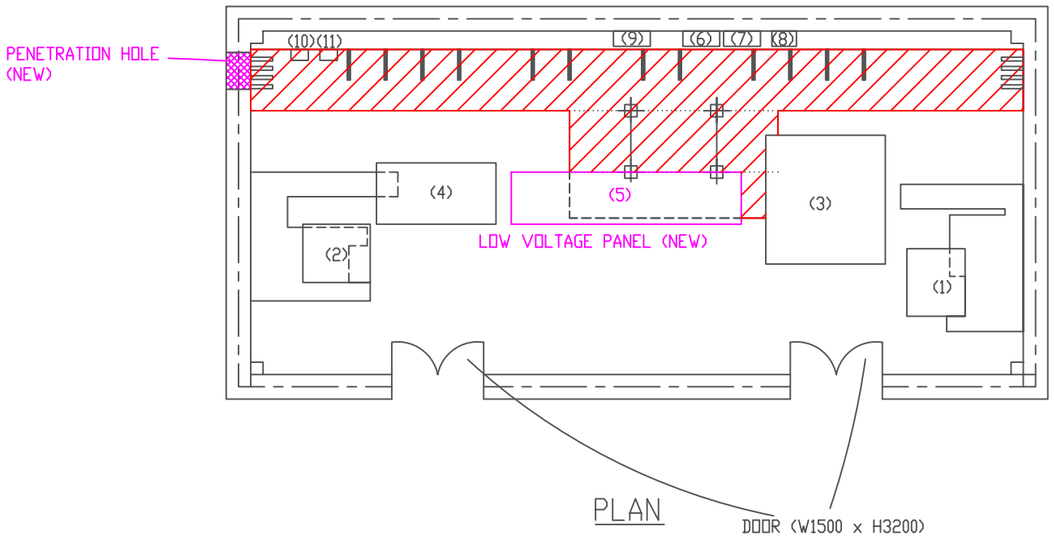
DEPTH FROM THE GROUND SURFACE TO THE CABLE SHALL BE
> MORE THAN 600MM SHOWN IN FINE LINE

ADEN/Yemen
(300kW)

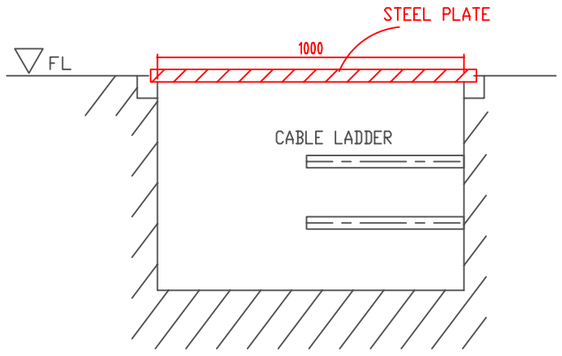
DRAWING NO. 05 CABLE LAYOUT PLAN



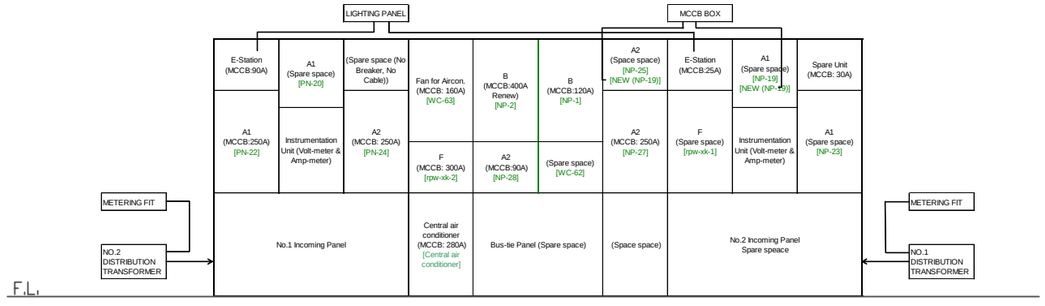
ADEN/Yemen
(300kW)



PLAN



CABLE TRENCH
(S=1/20)



FRONT VIEW
(EXISTING LOW VOLTAGE PANEL(5'))

NOTE

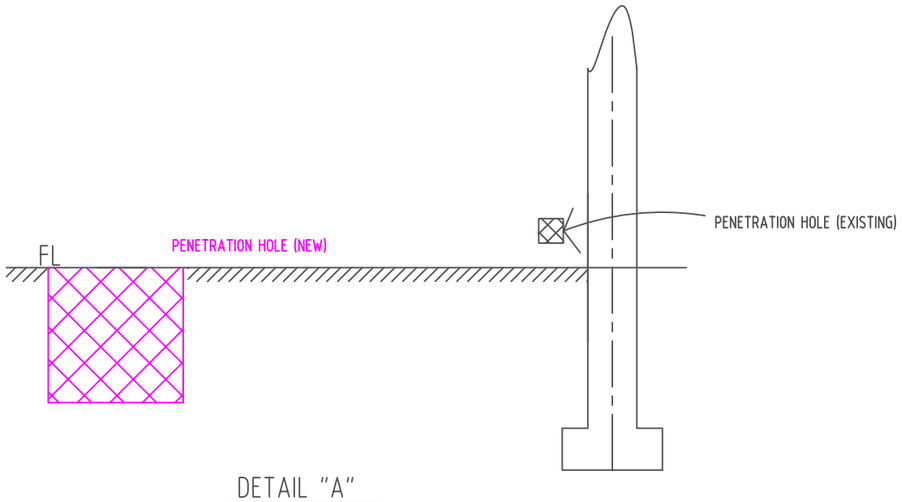
: STEEL PLATE

: PENETRATION HOLE

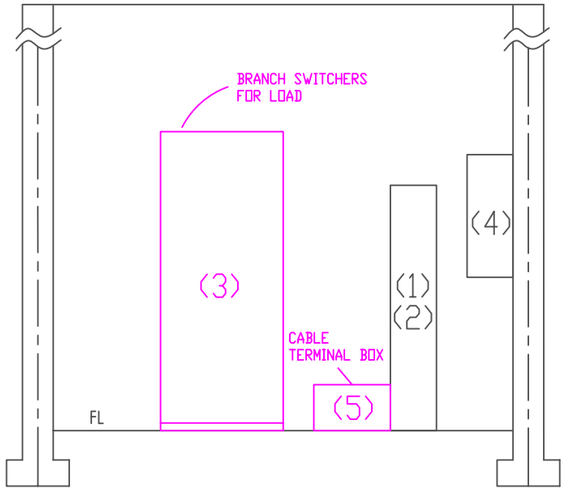
ELECTRICAL EQUIPMENT LIST

No.	EQUIPMENT	DESCRIPTION	QUANTITY	DIMENSION & WEIGHT				REMARKS
				WIDTH [mm]	DEPTH [mm]	HEIGHT [mm]	WEIGHT [kg]	
(1)	No.1 POWER RECEIVING UNIT	11/0.5kV,METAL-ENCLOSED SWITCHGEAR (RING MAIN SWITCH TYPE), R.M SWITCH : 630A-21.9kA / 3s-50Hz, FUSE SWITCH : 200A-3.15kA / 3s (LUCY SWITCHGEAR/FARNICE)	1	1,100	950	1,550	580	EXISTING
(2)	No.2 POWER RECEIVING UNIT	11/0.5kV,METAL-ENCLOSED SWITCHGEAR (RING MAIN SWITCH TYPE), R.M SWITCH : 630A-21.9kA / 3s-50Hz, FUSE SWITCH : 200A-3.15kA / 3s (LUCY SWITCHGEAR/FARNICE)	1	1,100	950	1,550	580	EXISTING
(3)	No.1 DISTRIBUTION TRANSFORMER	ONAN TYPE, 3Ph-1,000kVA-11/0.4kV-50Hz-1.98%z-Dyn11 (MADE IN KOREA)	1	1,950	2,100	1,950	3,100	EXISTING
(4)	No.2 DISTRIBUTION TRANSFORMER	ONAN TYPE, 3Ph-630kVA-11/0.4kV-50Hz-6.15%z-Dyn11 (MADE IN CCCP)	1	1,950	1,000	1,950	3,320	EXISTING
(5)'	LOW VOLTAGE PANEL (EXISTING)	-	1	3,750	850	1,950	-	EXISTING (REPLACE)
(5)	LOW VOLTAGE PANEL	-	1	-	-	-	-	NEW
(6) (7)	METERING FIT	METAL-ENCLOSED, WALL MOUNTING TYPE INSTALLED WAT-HOUR METER	2	500	600	200	20	EXISTING
(8)	MCCB BOX	METAL-ENCLOSED, WALL MOUNTING TYPE INSTALLED MCCB	1	300	200	200	10	EXISTING
(9)	LIGHTING PANEL	METAL-ENCLOSED, WALL MOUNTING TYPE CONSISTING OF MCCB	1	400	400	200	20	EXISTING

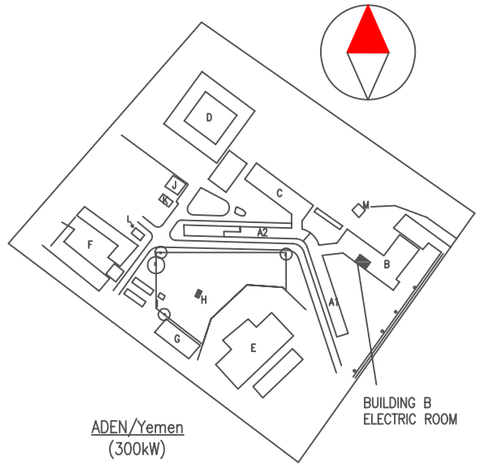
DRAWING NO. 06 EQUIPMENT LAYOUT (NO.1 ELECTRIC ROOM)



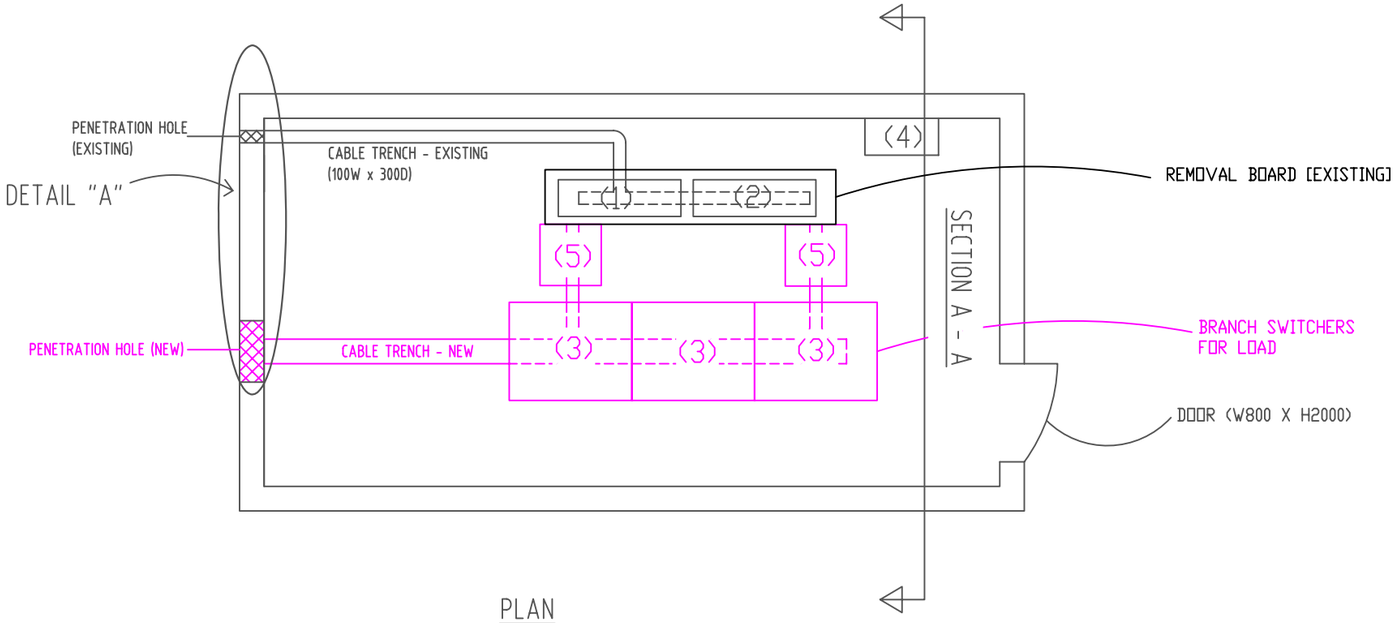
DETAIL "A"
(S=1/25)



SECTION A - A
(S=1/40)



ADEN/Yemen
(300kW)



PLAN

NOTE

: PENETRATION HOLE

ELECTRICAL EQUIPMENT LIST

No.	EQUIPMENT	DESCRIPTION	QUANTITY	DIMENSION & WEIGHT				REMARKS
				WIDTH [mm]	DEPTH [mm]	HEIGHT [mm]	WEIGHT [kg]	
1	LOW VOLTAGE DISTRIBUTION BOARD-1	METAL-ENCLOSED, SELF-STANDING TYPE CONSISTING OF MOLDED CASE CIRCUIT BREAKER FOR FEEDER CIRCUIT.	1	1,000	300	1,600	80	EXISTING
2	LOW VOLTAGE DISTRIBUTION BOARD-2	METAL-ENCLOSED, SELF-STANDING TYPE CONSISTING OF MOLDED CASE CIRCUIT BREAKER FOR FEEDER CIRCUIT.	1	1,000	300	1,600	80	EXISTING
3	BRANCH SWITCHERS FOR LOAD	-	1	-	-	-	-	NEW
4	LIGHTING DISTRIBUTION PANEL	METAL-ENCLOSED, WALL-MOUNTING TYPE CONSISTING OF MOLDED CASE CIRCUIT BREAKER FOR FEEDER CIRCUIT.	1	600	300	800	30	EXISTING
5	CABLE TERMINAL BOX	-	1	-	-	-	-	NEW

DRAWING NO. 07 EQUIPMENT LAYOUT (BUILDING B ELECTRIC ROOM)

APPENDICES

1. MEMBER LIST OF THE STUDY TEAM
2. STUDY SCHEDULE
3. LIST OF PARTIES CONCERNED IN THE RECIPIENT COUNTRY
4. MINUTES OF DISCUSSIONS
5. SOFT COMPONENT (TECHNICAL ASSISTANCE) PLAN
6. REFERENCES

1. MEMBER LIST OF THE STUDY TEAM

Member of the Study Team

1st Survey

No.	Name	Position	Affiliation
1	Mr. Yasumichi ARAKI	Team Leader	Financing Facilitation and Procurement Supervision Department, JICA
2	Mr. Hidemasa FUKUDA	Planning Management	Industrial Development Department, JICA
3	Mr. Kenjiro AZUMA	Procurement Planning & Management	JICS
4	Mr. Masaru NISHIDA	Chief Consultant/ PV Planning	NEWJEC Inc.
5	Mr. Kenichiro YAGI	Grid Connection PV System	NEWJEC Inc.
6	Mr. Nobuo KOMIYA	Electric Equipment	NEWJEC Inc.
7	Mr. Tetsuo TSURUSHIMA	Procurement/Cost Estimate	Japan Techno Co., Ltd.
8	Mr. Shoji TAKAMATSU	Institutional/Socioeconomic Expert	Japan Techno Co., Ltd.
9	Mr. Takao SHIRAISHI	Grid Connection and Operation	NEWJEC Inc.
10	Mr. Sho SHIBATA	Coordinator	NEWJEC Inc.

2st Survey

No.	Name	Position	Affiliation
1	Mr. Masaru NISHIDA	Chief Consultant/ PV Planning	NEWJEC Inc.
2	Mr. Kenichiro YAGI	Grid Connection PV System	NEWJEC Inc.
3	Mr. Nobuo KOMIYA	Electric Equipment	NEWJEC Inc.
4	Mr. Kazuhiro ARITA	Procurement/Cost Estimate	Japan Techno Co., Ltd.
5	Mr. Shoji TAKAMATSU	Institutional/Socioeconomic Expert	Japan Techno Co., Ltd.
6	Mr. Takao SHIRAISHI	Grid Connection and Operation	NEWJEC Inc.
7	Mr. Sho SHIBATA	Coordinator	NEWJEC Inc.

3rd Survey

No.	Name	Position	Affiliation
1	Mr. Yasumichi ARAKI	Team Leader	Financing Facilitation and Procurement Supervision Department, JICA
2	Mr. Masaru NISHIDA	Chief Consultant/ PV Planning	NEWJEC Inc.
3	Mr. Kenichiro YAGI	Grid Connection PV System	NEWJEC Inc.
4	Mr. Takao SHIRAISHI	Grid Connection and Operation	NEWJEC Inc.
5	Mr. Sho SHIBATA	Coordinator	NEWJEC Inc.

2. STUDY SCHEDULE

1st Survey

	Date	Day	JICA			Consultant							
			Team Leader	Planning Management	Procurement Planning & Management	Chief Consultant/ PV Planning	Grid Connection PV System	Electric Equipment	Procurement/ Cost Estimate	Institutional/Socio economic Expert	Grid Connection and Operation	Coordinator	Coordinator
			Mr. Araki JICA	Mr. Fukuda JICA	Mr. Azuma JICS	Mr.Nishida NEWJEC	Mr. Yagi NEWJEC	Mr. Komiya/ NEWJEC	Mr. Tsurushima Japan Techno	Mr. Takamatsu Japan Techno	Mr. Shiraishi NEWJEC	Mr. Shibata NEWJEC	Mr. Kimura NEWJEC
1	8-Jul-09	Wed											Move to Yemen
2	9-Jul-09	Thu											Planning the Project
3	10-Jul-09	Fri	Move to Yemen										Planning the Project
4	11-Jul-09	Sat	Move to Yemen / Courtesy Call (MoPIC, JICA Yemen Office, EoJ)										Courtesy Call
5	12-Jul-09	Sun	Discussion on Minutes (MoPHP, MoEE) / Site Survey (Sabaeen Hospital)										
6	13-Jul-09	Mon	Discussion on Minutes (JICA Yemen Office, MoPIC, MoPHP, MoEE)			Discussion on the Project (PEC)	Site Survey (Al-Wahda Hospital)		Site Survey (Sabaeen Hospital)	Site Survey (Al-Wahda Hospital)	Discussion on the Project (PEC)	Site Survey (Sabaeen Hospital)	Site Survey (Al-Wahda Hospital)
7	14-Jul-09	Tue	Signing of Minutes (JICA Yemen Office, MoPIC, MoPHP, MoEE)				Planning the Project	Site Survey (Sabaeen Hospital)	Planning the Project	Signing of Minutes		Site Survey (Sabaeen Hospital)	
8	15-Jul-09	Wed	Reporting the Result of 1st Survey (JICA Yemen Office, EoJ)				Planning the Project	Site Survey (Sabaeen Hospital)	Reporting the Result of 1st Survey			Site Survey (Sabaeen Hospital)	
9	16-Jul-09	Thu	Move to Japan			Planning the Project							
10	17-Jul-09	Fri	Move to Japan			Planning the Project							
11	18-Jul-09	Sat				Discussion on the Project (GTZ, PEC)	Site Survey (Sabaeen Hospital)		Discussion on the Project (Constructors)		Site Survey (Sabaeen Hospital)		Discussion on the Project (GTZ, PEC)
12	19-Jul-09	Sun				Discussion on the Project (JICA Yemen Office, MoPHP, MoPIC, MoEE)	Planning the Project		Discussion on the Project (Constructors, MoWE)		Planning the Project	Discussion on the Project (JICA Yemen Office, MoPHP, MoPIC, MoEE)	Discussion on the Project (Constructors, MoWE)
13	20-Jul-09	Mon				Site Survey (Al-Wahda Hospital)			Discussion on the Project (Constructors, MoWE, PEC)	Discussion on the Project (MoPHP, Constructors, MoWE, PEC)	Site Survey (Al-Wahda Hospital)		
14	21-Jul-09	Tue				Discussion on the Project (Sabaeen Hospital, MoEE)	Planning the Project		Discussion on the Project (Constructors, MoWE)		Discussion on the Project (Sabaeen Hospital, MoEE)		Planning the Project
15	22-Jul-09	Wed				Reporting the Result of 1st Survey (JICA Yemen Office)							
16	23-Jul-09	Thu				Move to Ethiopia							Move to Japan

