Jebba Hydro Electric Plc.
The Federal Republic of Nigeria

PREPARATORY SURVEY REPORT ON THE HYDRO POWER REHABILITATION PROJECT IN THE FEDERAL REPUBLIC OF NIGERIA

JANUARY 2012

JAPAN INTERNATIONAL COOPERATION AGENCY

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AFD
CR(10)
12-001

Summary

The Federal Republic of Nigeria (hereinafter referred as "Nigeria") is faced with an absolute shortage of electricity supply amidst burgeoning demand to cater for the needs of Nigeria's population of approximately 150 million. Under a background of sluggish investment, existing facilities are becoming increasingly deteriorated and reliable plant capacity (average actual capacity in 2010) is only 3,825 MW with respect to estimated demand of 6,836 MW. In addition, due to the fragile transmission and distribution infrastructure, only around 60 percent of the population has access to electricity and rolling blackouts frequently occur in the cities. Under such stagnant situation of the power sector in Nigeria, the present administration of President Jonathan has revitalised the power sector reform through establishment of the Presidential Task Force on Power backed up with formulation of Roadmap for Power Sector Reform in August 2010 in order to drive the power sector from the Government of the Federal Republic of Nigeria (FGN) regulated subsidised structure to a challenging market oriented privatised mechanism.

In the past, hydropower generation has maintained a constant level of total output of approximately 7,000GWh, however, since such constant contribution by hydropower relied on the existing highly deteriorated generation facilities without overhaul and the construction of new hydropower plants is far away, it is obvious that rehabilitation of the existing hydropower generation facilities is the only practical but indispensable way to sustain 30 percent of power generation in Nigeria by maintaining the present hydropower generation level in the hydropower generation stations.

Jebba Hydro Power Station (JHPS), which is the target of the Project, is composed of six hydro power generation units with rated output of 578.4MW (96.4MW x six units) and vertical axis fixed propeller turbines with rated head of 27.6m and maximum discharge per unit of 380m^3/sec. JHPS is a major facility that accounts for roughly 12.5 percent of Nigeria's total generating capacity, however, it hasn't undergone a full-scale overhaul since being commissioned in 1985 and the advancing deterioration of equipment at the station signifies that it is in urgent need of rehabilitation. The Project aims to rehabilitate the existing hydro power generation units, namely 2G1, 2G2, 2G3 and 2G5 under Japanese ODA Loan Scheme. Additionally, since stabilisation of generating capacity at the said electric power station will contribute to the state power policies of stabilising power supply and diversifying energy sources in Nigeria, where the power demand and supply situation is very tight, the Project fits with JICA's priority assistance sectors. The Project will help mitigate greenhouse gas emissions by alleviating the risk of breakdown at JHPS.

As a result of field investigation by the Preparatory Survey Team (Team) dispatched by Japan International Cooperation Agency (JICA), it was confirmed that the power generation facility

is remarkably deteriorated and need some replacement of parts due to the long-term operation. Necessary actions need to be implemented to recover their capacity of power generation. Operating conditions of turbine 2G1, 2G2, 2G3 and 2G5 are in acceptable level, however, there are some defects to be considered for its repair. In terms of control/ equipment, oil-leaking was detected at HV bushing of 2G3 main transformer. Two 225/50/15 ton overhead travelling cranes in the powerhouse are currently out of service and is in the process of rehabilitation by own fund of Jebba Hydro Electric Plc. (JHEP). All civil structures are maintained in good condition.

Jebba reservoir is located downstream of Kainji reservoir and has been depended largely on water discharge from Kainji reservoir especially during dry season. Therefore, an integrated reservoir operation system between Kainji and Jebba is presently in practice to maintain planned water discharge taking expected water inflow, high water level operation and no overflow without power generation, etc. into consideration.

JHPS has total staff strength of 446 as of 28th July, 2011. Departmental staff strength extends as Administrative Division, Maintenance Division and Operation Division with staff strengths of 210, 161 and 75, respectively. As some of the technical personnel of JHPS have worked there since the plant commenced operation, technology has been passed on to a certain degree. These employees have conducted routine O & M and all repairs at the station over 27 years and have kept the equipment in good condition over this time. Moreover, since the station adopts the old style control system and most operations are conducted based on the manual, the fact that personnel have continued O & M without mishaps indicates that they have a high degree of technical proficiency. JHPS also holds up the management strategy goals in its company's statement and has been practicing the plant management based on Maintenance Management System in order to maintain high level of O & M of the power station.

Concerning the financial capacity of JHEP, since revenue is covered by government grants, JHEP has a steady source of revenue. That is, since the O & M costs incurred by JHEP are guaranteed by FGN, there is no risk that O & M will be affected by lack of funding. However, FGN is currently aiming to "conduct a review of the pricing system including power tariff hikes and to promote the introduction of competitive principles such as the creation of a power trading market based on a power pooling system" with a view to realising further reform of the power sector, and it is likely that JHEP will need to adopt a management structure that does not depend on government grants and strive to introduce power tariffs that are sufficient to cover costs.

The result of power demand-and-supply forecast over 20 years shows that in terms of annual power balance for the entire country, in case of without new IPP projects scenario, supply capacity exceeds demand for both peak load and power consumption in 2023. Even though new IPP projects would be installed between 2015 and 2018, it will still be necessary to install the coal fired generation plants in 2023. In case of without new IPP projects scenario, if power shortage in 2013 would be resolved, the annual balance of power supply will be sufficient by 2023. In case of with new IPP projects scenario, the annual balance of power supply will be sufficient by 2024. Therefore, it is recommended that the Federal Ministry of Power (FMOP) is required to start the preparation of installation of coal fired generation plants to resolve shortfall of power, to import power from the neighbouring countries or to take necessary recuperative measures in advance with due appropriation of his investment budget.

Deterioration of main parts of generation unit is classified into two types of deterioration, i.e. i) deterioration of dielectric strength for electrical insulation parts, and ii) deterioration caused by mechanical stresses for mechanical supporting parts. As a result of combined progress of the above two deteriorations, the generation unit has gradually declined in terms of performance and it is approaching the end of its service life.

The scope of rehabilitation of 1) generators, 2) turbines and governors, and 3) control equipment has been elaborated through discussion with the related officers in JHPS based on the field investigation results by the Team. For generators, the stators, rotors, exciters and metal bearing parts will mainly be rehabilitated. For turbines and governors, the wicket gate levers, links and bushing, main shaft seals and regulating rings will be rehabilitated. And for control equipment, overhaul of four main transformers will be conducted.

The priority of rehabilitation of the four generation units, namely 2G1, 2G2, 2G3 and 2G5, is in the order from highest priority, 2G5, 2G1, 2G3 and 2G2.

Three options of Project Plan have been proposed in the range of project scale between 5 billion Japanese Yen (JPY) and 10 billion JPY as follows:
Option 1: Rehabilitation of 2G5 and 2G1
Option 2: Rehabilitation of 2G5, 2G1 and 2G3
Option 3: Rehabilitation of 2G5, 2G1, 2G3 and 2G2
Project components in all options are the same and include the renovation works for generator, hydro turbine and governors, and main transformers.

The total Project cost for the above three options is as follows:

Unit: Billion

Case	Project Component	PROJECT COST			
		Procurement and Installation (JPY)	Counterpart Fund (NGN)	Consultant Fee (JPY)	TOTAL of ODA Loan (JPY)
Option 1	Renovation work for Unit 2G5 and 2G1	5.115	2.162 (JPY1.081)	0.410	5.525

Option 2	Renovation work for Unit 2G5, 2G1, and 2G3	7.084	2.838 (JPY1.419)	0.520	7.604
Option 3	Renovation work for Unit 2G5, 2G1, 2G3 and 2G2	9.095	3.514 (JPY1.757)	0.633	9.728

Project periods of Option 1, Option 2 and Option 3 are 69 months, 81 months and 93 months, respectively, all of which include 24 months of defect liability period for the last rehabilitated unit.

The Project provides capacity development of JHPS staff through OJT during site rehabilitation work and technical overseas training to be conducted in the contractor's workshop as well as at JHPS.

Result of Financial Analysis per option is shown below:

	Option 1 2 units	Option 2 3 units	Option 3 4 units
FIRR (Project FIRR)	-	10.84%	12.93%
NPV under Loan Interest Rate (1.4%)	-155,502	335,919	694,029
B/C under Loan Interest Rate (1.4%)	0.86	1.27	1.49

Result of Economic Analysis per option is shown below:

	Option 1 2 units	Option 2 3 units	Option 3 4 units
EIRR (Project EIRR)	36.68%	40.97%	39.73%
NPV under 12% Discount Rate	360,186	596,973	737,756
B/C under 12% discount Rate	5.23	7.69	8.67

As a result of the implementation of the rehabilitation work under Japanese ODA Loan Scheme, the following Project effect indicators are considered as quantitatively monitored:

(1) Maintenance and improvement of plant safety and reliability,
(2) Extension of the equipment service limit and recovery of performance,
(3) Reduction of maintenance cost,
(4) Environmental improvement, and
(5) Ratio of utilisation of the facilities.

The emission reductions of the Project are deemed to be equal to the baseline emission because the Project itself does not produce any other emission.

CO_2 Emissions Reduction

	Total Contributing Output for CO_2	Amount of baseline emissions	Amount of emissions from project (tCO_2)	Leakage (tCO_2)	Total emission reductions (tCO_2)

	Reduction (Gwh)	(tCO_2/Mwh)			
Option 1 (2 Units Rehabilitation)	26,158	22,076,600	0	0	17,661,600
Option 2 (3 Units Rehabilitation)	38,870	32,805,170	0	0	26,244,800
Option 3 (4 Units Rehabilitation)	46,175	38,971,036	0	0	31,177,600

It is conservatively assumed that 80% of expected average power output will be generated for the prolonged period due to deterioration of turbine, because turbines are out of scope of this rehabilitation. As a result, the emission reduction will be 17,661,600 tCO_2, 26,244,800 tCO_2, and 31,177,600 tCO_2 in cases of two units (Option 1), three units (Option 2) and four units (Option 3) are rehabilitated respectively.

Concerning the Project impact on the natural environment, the examination was conducted over three phases, i.e. (1) before Project implementation, (2) during Project implementation, and (3) during Project operation and it was concluded that there is no adverse impact on the environment, except appropriate treatment and disposal of asbestos contained waste. Such waste shall be properly removed, transported and disposed of by a certified person by NESREA.

The Project site is located more than 300 kilometres from the capital Abuja and is also remote from the nearest towns, and the entrance to the power station is under constant guard, therefore, impacts on third parties will be negligible. Moreover, since most of the work will be conducted indoors, there will be little impact in terms of vibration, particulate or noise. In addition, since inhabited areas are far away from the station, there will be no impact on local residents.

It is recommended that Nigerian side shall undertake the following works in order to ensure the smooth implementation of the Project through Japanese ODA Loan Scheme, if it were approved by GOJ:
(1) FGN’s budget allocation 2012-2020 for the counterpart fund
(2) Proposed High-Level Steering Committee
(3) Project implementation schedule
(4) Monitoring for environmental and social considerations
(5) Proper operation and maintenance of the rehabilitated facilities
(6) Proper involvement for auditing, submission of reports and evaluation made by JICA

The necessity and feasibility of the Project and the importance of maintaining high reliability of the performance of the power generation units in JHPS in Nigerian power sector have been confirmed. This Project provides considerable benefit and effect mentioned above to Nigeria and contributes to the improvement of stabilisation of power generation in the country.

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Abbreviations

ACM	Approved Consolidated Methodology
AFREN	African Rural Electrification Network
AGM	Assistant General Manager
APL	Adaptable Programme Lending
AT & P	African Timber and Plywood Company
B/C	Benefit by cost
BBC	Brown, Boveri & Cie
BM	Build Margin
BPE	Bureau of Public Enterprises
BPP	Bureau of Public Procurement
CDF	Comprehensive Development Framework
CO_2	Carbon dioxide
Consultant Guidelines	Guidelines for the Employment of Consultants under Japanese ODA Loans
DISCO	Distribution company
EIRR	Economic Internal Rate of Return
ECN	the Energy Commission of Nigeria
E/N	the Exchange of Notes
EOI	Expression of Interest
EPSR Act	Electric Power Sector Reform Act
EPIC	Electric Power Implementation Committee
FIRR	Financial Internal Rate of Return
FGN	Government of the Federal Republic of Nigeria
FMOF	Federal Ministry of Finance
FMOP	Federal Ministry of Power
FNIP	the First National Implementation Plan
GDP	Gross Domestic Product
GNI	Gross National Income
GOJ	Government of Japan
GWh	Gigawatt Hour
HV	High Voltage
IDA	International Development Association
IEC	International Electrotechnical Commission
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
JHEP	Jebba Hydro Electric Plc.
JHPS	Jebba Hydro Power Station

JICA	Japan International Cooperation Agency
JPY	Japanese Yen
KEPCO	Korea Electric Power Corporation
KV	Kilovolt
L/A	Loan Agreement
LLI	Long lead items
MO	Market Operations
MVA	Mega Volt Ampere
MVAr	Mega Volt Ampere Reactive
MW	Megawatt
MWh	Megawatt Hour
MYTO	Multi Year Tariff Order
NAPTIN	National Power Training Institute of Nigeria
NBET	Nigeria Bulk Electricity Trading Co. Plc.
NCP	National Council on Privatisation
NCV	Net Calorific Value
NDI	Non Destructive Inspection
NBET	Nigeria Bulk Electricity Trading Co. Plc.
NEEDS	National Empowerment Economic Development Strategy
NEGIP	Nigeria Electricity and Gas Improvement Project
NELMCO	Nigerian Electricity Liability Management Company
NEPA	Nigerian Electric Power Authority
NERC	Nigerian Electricity Regulatory Commission
NESCO	Nigeria Electric Supply Company
NESREA	National Environmental Standards and Regulations Enforcement Agency
NGN	Nigerian Naira
NIPP	National Integrated Power Project
NITEL	Nigeria Telecommunications Plc
NGO	Non-Governmental Organisation
NPV	Net Present Value
ODA	Official Development Assistance
OJT	On-the-job training
O & M	Operation and management
OM	Operating Margin
OPEC	Organization of the Petroleum Exporting Countries
PHCN	Power Holding Company of Nigeria
Plc.	Public Liability Company
PM	Principal Manager
PPA	Power Purchase Agreement
PPA	Public Procurement Act

Procurement Guidelines	Guidelines for Procurement under Japanese ODA Loans
PRG	Partial Risk Guarantee
PRSP	Poverty Reduction Strategy Papers
QCBS	Quality- and Cost-Based Selection
REB	Regional Electricity Boards
ROADMAP	Roadmap for Power Sector Reform
SLI	Short Lead Items
SO	System Operation
TB	Tenders Board
TCN	Transmission Company of Nigeria
TICAD-IV	Tokyo International Conference on African Development-IV
TSP	Transmission Service Provider
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VAT	Value Added Tax
WB	World Bank
WHT	Withholding Tax
WRDSEM	Water Resources Development and Sustainable Ecosystems Management

Chapter 1

Outline of Preparatory Survey

Chapter 1 Outline of Preparatory Survey

1.1 Introduction

In November 2010, the Government of the Federal Republic of Nigeria (FGN) made a request for ODA Loan for the Hydro Power Rehabilitation Project in Nigeria (hereinafter referred to as "the Project") to the Government of Japan (GOJ). GOJ entrusted the survey to examine the viability of this request to the Japan International Cooperation Agency (JICA), the official agency implementing Japanese Government's technical assistance and expediting proper execution of Japanese ODA Loan. JICA, in consultation with GOJ, decided to conduct a Preparatory Survey (hereinafter referred to as "the Survey") and sent the survey team (hereinafter referred to as "the Team"), headed by Mr. Toshio YANO (Department Manager, Electric Power System and Plant Department), Yachiyo Engineering Co., Ltd.

The Team has conducted the series of field surveys; i.e. the first field survey from 12 July 2011 until 6 August 2011, the second field survey from 18 September 2011 until 23 October 2011, and the third field survey from 27 November 2011 until 16 December 2011. The first field survey included (1) explanation on Japanese ODA Loan Scheme, (2) the characteristics, objectives and methods of the Survey, (3) Site investigation to identify the present situations of the Jebba Hydro Power Station (JHPS), and (4) confirmation of mutual understandings regarding basic items of the Project through discussions with the Nigerian officers concerned. The second field survey covered (1) confirmation of the contents of Interim Report, (2) establishment of rehabilitation items of generation facilities to be covered by the Project, (3) development of Project Implementation Schedule, (4) confirmation of required procedures and process for project implementation, (5) additional site investigation and survey, and (6) preparation for budgetary allocation. The third field survey deals with (1) explanation and discussion on the contents of Draft Final Report. For details of field survey schedule, refer to Appendix-2.

This Preparatory Survey Report is prepared by the Team based on the findings and information obtained in the field surveys and analysis in Japan for the purpose of reporting (1) necessity of the Project, (2) present situation of target generation facility, (3) present condition of operation and maintenance (O & M), (4) proposed draft ODA Project Loan plans, (5) Project cost estimates and (6) Project implementation schedule to serve as a reference for decision to be made by GOJ on the implementation of the Project under Japanese ODA Loan Scheme.

1.2 Objectives of the Survey

JHPS (rated output 578.4 MW), which is the target of this Survey, is a major facility that accounts for roughly 12.5 percent of Nigeria's total generating capacity, however, it hasn't undergone a full-scale overhaul since the commencement of commercial operation in 1985 and the advancing deterioration of equipment at the station signifies that it is in urgent need of rehabilitation. Additionally, since stabilisation of generating capacity at the said electric power station will contribute to the state power policies of stabilising power supply and diversifying energy sources in Nigeria, where the power demand and supply situation is very tight, the Project fits with JICA's priority assistance sectors. Also, since it will be necessary to compensate with power supply from other thermal power stations in the event where JHPS breaks down, the Project will help mitigate greenhouse gas emissions by alleviating the risk of breakdown at JHPS. In this respect, the Project may also be regarded as an undertaking to mitigate climate change.

1.3 Status of the Survey

The aims of the Survey are to formulate the Project to meet the conditions of Japanese ODA Loan. The field survey is divided into three stages; first field survey, second field survey and third field survey; i.e. explanation of a draft final report.

It is important for both sides to understand that at the stage of the Survey no commitment is made from the Japanese side concerning the realisation of the Project through Japanese ODA Loan.

This preparatory survey report will serve as reference for FGN and JICA to set up the actual scope of works to be included in the scheme of Japanese ODA Loan through discussion at the time of Project appraisal by JICA. Based on JICA's reporting to GOJ on appraisal results, the GOJ will decide whether or not to pledge the implementation of the Project under Japanese ODA Loan.

1.4 Scope of the Project

Rehabilitation of hydroelectric power generation units 2G1, 2G2, 2G3 and 2G5

(Rehabilitation of 2G4 and 2G6 is excluded from the Scope of the Project.)

1.5 Scope of Work

- Consulting services required for selection of contractor and supervision of rehabilitation works
- Design, fabrication, transportation, replacement and/or repair of deteriorated parts, and comprehensive overhaul of the generation units concerned
- Institutional and capacity development of JHPS

1.6 Project site

JHPS is located at N = 9°08′14.53″ and E = 4°47′32.89″ on the border between Kwara State and Niger State in the central western part of Nigeria.

Location map of the Project Site is as shown on the page after the Summary in this Report.