2nd Survey

	Date	Day	Consultant					
			Chief Consultant/ PV Planning	Grid Connection PV System	Electric Equipment	Procurement/Cost Estimate	Grid Connection and Operation	Coordinator
			Mr.Nishida NEWJEC	Mr. Yagi NEWJEC	Mr. Komiya NEWJEC	Mr. Arita Japan Techno	Mr. Shiraishi NEWJEC	Mr. Shibata NEWJEC
1	4-Oct-09	Sun	Move to Yemen Discussion on the Project (JICA Yemen Office)			Move to Yemen	Move to Yemen Discussion on the Project (JICA Yemen Office)	
2	5-Oct-09	Mon	Courtesy Call (MoPIC, MoPHP, EoJ) Planning the Project			Move to Yemen Planning the Project	Courtesy Call (MoPIC, MoPHP, EoJ) Planning the Project	Planning the Project
3	6-Oct-09	Tue	Move to Aden Courtesy Call (Al-Wahda Hospital) Move to Sana'a	Move to Aden Courtesy Call (Al-Wahda Hospital)			Move to Aden Courtesy Call (Al-Wahda Hospital) Move to Sana'a	Move to Aden Courtesy Call (Al-Wahda Hospital)
4	7-Oct-09	Wed	Courtesy Call (MoEE, PEC)	Site Survey (Al-Wahda Hospital)		Discussion with Constructors	Courtesy Call (MoEE, PEC)	Site Survey (Al-Wahda Hospital)
5	8-Oct-09	Thu	Planning the Project	Site Survey (Al-Wahda Hospital)		Discussion with Constructors	Planning the Project	Site Survey (Al-Wahda Hospital)
6	9-Oct-09	Fri	Planning the Project	Site Survey (Al-Wahda Hospital)		Planning the Project	Planning the Project	Site Survey (Al-Wahda Hospital)
7	10-Oct-09	Sat	Planning the Project	Site Survey (Al-Wahda Hospital)		Discussion with Constructors	Planning the Project	Site Survey (Al-Wahda Hospital)
8	11-Oct-09	Sun	Planning the Project	Site Survey (Al-Wahda Hospital)		Discussion with Constructors	Planning the Project	Site Survey (Al-Wahda Hospital)
9	12-Oct-09	Mon	Move to Aden Site Survey (Al-Wahda Hospital) Planning the Project	Site Survey (Al-Wahda Hospital) Planning the Project		Discussion with Constructors Planning the Project	Move to Aden Site Survey (Al-Wahda Hospital) Planning the Project	Site Survey (Al-Wahda Hospital) Planning the Project
10	13-Oct-09	Tue	Move to Aden Site Survey (Al-Wahda Hospital)	Site Survey (Al-Wahda Hospital)		Discussion with Constructors	Site Survey (Al-Wahda Hospital)	
11	14-Oct-09	Wed	Planning the Project					
12	15-Oct-09	Thu	Site Survey (Al-Wahda Hospital) Planning the Project					
13	16-Oct-09	Fri	Site Survey (Al-Wahda Hospital) Planning the Project			Site Survey (Al-Wahda Hospital) Planning the Project Move to Sana'a	Site Survey (Al-Wahda Hospital) Planning the Project	
14	17-Oct-09	Sat	Site Survey, Discussion on the Project (Al-Wahda Hospital)			Discussion with Constructors	Site Survey, Discussion on the Project (Al-Wahda Hospital)	
15	18-Oct-09	Sun	Planning the Project	Site Survey, Discussion on the Project (Al-Wahda Hospital)		Discussion with Constructors	Site Survey (Al-Wahda Hospital) Discussion on the Project (PEC, Al-Wahda Hospital)	
16	19-Oct-09	Mon	Discussion on Minutes (Al-Wahda Hospital)			Planning the Project	Discussion on Minutes (Al-Wahda Hospital)	
17	20-Oct-09	Tue	Planning the Project Move to Sana'a			Planning the Project	Planning the Project Move to Sana'a	
18	21-Oct-09	Wed	Reporting the Results of 2nd Survey (MoPIC, MoPHP, EoJ, JICA Yemen Office)	Planning the Project Reporting the Results of 2nd Survey (JICA Yemen Office)			Reporting the Results of 2nd Survey (MoPIC, MoPHP, EoJ, JICA Yemen Office)	Reporting the Results of 2nd Survey (JICA Yemen Office)
19	22-Oct-09	Thu	Move to Djibouti					

3rd Survey

	Date	Day	JICA	Consultant			
			Team Leader	Chief Consultant/ PV Planning	Grid Connection PV System	Grid Connection and Operation	Coordinator
			Mr.Araki JICA	Mr.Nishida NEWJEC	Mr. Yagi NEWJEC	Mr. Shiraishi NEWJEC	Mr. Shibata NEWJEC
1	9-Apr-10	Fri		Move to Yemen			
2	10-Apr-10	Sat	Move to Yemen	Move to Yemen Courtesy Call (JICA Yemen Office, EoJ)			
3	11-Apr-10	Sun	Move to Yemen Discussion on the Project (MoPIC, MoPHP, MoEE)	Discussion on the Project (MoPIC, MoPHP, MoEE)			
4	12-Apr-10	Mon	Discussion on the Project (Al Wahda Hospital)				
5	13-Apr-10	Tue	Discussion on Minutes (MoPIC)				
6	14-Apr-10	Wed	Signing of Minutes Reporting the Result of 1st Survey (JICA Yemen Office, EoJ)				
7	15-Apr-10	Thu	Move to Japan	Planning the Project			
8	16-Apr-10	Fri		Move to Djibouti			

3. LIST OF PARTIES CONCERNED IN THE RECIPIENT COUNTRY

APPENDIX 3 List of Parties Concerned in the Recipient Country

Name and Organization	Position
Ministry of Planning and International Cooperation	
Mr. Hisham Sharaf Abdalla	Deputy Minister for International Cooperation
Mr. Omar Abdul Aziz Abdulghani	General Director for Bilateral Relations with the States of Asia and Australia
Mr. Mohammed Shamsaddin	Local Coordinator for JICA
Ministry of Public Health and Population	
Dr. Ghazi Ahmed Ismail	Deputy Minister for Curative Medicine Sector
Dr. Nasib Mansour Maljam	General Director for Service
Al Wahda hospital	
Dr. Mohammed Salem Baazab	Director General
Mr. Salah Salem	Deputy Director
Ms. Marian Tahr	Deputy Director
Mr. Mohamed Hakimi	Deputy Director
Mr. Hassan Mohamed	Head of Maintenance
Mr. Tareq Hamood	Head of Electric Equipment
Ministry of Electricity and Energy	
Mr. Ahmed Hasan Alaini	Deputy Minister
Mr. Mohammed Hamid Al Sha'abi	General Director for Renewable Energy Department
Rural Electricification and Renewable Energy Development Project	
Mr. Adnan Al-Akori	Director for Renewable Energy Department
PEC (Public Electricity Corporation)	
Mr. Ahmed H. Addawlah	Director for Technical & Environmental Inspection
Mr. Ahmed Ali Al-Safi	General Director for Studies and Technical Planning
Mr. Ali Ali Mohsen	Area Manager Aden
Mr. Mehdi Habtoor	Engineer
Mr. Mohel Bamatref	Engineer
GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit)	
Mr. Sabine Schwarz	Adviser for Renewable Energy
Ministry of Water and Environment	

Mr. Mahmoud M. Shidiwah	Chairman
Mr. Helal Ali Al-Riashi	Vice Director for Monitoring and Research
Mr. Salem Baquhaizel	Director for EIA Department
Mr. Ameen Mohammed Al Hmadi	Vice Director for Planning Department
Mr. Anwar NOAMAN	Director for Climate Change Unit
Mr. Ali Al-Dobhani	Director for Industrial Waste

Embassy of Japan in Yemen

Mr. Masakazu Toshikage	Ambassador
Mr. Mitsunori Nanba	Ambassador
Mr. Matahiro Yamaguchi	Counselor

JICA Yemen Office

Mr. Takeshi Komori	Resident Representative
Ms. Megumi Shuto	Programme Formulation Advisor

4. MINUTES OF DISCUSSIONS

Minutes of Discussions
on the Preparatory Survey
on the Project for Clean Energy Promotion Using Solar Photovoltaic System
in the Republic of the Yemen

The Government of Japan (hereinafter referred to as "GoJ") has established Cool Earth Partnership as a new financial mechanism. Through this, GoJ is cooperating actively with developing countries' efforts to reduce greenhouse gasses emissions, such as efforts to promote clean energy. A new scheme of grant aid, "Program Grant Aid for Environment and Climate Change ", was also created by GoJ as a component of this financial mechanism. According to the initiative of Cool Earth Partnership, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), in consultation with GoJ, decided to conduct a Preparatory Survey (hereinafter referred to as "the Survey") on the Project for Clean Energy Promotion Using Photovoltaic System in Yemen (hereinafter referred to as "the Project").

JICA sent to Yemen the Preparatory Survey Team (hereinafter referred to as "the Team"), headed by Mr. Yasumichi ARAKI, Advisor, Grant Aid Project Management Division 1, Financing Facilitation and Procurement Supervision Department, JICA, and is scheduled to stay in the country from July 11 to 23.

The Team held discussions with the concerned officials of the Government of Yemen and conducted a field survey.

In the course of discussions and field survey, both sides confirmed the main items described in the attached sheets.

Sana'a, July 14, 2009

Yasumichi ARAKI
Leader
Preparatory Survey Team
Japan International Cooperation Agency
JAPAN

Eng.Hisham Sharaf Abdullah
Deputy Minister for International Cooperation
Ministry of Planning and International Cooperation
YEMEN

for
Eng. Ahmed Hasan Al-Aini
Deputy Minister
Ministry of Electricity and Energy
YEMEN

Dr. Ghazi Ahmed Ismail
Deputy Minister for Curative Medicine Sector
Ministry of Public Health and Population
YEMEN

ATTACHMENT

1. Current Situation

Yemen has a chronic shortage of electricity due to lack of electricity generation capacity. The current power supply capacity in Yemen is only 900 megawatts (MW) while the demand consumption is estimated around 1,600 MW. People have been suffering from scheduled blackouts in the city area. The Yemen side has tried to increase the country's power generating capacity, expand the national power grid and introduce renewable energy systems. In the rural area, the Ministry of Electricity and Energy established the National Rural Electrification Program, which aims to introduce solar home systems for individual households out of power grid.

In this situation, both sides confirm that the Project, which introduces photovoltaic (PV) power generation systems connected with the national power grid, is one of the pilot systems to enhance the possibility of applying renewable energy.

2. Objective of the Project

The objective of the Project is to promote clean energy utilization and achieve emissions reduction by installing the PV system to be connected to the national grid.

3. Responsible Organization and Implementing Agency

3-1 The responsible organization is the Ministry of Planning and International Cooperation. The organization chart of the responsible ministry is shown in **Annex-1**.

3-2 The implementing agency is the Ministry of Public Health and Population. The organization chart of the implementing organization is shown in **Annex-2**.

3-3 The Ministry of Electricity and Energy including Public Electricity Corporation (PEC) shall be responsible for technical assistance to the Project.

4. Items Requested by the Government of Yemen

4-1 After discussions with the Team, the installation of the electric power generating system using photovoltaics including following main equipment was requested by the Yemen side.

(1) Solar module (panel)
(2) Junction Box
(3) Power Conditioner
(4) Data collecting and display device

4-2 The Yemen side requested three public hospitals, namely Sabaeen Hospital in Sana'a, Al Wahida Hospital in Aden and Al Thawra Hospital in Taiz, as candidate sites/facilities for installation of the PV system. The Team recommended the Yemen side to set up the priority order of the requested sites. However the Yemen side explained that Sabaeen Hospital in Sana'a and Al Wahida Hospital in Aden, as shown in **Annex-3**, were put on the high and same level priority due to the political and geological background, the priority was confirmed as the following table by both sides. The Yemen side understood that the Japan's Program Grant Aid for Environment and Climate Change might not be able to cover all the requested sites and

also understood the need to select the site(s) from the viewpoint of necessity, technical and financial viability, sustainability and cost-effectiveness.

City	Name of Hospital	PV Capacity	Priority
Sana'a	Sabaeen Hospital	100kW	2
Aden	Al Wahida Hospital	300kW	1

4-3 The Yemen side explained that there is no duplication between requested contents of the Project and any other plans implemented by the other donors or the Yemen side.

4-4 The Yemen side has understood that the final component and the design of the Project shall be determined at the timing of the Preparatory Survey 2 for design.

4-5 JICA will asses the appropriateness of the request and will report the findings to the GoJ.

5. Japan's Program Grant Aid for Environment and Climate Change

The Yemen side understood the Japan's Program Grant Aid for Environment and Climate Change scheme explained by the Team, as described in **Annex-4, 5, 6, 7 and 8**.

6. Schedule of the Study

6-1 The Team will proceed to further survey in Yemen until July 23 as the Preparatory Survey 1.

6-2 If the Cabinet of GoJ approves the Project based on the results of the Preparatory Survey 1, JICA will conduct the Preparatory Survey 2 for design.

7. Other Relevant Issues

7-1 Land for Installation of the PV system

Both sides confirmed that sufficient land space for installation of the PV system in Sabaeen Hospital in Sana'a and Al Wahida Hospital in Aden had been secured and available. The Team found there were a small unused building and shrubs on the candidate land for installation of solar panels in the Sabaeen Hospital. The Ministry of Public Health and Population accepted to remove those obstacles, if necessary, once the Sabeen Hospital was selected as a target site.

7-2 Procurement of Equipment

The Team explained that, in accordance with the policy of GoJ, products of Japan shall be procured for major equipment in the Project. The Yemen side agreed.

7-3 Coordination with Related Organizations

The Ministry of Public Health and Population shall be the focal point for the Project and responsible for the coordination with related organizations. The Yemen side agreed to establish a consultative committee in order to coordinate with the Japanese side which consists of the Embassy of Japan, the JICA office and the procurement agency. Terms of References of the Consultative Committee is referred to **Annex-9**.

7-4 Application of the Related Laws and Regulations

The Ministry of Electricity and Energy confirms that there is no obstacles to grant a license to the Ministry of Public Health and Population to own electric power station(s) connected to the national power grid without reverse current and use them to meet his/her own power demand at the present. It also explained that a new Electricity Law became effective on June, 2009. The Ministry of Public Health and Population shall be responsible for the application of that law and regulation through consultation with the Ministry of Electricity and Energy and other related organizations.

7-5 Operation and Maintenance

The Ministry of Public Health and Population agreed to secure and allocate the necessary budget and personnel for the operation and maintenance of the facilities procured and installed under the Project.

7-6 Customs and Tax exemption

The Yemen side shall be responsible for the exemption and/or reimbursement (payment/assumption) of all customs, tax, levies and duties incurred in Yemen for implementation of the Project.

7-7 The Yemen side shall ensure the security of all concerned Japanese nationals working for the Project, if deemed necessary.

7-8 The Yemen side shall provide necessary numbers of counterpart personnel to the Team during the period of their studies in Yemen.

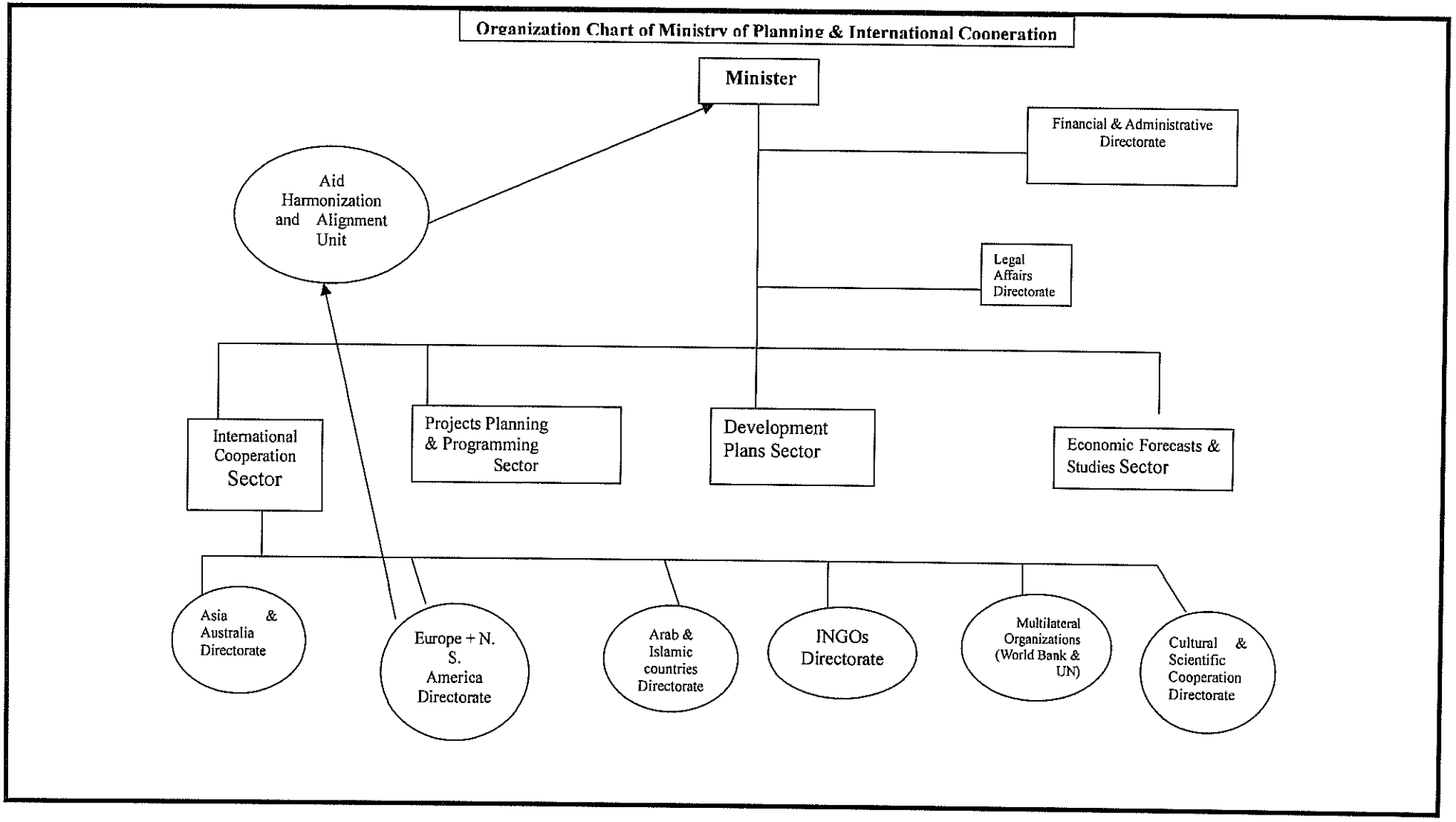
7-9 The Yemen side shall submit all the answers to the Questionnaire, which the Team handed to the Yemen side, by July 22, 2009.

<List of Annex>

Annex-1 Organization Chart of Ministry of Planning and International Cooperation
Annex-2 Organization Chart of Ministry of Public Health and Population
Annex-3 Candidate site of the Project
Annex-4 Program Grant Aid for Environment and Climate Change
Annex-5 General Flow of Program Grant Aid for Environment and Climate Change
Annex-6 Flow of Funds for Project Implementation
Annex-7 Project Implementation System
Annex-8 Major Undertakings to be taken by Each Government
Annex-9 Terms of References of the Consultative Committee

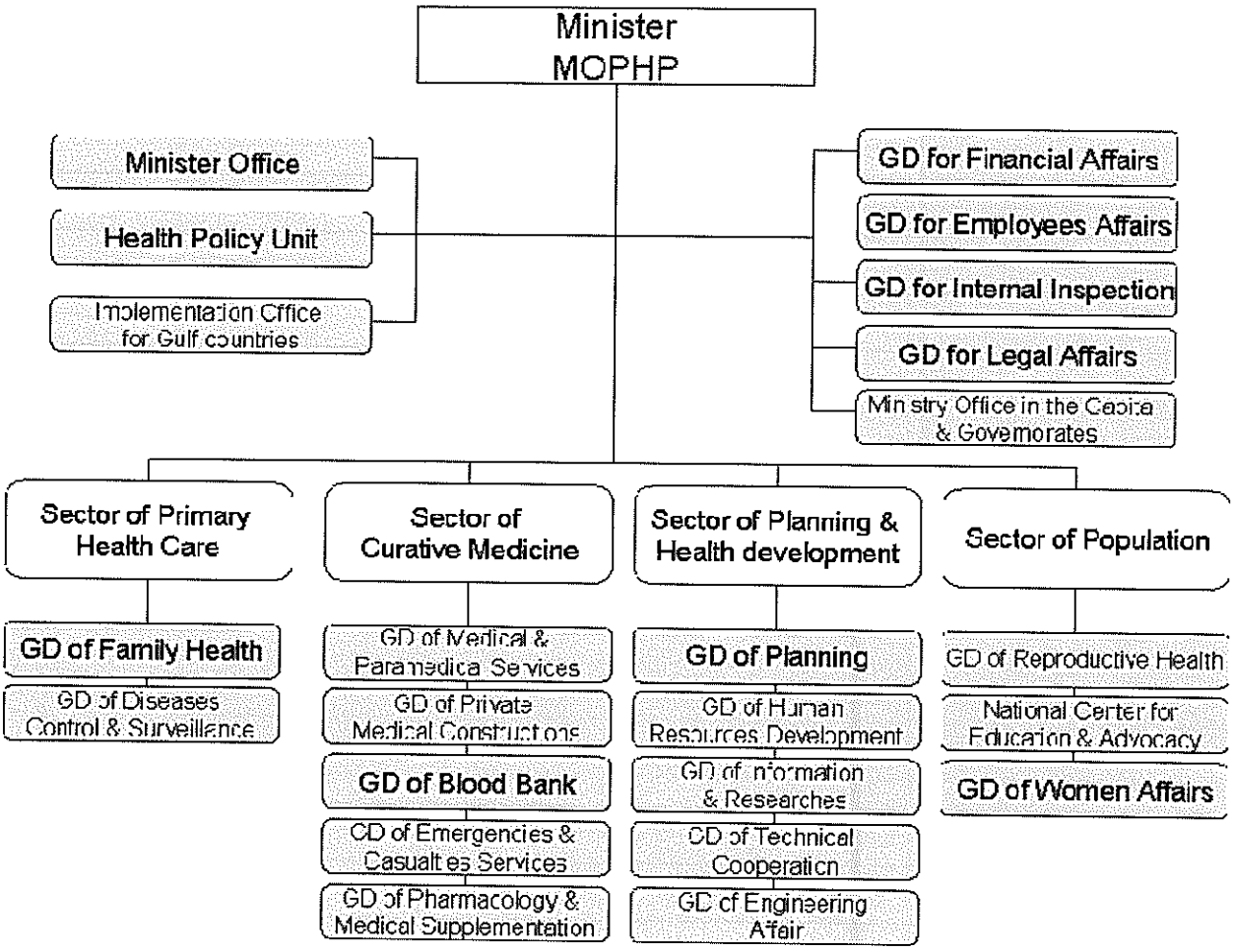
Annex-1

Organization Chart of Ministry of Planning and International Cooperation



Annex-2

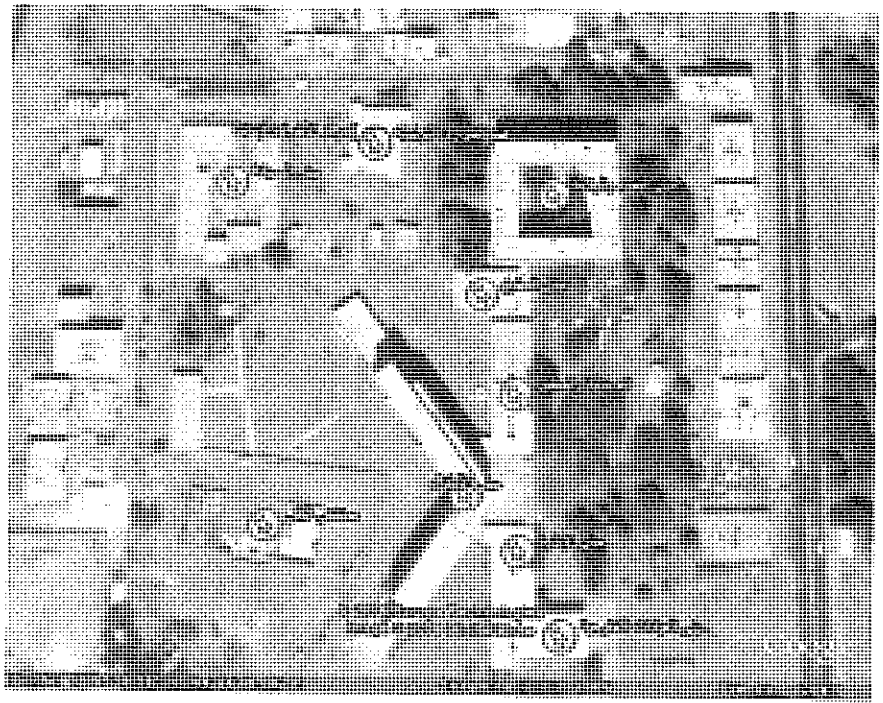
Organization Chart of Ministry of Public Health and Population



Candidate site of the Project

1. Sana'a: Al Sabeen Hospital for Motherhood & Childhood
Location: Al Sabeen Square, Capital Secretariat of Sana'a

2. Aden: Al Wahidah Hospital Aden
Location: Al Sheikh Otham District, Aden City



Annex-4

Program Grant Aid for Environment and Climate Change of the Government of Japan
(Provisional)

The Grant Aid provides a recipient country (hereafter referred to as "the Recipient") with non-reimbursable funds to procure the facilities, equipment, and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

Based on "Cool Earth Partnership" initiative of the Government of Japan, the Program Grant Aid for Environment and Climate Change (hereafter referred to as "GAEC") aims to mitigate effects of global warming by reducing GHGs emission (mitigation; e.g. improvement of energy efficiency) and to take adaptive measures (adaptation; e.g. measures against disasters related to climate change, including disaster prevention such as enhancing disaster risk management).GAEC may contain multiple components that can be combined to effectively meet these needs.

1. Procedures for GAEC

GAEC is executed through the following procedures.

Preparatory Survey 1	Preparatory Survey for projectz identification conducted by Japan International Cooperation Agency (JICA)
Application	Request made by a recipient country
Appraisal & Approval	Appraisal by the Government of Japan and Approval by the Cabinet
Determination of Implementation	The Notes exchanged between the Government of Japan and the Recipient Country
Grant Agreement (hereinafter reffered to as the "G/A")	Agreement concluded between JICA and the Recipient
Preparatory Survey 2	Preparatory Survey for design conducted by JICA
Implementation	Procurement through the Procurement Agency by the Recipient

Firstly, if the candidate project for a GAEC is identified by the Recipient and the Government of Japan, the Government of Japan (the Ministry of Foreign Affairs) examines it whether it is eligible for GAEC. When the request is deemed appropriate, JICA, in consultation with the Government of Japan, conducts the Preparatory Survey (hereafter referred to as "the Survey") on the candidate project as Phase 1 of the Survey with Japanese consulting firms.

Secondly, the Recipient submits the official request to the Government of Japan, while the appropriateness, necessity and the basic components of the project are examined in the course of Phase 1 of the Survey,

Thirdly, the Government of Japan appraises the project to see whether it is suitable for Japan's GAEC, based on the Survey report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes (E/N) signed by the Governments of Japan and the Recipient.

Fifthly, JICA engages Grant Agreement (G/A) with the Recipient and executes the Grant by making payments of the amount agreed in the E/N and strictly monitors that the funds of the Grant are properly and effectively used.

Procurement Management Agent is designated to conduct the procurement services of products and services (including fund management, preparing tenders, contracts) for GAEC on behalf of the Recipient. The Agent is an impartial and specialized organization that will render services according to the Agent Agreement with the Recipient. The Agent is recommended to the Recipient by the Government of Japan and agreed between the two Governments in the Agreed Minutes ("A/M").

2 Preparatory Survey

1) Contents of the Survey

The purpose of the Preparatory Survey (hereafter referred to as "the Survey"), conducted by JICA on a requested project (hereafter referred to as "the Project"), is to provide the basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Survey are as follows:

- Confirmation of background, objectives, and benefits of the Project and institutional capacity of agencies and communities concerned of the Recipient necessary for project implementation.
- Evaluation of relevance of the Project to be implemented under the Grant Aid Scheme for Environment and Climate Change from a technical, social, and economic point of view.
- Confirmation of items agreed upon by both parties concerning the basic concept of the Project.
- Preparation of the design of the Project and reference document for tender.
- Estimation of cost for the Project.

The contents of the original request will be modified, as found necessary, in the design of the Project according to the guidelines of Japan's Grant Aid scheme.

The Government of Japan requests the Government of the Recipient to take whatever measures necessary to ensure its responsibility in implementing the Project. Such measures must be guaranteed even if they may fall outside the jurisdiction of the implementing organization of the Recipient. This has been confirmed by all relevant organizations of the Recipient through the Minutes of Discussions.

2) Selection of consulting firms

For the smooth implementation of the Survey, JICA will conduct the Survey with registered consulting firms. JICA selects the firms based on proposals submitted by firms with interest in implementing the Survey. The firms selected will carry out the Preparatory Survey and prepare a report, based on the terms of reference set by JICA.

3. Implementation of GAEC after the E/N

1) Exchange of Notes (E/N)

The content of GAEC will be determined in accordance with the Notes exchanged by the two

Governments concerned, in which items including, objectives of the project, period of execution, conditions and amount of the Grant Aid are confirmed.

2) Details of Procedures

Details of procedures on procurement and services under GAEC will be agreed between the authorities of the two governments concerned at the time of the signing of the G/A.

Essential points to be agreed are outlined as follows:

a) JICA will supervise the implementation of the Project.
b) Products and services will be procured and provided in accordance with JICA's "Procurement Guidelines for the Program Grant Aid for Environment and Climate Change."
c) The Recipient will conclude a contract with the Agent.
d) The Agent is the representative acting in the name of the Recipient concerning all transfers of funds to the Agent.

3) Focal points of "Procurement Guidelines for the Program Grant Aid for Environment and Climate Change"

a) The Agent

The Agent is the organization, which provides procurement of products and services on behalf of the Recipient according to the Agent Agreement with the Recipient. The Agent is recommended to the Recipient by the Government of Japan and agreed between the two Governments in the A/M.

b) Agent Agreement

The Recipient will conclude the Agent Agreement, in principle, within two months after the signing of the G/A, in accordance with the A/M. The scope of the Agent's services will be clearly specified in the Agent Agreement.

c) Approval of the Agent Agreement

The Agent Agreement is prepared as two identical documents and the copy of the Agent Agreement will be submitted to JICA by the Recipient through the Agent. JICA confirms whether the Agent Agreement is concluded in conformity with the E/N, A/M, and G/A and the Procurement Guidelines for the Program Grant Aid for Environment and Climate Change then approves the Agent Agreement.

The Agent Agreement concluded between the Recipient and the Agent will become effective after the approval by JICA in a written form.

d) Payment Methods

The Agent Agreement will stipulate that "Regarding all transfers of the fund to the Agent, the Recipient will designate the Agent to act on behalf of the Recipient and issue a Blanket Disbursement Authorization ("the BDA")to conduct the transfer of the fund (hereinafter referred to as "the Advances") to the Procurement Account from the Recipient Account.

The Agent Agreement will clearly state that the payment to the Agent will be made in Japanese yen from the Advances and that the final payment to the Agent will be made when the total remaining amount become less than three percent (3%) of the Grant and its accrued interests excluding the Agent's fees.

e) Products and Services Eligible for Procurement

Products and services to be procured will be selected from those defined in the G/A.

f) Selection of firms

In principle, firms of any nationality could be contracted as long as the firms satisfy the conditions specified in the tender documents.

The same applies for any individual consultants who will be involved in the Project and provide services necessary for the training and guidance related to the Project.

The consultants that will be employed to do detail design and supervise the work for the Project, however will be in principle, Japanese nationals recommended by JICA for the purpose of maintaining technical consistency with the Study.

g) Method of Procurement
When conducting the procurement, sufficient attention will be paid to transparency in selecting the firms and for this purpose, competitive tendering will be employed in principle.

h) Tender Documents
The tender documents should contain all information necessary to enable tenderers to prepare valid offers for the products and services to be procured by GAEC.

The rights and obligations of the Recipient, the Agent and the firms supplying products and services should be stipulated in the tender documents to be prepared by the Agent. Aside from this, the tender documents will be prepared in consultation with the Recipient.

i) Pre-qualification Examination of Tenderers
The Agent may conduct a pre-qualification examination of tenderers in advance of the tender so that the invitation to the tender can be extended only to eligible firms. The pre-qualification examination should be performed only with respect to whether the prospective tenderers have the capability of concluding the contracts.

For this, the following points should be taken into consideration:
(1) Experience and past performance in contracts of similar kind
(2) Financial credibility (including assets such as real estate)
(3) Existence of offices and other items to be specified in the tender documents.
(4) Their potentialities to use necessary personnel and facilities.

j) Tender Evaluation
The tender evaluation should be implemented on the basis of the conditions specified in the tender documents.

Those tenderers which substantially conform to the technical specifications and other stipulations of the tender documents, will be judged in principle on the basis of the submitted price, and the tenderer who offers the lowest price will be designated as the successful tenderer.

The Agent will submit a detailed evaluation report of tenders to JICA for its information, while the notification of the results to the tenderers will not be premised on the confirmation by JICA.

k) Additional procurement
If there is any remaining balance after the competitive and/or selective tendering and/or direct negotiation for a contract, and if the Recipient would like to procure additional items, the Agent is allowed to conduct this additional procurement, following the points mentioned below:
(1) Procurement of same products and services

When the products and services to be additionally procured are identical with the initial tender and a competitive tendering is judged not efficient, additional procurement can be conducted by a negotiated contract with the successful tenderer of the initial tender.

(2) Other procurements

When products and services other than those mentioned above in (1) are to be procured, the procurement should be conducted through competitive tendering. In this case, the products and services for additional procurement will be selected from among those in accordance with the G/A.

l) Conclusion of the Contracts

In order to procure products and services in accordance with the guideline, the Agent will conclude contracts with firms selected by tendering or other methods.

m) Terms of Payment

The contract will clearly state the terms of payment. The Agent will make payment from the "advances," against the submission of the necessary documents from the firm on the basis of the conditions specified in the contract. When the services are the object of procurement, the Agent may pay certain portion of the contract amount in advance to the firms on the conditions that such firms submit the advance payment guarantee worth the amount of the advance payment to the Agent.

4) Undertakings required by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the Recipient is required to undertake necessary measures as the following:

a) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the Project.
b) To provide facilities for distributing electricity, water supply and drainage and other incidental facilities in and around the sites.
c) To ensure all the expense and prompt execution for unloading, customs clearing at the port of disembarkation and domestic transportation of products purchased under the Grant Aid,
d) To ensure that customs duty, internal taxes and other fiscal levies that may be imposed in the Recipient with respect to the purchase of the Components and the Agent's services will be exempted by the Government of the Recipient.
e) To accord all the concerned parties, whose services may be required in connection with supply of the products and services under the contracts, such facilities as may be necessary for their entry into the Recipient and stay therein for the performance of their work.

5) "Proper use of funds"

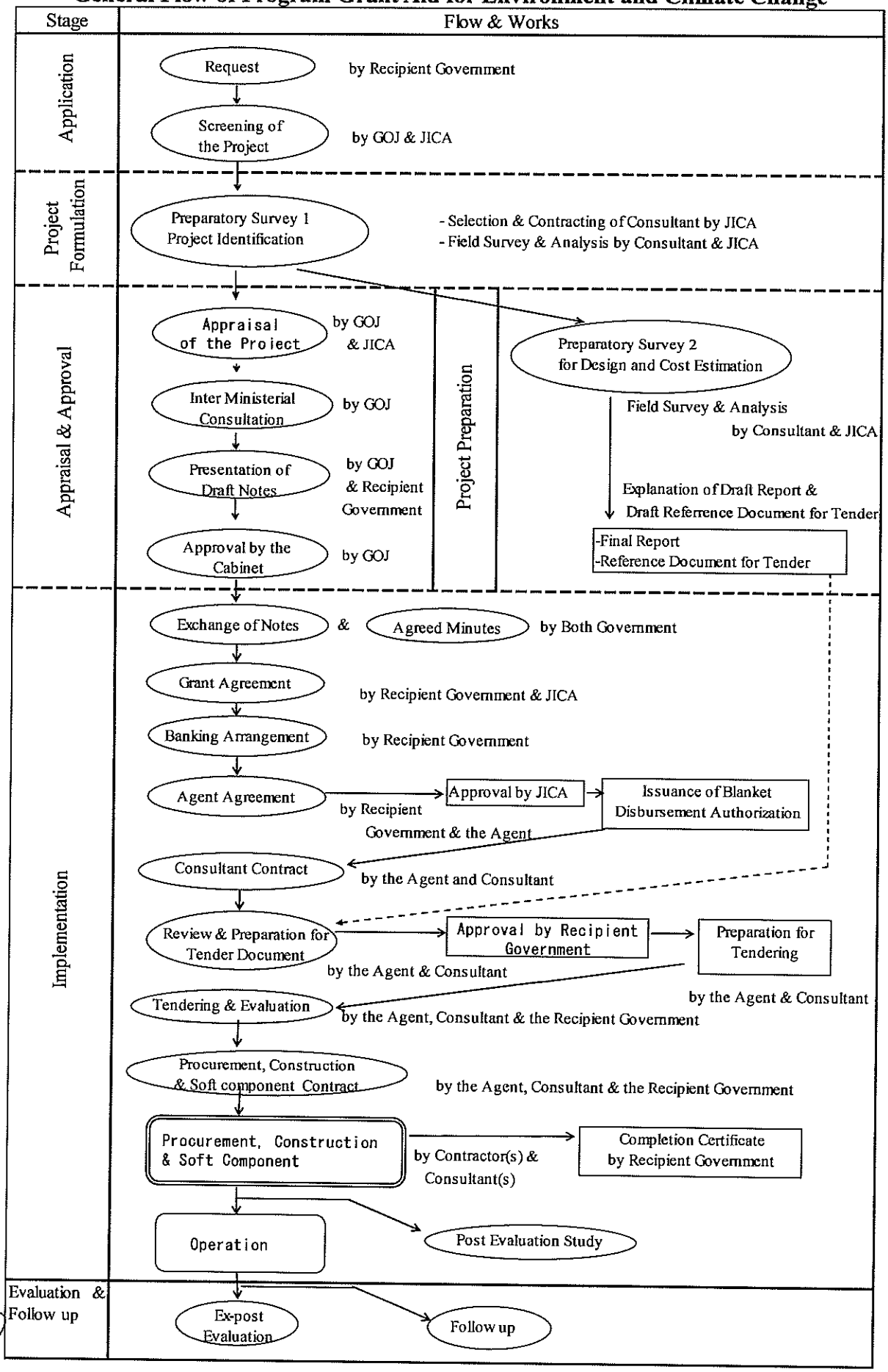
The Recipient is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign personnel necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

6) "Export and Re-export" of products

The products purchased under the Grant and its accrued interest will not be exported or re-exported from the Recipient.

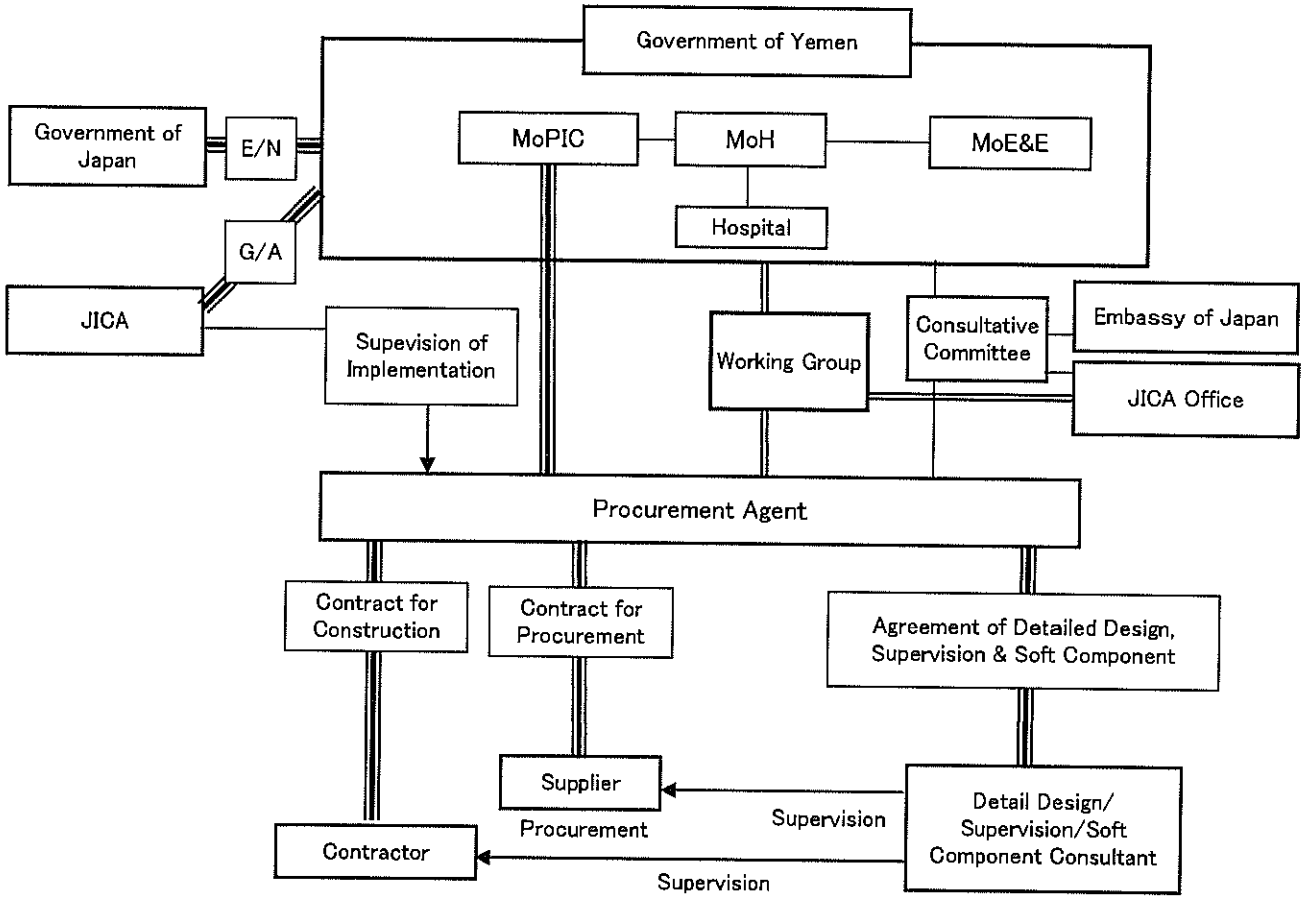
Annex-5

General Flow of Program Grant Aid for Environment and Climate Change



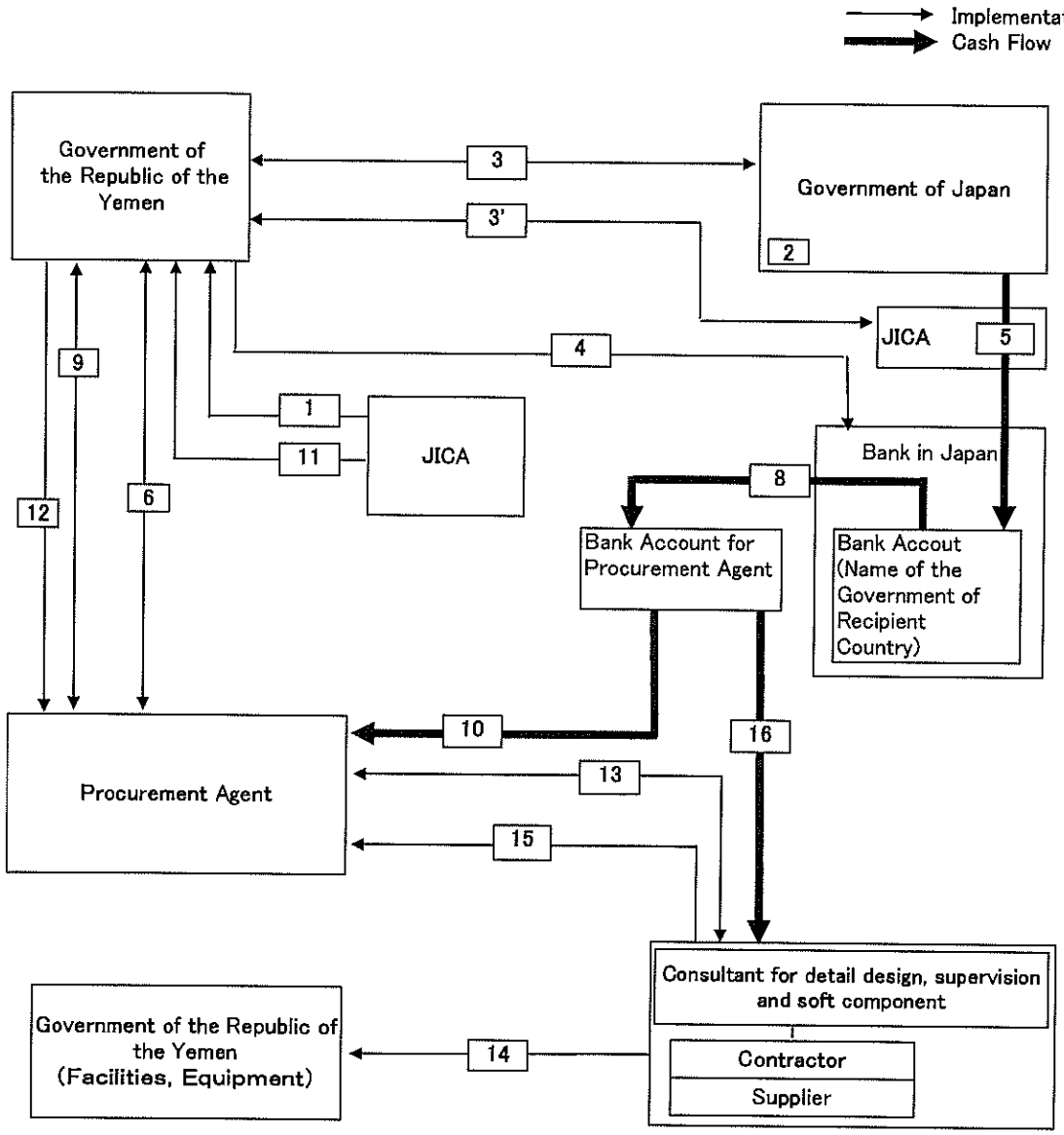
Annex-6

Project Implementation System



Annex-7

Flow of Funds for Project Implementation



1 Preparatory Survey / Reference Document for Tender

2 Approval of Cabinet

3 Signing of Exchange of Notes (E/N)

3' Signing of Grant Agreement (G/A)