Chapter 2

Present Situation of Nigeria

Chapter 2 Present Situation of Nigeria

2.1 Overall Perspective of Power Sector

2.1.1 Present Situation of Power Sector in Nigeria

The Federal Republic of Nigeria (hereinafter referred to as “Nigeria”) is faced with an absolute shortage of electricity supply amidst burgeoning demand to cater for the needs of Nigeria’s population of approximately 150 million. Under a background of sluggish investment, existing facilities are becoming increasingly deteriorated and reliable plant capacity (average actual capacity in 2010) is only 3,825 MW with respect to estimated demand of 6,836 MW. In addition, due to the fragile transmission and distribution infrastructure, only around 60 percent of the population has access to electricity and rolling blackouts frequently occur in the cities. Since this current situation in the electric power sector is the single largest impediment to economic growth and improvement to living standards in the country, the stable supply of electricity is a matter requiring urgent attention. Moreover, as consumption of petroleum is expected to grow in line with the rapid economic growth of Nigeria, from the viewpoint of energy security there is a need to move away from the conventional electric power policy that is dependent on oil.

2.1.2 Power Sector Development Policy of Nigeria

FGN adopted the National Electric Power Policy in 2001/2002 with the promulgation of the Electric Power Sector Reform Act (EPSR Act) in 2005 geared to improving efficiency throughout the sector and expanding electric power supply through private investment. Regarding expansion of power generating capacity, it commenced the National Integrated Power Project (NIPP) as a fast-track undertaking with funding from the Excess Crude Oil account and NIPP has been targeted to add an approximate total of 4,800MW by 2013. FGN regards the power sector as an important area within the 7-point Agenda that had been adopted and maintained over the previous two administrations, and the present administration is also working to improve efficiency in existing power stations under the First National Implementation Plan for NV20:2020. The present administration has established the Presidential Task Force on Power in June 2010 to drive the implementation of the reform of Nigeria’s power sector under the proactive initiative through the Presidential Action Committee on Power chaired by the President Jonathan ensuring that issues connected to the power sector benefit priority attention at the highest level. FGN has built the Roadmap for Power Sector Reform (ROADMAP) in August 2010 on the foundation of the National Electric Power Policy and the EPSR Act in 2005 in order to ensure that the fundamental changes to the ownership, control and regulation of the sector envisaged by the legislation are achieved and the downstream benefits are realised. Concerning thermal power stations, FGN is encouraging entry by Independent Power Producers (IPPs) through preparing the legal environment and so on, while in the hydroelectric power sector, development of power sources by public agencies is likely to continue for the immediate future. Furthermore, based on the National Energy Policy that was formulated in 2003, FGN is aiming to reduce dependence on petroleum and diversify energy sources to include more electric power, natural gas and solar energy. Through restoring the generating capacity of existing electric power stations via this undertaking, Nigeria will be able to make some contribution to stabilising power supply and diversifying electric power sources.

2.1.3 Power Sector Development Policy of Japan

GOJ, based on the basic policy that was agreed in bilateral policy discussions with FGN in 2005 and 2007, regards regional and rural development (regional electrification, regional water supply, sanitation, agriculture and rural community development) as a key area in its support for Nigeria. In the regional electrification field, Japan has provided financial support via the Cross River and Akwa Ibom Rural Electrification Project (grant aid, 2006~2008) and institutional support via the Master Plan for Photovoltaic Energy Utilisation (development study, 2006) and so on. In the Rolling Plan for Nigeria currently under revision, the GOJ regards the resolution of issues in power generation, transmission and distribution as priority development issues and is advancing the electric power programme according to this understanding. Moreover, in the TICAD-IV Yokohama Action Plan, Japan has expressed its intention to provide Japanese ODA loans worth up to US$4 billion to Africa in the infrastructure sector including electric power.

2.2 Social and Economic Situation in Nigeria

2.2.1 Social Situation in Nigeria

Two major rivers extending over the land of Nigeria characterise the climate zones in Nigeria as two zones, i.e. the semi-dry zone of sub-Saharan climate observed in the northern part, and the wetland zone in the southern part, which have resulted in development of a variety of cultures in the country. There are more than 250 tribes, who speak more than 500 languages including regional dialects. Major tribes, i.e. Hausa and Frani that mainly reside in the northern part of the country occupy approximately 30 percent of whole population, and Yoruba Tribe whose major resident area is south-western part of Nigeria holds approximately 20 percent of population. Ibo Tribe mainly lives in south and south eastern part with approximately 18 percent of population. In terms of religious distribution in Nigeria, the population ratios among Islam, Christianity and traditional religions are approximately 50 percent, 40 percent and 10 percent respectively, and moving deeper into the north of the territory, the influence of Islam becomes stronger. Official language in Nigeria is English, and some of the local languages spoken by major tribes such as Hausa, Yoruba and Ibo can also be used in assemblies and governmental organisations. Local languages are applied for classes up to the third grade of elementary education, while English is used from the fourth grade. However, English is hardly understood in rural areas and there are a plenty of people who cannot even understand Hausa, Yoruba or Ibo languages.

2.2.2 Economic Situation in Nigeria

Nigeria has a per capita Gross National Income (GNI) of US$1,118 (the World Bank, 2009) and is Africa's largest oil producer and holder of natural gas reserves, giving it the second highest Gross Domestic Product (GDP) in Africa. Nigeria produces approximately 2,130,000 barrels of oil a day, making it the sixth largest OPEC producer, and it relies on oil to provide approximately 40 percent of GDP, 85 percent of total revenue and 99 percent of total export value. Nigeria previously struggled with an accumulated debt burden of around US$40 billion, however, reforms by the civil administration of President Obasanjo, who came to power in 1999, earned international praise, and the Paris Club nations agreed to reduce Nigeria's debt of US$30 billion by 60 percent at the summit that was held in October 2005. The present administration of President Jonathan inherited the 7-Point Agenda of his predecessor and is tackling for stimulating Nigeria's economic growth and launching country onto a path of sustained and rapid socio-economic development through realisation of First Implementation Plan under Nigeria Vision 20: 2020.

2.3 Development Plan in Nigeria

2.3.1 National Development Plans

(1) National Empowerment Economic Development Strategy (NEEDS)

FGN compiled NEEDS in 2004. Corresponding to the poverty reduction strategy papers (PRSP) of other developing countries, the NEEDS indicated Nigeria's poverty reduction strategy up to 2007. According to this, the following goals were raised for the power sector:

- Promote the power sector reform program,
- Increase generating capacity by 2007 (4,200MW up to10,000MW),
- Increase capacity of transmission lines (5,838MVA up to 9,340MVA),
- Increase capacity of distribution lines (8,425MVA up to15,165MVA),
- Reduction of transmission and distribution losses (45% down to15%),
- Conduct development of alternative energies such as coal, solar power, wind power and hydropower,
- Improve the collection rate of electricity charges (70% up to 95%), and
- Promote deregulation of the power sector in order to encourage entry by private sector corporations.

The NEEDS also stated that promotion of agriculture and the food processing industry and enhancement of education and medical facilities were essential for regional development, and it was anticipated that stable power supply would facilitate the development of the region; however, the above target values have still not been attained.

Accordingly, FGN in May 2007 formulated a new 7-point Agenda encompassing urgent energy measures, security measures concerning life and property, land reforms, human resources development, compulsory education, poverty reduction and transport and infrastructure development, and embarked on economic development based on this. Under this, in order to boost power generating capacity under the top priority heading of urgent energy measures, FGN launched the NIPP entailing construction of power stations with combined capacity of 6,000 MW in the south of the country, and these facilities are scheduled to be successively completed in 2011 and 2012.

(2) First National Implementation Plan for NV20: 2020

The First National Implementation Plan (FNIP) is one of the core components to realise the Nigeria Vision 20:2020 and it covers the development plan from 2010 to 2013. Vision 20:2020 is a comprehensive national development plan and its goal is that Nigeria will become one of the 20 largest economies in the world.

- Expansion of investments in critical infrastructure
- Fostering private sector-led non-oil growth to build the foundation for economic diversification
- Investing in human capital development to enhance national competitiveness
- Changing the value system to encourage honesty, industry and eliminating the culture of worshipping money
- Entrenching merit as a fundamental principle and core value
- Addressing threats to national security
- Deepening reforms in the social sector and extending reforms to the states and local governments
- Correcting the weaknesses inherent in the revenue allocation framework
- Intensifying the war against corruption
- Establishing the process for free and fair elections

On the basis of Vision 20:2020, the FNIP aims to promote sustainable social and economic development in a competitive and environmentally friendly way. The FNIP sets six thematic areas, and one of areas is “Physical Infrastructure Development (power, transport, oil and gas infrastructure, housing and water resources)”. The current power sector faces difficulties such as poor maintenance system of power infrastructure and unfavourable enabling environment for private sector participation. Thus, the FNIP suggests the necessity of overhauling and rehabilitating the existing power plants. In addition, the massive rehabilitation and expansion of transmission and distribution infrastructure will enhance the current capacity, provide redundancies in the transmission and distribution systems and ensure a fully-integrated network which minimises transmission and distribution losses.

2.3.2 Power Sector Development Plans

(1) National Energy Policy

The draft version of the National Energy Policy was formulated in 1993 by the Energy Commission of Nigeria (ECN) as a general energy policy covering multiple energy sources such as petroleum, natural gas, electric power and renewable energies, and the final version was completed in August 2005. According to this policy, the following goals have been raised for the electric power sector:

- Secure stable power supply (not limited to grid electrification) for 75 percent of the population by 2020,
- Complete electrification to all state capitals, local government headquarters (774) and major cities by 2010 (note: currently 661 local government headquarters have been electrified),
- Promote introduction of the private sector assuming participation by citizens of Nigeria, and
- Promote industrial development of regional areas and limit migration from the regions to the cities.

Hydropower is one of the major sources of base load electricity generation. Despite its high initial capital cost, hydropower provides one of the cheapest and cleanest sources of electricity. The total technically exploitable large scale hydropower potential of the country is estimated at over 10,000 MW, capable of producing 36,000 GWh of electricity annually. Only about one fifth of this potential had been developed as of 2001. Hydropower generation accounts for a substantial part of the total electricity generation mix. National Energy Policy bears its policy of hydropower development in fully harnessing the hydropower potential available in the country in an environmentally sustainable manner under the strategies of establishing and maintaining multilateral agreements to monitor and regulate the use of water in international rivers flowing through the country, ensuring increased indigenous participation in the planning, design and construction of hydropower stations, providing basic engineering infrastructure for the production of hydropower plants, equipment and accessories and initiating and updating data on the hydro potential of Nigerian rivers and identifying all the possible locations for dams. Accordingly, the ultimate goal is to increase the percentage contribution of hydroelectricity to the total energy mix, to conserve non-renewable resources used in the generation of electricity, to diversify the energy resource base and to ensure minimum damage to the ecosystem arising from hydropower development.

(2) Roadmap For Power Sector Reform

According to the ROADMAP, that was compiled in August 2010, it is planned to develop generating capacity of 40,000 MW over the coming 10 years, as the target of Vision 20:2020 is set, and efforts are currently being made to improve efficiency at existing power stations, construct new power stations based on private sector investment and reduce loss factor in the existing transmission and distribution systems. The ROADMAP outlines the plan to accelerate the pace of activity with respect to reforms mandated under the EPSR Act. The ROADMAP specified that the promotion of the power sector reform and the EPSR Act will be achieved by the following items:

- The establishment of an appropriate pricing regime,
- The establishment of a bulk purchaser,
- The provision of FGN Credit Enhancement,
- Creating an efficient and motivated workforce,
- Operating the Nigerian Electricity Liability Management Company,
- Contracting out the management of the Transmission Company of Nigeria,
- Clarifying and strengthening the licensing regime, and
- Strengthening the Nigerian Electricity Regulatory Commission (NERC).

With regards to the above items, it is worth for pointing that the ROADMAP suggests that the development of generating capacity of 40,000 MW will be realised if the ownership and control of energy sector is changed from the public sector to the private sector. In other words, the ROADMAP mentions that the construction of new power plants should be mainly financed by the private sector. However, it also describes that the FGN itself plans to make available public finance for the construction of new power plant. The ROADMAP stipulates that the FGN obtain the necessary capital through the renovation of tariff system on power supply without relying on utilising national capital directly. Generation of 40,000 MW is an ambitious goal and to satisfy it, the FGN needs to implement a dramatic change of the power system for encouraging the participation of private sector and generating the public fund.

2.3.3 Transition of Nigerian Power Sector

The Electric Power Reform started in 2000 with the inauguration of Electric Power Implementation Committee (EPIC). The National Electric Power Policy document was approved by FGN in 2001. Nigerian Electric Power Authority (NEPA) was vertically unbundled into generation, transmission and distribution in 2004. The EPSR Act became law on 11th March 2005. NEPA was transformed into Power Holding Company of Nigeria Plc. (PHCN) as a holding company for the assets, liabilities, employees, rights and obligations of NEPA. The process of incorporation of PHCN was concluded on 5th May 2005. NCP by an Order published in a Federal Gazette gave 1st July 2005 as the initial transfer date of assets, liabilities and staff of NEPA to PHCN. NERC was inaugurated in October 2005 as the sector regulator. In November 2005, 18 new successor companies comprising of six generation companies, one transmission company and 11 distribution companies were incorporated. The Market Rules to guide the operations in the electricity industry were approved in 2008. Relevant market codes (grid, distribution, performance, metering, etc.) have been issued. Companies to carry on the role of bulk trading in transition and liability management have been incorporated as Nigeria Bulk Electricity Trading Co. Plc. (NBET) and Nigerian Electricity Liability Management Company (NELMCO). Rural Electrification policy developed by the Bureau of Public Enterprises (BPE) was approved in 2006 and the Agency established but operations suspended in 2009. On 1st July 2006, the assets, liabilities and staff of PHCN were transferred to the successor companies, thereby granting the latter greater operational autonomy.

Power shortages continue despite FGN efforts re-emphasise the need for private sector intervention. Available information indicates that all the plants in the unbundled PHCN are in poor condition with several of the units and supporting services completely down. There are capacity constraints in the transmission and distribution networks needing significant investment in better technology and management. The transmission and distribution capacity is still below 4000 MW. It is estimated that the sum of US$ 40 billion (NGN 6 Trillion) will be required to meet Nigeria's electric power requirement between now and 2020.

2.3.4 Privatisation Trends in the Power Sector

Nigeria embarked on privatization of the power sector under supervision by the Federal Ministry of Power (FMOP) in 2006, and PHCN currently has jurisdiction over six power companies (hydropower and thermal power stations), one transmission company (transmission lines and substations) and 11 distribution companies (distribution lines and distribution substations). However, due to the lack of maintenance and suspension of new investment brought about by recession of the Nigerian economy, PHCN-owned facilities have become increasingly deteriorated and large-scale power interruptions have become regular occurrences even in the cities. For this reason, many corporations and large-scale consumers operate private generating facilities. In order to counter this deterioration of generating facilities, FGN drew up plans to rapidly attract IPPs and raise generating plant capacity to 10,000 MW by December 2010, however, due to the major delays in NIPP projects described earlier, little progress has been made in resolving the power shortages.

Under such circumstances, the President's Office announced future reform of the power sector to power business investors in October 2010. According to this, the thermal power stations indicated in Table 3-3 will be sold off to the private sector in their current state and FGN will purchase power from them. As for hydroelectric power stations, these will remain under state ownership but their O & M will be contracted to the private sector. Further to the work plan approved under the ROADMAP document, BPE had published advertisement, between December 13 and 20, 2010, in both local and international media inviting prospective investors to express interest in the privatisation of PHCN successor distribution and generation companies. Following this announcement, the Secretariat of the National Council on Privatisation (NCP) had harvested 929 bids for individual successor companies from 331 Expressions of Interest (EOIs) received from prospective investors. 525 bids for the successor companies created from

PHCN have been shortlisted for the next stage in the privatisation of the electricity utility. BPE developed evaluation criteria in accordance with the requirements of the EOI. A strong inter-agency team constituted the evaluation committee that undertook the assignment. The List of companies shortlisted for the next stage of the privatisation of PHCN successor companies was press-released on June 7, 2011. The List includes. 40 companies for hydro generation companies, 87 for thermal generation companies and 80 for distribution companies. 31 companies out of 40 are shortlisted for Kainji, while 35 companies out of 40 are for Shiroro. The O & M of JHPS is also included in the scope of companies shortlisted for Kainji because the operation of JHPS is closely linked with that of Kainji. The deadline for submission of bids for the generation companies is January 30, 2012 whereas that for distribution companies is February13, 2012. The bid evaluation process for the distribution firms will be completed on March 2, 2012 while that for the distribution companies will be finalised on March 12, 2012. In case of JHPS, according to the concession schedule proposed by FGN, the tender shall be carried out by the end of January 2012, and the negotiation and conclusion of the contract will be completed by the end of June 2012.

In Nigeria’s foregoing privatisation exercise, Korea Electric Power Corporation (KEPCO) was contracted to implement repairs at Egbin thermal power station in May 2007, however, it will still take time to take over the station by KEPCO due to delay in settlement of labour issues.

2.4 Assistance by Other Donors

(1) Overall Perspective

The World Bank (WB) plans to provide a positive cooperation for the assist of power sector in order to renovate “the improvement of inferior power provision and low ratio of electrification” to Nigeria. The summary of this cooperation scheme is indicated in Table1 2-1.

Also, WB planned to implement the project of African Rural Electrification Network (AFREN) in Nigeria which WB has already been implementing in various areas in Africa. However, this project aimed to support these communities situating far from existing national power system and requiring low power demand by electrifying through solar photovoltaic system and the achievement ratio is extremely low. In Nigeria, the preparation for creating Comprehensive Development Framework (CDF), which WB has been implementing all over the world, commenced in February 2000. This programme was examined with feedback from a wide range of stakeholders such as representatives of each region, NGOs, and private sectors. This programme prioritised the following items and rural electrification project implemented by Japan’s grant aid scheme is posited in the CDF as an infrastructure upgrading indispensable for poverty eradication.

- Renovation of governmental mechanism (anti-corruption, renovation of management mechanism)

- Economic development (Infrastructure upgrading such as enhancement of power provision system)
- Poverty eradication (Improvement of rural residents' lives by means of infrastructure upgrading such as rural electrification)

Table 2-1 World Bank's Roadmap of Assistance for the Power Sector

Issues	Solution	Countermeasures
(1) Inferior power supply	Induction of market principle	• Establish the joint investment company by dividing generator, transmission, distribution and supply of electricity divisions owned by NEPA based on facility and duty. (Through this, NEPA is reorganised into six generation companies, one transmission company and 11 distribution companies under PHCN at present.) • As for generation and distribution divisions, they will be divided into more companies. (The ROADMAP stipulates to strongly promote private investment to each division.) • To promote the induction of competitive principle of power dealing market by review of power tariff system including increase of power tariff and power pool system.
(2) Low ratio of power system connection (electrification ratio)	Improvement of electrification ratio	• Under newly established electrification system as well as power company, the electrification shall be promoted by regional joint association style and/or induction of private investment. • To position joint association to an important role player of electrification by means of electrification such as expansion of new distribution line (power will be purchased from newly divided generation company), installation of generators in line with implementation of unique business operation including revision of power tariff.

WB, together with cooperative finance from Germany and United Kingdom, implemented "Power system preservation and rehabilitation project" to NEPA in August 1989 amounting up to US$70 million. This project aimed for assistance for constitutional improvement for major transmission/distribution facilities such as Kainji Hydroelectric Power Station, Sapele Afam Thermal electric Power Station. However, although this project was completed in December 1995 two years later than the original schedule, the output was less than expected. Table 2-2 illustrates assistances for this sector extended by other donors.

Table 2-2 Assistance made by other Donor Countries/ International Agencies (Energy and Power Sector)

(Unit: US$ thousand)

Year	Donor	Project title	Amount	Scheme	Outline
2006～2007	UNDP	Rural Electrification Project by Photovoltaic	-	Grant aid	Installation of mini-grid system to six communities in Nigeria. Power supply to 1000 residents on maximum, well pump and public facilities

Year	Donor	Project title	Amount	Scheme	Outline
		Mini-grid			
2009～2012	USAID	Energy/Climate Change Programme	1,200	Technical cooperation	Assistance for institution renovation for reviving IPP Generation by utilising flare gas burning in oil fields.
2009～2014	World Bank	Nigeria Electricity and Gas Improvement Project	200,000	Financing, technical cooperation and guarantee	i) Reinforcement of facilities for reduction of transmission/ distribution loss, ii) policy advocacy to the power sector reform and iii) guarantee on construction of gas transportation lines for existing thermal electric power stations.

(2) Outline of Nigeria Electricity and Gas Improvement Project implemented by the World Bank

WB implemented Nigeria Electricity and Gas Improvement Project (NEGIP) from 2009 and the project is scheduled to be completed by 2014. The project aims to (i) improve the availability and reliability of gas supply to increase power generation in existing public sector power plants, and (ii) improve the power network's capacity and efficiency to transmit and distribute quality electricity to the consumers, at a cost of US$200 million with IDA partial risk guarantees in the amount of US$400 million. There are three components to the project which are (i) risk mitigation through a series of partial risk guarantees in support of gas supply to increase power generation from existing public sector power plants, (ii) enhancement of transmission and distribution infrastructure by reinforcing distribution networks to increase electricity supply in selected cities including Kano, Kaduna, Eko, Ikeja, Ibadan, Abuja, Benin, Port Harcourt, Yola, Jos and Enugu, and (iii) technical advisory services required to sustain ongoing reforms undertaken by the recipients to improve the performance of the power sector. As at 27th of March 2011, the project has not been restructured and overall rating is satisfactory. The Project is underpinned by the gradual adoption of a new contractual structure for gas sales, supply aggregation and transfer agreements to the power sector as well as a sound gas pricing scheme to create a commercially enforceable contracting structure and adequate incentives for supplying and converting gas to power. The IDA credit was declared effective in July 2010 following delays. The US$200 million investment component is proceeding on implementation with approximately 75% of the credit proceeds in bidding stage with two large tenders representing US$123 million out of the US$200 million due to be contracted in the next three to five months from March 2011. The initial PRG's, between PHCN and Chevron Nigeria Ltd. and Shell Petroleum Development Company respectively, are in final stages of negotiations and expected to be in place in the next six months from March 2011.[1]

[1] Source: (1) Nigeria-Electricity and Gas Improvement Project: Report No: 47945-NG, WB; (2) Nigeria-Electricity and Gas Improvement Project (NEGIP): P106172-Implementation Status Results Report: Sequence 03

(3) Niger River Basin Water Resources Development And Sustainable Ecosystems Management Adaptable Programme Lending Project implemented by the World Bank

WB also implements a project named Niger River Basin Water Resources Development And Sustainable Ecosystems Management (WRDSEM) Adaptable Programme Lending (APL) Project in support of the first phase of the Niger River Basin Water Resources Development And Sustainable Ecosystems Management Program. The programme is implemented in the area of Niger river basin commenced in 2007. The programme has two phases and includes Nigeria, Republics of Benin, Guinea, Mali, Niger, Burkina Faso, Cote d'Ivoire, Chad and Cameroon included as borrower. Credits/Grants are mainly from IDA which is 186 million US Dollars for the first phase and US$314 million for the second phase. The total amount of Credits/Grants is to be US$233.20 million for the first phase and US$200.00 million for the second phase, donated by IDA as well as European Union, French Development Agency, Canadian International Development Agency and African Development Bank. The overall Programme objective is to enhance regional coordination, development and sustainability of water resources management in the Niger River Basin. The expected outcomes would include: (i) improved institutional coordination for regional management and development of water resources in the Niger River Basin; (ii) improved performances of rehabilitated hydroelectric plants in targeted areas; (iii) improved irrigated agriculture in targeted areas; and (iv) improved watershed management in targeted areas. The programme is to be completed in 2013. The overall Programme outcomes would be measured by:

・Percentage of activities implemented according to the Sustainable Development Action Plan,
・Hydropower capacity (MW) rehabilitated/installed throughout the Niger Basin,
・Increased hectares of irrigated surface,
・Percentage of watershed area within the Niger River Basin using agro-forestry, river bank stabilization, silt and sedimentation control.

The overall programme is expected, after completion of the full implementation period, to have benefited five million people in the Basin and indirectly benefited approximately 10 million people.

The project development objective is the same as the programme objective. However, the project outcomes are targeted to the five Niger Basin countries participating in the first phase. The key project outcome indicators, accordingly, will be:

・Percentage of activities implemented according to the Sustainable Development Action Plan;
・Hydropower capacity (MW) rehabilitated at Kainji and Jebba hydropower plants;
・Increased hectares of irrigated surface in Mopti region (Mail), Tillaberi region (Niger), Karimama and Malanville districts (Benin); and
・Percentage of watershed area in Faranah region (Guinea), Mopti region(Mali), Dosso and Tillaberi regions (Niger) and Alibori region (Benin) using agro- forestry, river bank stabilization, silt and sedmentation control.

The proposed ecosystems management activities will provide locally and regionally ecological services to improve both the quantity and quality of the basin water resources. Increased water availability associated with the rehabilitation of Kainji and Jebba hydropower dams will augment the energy production with more reliable electricity supply to Nigeria in neighbouring countries including Niger and Benin. One of the project components includes rehabilitation, optimisation and development of regional infrastructure such as Kainji and Jebba hydropower plants since they have the potential to increase the energy production at a low cost and to supply additional energy to Niger and Benin. Several agreements are already in place to support the regional dimension and complement the benefits to be accrued from the dams and hydropower plants rehabilitation. These agreements include: (i) the 1972 bilateral agreement between Nigeria and Niger to provide 40 MW of firm power supply over a 20 year period from Kainji hydropower plants; (ii) the 1992 re-negotiated bilateral agreement to allow the export of an additional 30 MW to Niger; and (iii) the extension of the existing bilateral agreements to 2007. These agreements will be further expanded and consolidated throughout the Basin in addition to the transmission lines to transport the generated electricity from these hydropower plants and other facilities through activities under the Northern Corridor to be included in the third phase of the West African Power Pool. The sub component includes rehabilitation of Kainji dam and hydropower plant (115.88 million US dollar equivalent). This subcomponents include: (i) rehabilitation and harmonization of productive electromechanical equipment to restore the available capacity of 760 MW; (ii) rehabilitation of auxiliary services; (iii) rehabilitation of the navigation lock; (iv) upgrading instrumentation and monitoring equipment; (v) improvement of the flood warning systems and development of a decision support and management system; (vi) implementation of the environmental action plan to mitigate potential impact of the rehabilitation of Kainji and Jebba sites; and (vii) operational support and reinforcement of PHCN and the National Focal Structure in Nigeria. And the subcomponents also include rehabilitation of Jebba hydropower dam (US$11.67milllion equivalent). This subcomponent consists of: (i) selected rehabilitation of electro-mechanical equipment to ensure the availability of the entire installed capacity of 578 MW; (ii) rehabilitation of auxiliary services; (iii) civil works for stabilisation of the tailrace channel and rehabilitation of upper navigation lock; (iv) upgrading of instrumentation and monitoring equipment; (v) prevention of tree invasion; and (vi) reinforcement of the maintenance workshops. The Niger Basin Authority would be responsible for the overall implementation and coordination of WRDSEM 1 on behalf of the five riparian countries participating in the First Phase Project.

Chapter 3

Necessity for the Project

Chapter 3 Necessity for the Project

3.1 Background of the Project

3.1.1 Present Conditions and Issues in Electric Power Sector

(1) Power Situation in Nigeria

1) Overlook of Power Sector in Nigeria

The power sector in Nigeria is governed by PHCN whose shares are held by the Federal Ministry of Finance (FMOF) and BPE. Subsidiary companies of PHCN supply most of the power consumed in Nigeria supplemented with power purchase from private owned plants. In Nigeria, there is widespread private provision of power usually referred to as captive power supply. In the most cases, captive power supply serves as supplementary power source to irregular public power generation and transmission.

Before the dawn of hydropower generation from the Kainji Hydropower Station, the power supply in the country had been largely dependent on thermal power generation. Even though the implementation of commercial operation of Kainji Hydropower Station ushered in the shifting of power generation to hydropower in the early 1970s, thermal power generation dominated again some years later. This was due to rapid growth of power demand, the uncertain water-inflow at Kainji reservoir from the River Niger, cost escalation of hydropower construction and the long lead time for construction and generation.

Power generation in Nigeria is characterised by inadequate supply capacity in contrast with installed capacity. It is observed that only one third of installed capacity can correspond to the peak demand because of the non-availability of spare parts and poor maintenance. A poorly-motivated workforce, vandalism and theft of cables and other vital equipment, accidental destruction of distribution lines, illegal connections and resultant over-loading of distribution lines are additional serious problems and threat to PHCN. These have caused unannounced load shedding/power cut, prolonged and intermittent power outages which most power consumers have been struggling with over the years. Power sector reform was initiated to improve these undesirable situations.

PHCN has a monopoly of public generation and distribution of power in Nigeria. PHCN also purchases power from private sector such as Nigeria Electric Supply Company (NESCO), Shell Company and African Timber and Plywood Company (AT & P) and the power is transmitted by the Transmission Company of Nigeria (TCN) and is distributed and sold by subsidiary distribution companies of PHCN to consumers.

Every consumer is supposed to receive a two-months' bill based on estimated consumption and a third or quarterly bill which reflects actual consumption after the meter readings. In some cases the meters are not read in six months and in other cases the estimates are arbitrary. There is need for a better billing system and motivation for meter-reading staff to improve their performance.

2) Current actual generation capacity of grid connected power system

As of July 2010, the total actual (on-grid) power generation capacity stood at 4,612 MW, of which the thermal power plants accounted for 3,382 MW and the hydro power plants accounted for 1,230 MW. However, not all of this actual capacity can be mobilised full-time throughout the year because of the following reasons:

- The average annual generation capacity from the three Hydropower plants (Kainji, Jebba, and Shiroro) is capped at an average of 950 MW per annum due to the available year-round water flow volume.
- The total actual generation capacity of the thermal plants (3,382 MW) is significantly less than their total installed capacity (6,539 MW), and the actual generation capacity of 3,382 MW should correspond to the annual average generation.
- In practice, however, much of the gap between total installed capacity and actual generation capacity can only be restored through rehabilitation. And in the meantime, the currently available units will still be exposed to temporary equipment failures and the need for routine maintenance and repair.

Hence, only 85 percent (2,875 MW) of the actual generation capacity of the thermal units can be treated as the available annual average generation capacity.

Thus, as shown in Table 3-1, the annual average generation for all grid-connected power plants as of July 2010 stood at approximately 3,825 MW.

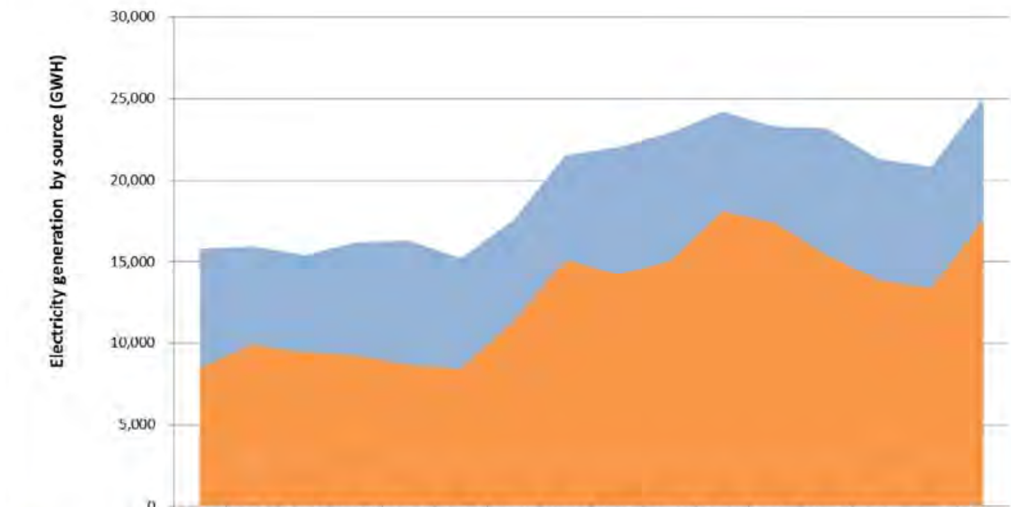
Table 3-1 Actual Generation Capacity of Grid Connected Power Plants

As of 2010	PHCN	NIPP	IPP	Total	Available average capacity (MW)	Remarks
Hydro	1,230	0	0	1,230	950	Given available water inflow
Thermal	1,862	0	1,520	3,382	2,875	85% capacity factor assumed
Total	3,092	0	1,520	4,612	3,825	

This figure of 3,825 MW is just above the higher end of the peak generation figures recorded in July 2010.

As described above, although power demand in Nigeria has reached approximately 6,836 MW, power supply output is still only 3,825 MW in spite of installed capacity of 6,600 MW holding in the existing power stations. This discrepancy in plant capacity and supply arises from deterioration of generation facilities in the hydropower stations of Kainji, Jebba and Shiroro. Also in thermal power stations, since some units have ceased operation due to deterioration of equipment and lack of maintenance, current output is only about 58 percent of the installed capacity.

Figure 3-1 shows Nigeria's electricity generation by source, i.e. hydropower generation and thermal power generation. In the last 16 years, hydropower generation maintains its constant level of total output of approximately 7,000 GWh, while thermal power generation reached to 17,600 GWh which is more than double from that in 1995. However, since the above constant contribution by hydropower relied on the existing highly deteriorated generation facilities without overhaul and the construction of new hydropower plant is far distant, it is obvious that rehabilitation of the existing hydropower generation facility is only practical but indispensable way to sustain 30 percent of power generation in Nigeria by maintaining the present hydropower generation level in the hydropower generation stations.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Hydroelectricity	7,336	6,079	5,971	6,986	7,619	6,783	6,256	6,390	7,823	7,877	6,120	5,889	7,776	7,443	7,465	7,416
Conventional Thermal	8,457	9,893	9,446	9,227	8,672	8,443	11,305	15,154	14,206	15,040	18,095	17,411	15,410	13,866	13,373	17,604

*Note that values of Hydroelectricity and Conventional thermal in 2006 are presumed values.

Figure 3-1 Movements and Balance in Hydroelectric and Thermal Power Generating Facilities

3) State-sponsored Power Generation

Table 3-2 shows the state-sponsored power generation (gas turbine) projects currently being implemented by Japanese and other overseas corporations in the south of Nigeria. Since these facilities will supplement 60 percent of the power shortage when they are successively completed, they will go a long way to alleviating power interruptions in the country. Meanwhile, since the demand for power is increasing every year, there is still urgent need to secure new power sources and improve efficiency in existing generating facilities.

Table 3-2 GTG Power Stations in Nigeria (under implementation)

Project Name	State (Location)	Output (MW)	Completion (Year)	Contractors
PHCN Alaoji Power Station (Combined Cycle)	Abia State	1,074	2012	Rockson Engineering
NIPP Egbema Power Station	Imo State	340	2013	Rockson Engineering
NIPP Gbarain Power Station	Bayelsa State	230	2013	Rockson Engineering
NIPP Omoku Power Station	River State	252	2013	Rockson Engineering
NIPP Ihovbor Power Station	Edo State	450	2012	Marubeni Corporation
NIPP Sapele Power Station	Delta State	450	2011	Marubeni Corporation
NIPP Calabar Power Station	Cross River State	560	2013	Marubeni Corporation
NIPP Olorunsogo Power Station	Ogun State	750	2011	SEPCO
NIPP Omotosho Power Station	Ondo State	500	2013	CMEC
SPDC Afam VI Power Station	Rivers State	650	2010	Daewoo
NIPP Gerugu Power Station	Kogi State	750	2013	SIEMENS
TOTAL		**6,006**		

The GTG Unit/Simple or Combined Cycle NIPP is currently being advanced in the south of Nigeria as shown in Table 3-2, however, since output from the project facilities will only be just under 4,000 MW when complete, total output will still be less than 10,000 MW. Since this still accounts for around just 70 percent of total power demand in Nigeria, even though these projects will help mitigate power interruptions, major improvement will still be a distant prospect.

Furthermore, since the above projects only pertain to construction of power stations and do not cover fuel (gas) supply facilities or power transmission lines, even when the power stations are completed, more time will be needed in order to realise power generation and transmission.

4) Foregoing Privatisation of Thermal Power Generation

KEPCO, on May 1, 2007, announced that it had received an order worth US$27 million from FGN to restore boilers and normalise the power station at Egbin in the south of the country. This power station, which has six units of 220 MW each, is located at 60 kilometres east of the country's economic centre of Lagos. Two generators at this power station were previously rendered inoperable by a boiler explosion. It will still take time to take over the station by KEPCO due to delay in settlement of labour issues.

5) Hydropower Generation

In Nigeria, hydropower accounts for approximately 30 percent of total generating output, making it the second most important source of power behind thermal generation (70 percent). Existing hydroelectric power stations comprise Kainji Hydroelectric Power Station[2] (rated output: 760 MW, potential generating output: 412 MW (efficiency 54 percent)) on the River Niger, Jebba Hydroelectric Power Station (rated output: 540 MW, potential generating output: 454 MW (efficiency 79 percent)) also on the Niger, and Shiroro Hydroelectric Power Station

[2] In 1972, 1.5 billion yen of loan assistance was provided by the Overseas Economic Cooperation Fund (OECF), and this was followed by a 2.5 billion yen loan in 1974.

(rated output: 600 MW, potential generating output: 480 MW (efficiency 80 percent)) on a tributary to the River Niger; however, due to generator breakdowns and operation suspensions due to water level adjustments, these power stations have a lot of idle time and cannot provide ample power supply. In particular, the large capacity Kainji Hydroelectric Power Station has badly deteriorated generating efficiency. The same thing is also happening at the other two hydroelectric stations and all facilities are in need of rehabilitation. Concerning future hydroelectric generation potential, since Nigeria has two major waterways in the River Niger and Benue River, there is potential for 10,000 MW, of which generating capacity of 734 MW has been confirmed in micro hydropower facilities (UNDP Report: Renewable Energy Resources in Nigeria, 2005).

6) Diversification of power source

FMOP has taken the initiative in compiling the Renewable Electricity Policy Guidelines as a policy guideline for expanding use of electricity generated from renewable energy, and this will be followed up as an indicator of future development.

According to these guidelines, in order to boost electric power supply capacity suited to economic and social development, diversify power resources from the viewpoint of energy security, as well as promote and improve regional electrification, it is necessary to promote power supply utilising renewable energies. The Renewable Electricity Action Programme is currently being formulated to provide concrete measures for realizing the said guidelines in future. According to this, the goal for renewable energy introduction over a decade between 2007 and 2016 has been set as shown in Table3-3. According to this, approximately 54 percent of the generation potential of micro hydropower will be achieved by 2016. This only represents 7 percent of the current deficit with respect to total demand; however, in terms of securing power sources and enabling low tariffs in the drive for regional electrification, this will be essential for raising the electrification rate.