4 Banking Arrangement (B/A)

5 Disbursement of Funds from the Government of Japan

6 Signing of Agent Agreement (A/A) +BDA

7 N/A

8 Transfer of Funds

9 Decision of Project Components

10 Payment of Remuneration for Agent

11 Recommendation of Consultant for Detail Design/Supervision (JICA→Government of the Republic of the Yemen)

12 Recommendation of Consultant for Detail Design / Supervision (Government of the Republic of the Yemen→Procurement

13 Conclusion of Contract

14 Construction and Procurement

15 Application for Payment

16 Payment

Annex-8

Major undertakings to be taken by each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure land		●
2	To clear, level and reclaim the site when needed urgently		●
3	To construct gates and fences in and around the site		●
4	To construct a parking lot if necessary		●
5	To construct roads		
	1) Within the site	●	
	2) Outside the site and Access road		●
6	To construct the facility and install the equipment	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities if necessary:		
	1)Electricity		
	a. The power distribution line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer for the site	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for conveying storm water, sewage, etc. from the site)		●
	b. The drainage system within the site (for sewage, ordinary waste, storm water, etc.)	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
8	To bear the following commissions applied by the bank in Japan for banking services based upon the Bank Arrangement (B/A):		
	1) Payment of bank commission		●
9	To ensure all the expense and prompt execution of unloading and customs clearance at the port of disembarkation in the recipient country		
	1) Marine or air transportation of the products from Japan or third countries to the recipient	●	
	2) To ensure all the expense and prompt execution of unloading, tax exemption and customs clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
10	To accord Japanese nationals and / or nationals of third countries, including persons employed by the agent whose services may be required in connection with the Components such facilities as may be necessary for their entry into recipient country and stay therein for the performance of their work.		●
11	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the Components and to the employment of the Agent will be exempted by the Government of recipient country		●
12	To maintain and use properly and effectively the facilities that are constructed and the equipment that is provided under the Grant.		●
13	To bear all the expenses, other than those covered by the Grant and its accrued interest, necessary for the purchase of the Components as well as for the agent's fees.		●
14	To ensure environmental and social consideration for the Programme.		●

Annex- 9

Terms of Reference of the Consultative Committee

1. To confirm an implementation schedule of the Programme for the speedy and effective utilization of the Grant and its accrued interest.

2. To discuss the modifications of the Programme, including modification of the design of the facility.

3. To exchange views on allocations of the Grant and its accrued interest as well as on potential end-users.

4. To identify problems which may delay the utilization of the Grant and its accrued interest, and to explore solutions to such problems.

5. To exchange views on publicity related to the utilization of the Grant and its accrued interest.

6. To discuss any other matters that may arise from or in connection with the G/A.

Minutes of Discussions
on the Preparatory Survey
on the Project for Introduction of Clean Energy by Solar Electricity Generation System
in the Republic of Yemen
(Explanation on Draft Final Report)

In July and October 2009, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Preparatory Survey Team on the Project for Clean Energy Promotion Using Solar Photovoltaic System (hereinafter referred to as "the Project") in the Republic of Yemen (hereinafter referred to as "Yemen"), and through discussions, field survey and technical examination of the results of the survey in Japan, JICA prepared a Draft Final Report of the Outline Design.

In order to explain and to consult with the concerned officials of the Government of Yemen on the component of the Draft Final Report, JICA sent Yemen the Preparatory Survey Team for Draft Final Report Explanation (hereinafter referred to as "the Team"), which is headed by Mr. Yasumichi ARAKI, Advisor, Grant Aid Project Management Division 1, Financing Facilitation and Procurement Supervision Department, JICA, from April 10 to 16, 2010.

As a result of discussion, both sides confirmed the main items described on the attached sheets.

Sana'a, April 14, 2010

Yasumichi ARAKI
Leader
Preparatory Survey Team
Japan International Cooperation Agency
JAPAN

Eng. Hisham Sharaf Abdullah
Vice Minister
Ministry of Planning and International Cooperation
YEMEN

Eng. Ahmed Hasan Al-Aini
Deputy Minister
Ministry of Electricity and Energy
YEMEN

Dr. Ghazi Ahmed Ismail
Deputy Minister for Curative Medicine Sector
Ministry of Public Health and Population
YEMEN

ATTACHMENT

1. Components of the Draft Final Report

The Yemen side agreed and accepted in principle the components of the Draft Final Report explained by the Team.

2. Program Grant Aid for Environment and Climate Change of the Government of Japan

Both sides reconfirmed to take necessary measures based on the previous Minutes of Discussion signed by both sides on July 14, 2009 (hereinafter referred to as "the previous M/D") in accordance with following procedures of the Program Grant Aid for Environment and Climate Change of the Government of Japan.

3. Schedule of the Study

JICA will complete the final report in accordance with the confirmed items and send it to the Ministry of Public Health and Population and carbon copy to the Ministry of Planning and International Cooperation by August 2010.

4. Confirmation of progress made for the previous M/D

4.1. Project site and capacity of PV module

Both sides confirmed that the project site was Al Wahda Hospital shown in **Annex-1** and the capacity of Photovoltaic (PV) module designed in the Project was 300kW based on the result of outline design and cost estimation.

4.2. Application of the Related Laws and Regulations

In the previous M/D, it was stated that the Ministry of Public Health and Population shall be responsible for the application, concerning a license for the installation of PV power station connected to the national power grid in the Project, to be submitted to the Ministry of Electricity and Energy. The Yemen side explained that the connection between PV power station installed in the Project and the national power grid was basically agreed by concerned ministries and organizations, and Al Wahda Hospital should submit necessary application forms for the connection to the Public Electricity Corporation at Aden.

5. Items of Equipment to be procured

The Team explained that the items of equipment to be procured as shown in **Annex-2** based on the result of the Preparatory Survey conducted in October 2009. After discussion, both sides confirmed that the major equipment such as PV modules (PV cells) and Power Conditioners should be products of Japan, and products of third country could be acceptable for other equipment as a part of components.

6. Soft Component

The Team explained that the following items were included in the soft component which meant

trainings for the operation and maintenance of equipment and PV system in the Project.

- Lectures on Basic knowledge
- Exercises on Construction Planning
- Exercise on Method of Operation and Maintenance
- On the Job Training (witnessing Tests and Inspections)
- Operation and Maintenance Management Planning
- Organization for better management
- Preparation of materials for public awareness of clean energy
- Workshop

7. Design of PV System (Function for Stand-Alone Operation)

Both sides shared the understanding on the necessity of stand-alone operation function during the electric blackout. The Team explained to the Yemen side that electric load control should be required in the target building designed to supply electricity by the stand-alone operation function, referring to the Chapter 2-2-4 in the Draft Final Report. The Team also explained that making a procedure for the load control would be supported through the soft component, and the personnel in charge should be trained.

The Yemen side agreed to take responsibility of the load control in Al Wahda Hospital by allocating appropriate trained personnel.

8. Project Cost

The Yemen side has understood that the Project cost should not exceed the amount agreed on the Grant Agreement (hereinafter referred to as "G/A"). Both sides also confirmed that the Project cost contains procurement cost of equipment, the cost for transportation up to the Project Site, installation cost, the procurement agent fee, and the consultant fee that includes the cost for soft component as a whole.

The Yemen side understood that the Project Cost Estimation attached as **Annex-3** is not final and is subject to change by the result of examination through revision of the Outline Design Study.

9. Project Schedule

Both sides confirmed the tentative implementation schedule as shown in the Draft Final Report.

10. Ownership and Responsibilities for Operation and Maintenance

The Yemen side has confirmed that the Ministry of Public Health and Population was the owner of the equipment for the PV system procured by the Project, and was responsible for the Operation and Maintenance (O&M) of the said equipment.

The Yemen side confirmed that the estimated cost for O&M described in the Draft Final Report and agreed to secure necessary budget and personnel for the O&M of Grid-connected PV system procured and installed under the Project.

11. Procurement Process of the Project

Both sides reconfirmed that procurement process would be supervised by the Procurement Agent (hereinafter referred to as "the Agent") with necessary consultation by the Consultative Committee (hereinafter referred to as "the Committee").

12. The Consultative Committee

The Yemen side confirmed that the Ministry of Planning and International Cooperation will chair the Committee in order to facilitate consultation and procurement process. The Terms of Reference of the Committee was settled in Annex-9 of the previous M/D.

The members of the Committee are as follows:

(1) Representative of Ministry of Planning and International Cooperation (Chair)
(2) Representative of Ministry of Public Health and Population
(3) Representative of Ministry of Electricity and Energy
(4) Representative of Local Council of Aden
(5) Representative of JICA Yemen Office

The meeting of the Committee shall be held immediately after the signing of the contract between the Agent and the consultant. Further meetings shall be held upon request of either the Yemen side or the Japanese side. The Agent may advise both sides on the necessity to call a meeting of the Committee.

13. Undertakings required by the Recipient Country

Both sides confirmed that the Yemen side should be responsible for following undertakings in addition to major undertakings described in the previous M/D.

(1) Allocation of land/space for installation of PV system

The owner of the land installed the equipment in the Project is Al Wahda Hospital. The Yemen side confirmed that the Ministry of Public Health and Population and Al Wahda Hospital had common understanding to use the land for the Project without any formal agreement.

(2) Preparation for the Site

Both sides agreed that Al Wahda Hospital should complete the following works for the preparation of the site by October 2010.

- To secure and keep open the space for PV system installation
- To clear and level the space for PV system installation
- To clean up the inside of electric rooms

(3) Environment and Social Considerations

Ministry of Water and Environment had submitted a letter to JICA consultant team and agreed that the Project was in accordance with Yemen's guideline for environmental and social consideration. It was confirmed that any procedures such as IEE/EIA were not necessary to conduct for the Project.

(4) Construction Permissions

Both sides confirmed that Al Wahda Hospital should obtain necessary permissions for the construction by the time of its commencement.

(5) Assignment of Counterpart Personnel

1) Overall project management

The Yemen side assigned following personnel for overall project management and coordination in each organization.

Ministry of Public Health and Population : Dr. Nasib Mansour AL-Mulagem; Director General of Medical Services

Ministry of Planning and International Cooperation : Mr. Mohammed M. Shamsaddin; Local Coordinator for Japanese ODA at MoPIC– Bilateral Cooperation with Asian and Australia Division

2) Soft Component

The Yemen side agreed to assign necessary personnel in accordance with the soft component implementation plan proposed by the Team. Both sides agreed that the positions and/or names of participants from concerned ministries and organizations would be informed at the first Consultative Committee meeting.

(6) Customs and Tax Exemption

The Yemen side agreed that the Ministry of Public Health and Population with coordination of the Ministry of Planning and International Cooperation shall be responsible for the exemption of all customs, tax, levies and duties incurred in Yemen for the implementation of the Project.

14. Confidentiality of the Project

Both sides confirmed that all the information related to the Project shall not be released to any outside parties before conclusion of all the contract(s) for the Project because they are confidential document that contains information related to the tender.

Such information includes the followings:

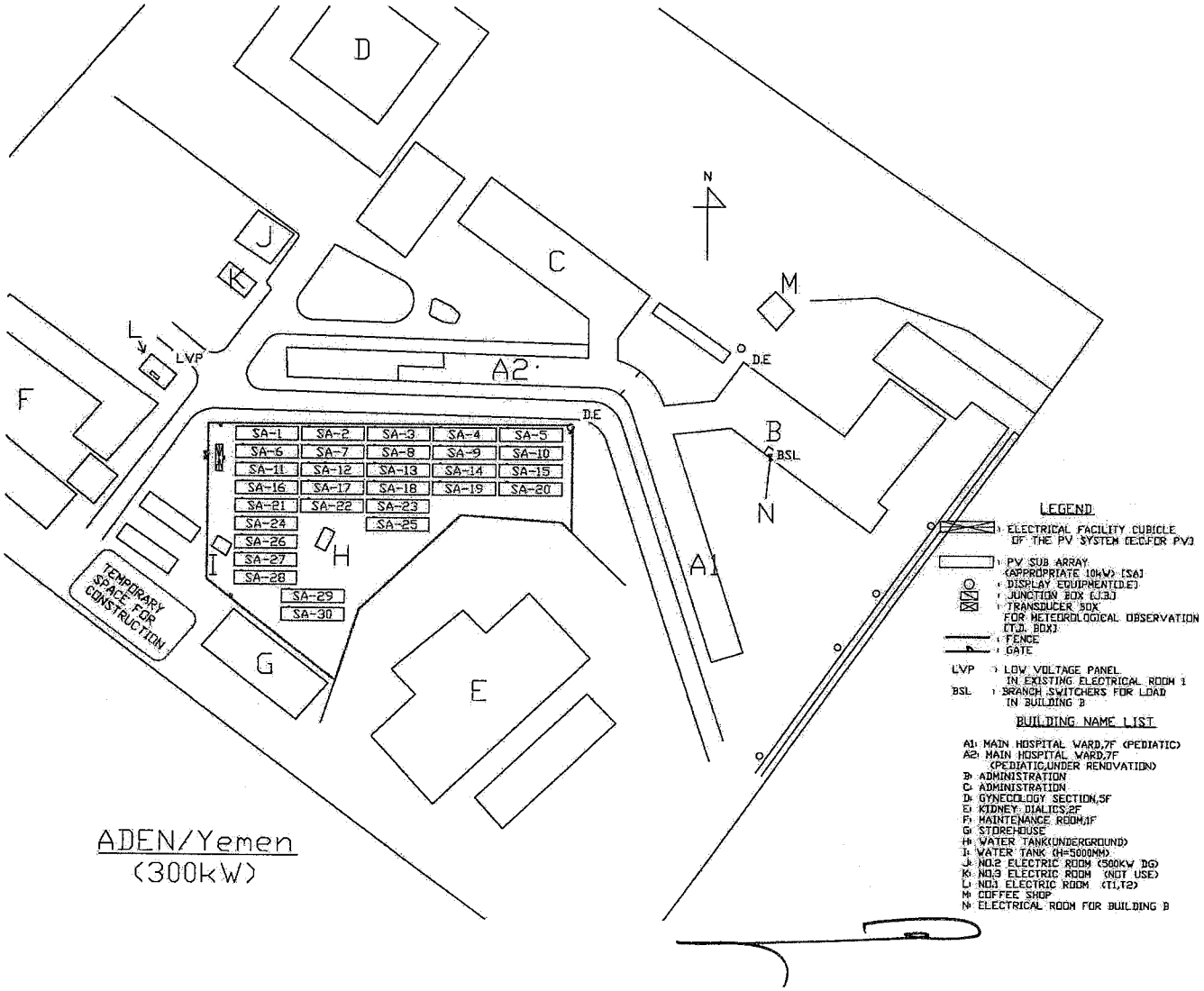
a) detailed drawings, specifications, and other technical information of the facilities and equipment;
b) cost estimation;
c) the Draft Final report;
d) the Final Report

<List of Annex>

Annex-1 Site Plan / Equipment Layout
Annex-2 List of Equipments
Annex-3 Project Cost Estimation (Confidential)

Annex-1

Site Plan / Equipment Layout



Annex-2

List of Major Equipments

Equipment		Quantity
Photovoltaic Generating System		1 system
	1-1. Photovoltaic (PV) Module	*300 kW*
	1-2. Junction Box	*1 lot*
	1-3. Power Conditioner Cubicle	*1 lot*
	1-4. Meteorological Observation Device	*1 unit*
	1-5. Branch Switcher Board	*1 unit*
	1-6. Low Voltage Panel	*1 unit*
	1-7. Electrical Facility Cubicle of the PV system	*1 unit*
	1-8. Support Structure for PV module	*1 lot*
	1-9. Miscellaneous Materials	*1 lot*
	1-10. Spare Parts, Consumables and Tools	*1 lot*
	1-11.Materials of wiring and earthing	*1 lot*
	1-12.Fence, gate and gravel surfacing	*1 lot*

Annex-3

Project Cost Estimation (Confidential)

This cost estimate is provisional and would be further examined by the Government of Japan for the approval of the Grant Aid.

1. Cost to be borne by the Japanese side:

2. Cost to be borne by the Yemen side: approximately YR 3,700,000

Item	Amount
1. Travel expenses for participants of training programs	YR 3,705,000
2. Total (1)	YR 3,705,000

On top of this, issuing commission of the permission for the persons related to the Programme to enter the project sites and providing office space to the Consultant will be borne by the Yemen side.

3. Cost to be borne by the Yemen side for Operation and Maintenance (every year)
   (1) Personnel expenses Approximately YR 324,000
   (2) Expendable and replacement parts cost in the short run Approximately YR 318,000
   (2') Expendable and replacement parts cost in the long run Approximately YR 1,373,000
   (3) Total (in the short run) Approximately YR 642,000
   (3') Total (in the long run) Approximately YR1,697,000

The equipment to be procured in the Programme can be operated and maintained by the existing maintenance staff of the facility (Al Wahda Hospital). The O&M work will take up a little time of the staff on daily basis, which is evaluated in money term here.

At intervals the equipment will require replacement of worn out parts and consumables. In the short run, most of parts and consumables to be needed will be covered by those provided in the Programme, only minor, locally available items have to be purchased by Yemen side. After the provisions of the Programme have run out, necessary items that have to be purchased by Yemen side will increase.

4. Conditions for estimation
   (1) Time of estimation: October 2009
   (2) Foreign exchange rate: US$ 1.00 = JP¥ 96.53 , YR 1.00 = JP¥ 0.471
   (3) Others: The above estimation was carried out in accordance with relevant rules and the guideline of Japan's Grant Aid.

5. SOFT COMPONENT (TECHNICAL ASSISTANCE) PLAN

(1) Background

The Project for Introduction of Clean Energy by Solar Electricity Generation System by the Government of the Republic of Yemen will procure a Photovoltaic Generation System with 300kW capacity, furnish it to Al Wahda Hospital and supply the generated energy to the hospital for its energy demand. For Yemen, this Project will be the first-ever experience to have a PV system with grid interconnection, although Yemen has a number of cases of independent off-grid solar systems. Therefore, it is important to train those Al Wahda Hospital tecnicians who will be actually operating and maintaining the equipment. At the same time, it is also important to inform officers in charge of facilities and technical matters of the public utility company PEC, and the Ministry of Electricity and Energy overseeing it, and other people who will be involved in the Project, regarding the technical features and institutional issues relevant to PV systems and their interconnection to the utility grid, to prepare them to handle renewable projects and to cooperate with private power producers in the future.