Table 3-3 Targets for Introduction of Renewable Energy in Nigeria

Type	Target year for introduction		
	2007	2010	2016
Micro hydropower	50MW	100MW	400MW
Solar power	10MW	20MW	130MW
Wind power	0	20MW	100MW
Biomass (bagasse)	0	15MW	105MW
Total	**60MW**	**155MW**	**735MW**

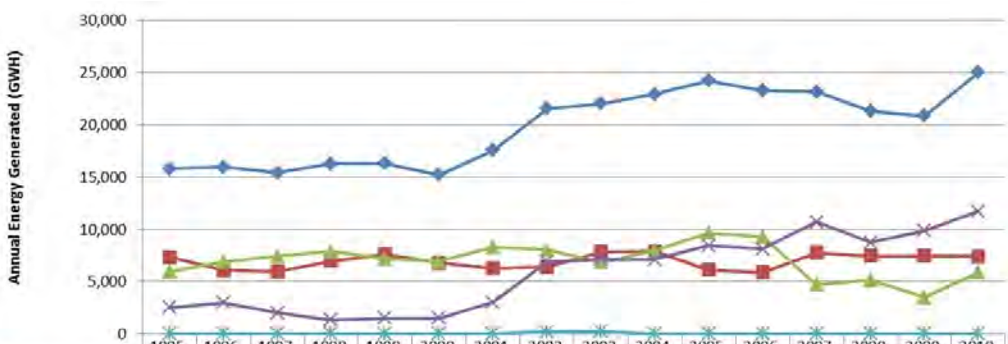
(2) Current Condition of Generating Facilities

Power supply in Nigeria is generated by thermal power stations operated by PHCN, and IPPs on the southern coast and three hydroelectric power stations located in central and western highlands, and this is supplied throughout the country via 330 kV and 132 kV trunk transmission lines. Table 3-4 outlines the current conditions of existing generating facilities and this shows that thermal power accounts for 70 percent of overall plant capacity and hydropower for 30 percent. Meanwhile, Figure 3-2 shows generated electric power. According to this, whereas hydropower accounted for 54 percent and thermal power for 46 percent in 1995, the situation has been reversed with thermal power (especially gas turbines) rising to 75 percent and hydropower declining to 25 percent by 2010. The power generating facilities are operated by independent power companies and IPPs separate from PHCN.

Table 3-4 Main Power Generating Facilities in Nigeria

Owner		Power Station	Generating Method	Rated Output (MW)	Potential Generating Output (2010 mean) (MW)	Annual Utilisation Factor (%)
PHCN	Kainji/ Jebba Hydro Electric Plc.	Kainji	Hydropower	760	412	54
		Jebba	Hydropower	578	320	56
	Shiroro Hydro Power Plc.	Shiroro	Hydropower	600	480	80
	Egbin Electric Power Business Unit (EEPBU)	Egbin (Lagos)	Steam power	1,320	1,148	87
	Ughelli Power Plc.	Delta	Gas turbine	972	393	43
	Sapele Power Plc.	Sapele	Steam power	1,020	105	10
	Afam Power Plc.	Afam	Gas turbine	776	221	36
	Ajaokuta	Ajaokuta	Steam power	55	25	46
	Ijora Thermal Power Station	Ijora	Diesel	65	0	0
IPP	AES	AES	Gas turbine	270	235	87
	Okpai	Okpai	Gas turbine	450	262	58
	Calabar Thermal Power Station	Calabar	Diesel	6.6	4.4	0
Total				**6,656**	**3,736**	**56**

Source: Opportunities for Investors in Nigeria's Power Sector, October 2010)



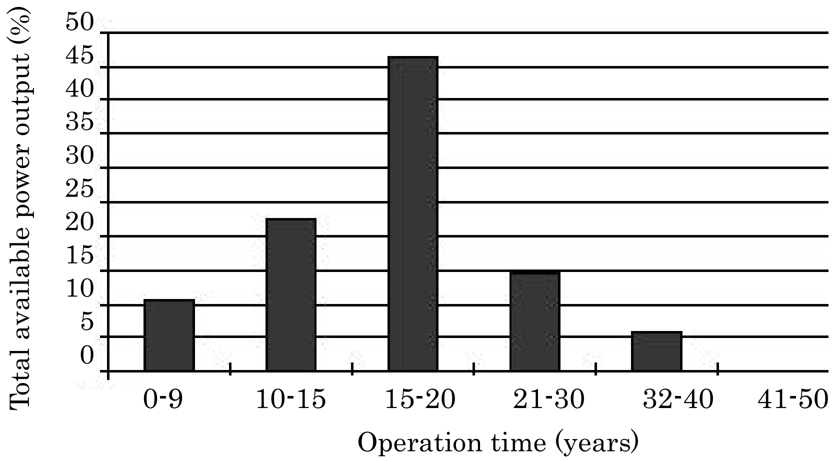
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Energy	15,793	15,972	15,417	16,253	16,291	15,227	17,563	21,544	22,029	22,917	24,215	23,300	23,187	21,309	20,838	25,020
Hydro power	7,336	6,079	5,971	6,986	7,619	6,783	6,256	6,390	7,823	7,877	6,120	5,889	7,776	7,443	7,465	7,416
Steam Turbine	5,953	6,908	7,422	7,887	7,194	6,942	8,269	8,034	6,820	7,943	9,660	9,295	4,700	5,141	3,476	5,899
Gas Turbine	2,503	2,984	2,019	1,340	1,478	1,501	3,029	6,906	7,141	7,095	8,435	8,116	10,710	8,725	9,897	11,705
Diesel	1	1	5	0	0	0	7	214	245	2	0	0	0	0	0	0

Year

*Note that values of Hydro power, Steam Turbine, Gas Turbine and Diesel in 2006 are presumed values.
Source: PHCN

Figure 3-2 Movements in Annual Generated Electric Energy

Since Nigeria's major power stations were constructed during the period from the mid-1960s to the late 1980s, equipment has become badly deteriorated; moreover, since the stations have no spare capacity, they cannot implement overhauls, while there are shortages of spare parts and engineers and so on. As a result, generating output as of 2005 was 3,736 MW, accounting for only around 60 percent of rated output. Figure 3-3 shows the state of deterioration of generating facilities owned by PHCN. According to this, approximately 65 percent of facilities are operating beyond their statutory service life of 15 years and are in need of urgent repairs.



Source: PHCN

Figure 3-3 Dilapidated status of the Power Station

(3) Current Condition of Transmission Facilities

TCN is made up of the Corporate Headquarters at Abuja, the National Control Centre (NCC) at Osogbo, two Supplementary NCC located at Benin and Shiroro, eight Regional Transmission Headquarters located at Bauchi, Benin, Enugu, Kaduna, Lagos, Osogbo, Port-Harcourt and Shiroro, and 32 work centres spread around the eight Regions. TCN, by virtue of its operating license, carries out the functions of Transmission Service Provider (TSP), System Operations (SO) and Market Operations (MO). Transmission Network is currently inadequate and inefficient in transmitting the current generated power to the places of demand. There have also been high transmission losses.

FGN will stop operating the current system: FGN will still maintain ownership of major portions of the system and will have a strong shareholding in the rest. All the Distribution Companies will be offered for sale to private sector investors based on sale of a minimum of 51 percent of FGN's equity in the companies. TCN will be handed over to a credible private sector company under a management contract.

Power transmission has improved significantly during the past years. Capacity of the system was increased, the amount of power that transmitted through the system increased by 25 percent and the number of system collapses was reduced to 13 cases and 17 cases during the last two years. Large-scale improvements in the infrastructure include:

1) 986.5km of 330kV lines out of which 50% have been completed.
2) 705.3km of 132kV lines out of which 396.8km, more than 50%, have been completed.
3) 1350MVA transformer capacity at 330/132kV out of which some 900MVA, more than 50 percent, have been completed.
4) 3000MVA capacity of 132/33kV transformers out of which 960 MVA, more than 50 percent, have been completed.

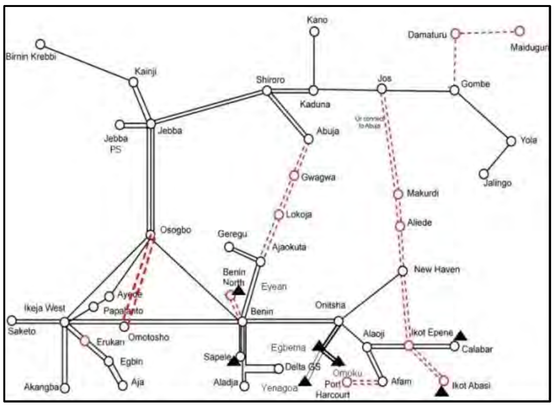
The power sector performance in the last two years is shown in Table 3-5.

Table 3-5 Performance of Power Transmission Sector

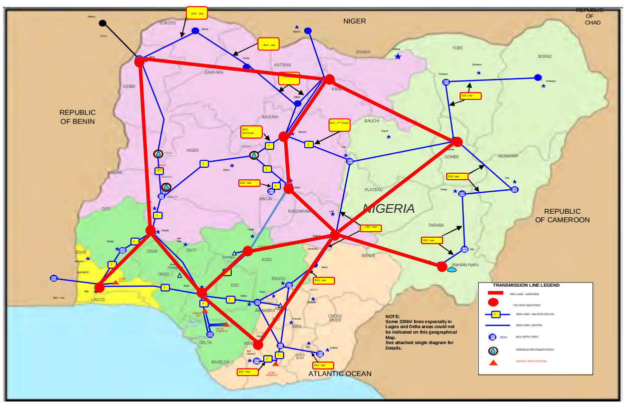
S/N	FACTOR	2009	2010
1	Energy Wheeled (MWh)	12,914,271.69	16,279,718.93
2	Capacity 330/132kV (MVA)	6,848	7,088
3	Capacity 132/33kV (MVA)	8,590	8,925
4	Number of 330kV Substations	32	32
5	Number of 132kV Substations	107	108
6	Total Number of 330kV Circuits	70	70
7	Total Number of 132kV Circuits	179	179
8	Length of 330kV Lines (km)	4,955.4	4,955.4
9	Length of 132kV Lines (km)	6,749	6,749
10	Average Transmission Loss (%)	8.04	8.75
11	Number of National Control Centres	1	1
12	Number of Supplementary NCC	2	2
13	Number of System Collapses	17	13

Source: 2010 Ministerial Briefing, FMOP

NIPP Critical T/L (330KV) Projects



Super Grid Plan (700KV)



(4) Basic concept of Power tariff renovation plan (MYTO)

NERC's commitment and mission are to ensure adequate, safe, reliable and affordable electricity provision. In January 2006, PHCN requested an average increase in its tariff by 60%

from the one that had been operative since 2002. NERC considered this request along with the industry's performance in recent years. The Commission found it necessary to adopt a holistic and scientific approach in order to amend pricing of electricity in the long term and to ensure gradual sector development through a cost reflective and fair tariff regime. The process took into consideration the interest of consumers and investors in simultaneously addressing the problems of electricity supply and proper pricing of power in Nigeria.

Commercial viability of the industry is a main issue to solve the problems of the power sector in Nigeria. NERC needed to develop a new tariff order for the industry predicated on revenue requirement and sustainability of the incumbent operators and new entrants as the industry had been barely able to generate enough revenue to cover its operating cost let alone meet its considerable capital expenditure needs. The industry was also not in a position to attract investment from the private sector, which is much needed if the twin problems of inadequate and unreliable electricity services are to be tackled. Cost-reflectivity was therefore a key consideration in the new tariff order for NERC although the impact of any tariff reviews on consumers was considered. At the centre of the new tariff order was a multi-year tariff model, which calculated electricity prices based on revenue requirements of the whole industry. This approach was introduced, aiming at ensuring the necessary support for operating and capital expenditures of the various sub-sectors of the industry, i.e. generation, transmission and distribution.

NERC established the schedule of tariffs to be paid each year for the following Nigerian Electricity Supply Industry (NESI) charges over the period 1 July 2008 to 30 June 2013:

- Wholesale price of generated electricity sold to the national grid;
- Transmission charges;
- Retail tariff schedules;
- Transmission system operator charge;
- PHCN Headquarters charge;
- Regulatory charge; and
- Payment and level of tariff equalisation payments between distributors in order to continue to maintain a national uniform tariff.

These regulated charges were established pursuant to the authority given under Section 76 of the EPSR Act (2005). The tariff path set for the five years was derived from a regulatory model of the NESI. The model was developed from historical data of the industry and forecasts provided by PHCN and its predecessor as well as adopted by NERC. This approach forms the basis of a Multi-Year Tariff Order (MYTO), applying an industry wide determination of current and future costs. NERC also carried out wide consultation with the industry operators, labour unions, consumer advocacy groups, the legislature and relevant government departments on both the MYTO methodology and tariff.

Retail tariff schedules have been reviewed each year and changes were and will be made to the regulated charges if there are material variations greater than plus or minus 5 percent (in magnitude) in the inflation rate, exchange rate and cost of gas. A major review of all inputs to the tariff calculation will be undertaken in 2012 and serve as the basis for a new MYTO to be used for next five years starting from 1 July 2013.

To avoid rate shock, the tariffs paid by consumers were set as less than cost reflective values over the first three years of the introduction of MYTO. However, federal government support has been provided in a form of subsidy to make up the shortfall caused by the difference between actual and cost reflective tariffs over this period, while the tariff moves gradually towards viable levels. The subsidy has been also ready to compensate the shortfall incurred when the tariffs are lower than the costs. Efforts to make the tariffs reach viable levels little by little have been made to lessen the burden on consumers while allowing them to gradually adjust to the new price level. The subsidy comes to an end when the price reaches the level reflecting the cost (i.e. in the 4th year).

3.2 Present Situation of Target Generation Facility and Issues

3.2.1 Outline of Jebba Hydroelectric Power Station

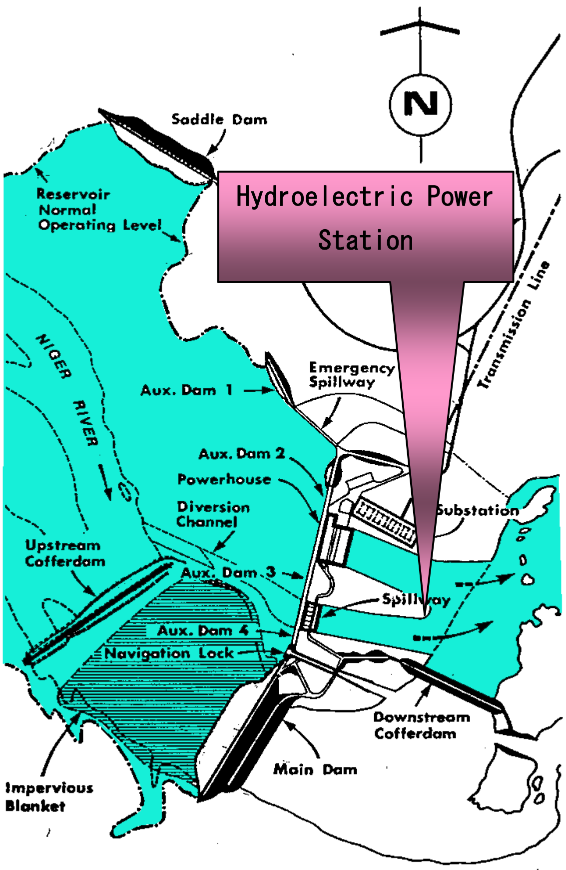


Figure 3-4 Layout of Jebba Dam and Facilities

Jebba Dam is located at N = 9°08′14.53″ and E = 4°47′32.89″ on the border between Kwara State and Niger State in the central western part of Nigeria. When the reservoir is full, the surface of dam lake reaches an elevation of EL = 103 m and covers an area of 303 km^2 and has capacity of 1,000,000,000 m^3, making it the country's second largest reservoir behind that of Kainji Dam. The main structure is a rock fill dam stretching for 670 m, and the main body is a straight gravity concrete dam with total length of 337 m. The dam and hydroelectric power station were completed in 1983 and commissioning test started in the same year. Although it was in 1985 when commercial operation commenced, the generating equipment has not undergone any overhaul in the 26 years since. This hydroelectric power station comprises six turbine and generator units and has rated generation capacity of 578.4 MW (96.4 MW/unit x six units); however, generating efficiency has declined due to deterioration of equipment and the current capacity is only around 80 percent. Currently, 2G6 is not operating due to breakdown.

3.2.2 Outline Features of Generation Facility

JHPS is a dam-type power station as indicated in Figures 3-5 and 3-6 and it uses vertical axis fixed propeller turbines made by Escher Wyss, Austria. The generators are made by Hitachi, Ltd., Japan.

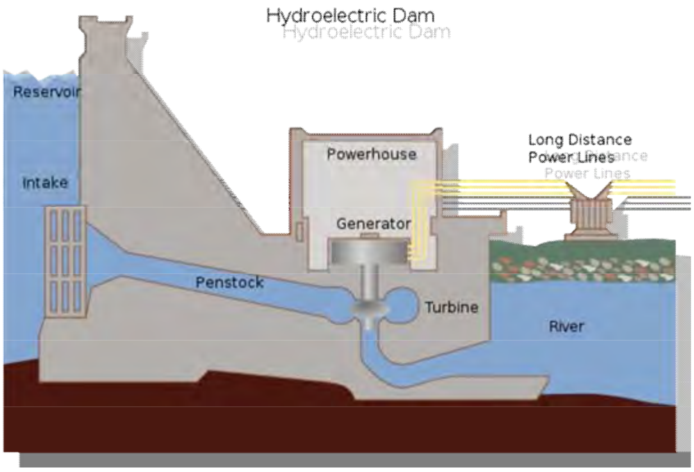


Figure 3-5 Basic Concept of the Dam-type Power Station

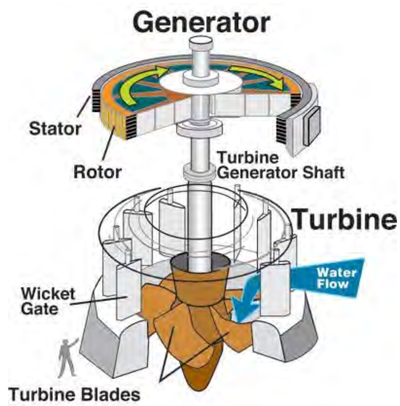


Figure 3-6 Composition of the Vertical Axis Fixed Blade Propeller Turbine and Generator

The turbines at JHPS are the vertical axis fixed blade propeller type made by Escher Wyss, Austria, and are the largest turbines out of those installed in African nations. The turbine propeller comprises five fixed blades and has a diameter of 7.1 m. The manufacturer received the order for the turbines from Niger Dam Authority in 1978 and manufactured them at a factory in Germany. The turbines took approximately seven years from manufacture to commissioning (the picture on the left shows the vertical axis propeller turbine at the power station when it was first manufactured, taken from the company’s homepage). Table 3-6 gives an outline of equipment specifications at JHPS.