The contractor will be conducting an Operation Guidance for the purpose of furnishing the operators with practical methods of operation and maintenance of the equipment. However, the basic knowledge underlying these methods is crucial in nurturing capabilities of judgment and decision making in various occasions of operating and maintaining the equipment, which is also useful in development and application thereto of future similar projects.

In particular, as the PV system to be installed at Al Wahda Hospital is designed to be equipped with "stand-alone function" which enables supplying power to part of the Hospital during blackout of power from the utility grid, it is important to understand the limitations and characteristics of the function for the proper use thereof.

The technicians at Al Wahda Hospital who will be operating the generating equipmenthave been managing the electric facilities in the Hospital, including a diesel generating unit, and very well learnt of their handling by experience. But they are not familiar with a more formal management method using drawings and official records. Therefore, the training must focus on the basics of the management of electric equipment. In particular, sessions at the initial stage such as "Basic theory of photovoltaic generation" scheduled at the beginning of the training program may have to be adopted to the level of understanding of participants, by careful monitoring of their capabilities. The officers of the Ministry of Electricity and Energy and public electricity company are, in theProject, tasked with formulating new rules for grid-interconnection. In addition, although the PV equipment is designed without "reverse current", the Project may achieve more if it can prompt them to consider future possibility of regularization of such technical arrangements. Therefore, the program intends to provide knowledge necessary for future formulation energy policy and designing of institutions, on the basis of the evaluation of effectiveness of renewable energy in the power system of the country, and the firm understanding of technical requirements of grid-interconnection

including reverse current. At the same time, as PEC is given a role to technically support the management activities conducted by the Hospital, he should be very well informed of the equipment and workings of PV system.

The country has not had experience of interconnecting renewable energy generation to the national power grid and the quality of electricity thereof is not quite stable or reliable. Therefore, the Project proposes to require the Contractor to carry out three-month inspection after the commissioning of the Products. Considering the plan that the training program will have to proceed with evaluation of, and adoption to the capability of participants, it is very useful to take advantage of this occasion, to carry out the revisory training programs at the same time, to build up the knowledge, to deepen it, and to secure the sustainability of firm operation and maintenance techniques.

(2) Target of Training Program

To achieve the objectives of the training programs, the specific targets are set as below.

[For operators of the equipment the Site]

- To operate and maintain PV system under normal and emergency conditions, with sufficient knowledge of the function of PV system in connection with the existing electric equipment in the facility,
- To deal with the daily and periodical inspection and maintenance, fully understanding their meaning and importance in the long run, and also able to change and procure the spare parts and consumables,
- To consider routine activities of operation and maintenance and prepare an operation and maintenance management plan,
- To be able to handle proper selection of loads and their arrangements at the destination of Stand-alone function,
- To have basic knowledge that empowers them to give trainings to novice operators within and outside the facility,
- To explain the system to the visitors using publicity leaflets prepared in the program.

[For officials of the Ministry and public electric company]

- To understand the PV system theories, technical characteristics, and institutional issues of grid-interconnection,
- To have technical knowledge relevant in preparing agreements between private owners of power generators and the public electric company,
- To acquire the knowledge for the development of future projects and guidance of new operation and maintenance staff,
- To promote the use of PV using the publicity leaflets prepared in the program.

(3) Outcome of training programs

- the operation and maintenance management plan has been established, and the PV system procured is operated and maintained autonomously and sustainably,
- the Stand-alone function is properly and safely used with appropriate arrangement of loads at the destination,
- O&M activities are followed up by using check sheets,
- Technical officers at the Ministry and PEC are equipped with knowledge on the method of planning and on the institutional provisions for interconnection of renewable power generation systems,
- Use of PV is being promoted using the publicity leaflets prepared in the program.

(4) Outcome confirmation and evaluation

Most tangible outcome will be the operation and maintenance management plan. The operation and maintenance management plan is a plan to be made on the basis of manuals and guidance provided by the Contractor, listing activities of O&M in short-term (daily activities), mid-term (a few months to a few years) and long-term (seven years, an interval of long term maintenance), specifically scheduling the activities, with check sheets for these activities, to make sure the activities are carried out as planned and desired. As discussed below, the training programs are divided into two periods, the first during the commissioning of the equipment and the other three months after the commissioning. The operation and maintenance management plan will be drafted in the first-period program and revised in the second, taking into account the actual experiences in three months.

Also, a trouble shooting manual is to be prepared in the training programs by participants. It is a summary of operators' experiences, and responses sought in discussions in consultation with trainers. The material prepared can be useful in evaluating the degree of understanding of basic knowledge, and the process of preparation itself is helping the deepening of understanding. It also can be used in similar projects elsewhere.

The exercises above are to be started by the discussion among the participants. After evaluating the results, the lecturer joins the discussion, giving additional explanations and instructions as required. Then the participants proceed with the tasks given. These three steps enable the lecturer to evaluate the degree of understanding of the participants before and after the exercise sessions.

Publicity Leaflet will be designed and prepared in the programs, with due consideration to the current status of renewable energy use in the recipient country, to be used and distributed to public in order to introduce the PV system procured in the Project and to promote the use of renewable energy.

Other outcomes in the first-period program will be evaluated in the following manners at the

beginning of the second-period program. The whole program will also be evaluated with the materials presented at the Work Shop to be held at the end of the programs, further supplemented by questionnaires.

- Evaluation of operation records and daily check sheets for three months,
- Evaluation of problem-response records for three months,
- Evaluation of communication and discussions in Trouble Shooting sessions in the second-period program,
- Evaluation of knowledge acquisition concerning the system-wide management, through Exercises, Workshop and its handouts prepared,
- A questionnaire conducted at end of the training programs

In preparing these questions, attentions should be paid to set particular questions and/or assignment concerning the key topics of the programs, which enable to assess the effectiveness of the training.

(5) Planning of training programs

1) Contents

Training program is planned to consist of a series of lectures, exercises, and OJTs led by Japanese consultants. The program is to be carried out in two separate periods; one during the commissioning of the equipment, and the other three months after the commissioning.

There will also be O&M training provided by the Contractor of the Project. Therefore, the consultant will coordinate with the Contractor and plan the details of his training program so that the necessary techniques and knowledge are effectively transferred to the participants of the program. Those training items with a symbol (*) below are the ones presumably provided by the Contractor. The consultants will provide additional information for such items, if necessary, to make them more relevant, not just "how to operate", in the context of understanding of PV systems.

<u>Before commissioning (approximately starting 4 weeks before commissioning)</u>

Lectures on basic knowledge

- Basic theory of photovoltaic generation
- Utilization of photovoltaic generation
- Grid-interconnection and its planning
- Understanding surplus and reverse current
- Supply of power to Hospital from the grid
- Power demand and loads in Hospital
- Workings of PV equipment during blackout
- Stand-alone operation and protection functions

- Load management at the destination of Stand-alone mode power
- Planning PV systems
- Arrangement between PV owner and power utility

Lectures on construction planning

- Installation of PV equipment
- Power distribution in the facility
- Electric equipment in the facility and connection of PV system
- Scheduling works
- Work supervision and inspection, take-over

OJT program

- Witnessing connection works
- Witnessing pre-commissioning/commissioning tests

<u>After commissioning of PV system (continued from "before commissioning " program)</u>

Training provided by the Contractor

- Starting, stopping, restarting the system (*)
- Daily inspection and maintenance (*)
- Periodical inspection and maintenance (*)
- Consumables and replacement work (*)
- Occurrence of faults and actions (*)

Planning O&M works on the basis of Operation Manuals (exercises)

- Making daily check sheet/log sheet form
- Making failure/accident record form
- Maintaining PV equipment in a good condition
- Remedying problems occurred in stand-alone operation
- Making Operation and Maintenance Management Plan

For promotion of renewable energy use

- Design and preparation of publicity leaflet

It is very often experienced, in Japan and in other countries as well, that initial setting of the equipment and/or the lack of familiarity of operation lead to malfunction or unsatisfying performance of the equipment. Therefore, it is necessary to carry out revisory training program a certain period after the commissioning. Initial malfunctions and poor operation practices generally show up soon after the commissioning, but settle down as the countermeasures are taken. It is not wise to leave them for too long without doing anything, while too short an observation may overlook the problems or leave operators insufficient time and experiences. Therefore, the revisory training program is proposed to take place soon after approximately three month period since the commissioning, when certain experiences and operation records have

built up. Then, the three month experience of actual operation and maintenance of PV equipment, operation issues unique in the implementation and in Al Wahda Hospital circumstances are reviewed to address problems and questions, and to revise the operation and maintenance management plan. This process aims for the establishment of more pragmatic and steady method of operation.

On top of these, the records of power generation are to be analyzed to provide exercise materials for more advanced operation planning and brief financial assessment, in order to build a capability for planning and management of PV systems in wider applications. It should be coordinated with the three month inspection carried out by the Contractor engineer, to make witnessing thereof part of training programs, and video-record the inspections, adjustments and changing of parts along with the conversations take place during the proceeding between Contractor engineer and program participants. The recorded material can be reviewed during later sessions of the program. The material should be brought back to Japan, edited and recorded on DVDs, which will be used later on such occasions as the guidance of new members of operation staff, or that of similar projects outside the facility. This aims at the promulgation of Project's positive effect in time and in space, resulting in the realization of initial objectives of the Project.

The following contents are being considered.

Three months after the commissioning

Evaluation of Establishment of Techniques

- Evaluation of knowledge of basic operation methods
- Evaluation of knowledge of basic maintenance works

Revision of Operation and Maintenance Activities

- Evaluation of 3 month experience of operation and maintenance (as input)
- Trouble shooting sessions (by questionnaire, Q&A session, discussion)
- Revising daily operation and check sheets (exercise)

Improvement of Operation and Maintenance Methodology for Long-run

- Planning operation with considerations on seasonal changes (to consider changes in output of PV system by seasons and resulting operation methods)
- Witnessing three month inspection (there will be demonstration of replacement of parts, such as fuses by manufacturer's engineer)
- Recording the three month inspection (video-taped and recorded on DVD media)

Preparation of Trouble Shooting Manual

- Discussion on the problems experienced and responded in three months, finding better responses and solutions, compiling information into " Trouble Shooting Manual ",

Support for establishing advanced organization for operation and maintenance

- Brief financial assessment of the generation equipment (comparison of income and expenses)
- Improvement of management of equipment for better financial performance of the equipment,
- Planning better use of PV system responding to the increase in power demand,

Round up Exercises

- Revising the operation and maintenance management plan
- Questionnaire

Workshop

- Presenting revised operation and maintenance management plan and Trouble Shooting Manual,
- Reporting results of brief financial assessment and operation records.

2) Participants

Candidate participants to the training sessions are as follows.

Al Wahda hospital technicians:	Those who will be actually operating the PV system
PEC officers:	in distribution, power purchasing or power plant management related departments, with engineering background (preferably having a degree in electric engineering)
MEE, MPHP officials:	in regulatory planning, facility management or facility planning related departments, preferably with engineering background
Other	If there are requests from other ministries or organizations, they may appoint persons in charge of public facility planning and/or its maintenance to join the program.

Preliminary assignment for these participants is shown in the table below.

Table 1 Program Contents and Participants

Activities	Technicians (3-4person)	PEC (2-3person)	Ministries (2-3person)	Others (2-3person)
Before commissioning				
Lectures on basic knowledge	○	○	○	○
Lectures on construction planning	○	○	○	
OJT program	○	○	○	
After commissioning				
Reinforcement of Contractor Guidance	○	○		
Planning O&M works	○			
For promotion of renewable energy use	○	○	○	
Three month after commissioning				
Establishment of Techniques	○	○		
Revision of O&M Activities	○			
Improvement of O&M for Long-run	○			
Preparation of Trouble Shooting Manual	○	○		
Advanced Organization for O&M	○		○	
Round up Exercises	○	○	○	○
Workshop	○	○	○	○

3) Schedules

The schedule for the abovementioned program is shown below.

Table 2 Training program before/after commissioning

		-4w	-3w	-2w	-1w	0w	1w	2w	3week
Activities	Preparation								
	Basic knowledge lectures								
	Construction exercise								
	OJT								
	Reinforce Contractor Guidance								
	O&M Management Planning								
	Promotion Material								
Participant	Hospital technicians								
	PEC officers								
	Ministry Officials								
Lecturers	Consultant (leader)								
	Consultant (assistant)								
	Interpreter								

Table 3　Training program three months after commissioning

		1w	2w	3w	4w
Activities	Establishment of Techniques	―			
	Revision of O&M Activities		―		
	Improvement of O&M for Long-run			―	
	Preparation of Trouble Shooting Manual		―		
	Advanced Organization for O&M			―	
	Round up Exercises				―
	Workshop				▼
Participant	Hospital technicians	―	―	―	―
	PEC officers		―		―
	Ministry Officials			―	―
Lecturer	Consultant (leader)	―	―	―	―
	Consultant (assistant)		―	―	―
	Interpreter	―	―	―	―

(6) Resources for the training program

As already mentioned, this PV system with grid interconnection is first-ever experience in Yemen. Therefore, Japanese consultants are assumed to undertake the implementation of training programs. Consultants to be assigned should have adequate experiences in planning of PV system with grid interconnection.

There will be two Japanese consultants, one leader and one assistant, to be lecturers to the programs of both periods. National consultants are not considered as the recipient country does not have an experience in similar projects.

As the official foreign language of the country is Arabic, and the participants may not be good at speaking English, translation/interpretation service is necessary. But Arabic-English interpretation service available in the country will have problems in technical terms and expressions. If consultants give a lecture in English and an interpreter translates to Arabic, it is most likely to cause confusion and misunderstanding. Therefore, the translation between Japanese and Arabic is more desirable, and the interpreter should be sought in Japan. Hiring Japanese-Arabic interpreter has some other advantages; such as translating additional materials obtained from the Contractor to use in the lectures, which are very likely written in Japanese.

The work schedule of consultants is planned as below. The first period program takes forty days, and the second twenty days. After including return travels to and from the Site, the assignment should be two months and one month, respectively.

Table 4　Work Schedule of Consultants

Program	Work Description	Duration
Preparation　5 days	- Discussion on contents and materials with MEE and PEC - Confirmation of contents with Al Wahda Hospital - Coordination with the Contractor - Preparation of materials	2days 1day 1day 1day
Before commissioning　15 days		
Lectures on basic knowledge	- Basic theory of photovoltaic generation - Utilization of photovoltaic generation - Grid-interconnection and its planning - Understanding surplus and reverse current - Supply of power to Hospital from the grid - Power demand and loads in Hospital - Workings of PV equipment during blackout - Planning PV systems - Arrangement between PV owner and power utility - Stand-alone operation and protection functions - Load management at the destination of Stand-alone mode power	10days in total
Lectures on construction planning	- Installation of PV equipment - Power distribution in Hospital - Electric equipment in Hospital and connection of PV system - Scheduling works - Work supervision and inspection, take-over	0.5days ↓ 1day 1.5days 1day
OJT program	・ Witnessing connection work and tests/inspection of the Contractor	（5days）
After commissioning　20 days		
Reinforcement of Contractor Guidance	- Following Operation Guidance of the Contractor; - additional explanations given on workings of PV system in the facility, using Operation and Maintenance Manual and the training materials, - discussions on findings of participants.	5days
Planning O&M works	- Proposing daily activities needs and making daily check sheet/log sheet form - Listing periodical inspection items, activity necessary, to make check sheet, - Listing long-term inspection items, activity necessary, to make inspection schedule - Discussion on the use of stand-alone function, - Checking electric equipment inside buildings, listing, and arranging the loads - Discussion and preparation of　stand-alone function utilization guideline	12days in total
Promotion of renewable energy use	- Planning the materials, editing, laying-out, and prepare the leaflets	5days
Three months after commissioning　20 days		
Establishment of Techniques	- Confirmation and evaluation of operation records by the Consultant, - Confirmation of basic operation knowledge and technique, - Discussions on daily operation and maintenance activities.	1day 1day 1day
Revision of O&M Activities	- Revision and evaluation of three-month experience of operation and maintenance, - Trouble shooting (extracting problems and solutions, through enquiries and discussions), - Revision and evaluation of Stand-alone operation records, - Revision of daily operation and maintenance check sheets.	1day 1day 1day 1day
Improvement of O&M for Long-run	- Considering seasonal changes of demand and power generation, - Witnessing three-month inspection carried out by the Contractor(including changing of spare parts), - Recording the above on video.	1days 2days （half day） （2days）
Preparation of Trouble Shooting Manual	- Summarizing problems and solutions extracted in the above program to prepare Trouble Shooting Manual.	1day
Advanced Organization for O&M	- Simple financial analysis of PV equipment (cost and income related to PV operation), - Discussion on management of facilities and equipment, - Increase of demand, consumption of PV generated energy, and better use of energy in the facility.	1.5days 1days 1.5days
Round Up Exercises	- Updating Operation and Maintenance Management Plan, - Questionnaires on understanding, - Preparation of Work Shop presentation.	2days 1days 2days
Work Shop	- Presenting Operation and Maintenance Management Plan, Trouble Shooting Manual and reporting records of operation including financial performance.	1day

(7) Schedule of training programs

Work schedule of training programs is as shown below, assuming that the agreement between procurement agents and contractors will be concluded in 10/2010.

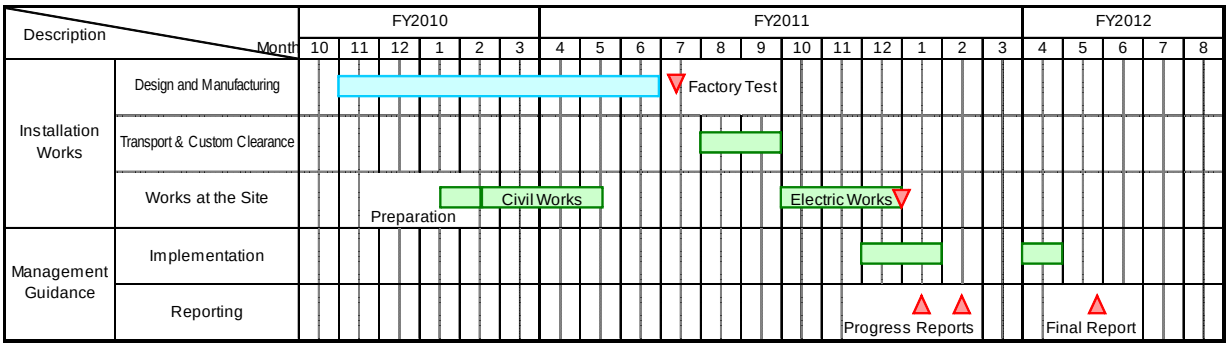


Figure 1 Management Guidance Implementation Schedule

(8) Products of training programs

Products of training programs are outlined below.

- A training program textbook prepared by the Consultant
- Output of Exercises (A single line diagram of the facility, etc.)
- Publicity Leaflet
- Progress reports
- Visual record (DVD) of Periodical Inspection (three month inspection)
- Operation and Maintenance Management Plan (with revision)
- Trouble Shooting Manual
- Workshop materials
- Results of questionnaires
- Final report (including evaluations of operation records and trouble shootings)

(9) The responsibility of receipt country

As Al Wahda Hospital is located in Aden, transportation expenses, accommodation costs, and allowances of participants should be borne by their affiliations in the case of participation from outside Aden.

It is important that participants take part in the training programs in full for the achievement of program objectives, which, however, requires the participants of being away from their work places for weeks. Therefore, there must be an official designation as a participant given by the section/ department management who appreciates the usefulness of the programs. It is also important that government agencies appoint persons who will be in charge of PV and renewable energies in the future.

6. REFERENCES

6.1 Technical Notes for Draft Basic Design

MINUTES OF MEETING

Project for Introduction of Clean Energy using Photovoltaic Power

Subject	The scope of PV system of Wihda Hospital
Date	October 19, 2009.
Time	10:00 a.m. – 12:00 p.m.
Place	Meeting room at Al Wihda Hospital, Aden
Participants	1. Al Wihda Hospital members
	2. JICA STUDY TEAM

Result of Meeting

1. Proposed PV Project

JICA STUDY TEAM explained [**Proposed PV Project at Al Wihda Hospital**] to Al Wihda Hospital (the hospital) as per attachment-1, and Al Wihda Hospital agreed with Proposed PV Project.

And JICA STUDY TEAM explained the basic design of Low Voltage Panel to the hospital as per attachment-2, and the hospital agreed with the basic design of Low Voltage Panel in No.1 electrical room.

2. Request and suggestion by Al Wihda Hospital

Regarding electric power supply in the case of power failure (blackout) of the Grid requested by the hospital, JICA STUDY TEAM agreed to provide "stand alone operation" which enables sending power from PV system to Building B during blackout.

3. Request and confirmation by JICA STUDY TEAM

The hospital understood that application procedures necessary to obtain approvals and/or licenses related to installation, operation and grid-connection to the PV system shall be initiated by the hospital.

4. Temporary facilities of construction

Al Wihda Hospital prepares the space in the hospital for the storage of the materials imported from Japan and other temporary facilities during construction at free of charge.

5. Others

The hospital understood that the final scope of the PV system and the design of the Project shall be determined by the JICA Headquarters and the Government of Japan.

Aden, October 19, 2009

Al Wihida Hospital

19.10.09

Dr.Mohamed Salem Baazab
General Manager of
Al Wihida Hospital

JICA STUDY TEAM

西田雅

Masaru Nishida
Chief of Consultants of
JICA PV Study Team

Discussion on Proposed PV Project at Al Wihda Hospital

Date: October 17th, 2009

Place: Al Wihda Hospital

1. Scope of the Project

The Project proposed will provide Al Wihda Hospital with the Works as shown below.

- Installation of PV system with a capacity of 300kW
- Installation of Electrical Facility Cubicle
- Replacement of Low Voltage Panel in Electric Room No.1 and a Branch Switcher Board in Building-B
- Installation of fences and gates surrounding PV modules

The PV system under planning is also presented as in Attachment 1 and the following drawing list.

[List of Drawings to be presented]

- YE-01 SINGLE LINE DIAGRAM (EXISTING NO.1 ELECTRIC ROOM)
- YE-02 SINGLE LINE DIAGRAM (GRID CONNECTION POINT)
- YE-04 GENERAL LAYOUT PLAN
- YE-12 CABLE LAYOUT PLAN (OUTSIDE)
- YE-15 EQUIPMENTS LAYOUT&MODIFICATON (EXISTING ELECTRIC ROOM NO.1)
- YE-16 EQUIPMENTS LAYOUT&MODIFICATON (BUILDING B)
- YE-18 PAVING STONE PLAN
- YE-19 LAYOUT OF FENCE AND GATE
- YE-20 FENCE, GATE (DETAIL)

2. Operation of the PV System

(1) Operation under normal condition

PV System is designed to start sending power in the morning and stop in the late afternoon every day, by a scheduled timer.

If the power from the power company (PEC) network is cut (black out), the PV system automatically shuts down. After the power is back, the PV system must be restarted manually.

(2) Stand-alone operation under power cut from Power Company

Upon a request from the Hospital, the PV system is designed to be equipped with "stand-alone operation function", which enables the operation of the PV system during black out. Stand-alone operation may be activated as follows:

- When the electricity supply from PEC is down, the PV system will be shut down automatically.
- Then, by manual operation, the PV system may be restarted to meet the limited demand of the Hospital.
- "The limited demand" is proposed to be those in Building-B (Administration Ward) as it has not been supplied with power from back-up diesel generator.
- The PV system may not be able to meet the electricity demand in the whole Building-B, as a PV system has inherent unreliability due to the weather. Those part of the building to be supplied with power by PV system during black out can be selected by switches in "Branch Switcher Board in Building-B ".
- When the power from PEC is back, by manual operation, the PV system must be once shut down and restarted in normal operation mode.

(3) Maintenance

- Daily inspection will have to be done once a day by maintenance staff of the Hospital.
- Other periodical inspections will be necessary, which may involve replacement of consumables and worn-out parts.

3. Construction

There are a few important matters that need to be understood about the construction work.

(1) Interruption of Power Supply to the Hospital at the power system switch

The electric panels (boards), one in the Electric Room No.1 and the other in Building B, will have to be replaced by new ones. The replacement work requires interruption of power supply from PEC, to relevant part of the Hospital, that are Building A, B, and F.

There will be mobile diesel generators to be employed by the Contractor as substitute source of power. However, there will be absolute power cuts to the Hospital, a few times during the Work, to switch the source of power from/to PEC to/from mobile diesel units.

Details of the Work will be planned, and submitted for approval of the Engineer, by the Contractor.

(2) Need to Secure Temporary Storage of Materials and Equipment

The Hospital is requested to secure, free of charge, the space in the Hospital for storing materials and equipment transported from Japan. The area suitable for the purpose is shown in a green rectangle in Figure 1.

(3) Temporary Storage of Construction Waste

The construction work will produce large amount of wastes. They will have to be stored temporally somewhere in the premise of the Hospital before the Contractor dispose of it in a proper and lawful way.

4. Preparation for the Project

(1) Application for the interconnection of the PV system to PEC network.

As the Hospital will become an owner of generation equipment for his own use, and the equipment will be interconnected to PEC network, a necessary procedure, which may involve applying for a license, will have to be initiated by the Hospital.

(2) Preparation of the Site

The following matters should be undertaken by Yemeni side.

- To secure and keep open the space for PV system installation
- To clear and level the space for PV system installation
- To clean up the inside of electric rooms before the construction work starts.

5. Project Schedule (tentative only)

- Preparation of contract with the Contractor : mid 2010
- Commencement of the Work at the Site : early 2011
- Completion of the Project and Commissioning : early 2012

6. Matters to be Confirmed

- Cable list in Existing Electric Room NO.1
- Load list of Building B
- Drawings and/or information of underground structures, pipes and cables in the installation areap
- Expected increase of power demand after re-opening of rehabilitated part of the Building A
- Expected date of completion of the rehabilitation work
- Some details of financial statement of the Hospital

Attachment-1

Basic Specification of PV System (Draft)

Name of Site :Al Wahidah Hospital Aden

Item	Specification
Type of the PV system	Grid connection (No Storage Battery)
Capacity of the PV system	300kW
Basic configuration of the PV system	Refer to Fig.1
Basic layout of the PV system	Refer to the drawing NO.YE-04
Electrical facility cubicle of the PV system	Refer to Fig.2
Grid connection point	Low voltage (At secondary side of the transformer)
Support stand of the PV module	Hot dip zincing
Reverse power flow	Do not supply surplus power to the grid. (Prohibition from electric power company)
Protection Relay of Grid connection	Over current(OC), Over voltage(OV), Under voltage(UV), Over frequency(OF), Under frequency (UF), Islanding detector
Electric power supply in the case of power failure (blackout)	Building B is to be fed with power from the System during power failure (blackout) of the grid (PEC network)
Display system	2 sets to be installed. Information to be displayed are 1) Current Output of the System (kW) 2) Energy Generated the day (kWh) 3) Estimated reduction of CO2 emission
Fence and Gate for PV system	Refer to the drawing NO.YE-19,YE-20
Meteorological observation device	Solar radiation and Thermometer system at the PV panels
Language of operation and maintenance manuals	English

Note) Due to the instability of PV output, PV system cannot supply power to critical load such as life supporting equipment.

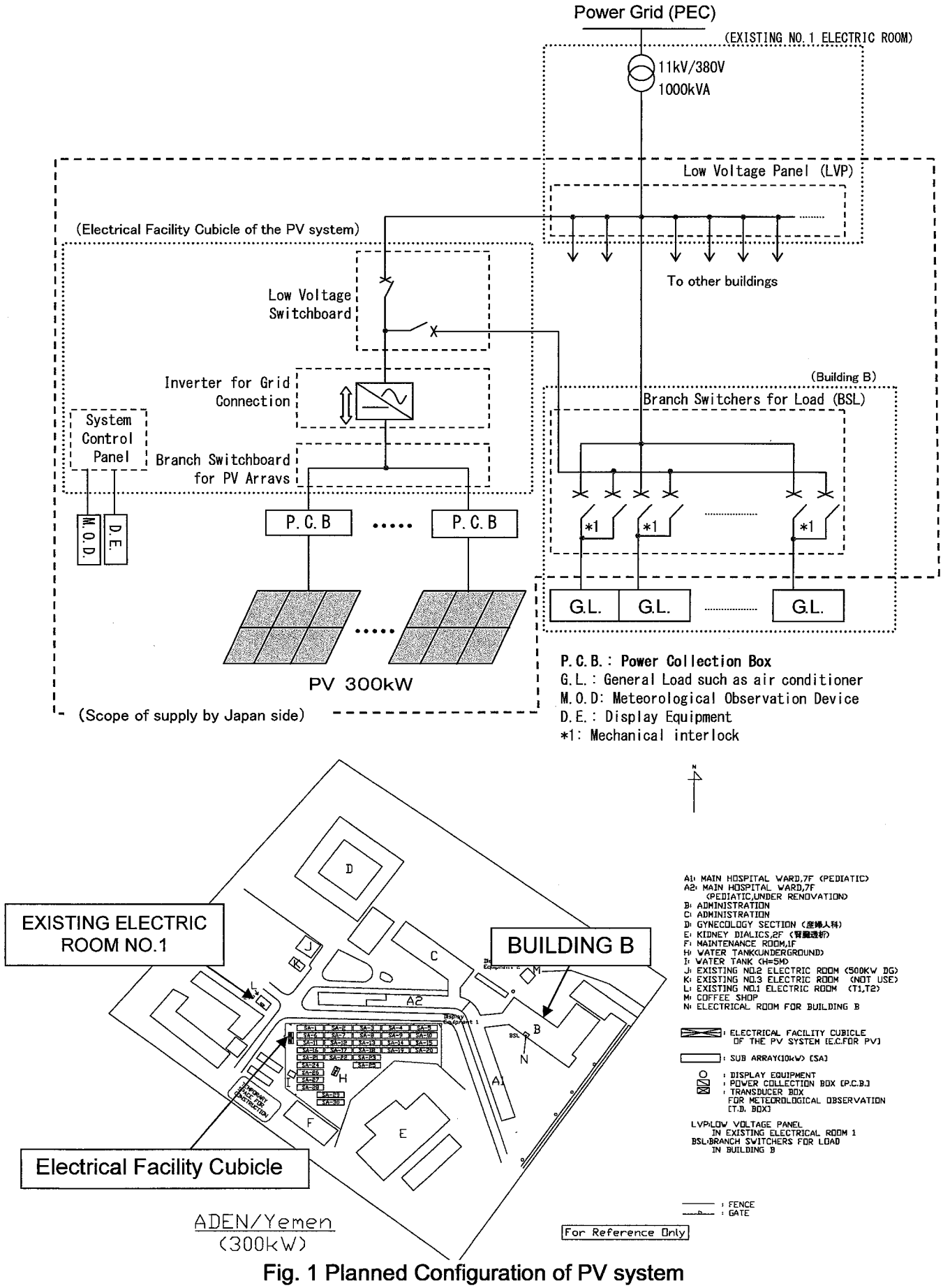


Fig. 1 Planned Configuration of PV system

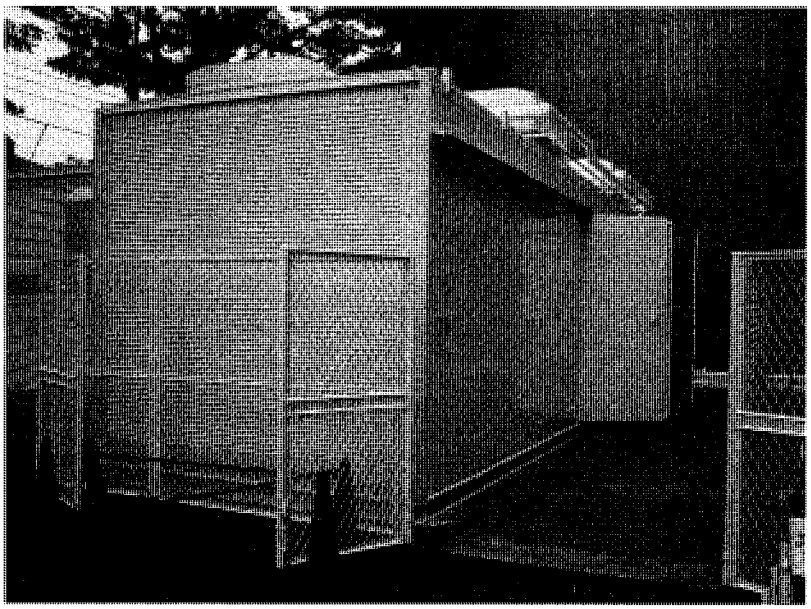
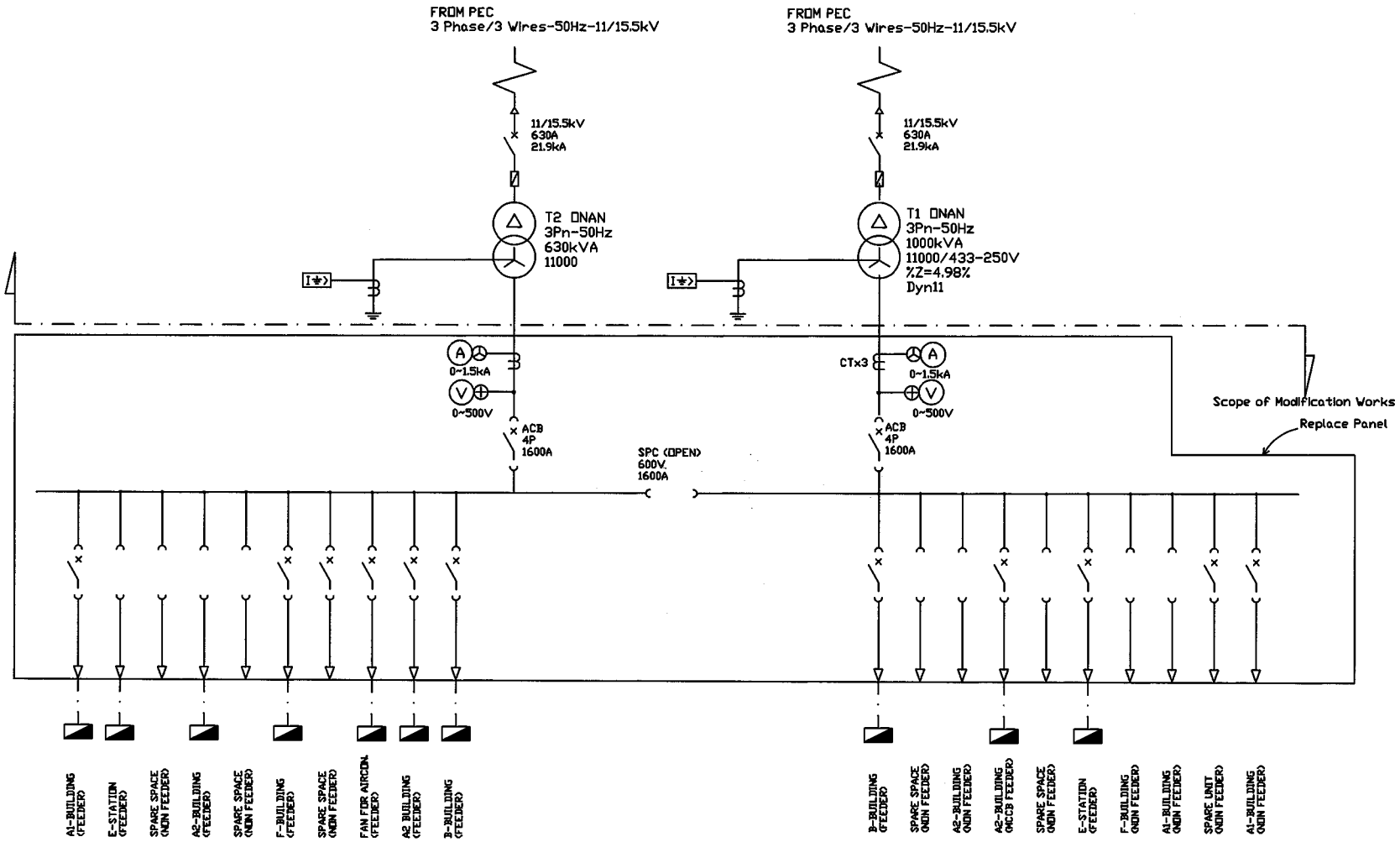
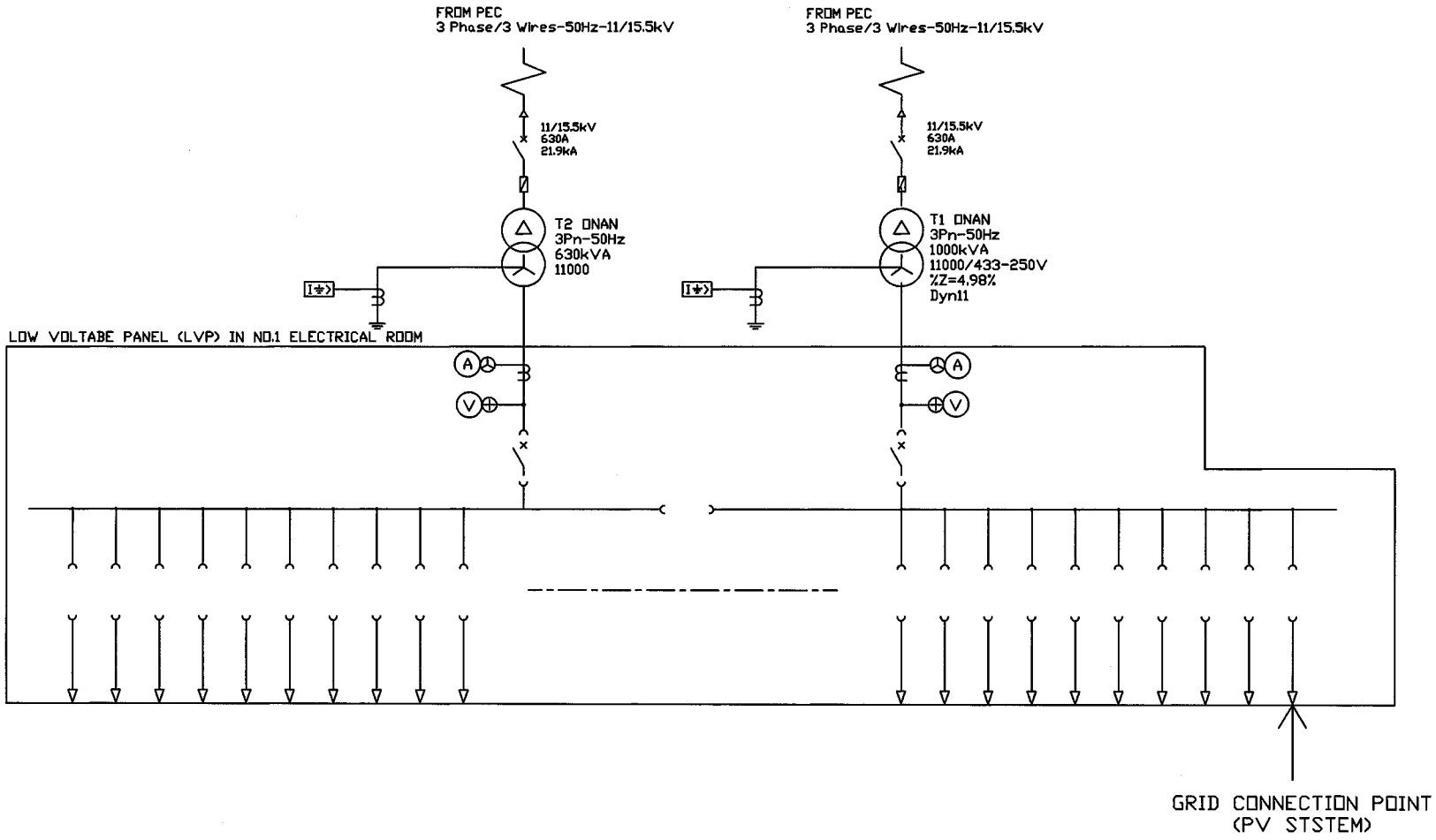


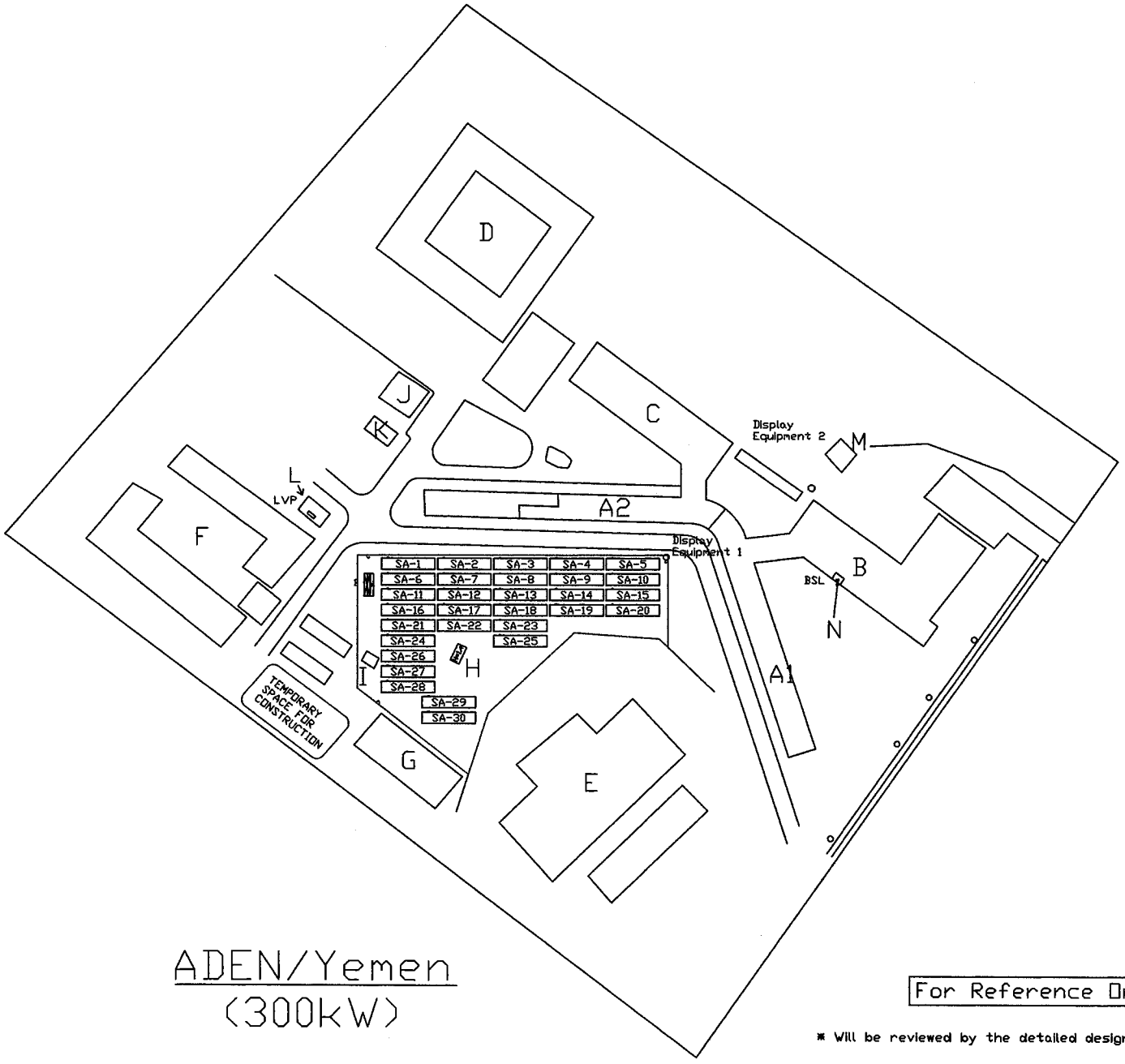
Fig.2 Example of Electrical Facility Cubicle of the PV system