Table 3-6 Outline Specifications of Equipment at Jebba Hydroelectric Power Station

Item/Contents	Unit No.					
	2G1	**2G2**	**2G3**	**2G4**	**2G5**	**2G6**
1. Turbine	**Fixed Blade Propeller Single Runner**					
(1) Manufacturer	Escher Wyss/Vatech/ANDRIZ, Austria					
(2) Turbine Blades	5 blades (blade diameter at time of installation: 7,100mm)					
(3) Guide Vane (Wicket Gate)	24					
(4) Head (m)	Min.25.0m～Max.29.7m					
(5) Effective water volume (m^3/sec)	380m^3/sec.					
(6) Effective water level during operation (m)	99.0m~103.0m					
(7) Peak output (‘MW)	96.4 MW (Output at Max. Rated Head: 102.9 MW)					
(8) Revolutions (rpm)	93.75 rpm, Runner Away Speed: 179 rpm					
2. Generator	**Type : Synchronous (Commissioning Year 1985)**					
(1) Manufacturer	HITACHI, Japan					
(2) Output (MVA/MW)	103.5MVA/96.4MW					
(3) Revolutions (rpm), rotating direction	93.75 rpm/clockwise					
(4) Cooling method	Air Cooling, 12 Air Coolers/ One Generator					
(5) Power factor	0.85					
(6) Voltage (kV), current (A)	16,000V/3,735A					
(7) Frequency (Hz)	50 Hz					
(8) Poles	64					
(9) Applicable standard	ANSI C50.12 (1965)					
3. Auxiliary equipment						
(1) Control system	Analogue local control for UG4, UG5 & UG6 and digital local control for UG1, UG2 & UG3					
(2) Main transformer	16/330 kV, 119 MVA x 6					
(3) Maintenance overhead crane	Main crane 225 ton x 2 units (auxiliary crane 50 ton/15 ton)					
(4) In-station transformer	11kV/415V, 2 MVA x 4					

3.2.3 Present Situation of Generation Unit and Auxiliary Facility

3.2.3.1 Generator

(1) Summary

As the scope of the Project indicates, site inspections of generators 2G1, 2G2, 2G3 and 2G5 have been carried out during the survey period. As a result, it was confirmed that the power generation facility is remarkably deteriorated and needs some replacement of parts due to the long-term operation. Necessary actions need to be implemented to recover their ability of power generation.

(2) Key results

1) Stator

During this site inspection, contamination by oil leakage and oil mist was observed on the surface of the stator. The insulation deterioration such as transformation of insulation cap at the turbine side and powder's occurrence was confirmed (Photo 3.1-1 - Photo 3.1-3). In addition, loosening of the stator wedge caused by the electro-magnetic vibration at normal operation was confirmed.

Photo 3.1-1 Insulation cap

Photo 3.1-2 Powder occurrence on coil end

Photo 3.1-3 Tapping of stator wedge

2) Rotor

Although the observation did not detect major defects, since the insulation deterioration occurs after more than 25 years operation in general, the possibility of insulation deterioration was presumed. Also, because accidents of crack development happened previously in the rotor spiders of 2G3 and 2G5, similar diagnosis are also presumed to occur in 2G1 and 2G2 (Photo 3.1-4 and Photo 3.1-5).

Photo 3.1-4 Repaired rotor Spider (2G5)

Photo 3.1-5 Present condition of rotor spider (2G2)

3) Collector ring

Although the observation did not detect major defects, since the insulation deterioration occurs after more than 25 years operation in general, the possibility of insulation deterioration was presumed. Photo 3.1-6 shows the current condition of collector ring.

Photo 3.1-6: Collector ring

4) Bearing and surrounding devices

Although thrust bearings were not dismantled during this site inspection, the following items were presumed.

- Occurrence of the fretting wear on the thrust runner
- Wearing off the rubbing parts on thrust bearings and guide bearings
- Occurrence of deterioration in functioning by heat contact stress of 1,665 ton thrust bearing load on spring supports for Hitachi pivot spring

5) Oil cooler and air cooler

Although defects such as water-leaking were not detected, flaws, oil-stain and dust of air cooler fin were confirmed (Photo 3.1-7 and Photo 3.1-8). Performance degradation and/or the thickness decreasing of the cooling pipes were confirmed.

Photo 3.1-7 Damage of air cooler fin

Photo 3.1-8 Oil-stain and dust of air cooler fin

6) Oil lift pump and oil circulation pump

Oil-gathering was confirmed around oil lift pump and oil circulation pump due to oil-leaking ubiquitously from each of equipment (Photo 3.1-7 and Photo 3.1-8). Also, performance degradation and/or the thickness decreasing of the circulating pipes on oil lubricating pumps and high pressure oil pump is presumed.

Photo 3.1-9 Oil-gathering around oil lift pump

Photo 3.1-10 Oil-leaking from oil circulating pump

7) Brake ring

Discolouration, hair-crack and wearing-off etc. was confirmed (Photo 3.1-10).

Photo 3.1-10 Brake ring

8) Oil flow control valves

It was confirmed that the oil flow control valves for thrust bearing shoes was not well adjusted. Also, oil-leaking was observed (Photo 3.1-11 and Photo 3.1-12).

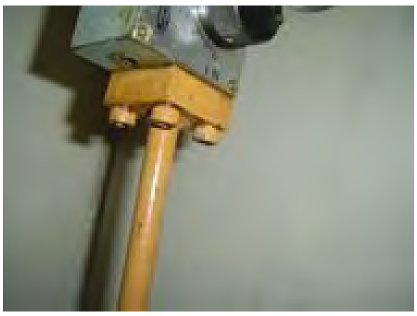


Photo 3.1-11 Oil-leaking from Oil Flow control valve

Photo 3.1-12 Oil-gathering underneath Oil Flow control valve

9) Space heater

Cover was deformed. (Photo 3.1-13).

Photo 3.1-13 Deformation of space heater covers were detected

10) Instruments

Indication error in the instruments and wire-breaking were confirmed (Photo 3.1-14 and Photo 3.1-15). It was confirmed that some displays of instruments were unreliable.

Photo 3.1-14 Indication error of resistance thermal detector (RTD) thermometer

Photo 3.1-15 Oil temperature sensor

For further detail of result of generator inspection, reference shall be made to the Appendix-6.1 and 6.2.

3.2.3.2 Turbine

(1) Summary

The Team implemented the unwater site inspection solely for turbine 2G2 due to the time constraint, which JHPS can share from operation time of available generation units, for the inspection. At the same time, it was difficult for JHPS to share from operation time of other units for the inspection in order not to interrupt the power supply to the demand.

The Team accepted the above proposal from JHPS because the running hours of 2G2 in the last five years are not so different from those of other units, namely 35,208 hours for 2G1, 24,769 hours for 2G2, 34,556 hours for 2G3 and 29,881 for 2G5, and the actual operating conditions of other units are almost similar to those of 2G2 considering the uniformity in operation conditions such as head for power generation, and water temperature and quality.

On the other hand, inspection of turbine 2G1, 2G3 and 2G5 was carried out through observing their operations. The Team found the followings:

1) Parts in the water passage of 2G2 have been deteriorated over the past 28 years of operation.
2) It is presumed that parts in the water passage of 2G1, 2G3 and 2G5 are almost similar to 2G2.
3) Operating conditions of turbine 2G1, 2G2, 2G3 and 2G5 are at an acceptable level, however, there are some defects to be considered for repair.

(2) Key results of turbine 2G2

1) Runner

Cavitation corrosion on bottom surface of the blade was not observed. It was observed that it has been repaired during recent maintenance (Photo 3.2-1).

Photo 3.2-1 The bottom surface of the blade

2) Shaft seal

Present status of shaft seal is not in satisfactory condition. (Photo 3.2-2 - Photo 3.2-5).

Much leakage water was found (see “Operating modes of pumps” for water drainage pumps described hereunder).

Discharge of water supply - 150 lit/min.

Pressure of supply of water is not measured continuously. Water pressure gauge is not installed in the pipeline.

There is uneven wear on the working surfaces of Teflon segments. (Photo 3.2-6 – Photo 3.2-7)

Photo 3.2-2 Shaft seal

Photo 3.2-3 Shaft seal

Photo 3.2-4 Water level in shaft seal

Photo 3.2-5 Shaft seal

Photo 3.2-6 Teflon segments (replaced)

Photo 3.2-7 Teflon segments (replaced)

According to JHPS's information,

- Teflon segment has been replaced every two to three years,
- Filter (Photo 3.2-8) does not fully clean the supply water to the shaft seal, and
- Shaft seals are important parts for turbine operation, but repaired seals in the 2G2 turbine do not work properly.

Photo 3.2-8 Filter for Shaft Seal Supply Water

3) Drainage pump and Water supply pump

Both drainage pumps (first-direct current: DC, second - alternating current: AC) were already worn. (Photo 3.2-9).

- Water supply pumps for shaft seal do not provide required quantity of clean water (Photo 3.2-10).
- A filter does not provide quality of cleaning water for supply to the seals shafts.

Photo 3.2-9 Drainage Pump

Photo 3.2-10 Water supply pump

4) Wicket Gate

Regulation ring of 2G2 is moving smoothly.

According to JHPS's information:

- Mechanical servo locks for the regulating ring are damaged and replacement is needed for all the units. (Photo 3.2-11).

There is leakage oil through servomotor seals at all units (Photo 3.2-12)

Drainage through pistons of servomotors also is increased; refer to Table 3-7 for pumps oil pressure units.

Leakage water through upper seals of vanes stems are as shown below.

- 2G1: Approx. 0.15 litre/sec.
- 2G2: Practically no leakage
- 2G3: Approx. 1.0 litre/sec.
- 2G5: Approx. 0.3 litre/sec.

There is backlash in link No.16 (joint with pin of regulation ring) at 2G1.

Photo 3.2-11 Stopper of Regulation Ring

Photo 3.2-12 Oil on Turbine Cover

Table 3-7 Operating Modes of Pumps

	Operation	No operation	Working cycle – Operation/ No operation
2G1 pump oil pressure unit	56 second	12 minute	1/12
2G3 pump oil pressure unit	47 second	7 minute	1/9
2G1 water drainage pump	5 minute	8 minute	1/1,6
2G3 water drainage pump	1 hour and 24 minute	6 minute	14/1

For further detail of result of turbine inspection, reference shall be made to Appendix-7.1.

3.2.3.3 Control/Equipment

(1) Summary

The investigation was carried out through discussions with O & M staffs of JHPS and observation of equipment. According to the O & M staffs, there was no flaw in 2G1, 2G2, 2G3 and 2G4. Although the Team confirmed that the equipment successfully display the output of generated power, the Team could not thoroughly confirm the present condition of control system. However, since nearly 30 years have passed since the commencement of operation, the measurement display equipment on the mimic board and fault recorder etc. were found to be left broken down. There seems not to be a problem in the O & M of the power station and switchyard. However, the facilities are getting too old and the procurement of these repair parts is becoming difficult. Summary of findings is shown in Table 3-8.

Table 3-8 Summary of Control/Equipment

Equipment		2G1	2G2	2G3	2G5
Control panel	Generator control panel, protective relay panel, switchboard, transmission line panel	Some of analogue and digital meters are out of order. According to the interviews, the protection panels are working properly. However, there is concern about the failure due to aging of components that have been used beyond their durable period.			
Storage battery	Battery, charger	Bank A of station storage batteries are already updated. According to the interviews, the charger is working properly. However, there is concern about the failure due to aging of components that have been used beyond their durable period.			
330kV Circuit breakers	Circuit breaker, disconnecting switch, PT, CT	The three circuit breakers are already updated. According to the interviews, the switchyard equipment is working properly. However, there is concern about the failure due to aging of components that have been used beyond their durable period.			
Transformers	Transformer, bushing	None	None	Oil leakage	None
Cable	Control cable, power cable	In the exterior, a problem was not seen.			

(2) Control and Protection Panel

1) Control desk

Start and stop operation of the generator is done by push-button switch on the analogue type control desk (each unit). The circuit breakers for power generation have been installed on the HV (330kV) side of the main transformer, and are installed in the Switchyard.

Operator connects the generated power in JHPS to the national grid by different switch (Discrepancy switch) while checking the grid voltage and frequency on synchronised panel.

If the circuit breaker is not turned on by input signals to the breaker, repeat the blinking light of this discrepancy switch. If successfully operated, the lamp goes out.

In addition, the generator voltage, the current, the power and power factor, etc. are indicated in analogue meter on the control desk.

Photo 3.3-1 Control desk

2) Switchyard mimic board

Control switches for the switchyard breakers associated with each generator are located on the control desk. All other breakers and disconnect control switches are located on the switchyard mimic control panel.

At the top of the switchyard mimic board, a frequency display unit is installed.

The left side of the switchyard mimic board is the civil indicators (water level of tailrace and opening of the gate), annunciator alarms for the failure of JHPS, synchronous and mimic bus of 11kV/415V aux. power in the centre, there are mimic bus of 330kV switching station on the right.

The opening of each gate is displayed on the analogue meter, and this indicates the gate fully opened or the gate fully closed by limit switches installed at the gate.

In the event of double generator failure, as well as to a disconnection from the power system and stop the generator, the fault indicator flickers on the supervisory board.

In the event of serious failure in the generator, as well as fault indicator flickers on the supervisory board, and a disconnection from the mains to stop the generator.

The control desk and switchyard mimic boards are freestanding panels installed in a single row. The control desk and the mimic boards contain a mock set-up for the complete Jebba generating and transmission system showing all generators, powerhouse, auxiliaries, circuit breakers, disconnect switched, ground switching transmission lines, transformers and buses. It was confirmed that all MW indicators on mimic panel are in bad condition. Data is not automatically sent to National Control Centre (Photo 3.3-2).

All discrepancy and control switches on the control desk and switchyard mimic board are identified by PHCN. Each discrepancy switch is working properly.

Annunciation alarms and MW, MVAr and kV meters are also mounted on the mimic board. MW meters on the switchyard mimic board are failed.

Photo 3.3-2 Mimic panel

3) The switchyard protection relay panels

The switchyard protection relay panels are installed in a separate room adjacent to the control room. There are 25 panels arranged in two rows in the switchyard relay room.

4) Fault Recorder

The fault recorder is utilised to record disturbances on the two outgoing 330kV transmission line circuits from Jebba switchyard. The fault recording system is used to continually monitor the power system and is fully automatic with pre-fault data storage for use in sensing and recording electrical quantities and events associated with transients on the electric power system. However, according to interviews, the fault recorder has been out of order.

(3) Storage Battery and Charger

The 110V storage battery and charger system contains two banks of batteries and three battery chargers which were supplied to the loads imposed by the operation, control, indications, and alarms of powerhouse and switchyard. One bank of storage batteries was already updated (Photo 3.3-3).

Photo 3.3-3 A group of updated battery

(4) 330kV Circuit Breaker (CB)

Circuit breakers are the high speed outdoor type, manufactured by Brown, Boveri & Cie (BBC), with pneumatic operating mechanism, capable of making or breaking electrical circuits under normal and abnormal conditions (Photo 3.3-4). Circuit breaker operation is manually initiated for the normal switching of system components in or out of service as operating requirements dictate or automatically initiated by protective relays. Three CBs have been already updated to spring powered stored energy operating mechanism type (Photo 3.3-5) for 2G2, 2G4 and 2G5. According to interviews, other CBs will also be updated in near future.

Photo 3.3-4 Old 330kV circuit breaker (BBC ELF 362 nc 2a 1983)

Photo 3.3-5 New 330kV circuit Breaker (Areva GL315 2010)

(5) 119MVA Transformers (16/330kV)

The six transformers are installed in the area between the powerhouse and the dam at elevation 86.0m in bay adjacent to the upstream wall of the powerhouse. Each transformer is located off centre to the North of the respective generator and connected directly with bus duct. As for the B phase of the HV bushing of 2G3, oil-leaking was detected (Photo 3.3-6).

On the other hand, the life of the diaphragm in conservator on the top of the transformer is 15 years. The replacement is recommended.

Photo 3.3-6 Oil-leaking on B phase of 2G3

(6) Cable

All cables are put on the cable trays in the power station, the switchyard equipment and the administration building. The cable trays are installed on the side walls of the switchyard trenches and cable tunnel to administration building. All cables from switchyard to administration building are sealed at the cable entrance to prevent any water from entering into the cable tunnel. All cable trenches in the switchyard and power station are covered with concrete covers and steel plates. As for the cable insert of the boards and cubicles, cable glands have been used. Major problems were not observed in the present situation.

3.2.3.4 Auxiliary Equipment

The two 225/50/15 ton cranes installed inside the powerhouose are currently out of operation due to failure of the brakes, control circuits and power collectors. Since these cranes are indispensible for carrying out normal maintenance work as well as upgrading the existing generators, FGN will need to repair and restore these cranes before the start of the rehabilitation work.

Moroever, because the wire rope and other parts have gone beyond their service life, it will be desirable to replace such parts during the rehabilitation and restoration work.

JHPS is in the final stage of selection of the contractor for rehabilitation of these cranes. The Bureau of Public Procurement (BPP) approved the rehabilitation work of crane in the powerhouse and as of December 2011, the original equipment manufacturer (OEM) has just been selecterd as the contractor. The overall rehabilitation work is projected to be completed by the middle of 2012.

Photo 3.4-1 Overhead Crane Full View

Photo 3.4-2 Main Crane winch Section

3.2.3.5 Civil Structure

(1) Summary

The Jebba reservoir depends solely on the discharge from Kainji Dam during dry season (December to March). During rainy season, some tributaries downstream of Kainji flow into Jebba reservoir in addition to Kainji discharge. This inflow and effective water management by JHPS allow the operation through the year round.

All concrete structures in JHPS on the upstream/downstream surface have similar deterioration which includes general roughness of 5 to 10mm along the shoreline due to aging. Also it is observed some holes and honeycombs found on concrete surface caused by loss of coarse aggregates, and those are obviously caused by wave action for long periods.

The complete or partial losses of concrete joint sealing materials on all the expansion joints are observed. A few other deteriorations such as concrete bit are observed at some locations.

Intake, spillway and auxiliary concrete dams are generally in good condition. No remarkable erosion and/or other damages are observed.

In comprehensive inspection report[3] as of year 2000 and annual technical reports as of years 2008 and 2009, the following deficiencies have been pointed out:

[3] The Report was prepared by JHPS based on the survey carried out in May 2000, and covered visual as well as video inspection of powerhouse, intake, spillway and underwater portion of appurtenant structures of Auxiliary 2, 3, and 4.

1) Draft tube concrete has still sound surface irrespective of the fact that high velocity flow of water with some sort of suspended debris has passed through it. No crack was found except No.5 north draft tube opening which seems like local crack width about 10mm.

2) At main spillway areas, loose rock and infract boulders are observed being piled up to the level of stoplog gate sill especially in the middle of upstream channel. Serious signs of erosion and deposition are noted in the upstream discharge channel. Minor damage to lip concrete is also observed on some stoplog gate sills.

3) The flow from drain hole AD53 in Auxiliary Dam 3 remains within the range from 100.20 to 151.80 1itres/minute which is considered excessive in spite of water head from the reservoir levels. Comparison with the data in 2010 shows that the flow rate is increasing. This abnormal flow has been continuing since 2000, and JHPS has already started investigation study and will take countermeasures against it.

4) North wall of main spillway discharge channel collapsed in 1991, and the south wall of the channel, where the riprap rock fill have been dropped into the channel, has also eroded progressively. Both the north and south walls of the channel are progressively collapsing, depositing and accumulating debris of rocks into the channel.

In the first field survey by the Team conducted in July 2011, the above-mentioned issues were not considered serious judging from the Team's experiences, because water volume of leakage water from Auxiliary Dam 3 is not so high, and the collapse and erosion of Main Spillway channel would not seriously affect the flood control function at present.

Therefore, it can be said that the structures are maintained in good working condition and are in no way threatened by any of observed deficiencies mentioned above.