Project for Introduction Of Clean Energy using Photovoltaic Power		
TITLE : SINGLE LINE DIAGRAM (EXISTING NO. 1 ELECTRIC ROOM)		
DRAWING NO. YE-01		Rev.1
DATE	DRAWN	CHECKED
SCALE: Non.(A3) Unit:		
NEWJEC	NEWJEC Inc. Osaka, JAPAN	



Project for Introduction Of Clean Energy using Photovoltaic Power		
TITLE : SINGLE LINE DIAGRAM (GRID CONNECTION POINT)		
DRAWING NO. YE-02		Rev.1
DATE	DRAWN	CHECKED
SCALE: Non.(A3) Unitmm		
NEWJEC	NEWJEC Inc. Osaka,JAPAN	



A1: MAIN HOSPITAL WARD,7F (PEDIATIC)
A2: MAIN HOSPITAL WARD,7F
(PEDIATIC,UNDER RENOVATION)
B: ADMINISTRATION
C: ADMINISTRATION
D: GYNECOLOGY SECTION,5F (産婦人科)
E: KIDNEY DIALICS,2F (腎臓透析)
F: MAINTENANCE ROOM,1F
G: STOREHOUSE
H: WATER TANK(UNDERGROUND)
I: WATER TANK (H=5M)
J: EXISTING NO.2 ELECTRIC ROOM (500KW DG)
K: EXISTING NO.3 ELECTRIC ROOM (NOT USE)
L: EXISTING NO.1 ELECTRIC ROOM (T1,T2)
M: COFFEE SHOP
N: ELECTRICAL ROOM FOR BUILDING B

: ELECTRICAL FACILITY CUBICLE OF THE PV SYSTEM [E.C.FOR PV]

: SUB ARRAY(10kW) [SA]

: DISPLAY EQUIPMENT
: POWER COLLECTION BOX [P.C.B.]
: TRANSDUCER BOX FOR METEOROLOGICAL OBSERVATION [T.D. BOX]

LVP:LOW VOLTAGE PANEL IN EXISTING ELECTRICAL ROOM 1
BSL:BRANCH SWITCHERS FOR LOAD IN BUILDING B

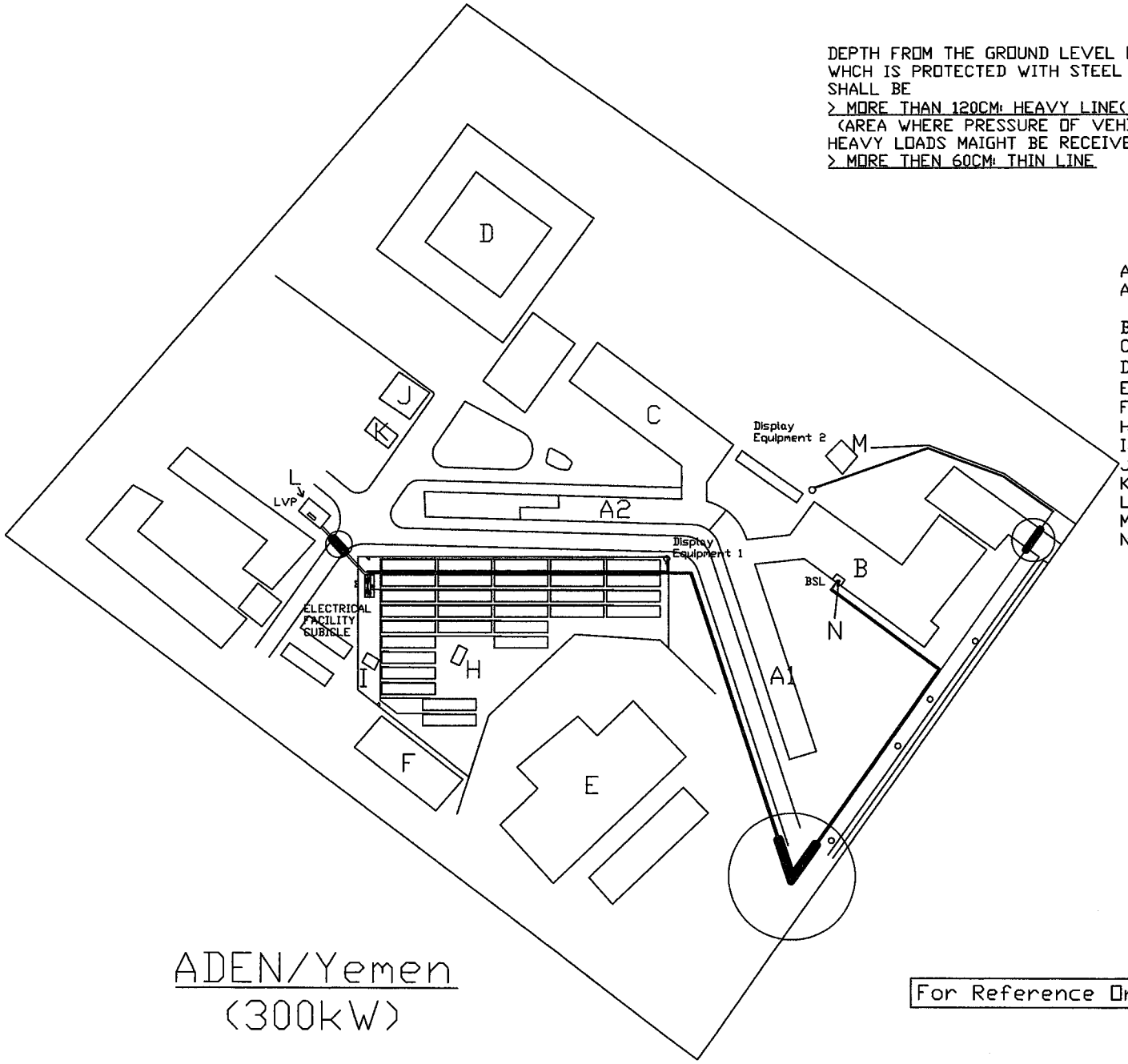
: FENCE
: GATE

ADEN/Yemen
(300kW)

For Reference Only

* Will be reviewed by the detailed design result, if necessary.

Project for Introduction Of Clean Energy using Photovoltaic Power		
TITLE : GENERAL LAYOUT PLAN		
DRAWING NO. YE-04		Rev.1
DATE	DRAWN	CHECKED
SCALE: ---- Unless		
NEWJEC	NEWJEC Inc. Osaka,JAPAN	



DEPTH FROM THE GROUND LEVEL OF THE CABLE WHCH IS PROTECTED WITH STEEL STRIP IN COIL SHALL BE
> MORE THAN 120CM: HEAVY LINE(O)
(AREA WHERE PRESSURE OF VEHICLE AND OTHER HEAVY LOADS MAIGHT BE RECEIVED)
> MORE THEN 60CM: THIN LINE

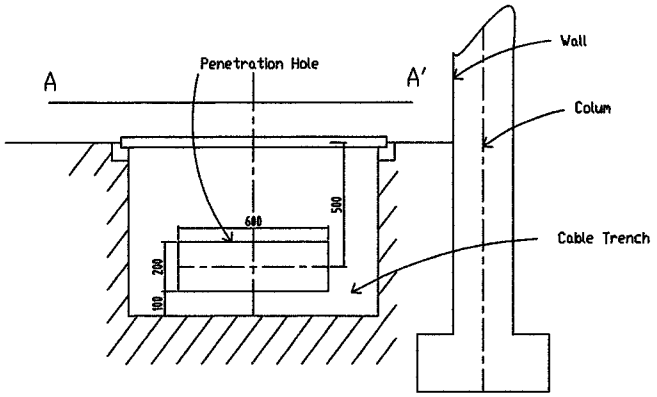
A1: MAIN HOSPITAL WARD,7F (PEDIATIC)
A2: MAIN HOSPITAL WARD,7F (PEDIATIC,UNDER RENOVATION)
B: ADMINISTRATION
C: ADMINISTRATION
D: GYNECOLOGY SECTION (産婦人科)
E: KIDNEY DIALICS,2F (腎臓透析)
F: MAINTENANCE ROOM,1F
H: WATER TANK(UNDERGROUND)
I: WATER TANK (H=5M)
J: EXISTING NO.2 ELECTRIC ROOM (500KW DG)
K: EXISTING NO.3 ELECTRIC ROOM (NOT USE)
L: EXISTING NO.1 ELECTRIC ROOM (T1,T2)
M: COFFEE SHOP
N: ELECTRICAL ROOM FOR BUILDING B

LVP:LOW VOLTAGE PANEL IN EXISTING ELECTRICAL ROOM 1
BSL:BRANCH SWITCHERS FOR LOAD IN BUILDING B

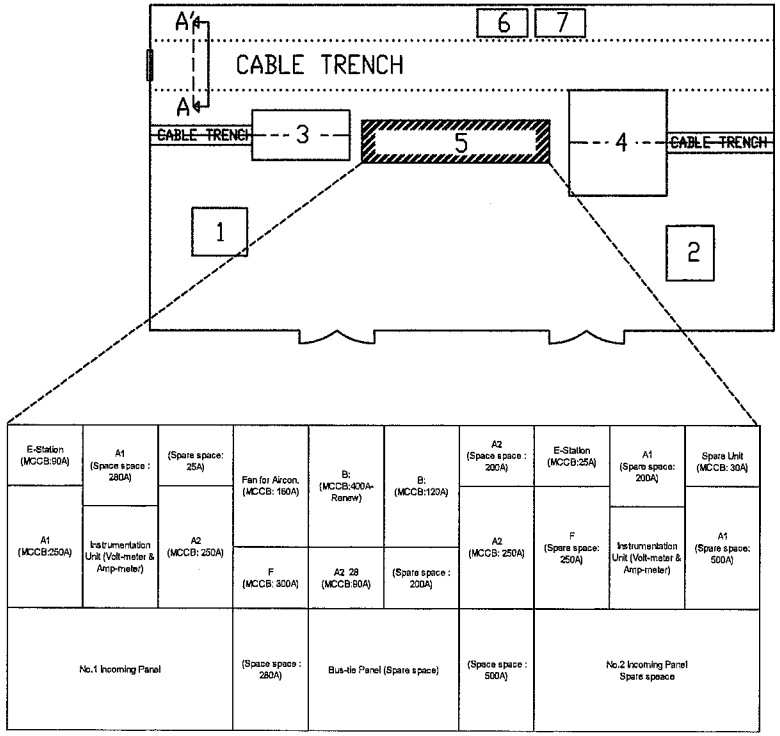
ADEN/Yemen
(300kW)

For Reference Only

Project for Introduction Of Clean Energy using Photovoltaic Power			
TITLE : CABLE LAYOUT PLAN (OUTSIDE)			
DRAWING NO. YE-12			Rev.1
DATE		DRAWN	CHECKED
SCALE: ----	Unit:mm		
NEWJEC	NEWJEC Inc. Osaka, JAPAN		



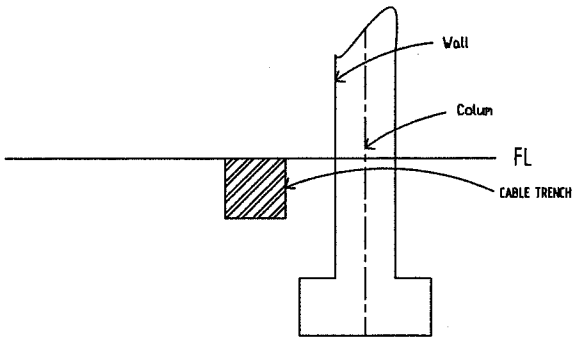
DETAILED PENETRATION HOLE
(A~A' SECTION)



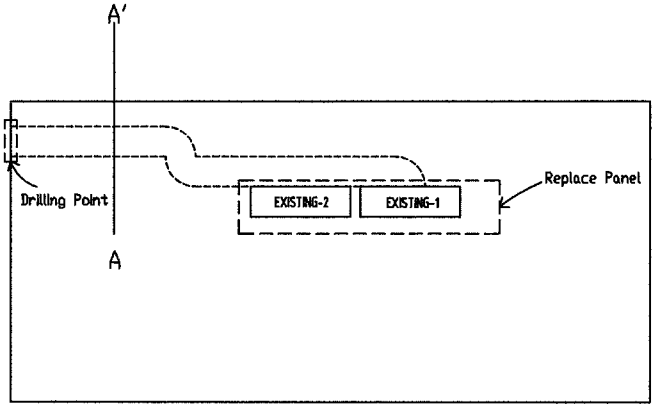
: Replace Panel

No.	EQUIPMENT	DESCRIPTION	QUANTITY	DIMENSION & WEIGHT				REMARKS
			UNIT	WIDTH [mm]	DEPTH [mm]	HEIGHT [mm]	WEIGHT [kg]	
1	No.1 Power Receiving Unit	11kV Switchgear Unit	1	1,100	950	1,550	580	
2	No.2 Power Receiving Unit	11kV Switchgear Unit	1	1,100	950	1,550	580	
3	No.1 Distribution Transformer	3Ph-630kVA-11/0.4kV-50Hz-5.15%z-ONAN-Dyn11, CCCP	1	1,950	1,000	1,950	3,320	
4	No.2 Distribution Transformer	3Ph-1000kVA-11/0.433kV-0.25kV,4.86%z-ONAN-Dyn11, KOREA	1	1,950	2,100	1,950	3,100	
5	L/V Distribution	AC460V-Multi stage type MCC-CCCP	10	375	850	1,950	2,000	
6	Metering Pit	Wall mounting type	2	500	600	200	20	
7	Lighting Distribution Board	Wall mounting type	1	400	400	250	30	

	PROJECT TITLE	DRAWING TITLE	Scale :	Designed by	Checked by	Approved by	Date :
		EQUIPMENTS LAYOUT&MODIFICATION (EXISTING NO. 1 ELECTRIC ROOM)	1 : 100 (A3)				
			Date: 07.JULY.2008	Draftman	Drawing No. YE - 15		Edition / Sheet

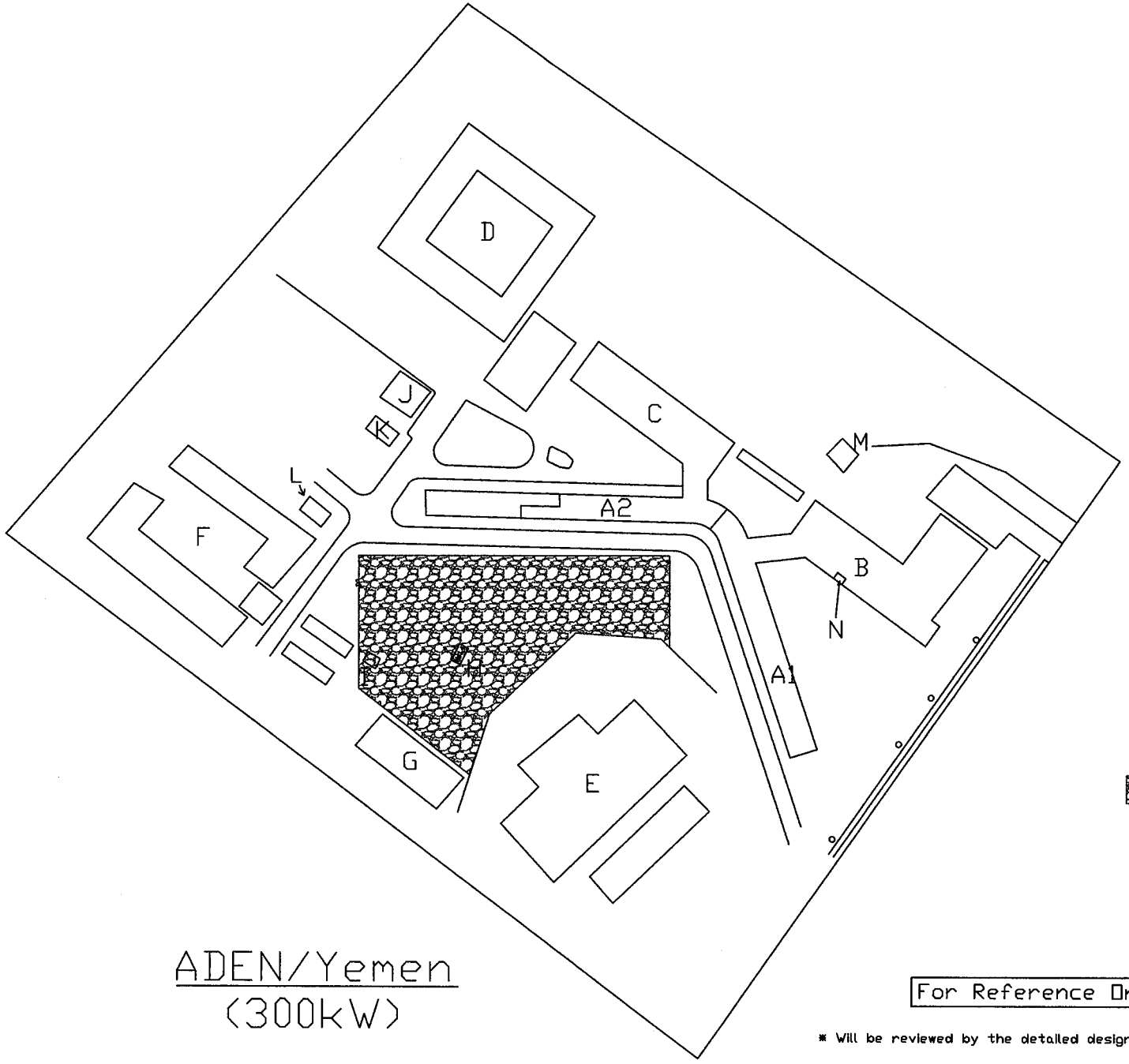


DETAILED PENETRATION HOLE
(A-A' SECTION)



No.	EQUIPMENT	DESCRIPTION	QUANTITY	DIMENSION & WEIGHT				REMARKS
			UNIT	WIDTH [mm]	DEPTH [mm]	HEIGHT [mm]	WEIGHT [kg]	
1	LOW VOLTAGE DISTRIBUTION BOARD-1	Metal-enclosed, wall mounting type consisting of molded case circuit breaker feeder circuits	1	1,000	300	2,350	80	Existing Panel
2	LOW VOLTAGE DISTRIBUTION BOARD-2	Metal-enclosed, wall mounting type consisting of molded case circuit breaker feeder circuits	1	1,000	300	2,350	80	Existing Panel

	PROJECT TITLE	DRAWING TITLE	Scale :	Designed by	Checked by	Approved by	Date :	
		EQUIPMENTS LAYOUT&MODIFICATION (BUILDING B ELECTRIC ROOM)	1 : 100 (A3)					
			Date: 07.JULY.2008	Draftman	Drawing No. YE - 16		Edition	Sheet



A1: MAIN HOSPITAL WARD,7F (PEDIATIC)
A2: MAIN HOSPITAL WARD,7F
(PEDIATIC,UNDER RENOVATION)
B: ADMINISTRATION
C: ADMINISTRATION
D: GYNECOLOGY SECTION,5F (産婦人科)
E: KIDNEY DIALICS,2F (腎臓透析)
F: MAINTENANCE ROOM,1F
G: STOREHOUSE
H: WATER TANK(UNDERGROUND)
I: WATER TANK (H=5M)
J: EXISTING NO.2 ELECTRIC ROOM (500KW DG)
K: EXISTING NO.3 ELECTRIC ROOM (NOT USE)
L: EXISTING NO.1 ELECTRIC ROOM (T1,T2)
M: COFFEE SHOP
N: ELECTRICAL ROOM FOR BUILDING B

: PAVING STONE
(t=10 cm)

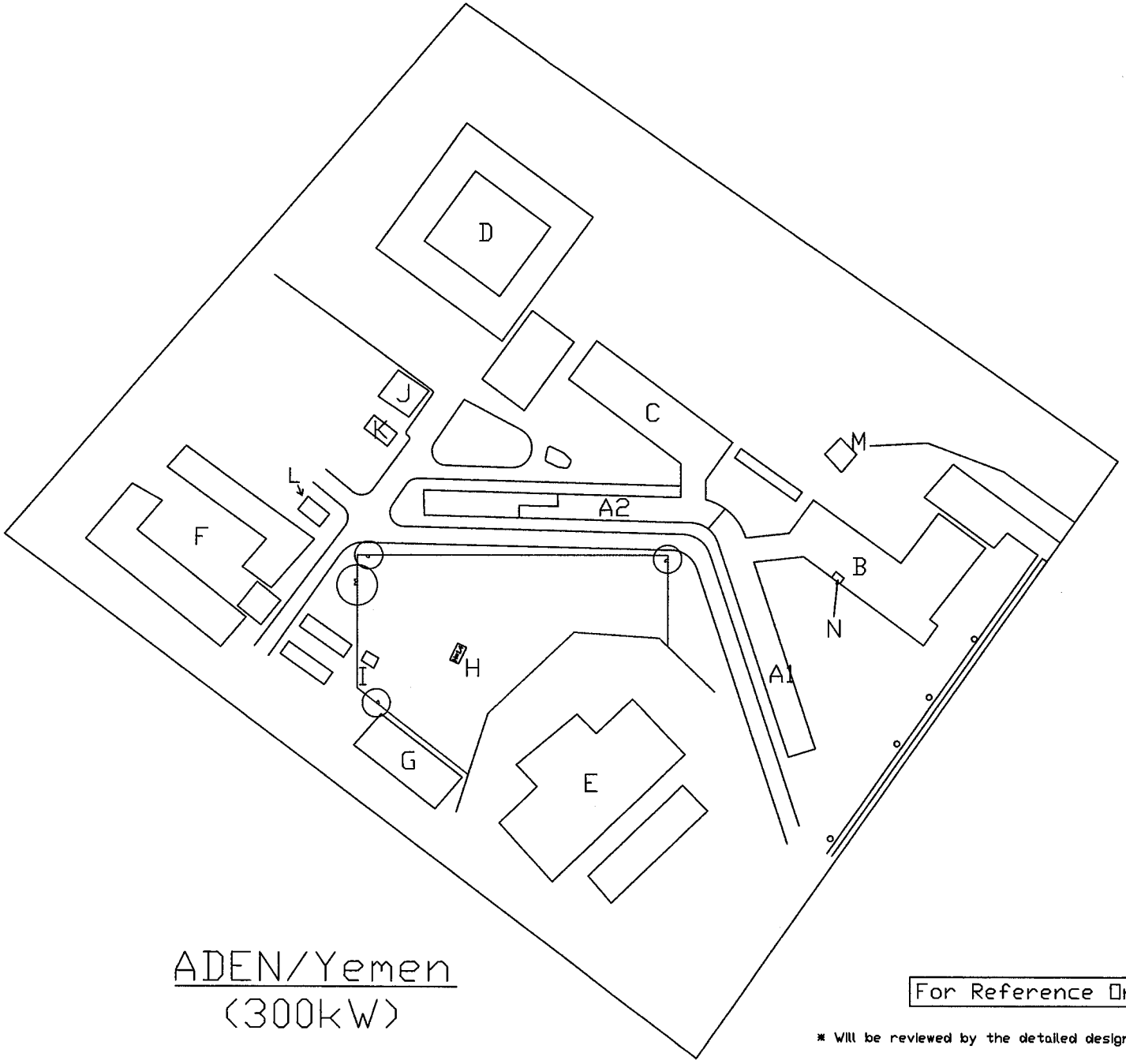
: FENCE
: GATE

ADEN/Yemen
(300kW)

For Reference Only

* Will be reviewed by the detailed design result, if necessary.