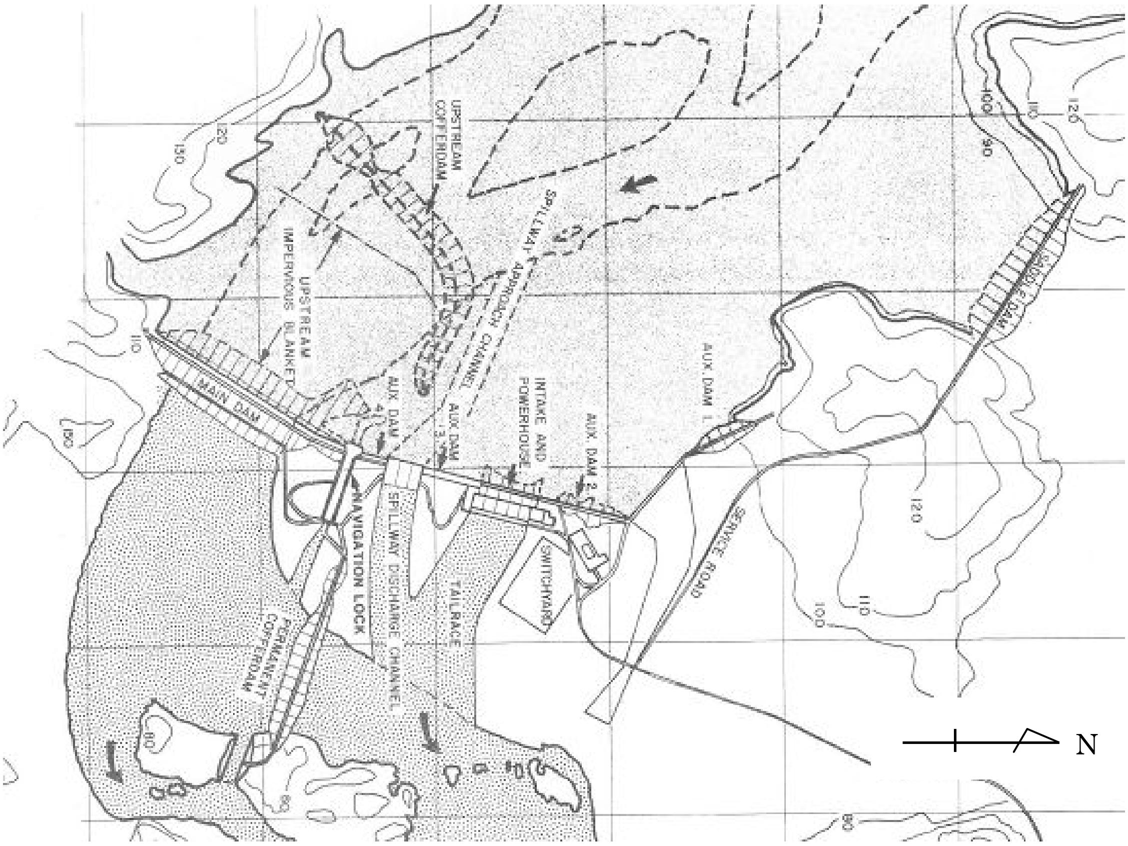


Figure 3-7 General Plan of Jebba Hydro Power Station

(2) Main Dam

JHPS structures are mainly constructed on sound rock while the main dam is built on 40-60m deep alluvial deposit foundation of loose non-compacted sand which was vibro-compacted and properly treated prior to construction. The main dam, spillway, intake, powerhouse and emergency spillway are linked by small auxiliary dams to form continuous structures with crest length of about 2,000 metres.

Photo 3.5-1 View of main structures from upstream

Photo 3.5-2 View of rock-fill dam

1) Salient features

Table 3-9 Main Dam

Type	Zoned Rockfill
Crest EL	108.00m
Crest width	10.00m
Crest length	670.00m
Max. height above lowest foundation	40.00m
Normal operation level of reservoir	103.00m
Min. operation level of reservoir	99.00m
Effective storage water volume	1,000,000,000 m^3

2) Main dam is provided with monitoring instruments at various sections as shown in Table 3-10.

There is no measurable leakage water volume from the pressure relief wells at the main dam toe. The pore water pressure readings from the upstream blanket and the differential zones of the main darn foundation were not collected. There are 35 survey settlement monuments installed to measure vertical movement (settlement), and their readings are stable for a decade. Seven out of nine inclinometer holes are functioning well and their readings demonstrated that the main dam structure is still solid and there were no serious movements.

Table 3-10 No. of Measuring Instruments in JHPS Structures

(As of 2009)

	Settlement monument	Pressure relief well and Drain	Piezometers	Inclinometer	Standpipes	Monument indicators	Measuring wires
Main Dam	35	34	66	9	9		
Navigation Lock		45			6	1	
Main Spillway		42			20	2	
Intake and Powerhouse							
Saddle Dam	18						1
Emergency Spillway							1
Auxiliary Dam 1							1
Auxiliary Dam 2		30				2	1
Auxiliary Dam 3		55				3	
Auxiliary Dam 4		26				2	1

Judging from visual inspection done by the Team in July 2011, Main Dam is considered as in good condition, because no remarkable leakage water from dam and no deterioration of dam body except aging phenomena are found.

(3) Auxiliary Dams 2, 3 and 4

Auxiliary Dams 2, 3 and 4 form a part of the reservoir impounding structure. Auxiliary Dam 2 is located north of Intake structure, Auxiliary Dam 3 is between intake and spillway structure, and Auxiliary Dam 4 is between spillway and navigation lock structure. All auxiliary dams mentioned-above are of non-overflow mass concrete gravity type. Four storage chambers with slots are provided in Auxiliary Dam 3 for storing intake bulkhead gates, trash rack panels and spillway emergency gate. The 400 ton gantry crane travels on the deck of Auxiliary Dam 3 on which it moves between intake and main spillway structure.

1) Salient features

Table 3-11 Auxiliary Dams

	Auxiliary Dam 2	Auxiliary Dam 3	Auxiliary Dam 4
Type	Concrete gravity	Concrete gravity	Concrete gravity
Crest Elevation	108.00m	108.00m	108.00m
Crest Length	93.00m	167.00m	71.50m
Max. Height	26.5m	24.5m	22m
Max. Base Width	18m	16m	14m

2) Auxiliary Dams 2 and 4

Auxiliary Dams 2 and 4 are in good condition. Leakage water through the drains is in the range between 1.60 and 4.44 litres/min. and between 2.64 and 3.09 1itres/min., respectively and these values are within the tolerable limit judging from the experience of the Team. Leakage water records in 2009 are shown in Tables 3-12 and 3-13.

Table 3-12 Leakage Water Auxiliary Dam 2

Month (2009)	Reservoir water level(m)	Tailrace water level(m)	Leakage water volume(litre/min)
Jan	101.38	73.60	4.44
Feb	101.36	74.20	4.20
Mar	100.80	73.20	3.60
Apr	100.78	74.00	2.04
May	100.17	74.00	2.10
Jun	99.29	73.50	1.90
Jul	99.06	73.90	1.76
Aug	99.42	73.80	1.60
Sep	102.37	74.90	4.20
Oct	101.42	74.90	3.30
Nov	102.99	74.30	3.72
Dec	100.73	74.40	2.02

Table 3-13 Leakage Water Auxiliary Dam 4

Month (2009)	Reservoir water level(m)	Tailrace water level(m)	Leakage water volume(litre/min)
Jan	101.28	74.00	2.82
Feb	101.74	74.60	2.86
Mar	101.08	74.00	2.75
Apr	99.88	74.20	2.70
May	100.01	74.00	2.77
Jun	99.10	72.40	2.65
Jul	99.12	73.50	2.64
Aug	99.32	74.80	2.65
Sep	102.89	74.90	3.08
Oct	101.39	74.20	2.88
Nov	102.69	75.00	3.09
Dec	100.86	74.80	2.88

3) Auxiliary Dam 3

Leakage water from the pressure relief drains in Auxiliary Dam 3 fluctuates between 6.77 and 10.24 1itres/min. which is not so serious and within the assumed limit. On the other hand, the flow from drain hole AD53 in Auxiliary Dam 3 remains in the flow range from 100.20 to 151.80 1itres/min., which is considered excessive in spite of water head from the reservoir levels. In comparison with the data in 2010, it is shown that the flow rate is getting higher and higher gradually. This abnormal flow has been continuing since 2000, and JHPS has already started investigation study and will take countermeasures against it.

The oozing downstream slab of Auxiliary Dam 3 is also unusual, which is seen like shallow puddle. This leakage may be bypassing the drain holes through open joints.

Both of abnormal water leakage from drain hole AD53 and oozing of downstream slab are under study for detection of causes and countermeasures by French consultant.

Figure 3-8 Leakage Water Auxiliary Dam 3

Table 3-14 Leakage Water Auxiliary Dam 3

Month (2009)	Reservoir water level(m)	Tailrace water level(m)	Leakage water volume (litre/min)
Jan	101.62	74.00	124.40
Feb	101.36	74.20	128.58
Mar	100.80	74.20	118.57
Apr	99.84	74.20	151.02
May	100.00	74.00	120.27
Jun	99.29	73.60	121.19
Jul	99.06	73.90	117.19
Aug	99.42	73.80	94.65
Sep	102.37	74.90	122.44
Oct	101.32	73.80	114.14
Nov	102.80	75.00	125.92
Dec	100.19	74.40	127.71

(4) Auxiliary Dam 1 and Saddle Dam

1) Salient features

Table 3-15 Auxiliary Dam 1 and Saddle Dam

	Auxiliary Dam 1	Saddle Dam
Type	Zoned earth and rockfill	Zoned earth and rockfill
Crest Elevation	108.00m	108.00m
Crest Length	275m	540m
Crest Width	7m	7m
Max. Height	14m	29m

2) Auxiliary Dam 1 is maintained regularly and in good condition. Leakage water from saddle dam is monitored at the downstream toe, and it varies from 9.09 to 23.60litres/min. It will be correlated with the reservoir water level, and is not so remarkable volume compared to the similar scale of dam. Saddle dam is maintained regularly and in good condition.

Photo 3.5-3 Saddle dam from right abutment

(5) Powerhouse

1) Salient feature

Table 3-16 Powerhouse

Type	Surface
No. of Unit	6
Length of powerhouse	206m
Width of powerhouse	36m
Max. Height from bottom	54.5m

2) The portion below EL.86.00m is considered as the powerhouse structure. It comprises draft tube, foundation of turbines/generators for six units and erection bay. Foundation and draft tube of each unit are separated from other unit on each side by expansion joints. The erection bay (service bay) is located at north end of powerhouse with two stories, where upper level is for erection and lower level is for workshop and storage.

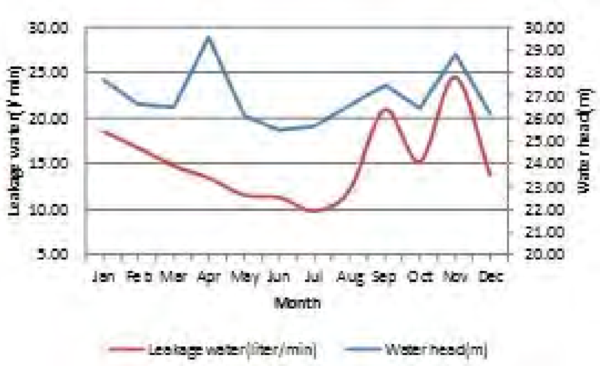


Figure 3-9 Leakage Water Powerhouse and Intake

Table 3-17 Leakage Water Powerhouse and Intake

Month (2009)	Reservoir water level(m)	Tailrace water level(m)	Leakage water volume (litre/min)
Jan	101.69	74.00	18.58
Feb	101.30	74.70	16.76
Mar	100.79	74.30	14.79
Apr	100.52	71.00	13.47
May	100.12	74.00	11.61
Jun	99.48	74.00	11.38
Jul	99.18	73.50	9.88
Aug	100.04	73.50	12.17
Sep	102.37	74.90	20.96
Oct	101.22	74.80	15.29
Nov	103.10	74.30	24.53
Dec	100.64	74.40	13.78

Photo 3.5-4 Powerhouse and tailrace afterbay

The floor and walls are smooth and no damage has been found. As for concrete draft tube, the floor/wall/pier of all units are smooth and no damages are observed. Expansion joint sealant between No.5 and No.6 is missing from El 51.00m to 67.80m. Powerhouse structures are maintained regularly and in good condition.

(6) Intake

1) Salient feature

Table 3-18 Intake

Type	Submerge
No. of Unit	6
Crest Elevation	108.00m
Width at base	41m
Max. Height from bottom	46m

Photo 3.5-5 Intake and Gantry Crane

2) Intake structure is located on the left bank of Niger River between Auxiliary Dams 2 and 3, immediate upstream of powerhouse structure and forms a part of reservoir impounding structure. Each intake contains water passage from reservoir to penstock and inlet of spiral casing tube. The water passage consists of entrance, transition section and penstock elbow. The entrance of each intake is divided into two water ways by concrete centred pier.

With visual inspection by the Team in July 2011, the structure concrete such as floor, wall and pier is sound and has no damage. Expansion joint sealants are missing intermittently between No.4 and No.5, No.5 and No.6, and Auxiliary Dams 3 and 6. A lot of logs and debris are found, and are standing and/or lying on the bottom of trash rack gate thread and groove.

In the intake gallery, total monthly average discharge of leakage water from 60 numbers relief drains varies between 9.88 and 24.53 litres/min. This data shows there is no threat to the structure, and the piezometric level reading, which is reading of water level in drill holes standpipe with 25mm diameter, in comparison with the previous year’s reading shows stable condition as referring to Table 3-18.

(7) Spillways

Photo 3.5-6 Main Spillway from downstream

1) Main spillway is located on the left bank of Niger River between Auxiliary Dams 3 and 4 with six radial gates of 12m wide and 9.5m height. The spillway is designed to control design flood safety discharged from dam at all times. The flow through the spillway is controlled by six radial gates, operated by means of hydraulic cylinders provided on the both abutment.

Emergency spillway is provided at left bank between Auxiliary Dams 1 and 2 for discharging excess water of design flood.

2) Salient features

Table 3-19 Spillways

	Main Spillway	Emergency Spillway
Type	Underflow with flip bucket	Free flow
Total Length	108m	220m
Gate No.	6 (Width12m, Height9.5m)	-
Design Flood	13,600m^3/sec	16,400m^3/sec

3) With visual inspection by the Team in July 2011, as for main spillway, no damage or debris is accumulated in upstream approach channel including apron slab. The concrete surface of stoplog bottom seal beam areas is fairly rough. The guide wall and flip bucket concrete is in good condition and no debris/materials are deposited in flip bucket. Expansion joint sealants are missing intermittently. In the main spillway gallery, which provides water drain for leaking water and applied for inspection purpose of main spillway body, most of relief drain readings are less than 1 litre/min. and this shows very little quantity of leakage water from upstream taking hydraulic pressure and reservoir volume into consideration. The piezometric level readings are also normal. Therefore, no evidence of abnormal distortion to the structure is found.

As for emergency spillway, the overflow weir and surroundings are maintained regularly and in good condition.

4) North and south walls of main spillway channel are collapsed, debris are depositing and accumulating in the discharge channel. The north damage, which riprap rocks have been eroded into the channel, is more serious than the south one.

In the field survey by the Team in July 2011, the above-mentioned collapses are not so serious judging from their experiences, because the collapse and erosion of main spillway channel would not seriously affect the flood control function at present. Therefore, it can be said that the structures are maintained in good working condition and are in no way threatened by any of observed deficiencies mentioned above.

(8) Gates

Gates for O & M are provided for each structure, and those are in good operation except No.4 Intake Gate of which the top seal rubber should be exchanged due to water leakage caused by deterioration. Gates provided are shown in Table 3-20.

Table 3-20 Hydro-mechanical Equipment in Jebba

Facilities	Type	Size	Nos.
Main Spillway	Radial gate, Hydraulic Ope.	B×H=12m×9.5m	1×6= 6
	Emergency closure gate	B×H=12m×16m	1×6= 6
	Stoplog	B×H=12m×12.3m	1
Intake	Vertical slide gate	B×H=9m×19m	2×6= 12
	Stoplog	B×H=9m×19m	2
Tailrace	Vertical slide gate	B×H=10m×6.6m	2×2= 4
Navigation Lock	(Upstream) Sector gate	B×H=12.2m×10.5m	1
	(Downstream) Vertical slide gate	B×H=12.2m×18.5m	1
Gantry Crane	Rail travelling	400t for Intake,70t for Tailrace	1+1
Filling Valve	Provided in intake pier	12 inches siameter	6

(9) Reservoir Operation

Photo 3.5-7 View of reservoir from upstream

1) Jebba reservoir with gross storage volume of $3.88\times10^9 m^3$ and effective storage volume of $1.08\times10^9 m^3$. Kainji reservoir, which is located on the upstream of Niger River, has 12 and 15 billion as gross and effective volume, respectively. Rainfall usually starts in the month of April, and will drops sharply in the beginning of October. The annual average rainfall in total reaches approximate 1,000mm, and it is harvested in consecutive months from April to October. Robust inflow into the reservoir

sustained Jebba power generation. Inflow to Jebba reservoir makes up of Kainji discharge and inflow from tributaries.

In 2008, Jebba reservoir recorded annual inflow of $40.866 \times 10^9 m^3$, and this represents reservoir replenishing rate of about 11 taking Jebba effective storage volume into consideration. Normal annual reservoir operation is that the reservoir level reaches full surface level of EL.103.00m in October and recedes down to minimum level of EL.99.00m in April.

Table 3-21 Rainfall Harvest (mm) in Jebba from 2005 to 2009

Month	2005		2006		2007		2008		2009	
	Precipitation (mm)	No of rain days	Precipitation (mm)	No of rain days	Precipitation (mm)	No of rain days	Precipitation (mm)	No of rain days	Precipitation (mm)	No of rain days
Jan	-	-	-	-	-	-	-	-	-	-
Feb	-	-	30.1	1	-	-	-	-	-	-
Mar	1.0	1	-	-	2.0	1	-	-	-	-
Apr	123.7	3	7.0	1	71.0	3	93.8	5	128.6	7
May	69.0	8	143.5	10	178.0	9	79.6	7	37.5	6
Jun	154.1	12	144.5	9	140.0	9	189.0	9	99.6	12
Jul	94.9	10	145.5	14	249.0	10	242.8	13	127.0	14
Aug	177.1	7	252.5	11	327.0	17	192.9	16	227.5	14
Sep	240.5	14	217.3	16	121.0	11	185.8	13	172.2	16
Oct	77.0	5	62.5	7	48.0	4	54.3	4	141.4	8
Nov	-	-	-	-	-	-	-	-	-	-
Dec	-	-	-	-	-	-	3.4	1	-	-
Total	937.3	60	1002.9	69	1136.0	64	1041.6	68	933.7	78

2) Sedimentation in reservoir

The surrounding area of JHPS, which is located in the Niger River, comprises mountains of elevation from 70m to 200m at the downstream areas of the Niger River. The downstream area of the Niger River shows gentle topography of elevation 0m to 50m. The length and drainage area of the Niger Rriver are approximately 4,180 km and 2,092,000 km^2 respectively.

Jebba Dam is located at just downstream of Kainji Dam, whose reservoir volume is 4 times of Jebba reservoir, the inflow of suspended sediment to Jebba reservoir is restricted due to Kainji reservoir. Taking the situation of Jebba reservoir into account, the amount of sedimentation inflow to Jebba resrvoir is assumed to be very low. Deposition of earth and sand of this dam is small. At present, the flood damage caused by the sedimentation influence at upstream of Jebba reservoir is not generated.

3.3 Present Situation of Operation and Maintenance and Issues

3.3.1 Overall Situation of Operation and Maintenance

(1) General

Jebba Hydro Electric Plc.(Public Liability Company) (JHEP) is developing its business as limited to the role of power generation. The main categories of business are generating power and evacuating power through its transmission line and selling power to transmission companies. Current status of O & M of JHEP is performed smoothly for 24 hours by three shifts with four turns. The number of staffs is 466 persons in total as of July 2011, which includes the staffs of school and hospital operation inside of premises of JHPS. Visual inspection of civil structures is done by Dam Instrumention Deparement with seven staffs and is carried out everyday, and the observation/measuring of leakage water at various points is done twice in every month and its data are recorded but have not been sorted out and computerised. Reservoir operation, which means reservoir level control and flood control, is carried out by the Hydrology Department with 12 staffs.

The operation outages, which caused system collapse and forced outage, were recorded 47 times in 2008 and 44 times in 2009, respectvely. Those occurances per month in 2009 are shown in Table-3-22. The large-scale accident on civil structures have not occurred since commissioning of commercial operation.

Predictive maintenance actions, such as early repair/exchange of parts etc., have been taken, and technical transferring and on the job-training (OJT) have been carried out. Therefore, it must be said that JHEP provides sufficient operation and maintenance technique and management and organisation.

Table 3-22 System Collapsed/Forced Outage as of 2009

Month	Total/Partial	System Induced	Equipment/	Total
Jan	1			1
Feb	3	2		5
Mar	3	1		4
Apr	3		1	4
May	3	2		5
Jun	5		2	7
Jul	5			5
Aug	4			4
Sep	1			1
Oct		2	1	3
Nov	1		2	3
Dec	1	1		2
Total	30	8	6	44

Notes: 1) Total/Partial Collapsed: Those disturbances that resulted in total system collapsed or partial collapsed.
2) System Induced: Those disturbances that influenced the tripping of some units.
3) Equipment/ Breakdown: Fired outages due to breakdown of machines.

(2) Reservoir Operation

Jebba reservoir located downstream of Kainji reservoir and has been depended largely on water discharge from Kainji reservoir especially during dry season when water inflow volume from own catchment drops. Therefore, an integrated reservoir operation system between Kainji and Jebba is presently in practice to maintain planned water discharge taking expected water inflow, high water level operation and no overflow without power generation, etc. into consideration. Improved operation system should be introduced before completion of rehabilitation projects both in Kainji and Jebba.

(3) Operation Record of JHPS

Table-3-23 shows the operation record of JHPS from 2002 to 2010 including four target units, which are flagged for rehabilitation, and Table-3-24 shows various operating indicators based on the operating time and output of each unit.

Prioritisation of rehabilitation for the target units shall be decided taking the operation record into consideration as described in Chapter 4.

Table 3-23 Operating Record of Jebba HPS

Year	Unit No.	2G1		2G2		2G3		2G4		2G5		2G6	
		Total output (MWh)	Operating hours (Hrs)	Total output (MWh)	Operating hours (Hrs)	Total output (MWh)	Operating hours (Hrs)	Total output (MWh)	Operating hours (Hrs)	Total output (MWh)	Operating hours (Hrs)	Total output (Mwh)	Operating hours (Hrs)
2002	Total	374,805	4,576	256,224	3,260	679,216	8,182	101,652	1,290	471,573	5,860	203,030	2,487
Plant Factor		0.455	0.522	0.311	0.372	0.825	0.934	0.123	0.147	0.573	0.669	0.247	0.284
2003	Total	637,125	7,745	391,748	4,902	434,779	5,293	345,565	4,443	555,483	6,790	206,341	2,562
Plant Factor		0.774	0.884	0.476	0.560	0.528	0.604	0.420	0.507	0.675	0.775	0.251	0.292
2004	Total	540,013	6,481	427,028	5,326	575,118	6,209	435,629	5,493	431,192	5,080	294,769	3,491
Plant Factor		0.656	0.740	0.519	0.608	0.698	0.709	0.529	0.627	0.524	0.580	0.358	0.398
2005	Total	465,233	5,700	294,732	3,645	563,057	6,725	311,977	3,890	438,475	5,319	194,756	2,051
Plant Factor		0.565	0.651	0.358	0.416	0.684	0.768	0.379	0.444	0.532	0.607	0.237	0.234
2006	Total	563,904	6,798	259,643	3,302	444,490	5,316	177,331	2,188	448,556	5,464	277,823	3,309
Plant Factor		0.685	0.776	0.315	0.377	0.540	0.607	0.215	0.250	0.545	0.624	0.337	0.378
2007	Total	484,345	5,853	366,209	4,581	625,671	7,451	390,559	4,785	455,856	5,535	406,259	4,827
Plant Factor		0.588	0.668	0.445	0.523	0.760	0.851	0.474	0.546	0.554	0.632	0.493	0.551
2008	Total	614,190	7,416	368,472	4,086	528,796	6,296	418,801	5,137	505,718	6,146	358,997	4,281
Plant Factor		0.746	0.847	0.447	0.466	0.642	0.719	0.509	0.586	0.614	0.702	0.436	0.489
2009	Total	535,585	6,891	525,995	6,556	653,385	7,900	309,142	4,047	532,495	6,517	120,455	1,447
Plant Factor		0.650	0.787	0.639	0.748	0.793	0.902	0.375	0.462	0.647	0.744	0.146	0.165
2010	Total	686,252	8,250	511,168	6,244	637,860	7,593	335,563	4,238	522,898	6,219	0	0
Plant Factor		0.833	0.942	0.621	0.713	0.775	0.867	0.408	0.484	0.635	0.710	0.000	0.000

Table 3-24 Plant Factor, Operation factor etc., Other Operation Index (from 2002 to 2010)

	2G1	2G2	2G3	2G5
Average Plant Factor	0.661	0.459	0.694	0.589
Average Operation Factor	0.757	0.531	0.773	0.671
Operating Efficiency(/hr)	0.873	0.864	0.897	0.877
Nos. of months operated for less than 1 week	4	16	11	5
Total Output for 9 years（MW)	4,901,452	3,401,219	5,142,372	4,362,246
Total Operation Hours in 9 years(hr)	59,709	41,903	60,965	52,930
Output per hour (MWh/hr）	82.088	81.170	84.349	82.416

Note: *1) Calculation period from 2002 to 2010
*2) Plant Factor = Total Output/Possible Output in total
*3) Operation Factor = Total Operating Hours/Possible Operation Hours in total
*4) Number of month which operating hours are less than one week (168hrs in total).
*5) Operating Efficiency = Total Output / (Possible Output x Total Operation Hours)
*6) #6 Unit has been stopped operation from April, 2009
*7) Output per unit operating hour = Output in nine years total/Operating Hours in nine years total

Like other power stations in this country, including thermal and hydro power stations, JHEP formulates a schedule of power generation such as target annual and monthly power generations. This schedule is required to be submitted to PHCN in accordance with Service Agreement. Each power station shall report the actual records of output made in previous year and month to PHCN every following year and month respectively. Also, in case that actual output is far less than the target output, penalty will be imposed.

3.3.2 Executing and Implementation Agency

(1) Operation and Maintenance by Executing and Implementing Agency

As some of the technical personnel of JHPS have worked there since the plant commenced operation, technology has been passed on to a certain degree. These employees have conducted routine O & M and all repairs at the station over 27 years and have kept the equipment in good condition over this time. Moreover, since the station adopts the old style control system and most operations are conducted based on the manual, the fact that personnel have continued O & M without mishaps indicates that they have a high degree of technical proficiency.

Since the turbine and generator rehabilitation work here will largely entail replacement of existing equipment, instruments and parts, it will be possible to operate and maintain the equipment using conventional technology.

However, although station personnel possess routine O & M capacity, they have also experienced the operating accident that made rehabilitation necessary in 2009 and they need to receive equipment operation training in predictive and preventive maintenance measures and measures based on simulations of various accident situations. Therefore, to ensure that the station personnel can operate and maintain the facilities immediately after rehabilitation, the following equipment predictive and preventive maintenance measures and operation training techniques are recommended:

Maintenance consists of the following three types:

1) **Periodic maintenance** entails securing the reliability of equipment through implementing inspections and repairs according to predetermined cycles and schedule. Such cycles are determined equipment by equipment based on their respective past performances. This is the type of maintenance that is currently conducted. Contents are usually prescribed in the form of safety regulations or in-company standards.

2) **Preventive maintenance** entails securing the reliability of equipment through implementing inspections and repairs at regular or irregular intervals according to equipment characteristics with a view to preventing in advance occurrence of critical failures. Such maintenance may sometimes be termed as periodic maintenance.

3) **Predictive maintenance** entails appropriately implementing repairs and upgrades just before problems are about to become manifested (on the service limit of equipment) in line with the progress of degradation of equipment. The timing of such repairs and upgrades is determined based on the monitored state of equipment. Examples of such maintenance include deciding the renewal period of coils based on insulation diagnosis of stators or setting the repair and renewal schedule for mechanical parts based on the results of non-destructive inspections.

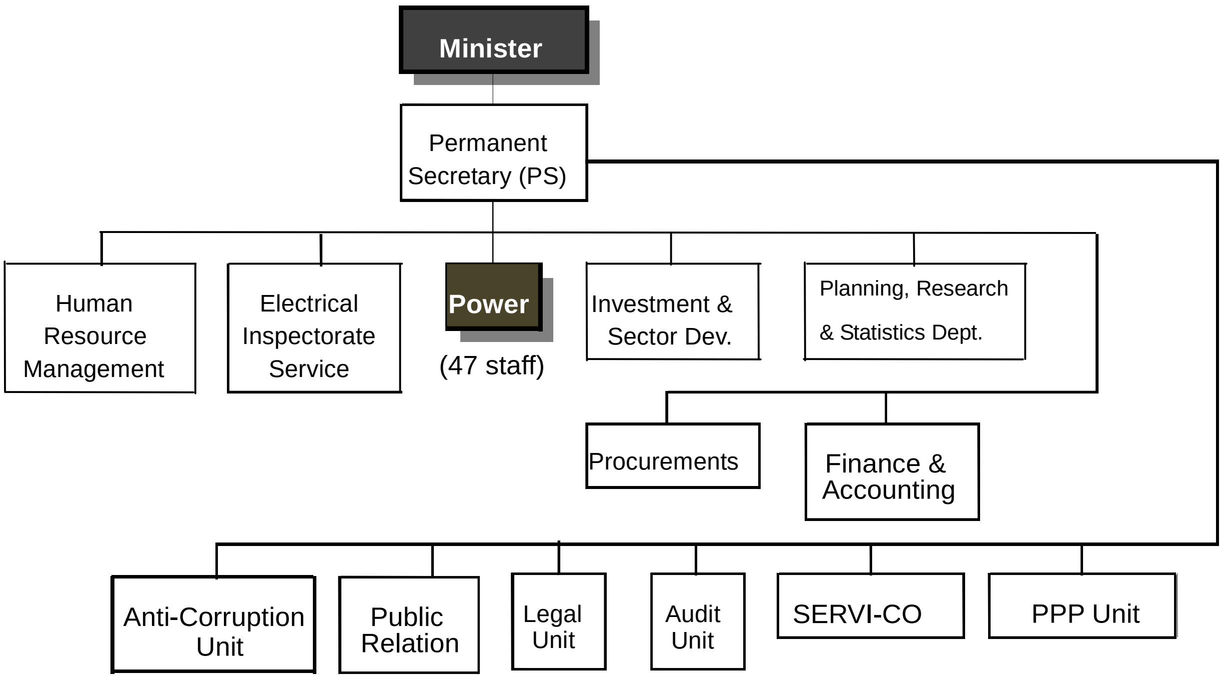
(2) Examination of the Project implementation structure

1) General

In the Nigerian power sector, FMOP conducts supervision, while at present PHCN is responsible for operating and maintaining all power generating, transmission and distribution facilities throughout the country. Also, there are areas where regional electricity boards (REB) belonging to state governments plan and operate electrical facilities and other areas where IPPs such as NESCO and AES, etc. operate facilities. Nigeria is promoting a power sector reform programme according to the NEEDS, and following approval of the Electric Power Sector Reform Bill in March 2005, the EPSR Act officially came into force. The PHCN is divided into six power generating companies, one transmission company and 11 distribution companies, and PHCN as a holding company for the assets, liabilities, employees, rights and obligations of NEPA was established in May 2005. In July 2006, the assets, liabilities and staff of PHCN were transferred to the successor companies.

2) Federal Ministry of Power (FMOP)

FMOP, the supervisory government agency for the Project, is divided into seven departments (Power Department, Electrical Inspectorate Service, Investment and Sector Development Department, Procurements Department, Planning, Research and Statistics Department, Finance and Accounting Department and Human Resource Management Department) as shown in Figure 3-10. It has 15 branch offices throughout the country and possesses 907 employees as of October 2010. Moreover, following reform of the power sector, FMOP became the ultimate supervisory agency concerning policy planning and implementation for regional electrification and it conducts monitoring and assessment of regional electrification programs from the policy perspective. Japan has previously conducted the regional electrification project and master plan survey for utilisation of solar energy with FMOP, which is the supervisory agency in the particular project. In these undertakings, since technical personnel from FMOP implemented comprehensive survey work jointly with the Japanese consultants and produced results that were in no way inferior, they are deemed to possess technical understanding.



Notes: (1) The blue coloured department is in charge of the Project, and the figures in parentheses show the number of employees.
(2) The current President jointly holds the post of FMOP as of October 2010, while the Minister of State is in charge of practical affairs.
(3) FMOP has a work force of 907 employees (as of October 2010).

Source: FMOP

Figure 3-10 Organisation Chart of FMOP

3) Jebba Hydro Electric Plc. (JHEP)

JHEP will be the executing and implementing agency when it comes to Project implementation. It is also scheduled for JHEP to directly implement O & M of the repaired and renovated equipment. The staff of JHEP is likely to continue to operate and maintain JHEP in immediate future in spite of the Nigerian policy on privatisation and commercialisation.

Figure 3-11 shows the organisation chart of JHEP. There are three divisions in JHEP; namely

Administrative Division including CEO's office under direct control of CEO, Maintenance Division under control of Assistant General Manager (Maintenance) and Operation Division under control of Assistant General Manager (Operation). Under Administrative Division, there are 12 offices including CEO Office. Maintenance Division has twelve offices and Operation Division has four offices.

Table 3-25 Departmental Staff Strength as at 28th July, 2011

S/No.	Department	Total
CEO Office		
1	Chief Executive Officer Office	4
	Subtotal	**4**
Maintenance Division		
1	Asst. General Manager (Maintenance) Office	5
2	Principal Manager (Auto Mech.) Office	12
3	Principal Manager (Auxiliary) Office	14
4	Principal Manager (Elect.) Office	16
5	Principal Manager (Estate) Office	30
6	Principal Manager (Gen./Workshop) Office	12
7	Principal Manager (PC&M) Office	7
8	Principal Manager (R&A) Office	8
9	Principal Manager (Planning) Office	4
10	Principal Manager (T/S) Office	15
11	Principal Manager (Turbine) Office	13
12	Principal Manager (Water Works) Office	25
	Subtotal	**161**
Operation Division		
1	Asst. General Manager (Operations) Office	4
2	Principal Manager (Generation) Office	52
3	Principal Manager (Hydrology) Office	12
4	Principal Manager (Geology; Dam Instrumentation) Office	7
	Subtotal	**75**
Administration Division (CEO's direct control)		
1	Industrial Relations Office	1
2	Principal Manager (HR) Office	55
3	Principal Manager (Audit) Office	2
4	Principal Manager (Performance Mgt.) Office	2
5	Principal Manager (F&A) Office	17
6	Principal Manager (Medical) Office	60
7	Principal Manager (Procurement) Office	3
8	Principal Manager (School I) Office	27
9	Senior Manager (School II) Office	24
10	Senior Manager (Legal) Office	1
11	Manager (Fire/Safety) Office	14
	Subtotal	**206**
	Grand Total	**446**

Source: JHPS

JHPS has total staff strength of 446 as of 28th July, 2011 as shown in Table 3-25. Departmental staff strength is also shown in Table 3-25 and Administrative Division, Maintenance Division and Operation Division have staff strengths of 210, 161 and 75, respectively.

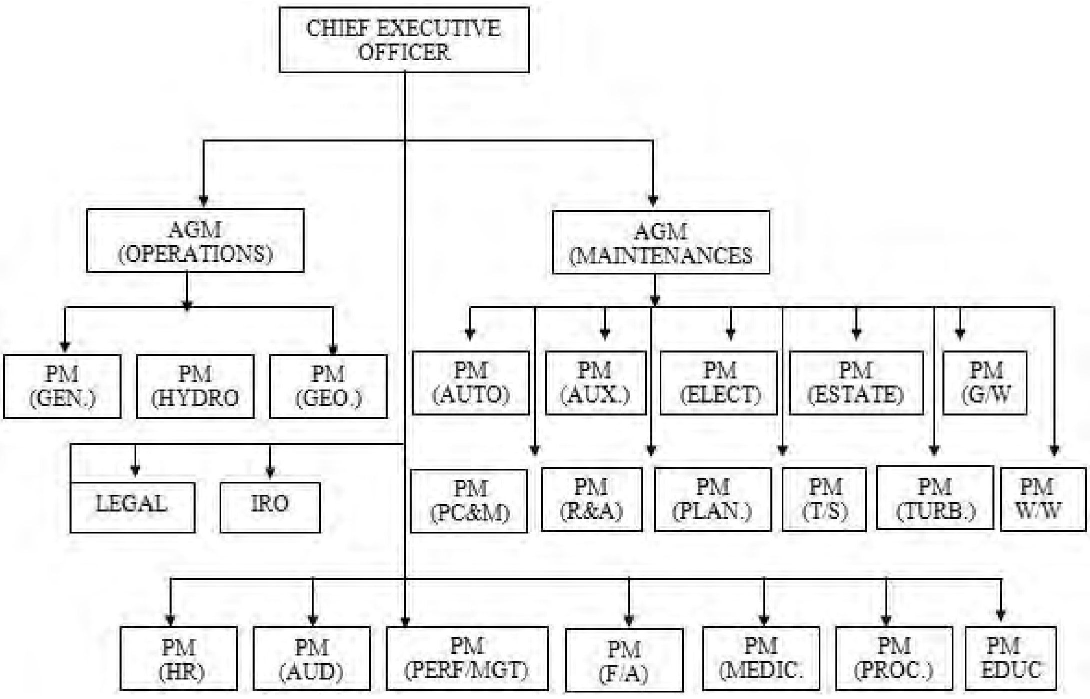


Figure 3-11 Jebba Hydroelectric Power Station Organisation Chart

Total staff strength of JHPS in the last seven years is as shown in Table 3-26. On rough average, total staff strength is in the level of 450 with technical 210 and non-technical 240. Technical staff strength is almost constant in the last seven years and it is reasonable since the number of generation facilities subject for O & M are constant since start of its operation in 1983. However, as Table 3-26 shows, the number of total staff in December 2010 plummets by 25 comparing previous year. This is because during this month, mass-retirement of staff was generated. In this sense, this figure, 425 is considered to indicate the momentary value of staff strength. As a matter of fact, the total number of staff recovered to 446 as of July, 2011 due to recruitment of sufficient number of staff to compensate the mass number of retirement as Table 3-25 indicates.

Table 3-26 Staff Strength of JHPS

Year	Technical	Non-Technical	Total
Dec. 2004	207	240	447
Dec. 2005	209	242	451
Dec. 2006	208	247	455
Dec. 2007	211	261	472
Dec. 2008	210	246	456
Dec. 2009	215	235	450
Dec. 2010	210	215	425

Source: JHPS

(3) Technical Capacity of Executing and Implementing Agency

As some of the technical personnel of JHPS have worked there since the plant commenced operation, technical skills have been passed on to a certain degree. These employees have conducted routine O & M and all repairs at the station over 27 years and have kept the equipment in relatively good condition in spite of their long-term operation. Moreover, since the station adopts the old style control system and most operations are conducted based on the manual, the fact that personnel have continued O & M without mishaps indicates that they have a high degree of technical proficiency.

Training/skill-up of operation/maintenance technology for staffs has been carried out at appropriate intervals, and the National Power Training Institute of Nigeria (NAPTIN) was established to take over taining/capacity building for power sector improvement. Therefore, it is admitted that JHPS provides some structures of operation/maintenance of its facilities such as quality of staff assignment, engineer level and organization.