Project for Introduction Of Clean Energy using Photovoltaic Power		
TITLE : PAVING STONE PLAN		
DRAWING NO. YE-10		Rev.1
DATE	DRAWN	CHECKED
SCALE: ---- Unless		
NEWJEC	NEWJEC Inc. Osaka, JAPAN	



A1: MAIN HOSPITAL WARD,7F (PEDIATIC)
A2: MAIN HOSPITAL WARD,7F
(PEDIATIC,UNDER RENOVATION)
B: ADMINISTRATION
C: ADMINISTRATION
D: GYNECOLOGY SECTION,5F (産婦人科)
E: KIDNEY DIALICS,2F (腎臓透析)
F: MAINTENANCE ROOM,1F
G: STOREHOUSE
H: WATER TANK(UNDERGROUND)
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K: EXISTING NO.3 ELECTRIC ROOM (NOT USE)
L: EXISTING NO.1 ELECTRIC ROOM (T1,T2)
M: COFFEE SHOP
N: ELECTRICAL ROOM FOR BUILDING B

: FENCE
: GATE

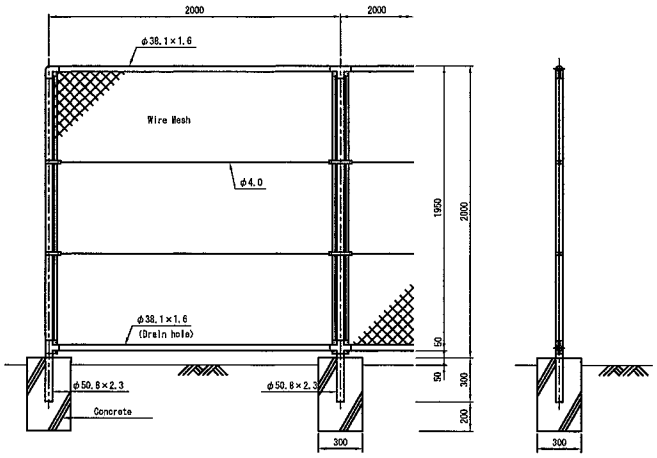
ADEN/Yemen
(300kW)

For Reference Only

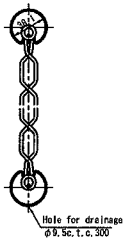
* Will be reviewed by the detailed design result, if necessary.

Project for Introduction Of Clean Energy using Photovoltaic Power		
TITLE : LAYOUT OF FENCE AND GATE		
DRAWING NO. YE-19		Rev.1
DATE	DRAWN	CHECKED
SCALE: ---- Unitm		
NEWJEC	NEWJEC Inc. Osaka,JAPAN	

PC−A2000 S=1:20



Cross Section of Fence S=1:3

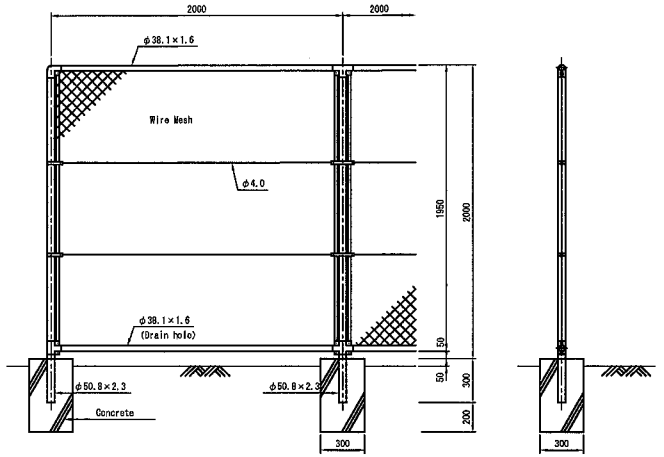


Note
・Paint ・・・ Zinc hot dipping covered by rust proof paint
Washer: zinc hot dipping only

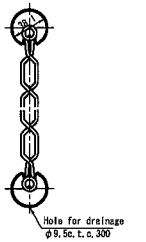
YE-20 FENCE,GATE(DETAIL)
[NON SCALE]

PC−A2000 S=1:20

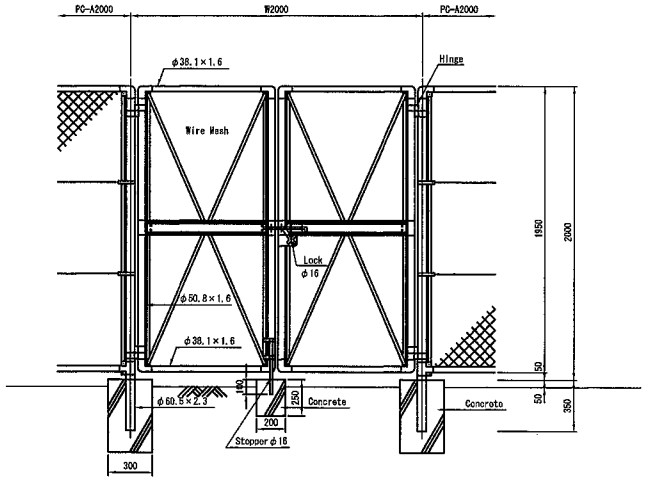
Note
・Paint ・・・ Zinc hot dipping covered by rust proof paint
Washer: zinc hot dipping only



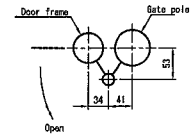
Cross Section of Fence S=1:3



PC Gate H2000×W2000 S=1:20

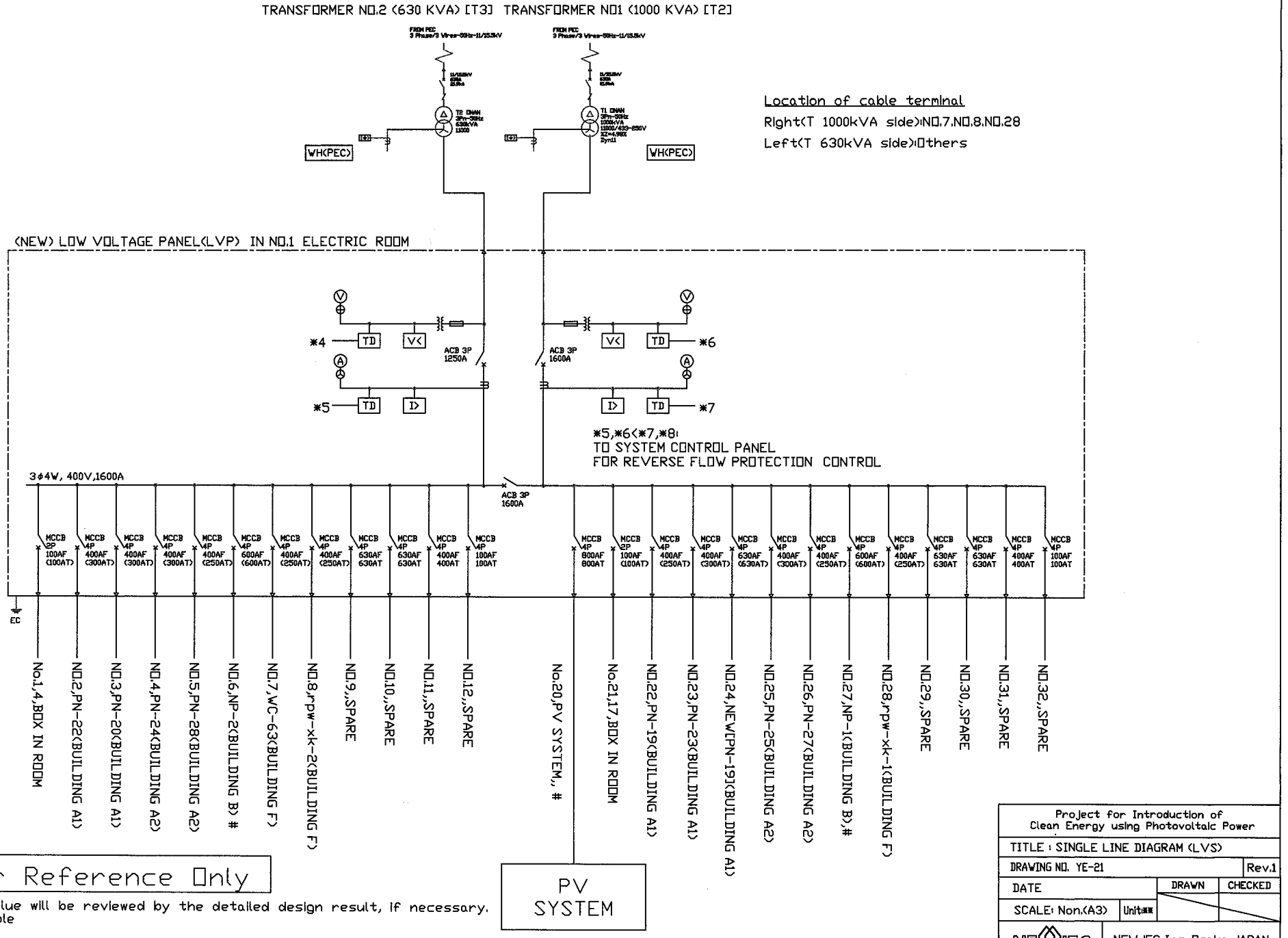


Detail of Gate pole・Door frame



Note
・Paint ・・・ Zinc hot dipping covered by rust pr
Washer: zinc hot dipping only
・The maximum angle of Gate Opening : 180°

Attachment -2



For Reference Only

* The value will be reviewed by the detailed design result, if necessary.
# New cable

Project for Introduction of Clean Energy using Photovoltaic Power			
TITLE : SINGLE LINE DIAGRAM (LVS)			
DRAWING NO. YE-21			Rev.1
DATE		DRAWN	CHECKED
SCALE: Non.(A3)	Unit:		
NEWJEC	NEWJEC Inc. Osaka,JAPAN		

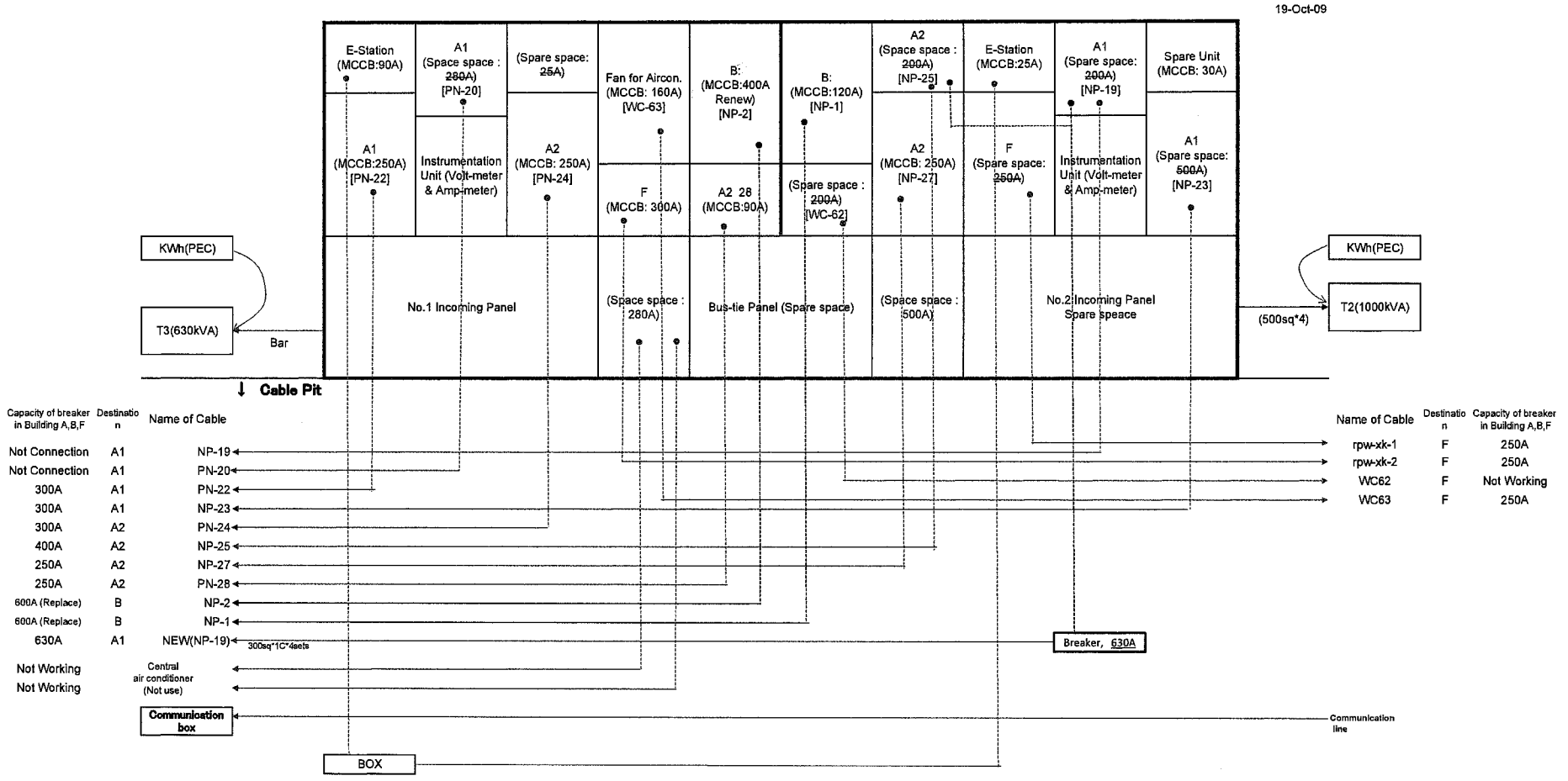
Capacity of Breakers of Low Voltage Panel(LVP) in No.1 Electrical Room

19-Oct-09

No.	Name of cable	From	To	EXISTING SYSTEM					NEW SYSTEM				
				Number of cable/core	Working / Not Working	Remarks	Capacity of breaker in Low Voltage Panel	Capacity of breaker in Building A,B,F	No,	Capacity of breaker in NEW Low Voltage Panel	Cables	Cable Terminal in LVP	Remaks
1	4	T3	BOX IN ROOM	2 core	working	IN HOUSE USE	90A	-	1	100A	Not replace	Left (T 630kVA side)	
2	PN-22	T3	Building A1	4 core	working		250A	300A	2	300A	Not replace	Left (T 630kVA side)	
3	PN-20	T3	Building A1	4 core	working		(280A)	-	3	300A	Not replace	Left (T 630kVA side)	
4	PN-24	T3	Building A2	4 core	working		250A	300A	4	300A	Not replace	Left (T 630kVA side)	
5	PN-28	T3	Building A2	4 core	working		90A	250A	5	250A	Not replace	Left (T 630kVA side)	
6	NP-2	T3	Building B	4 core	working	NEW BREAKER	400A		6	**600A**	**Replace**	Left (T 630kVA side)	
7	WC-63	T3	**Building F**	4 core	working		160A	250A	7	250A	Not replace	Right (T 1000kVA side)	
8	rpw-xk-2	T3	**Building F**	4 core	working			250A	8	250A	Not replace	Right (T 1000kVA side)	
9	17	T2	BOX IN ROOM	2 core	working	IN HOUSE USE	25A	-	21	25A	Not replace	Left (T 630kVA side)	
10	NP-19	T2	Building A1	4 core	working			-	22	250A	Not replace	Left (T 630kVA side)	
11	NP-23	T2	Building A1	4 core	working		(500A)	300A	23	400A	Not replace	Left (T 630kVA side)	
12	NEW (NP-19)	T2	Building A1	1 core*4	working	NEW CABLE 300sq	630A	630A	24	630A	Not replace	Left (T 630kVA side)	
13	PN-25	T2	Building A2	4 core	working		(200A)	400A	25	400A	Not replace	Left (T 630kVA side)	
14	PN-27	T2	Building A2	4 core	working		250A	250A	26	250A	Not replace	Left (T 630kVA side)	
15	NP-1	T2	Building B	4 core	working		120A		27	**600A**	**Replace**	Left (T 630kVA side)	
16	rpw-xk-1	T2	**Building F**	4 core	working			250A	28	250A	Not replace	Right (T 1000kVA side)	
	cy-3	T3	Central Air Conditioner	4 core*2	Not working		-	-		-			Not connection
	WC-62	T2	Building F	4 core	Not working		(200)						Not connection
	2	No cable					-	-					No cable
	19	No cable					-	-					No cable
	20	Nocable					-	-					No cable

Souse: Material from Hospital (18 Oct. 2009)

Low Voltage Panel in No.1 Electrical Room



RED LINE : Removal

List of load in Building B (administration)

18 October, 2009

Name	Light	Air conditioner	X-ray1	X-ray2	Fans	Refrigerator		Computer	Device of dental clinic
Capacity	80W	10A	100A,3ph	60A,3ph	100W	1.5A	6A	?	?
Number of load(s)	200	57	1	1	70	14	4	10	2
Operating day/hours	8:00-13:00	8:00-13:00	24 hour shand-by	24 hour shand-by	8:00-13:00	24 hour	8:00-13:00	8:00-13:00	8:00-13:00
Remarks									

Source : Material by Hospital (18 Oct.2009)

6.2 The Letter for Environmental Impact Assessment

بسم الله الرحمن الرحيم

REPUBLIC OF YEMEN
Ministry of Water and Environment
Environment Protection Authority
No/Ref: ....
Date: ....
No.of Pages: ....

الجمهورية اليمنية
وزارة المياه والبيئة
الهيئة العامة لحماية البيئة
الرقم / المرجع: [illegible]
التاريخ: ٢٠٠٩/١١/١١
عدد المرفقات:

Mr. Shoji Takamatsu
In charge of Environmental and social consideration
JICA Preparatory survey team

Subject: The Project for Clean Energy Promotion using Solar Photovoltaic System in the Republic of Yemen

Dear Sir

With reference to the above mentioned subject and the screening procedure for environmental and social consideration about the project mentioned in your letter. We would like to inform you that we agree to your opinion which is in accordance with Yemen and JICA`s guideline for Environmental and Social Consideration.

Best Regards

Mahmoud ~~M.Shidiwah~~

Chairman
Environmental protection Authority
Ministry of Water &Environment
Republic of Yemen

EPA

صنعاء - ص.ب : (١٩٧١٩)-هاتف: ٢٠٧٨١٦/٧ - فاكس : ٢٠٧٣٢٧ بريد إلكتروني : epa-yemen@yemen.net.ye
Sana'a - P.O.Box: (19719) - Tel: (207816/7) - Fax: (207327) - E-mail:epa-yemen@yemen.net.ye
www.yemenenvironment.org :الموقع الإلكتروني


JICA