Since the turbine and generator rehabilitation work under the Project here will largely entail replacement of existing equipment, instruments and parts, it will be possible to operate and maintain the equipment using conventional technology.

JHPS holds up the following strategy goals in its company’s statement in order to maintain high level of O & M of the power station:

1) Strategy I: Ensuring that maintenance programme / schedules are adhered to.

JHPS has a documentation called Maintenance Management System (MMS). MMS includes detailed procedures and schedules of maintenance management. Staffs submit their report to their PM by 3:00pm every working day and it will be reviewed and any rectification will also be made, if necessary, by each PM within the same day. The overall report will be made by each PM to their AGM and the feedback to the staffs will be revealed at 8:30am in the following morning.

2) Strategy II: Ensuring availability of adequate spare parts for prompt rectification of faults.

The procedure of procurement of new spare parts was clarified by JHPS. After the CEO’s approval of procuring new parts was given, it will be transferred to Store Section under Department of Technical Services. Department of T/S is responsible for keeping all kinds of spare parts in JHPS. Procurement Planning Committee is organised under the CEO and it decides Annual procurement plan.

3) Strategy III: Improve on the clear cut maintenance culture that is already on ground.

It was confirmed that the technical skills/ expertise were transmitted to other staffs through OJT.

4) Strategy IV: Maintain high level of discipline amongst staff through leadership by

example.

Performances of heads of subsection are evaluated by PMs.

5) **Strategy V: Maintain a high level professional / skilled managers through well packaged and coordinated training programme to meet the current challenges in Engineering and overall human resources development.**

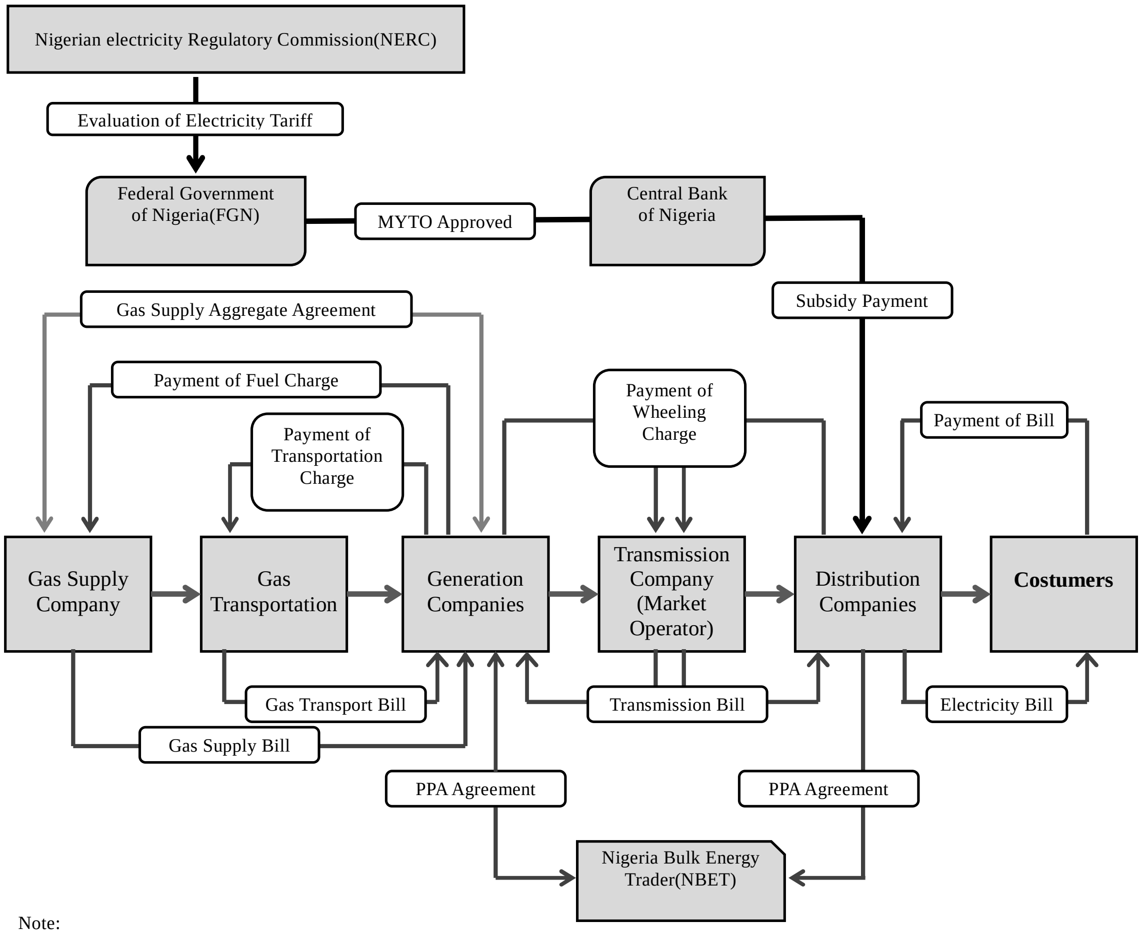
National Power Training Institute and (National) Society of Engineers provide workshops and trainings. In addition, JHPS organises in-house training and induction, especially to new comers. JHPS also engages consultants to organize training, if necessary.

However, although station personnel possess routine O & M capacity through the above mentioned quality control efforts, they have also experienced the operating accident that made rehabilitation necessary in 2009 and they need to receive equipment operation training in predictive and preventive maintenance measures and based on simulations of various accident situations. Therefore, to ensure that the station personnel can operate and maintain the facilities immediately after rehabilitation by the Project, it is recommended for JHPS to implement equipment predictive and preventive maintenance measures and operation training techniques as specified in Chapter 6. The proposed capacity development programme for the station personnel in the implementation stage of the Project and details of these measures and programme are described in Chapter 6.

(4) Financial Capacity of Executing and Implementing Agency

Concerning the financial capacity of the implementing agency, i.e. JHEP, since revenue is covered by government grants, JHEP has a steady source of revenue as shown in Appendix-5. That is, since the O & M costs incurred by JHEP are guaranteed by FGN, there is no risk that O & M will be affected by lack of funding. However, Nigeria is currently aiming to "conduct a review of the pricing system including power tariff hikes and to promote the introduction of competitive principles such as the creation of a power trading market based on a power pooling system" with a view to realising further reform of the power sector, and it is likely that JHEP will need to adopt a management structure that doesn't depend on government grants and strive to introduce power tariffs that are sufficient to cover costs.

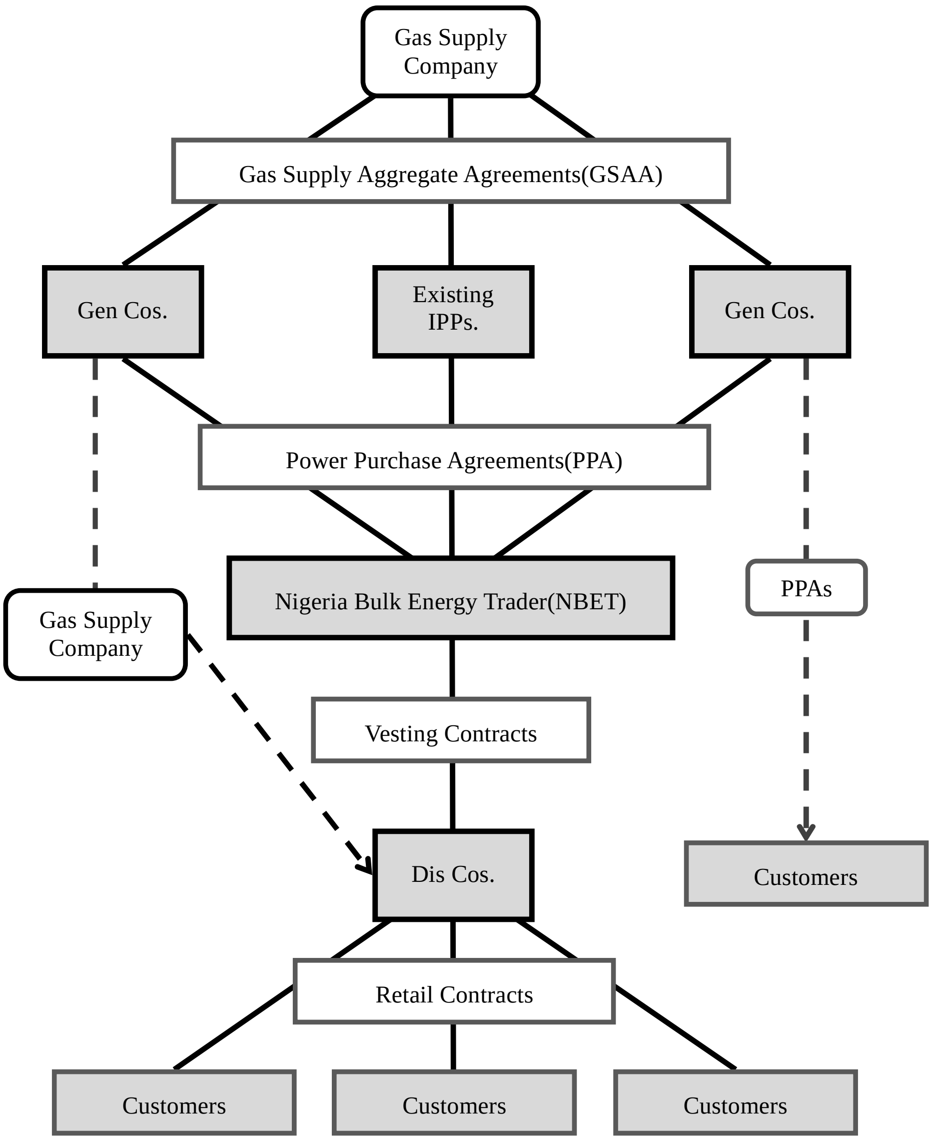
The income of JHEP is composed both of capacity charge (constant cost for power capacity provided) and energy charge (valuable cost for generating power). All of wholesale power tariff for the share of JHEP is paid as subsidy called MYTO as shown in Figure 3-12. Moreover, the stable income has been secured with the charge of cost cover level set by NERC. It means that JHEP is guaranteed its operating cost for healthy O & M of power station and avoids inferior influences on O & M due to its problems of financial affairs. Even if distribution companies were in arrears with their power purchase agreement (PPA) payment to NBET as bulk power trader, NBET should pay their arrears to JHEP based on PPA instead of distribution companies. The value chain between power sectors and FGN involved and contract structure among power producers, NBET and distributers are shown in Figures 3-12 and 3-13, respectively.



Note:
MYTO: Multi Year Tariff Order as same meaning as Subsidy
PPA: Power Purchase Agreement

Source: PHCN, FMOP, 2011

Figure 3-12 Value Chain in Fuel Suppliers and Power Sectors



Note: Vesting contract means wholesale contract

Source: PHCN, FMOP, 2011

Figure 3-13 Contract Structures among Power Producers, Bulk Traders and Distributers

Concerning the financial capacity of the company that owns JHPS, assessment has been made whether or not the company has the ability to appropriately implement O & M at the plant using its own funds upon examining financial indicators such as profit performance (net profit/net fixed assets), financial robustness (own capital ratio = capital (borrowing + capital)), cash management (own fund ratio = own funds/new investment) and liability ratio (liability ratio = own funds/debt repayments). For details, reference shall be made to Chapter 7.

3.3.3 Overall Operating Condition of Power Station Equipment

Table 3-27 shows the operating time and output of each unit in 2010. Concerning 2G6, this has been idle ever since it was rendered inoperable by the accident of April 21, 2009. As for 2G4, it is currently operating while adjusting the operating time after the station side fitted it with the rotator from 2G6. However, against the background of an extremely tight power supply and demand situation, JHPS has started full operation after receiving annual maintenance in August 2011. In consideration of heavily deteriorated condition of 2G4, JHPS understands that the present operation shall be limited to serve for peak power supply only.

In general, the service life of commercial hydroelectric generating facilities is considered as 22 years; however, JHPS has already been operating for 26 years since construction even without any overhauls carried out in the past and its maintenance expenses are increasing. In this respect too, it is deemed appropriate to renew the station equipment under JICA ODA project loan scheme as soon as possible.

Table 3-27 Generating Performance of JHPS in 2010

Generator	Total generated electric energy (MWh)	Operating time (hours)	Operating factor (%)
2G1	686,252	8,213.9	93.8
2G2	511,168	5,820.3	66.4
2G3	637,869	7,659.3	87.4
2G4	335,563	4,165.6	47.6
2G5	522,898	5,964.5	68.1
2G6	Not Available		
Total	**2,693,741**		**72.7 (average)**

2G1, 2G2, 2G3 and 2G5, which are the target equipment of this Survey, are operating without any particular problems, however, amidst an extremely tight power supply and demand situation, they are having to operate at full load. Moroever, considering that they have been in operation for 26 years, they could break down at any time.

Looking at the way in which 2G4 and 2G6 broke down, reverse currents from the power grid caused the circuit breakers of 2G3 and 2G5 inside the station to go parallel-off (cutting off power), and although this had no impact on the 2G3 and 2G5 generators, the circuit breakers of 2G4 and 2G6 failed to perform parallel-off operation due to circuit breaker failure (the area marked as red in Figure 4-5). Circuit breakers in the power station should be operable by remote manual operation from the control room, however, even this failed to perform parallel-off operation. The cause of the failure in parallel-off was either air leak in the circuit breaker or failure in the control system.

Because the generator circuit breakers in 2G4 and 2G6 failed to achieve parallel-off operation, the generators fell into a motoring state (operating as motors) while in connection with the grid, resulting in the generators becoming overheated and damaged. Moreover, when this accident occurred, the above four generators were in operation, but fortunately 2G1 and 2G2 were not operating at the time.

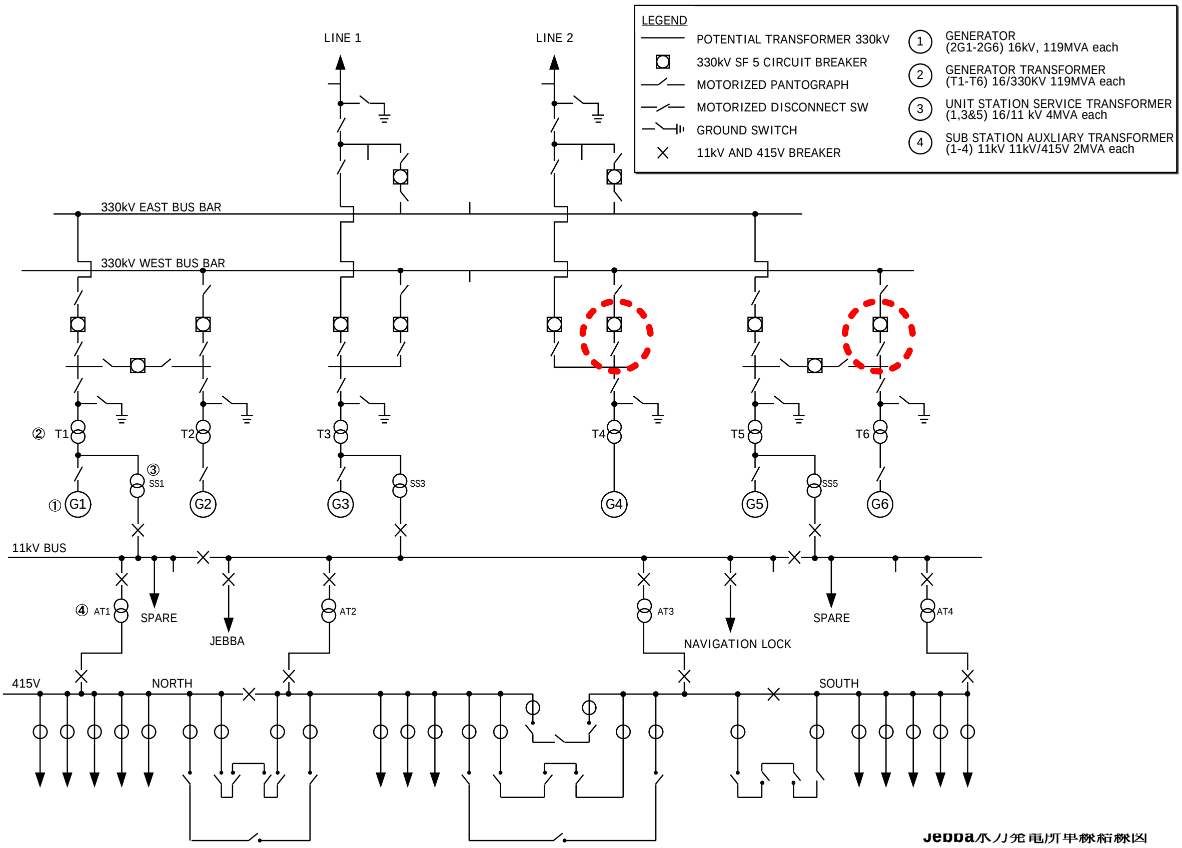
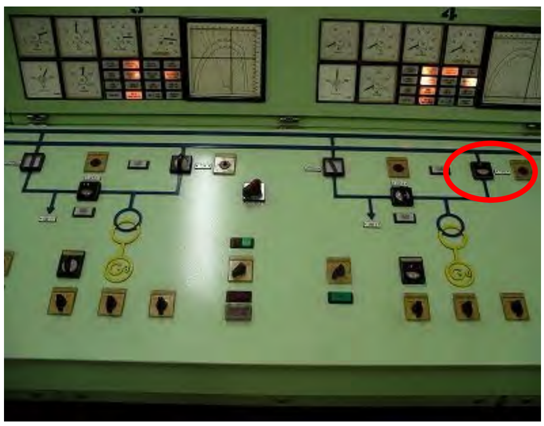


Figure 3-14 Jebba Hydroelectric Power Station Single-line Diagram

Jebba Hydroelectric Power Station Control Room



Substation Circuit Breaker Remote Control Panel (Jebba Hydroelectric Power Station Control Room)

3.4 Power Demand-and-Supply Analysis

(1) General

Power demand forecast, which is the nationwide power demand/supply balance over electrified and non-electrified areas, is made based on power sector development plans in future covering power generation, transmission and distribution, which depend on power sales to all categories of consumers. To be precise, the amount of power generation from private owned power plants, which sell a significant amount of power to consumers, only accounts for the surplus power from the private generators after deducting the power for internal use from the total generated power by the said private generators. Appropriate energy mix with thermal, hydro, nuclear and renewable energy etc. and energy balance between domestic use and power import/export have to be considered for the purpose of national energy security.

Stable power supply is indispensable as economic infrastructure for the development of Nigeria. The capacity, efficiency and stability of power supply not only influence investment by existing enterprise but also play major roles in the economic environment creation.

Power generation and consumption data are not available in digital format at present. PHCN is requested to focus its attention in respect of data collection and its analysis on the following items: PHCN is requested to issue the report of energy statistics every year.

- Power generation statistics,
- Transmission statistics,
- Distribution statistics, and
- Power sales statistics.

Each of the statistics has to include the following information:

- Name of power station,
- Number of generating unit,
- Generation type,
- Turbine set,
- Quantity of power generated in GWh (giga-watt hours), and
- Installed capacity in GW (giga-watt)

All the statistical information on power supply and demand shall be produced in the course of day-to-day administration.

(2) Method adopted in Power Demand Forecast

Based on the survey of actual power utilisation, the total power consumption per consumer (per capita) of each sector (domestic, commercial, industry and public, etc.) was estimated. Applying the power consumption to the number of consumers and considering the growth rate of consumption in each sector, the power demand forecast for the specified year of 2010 was elaborated as a base year for the forecast. The forecast was carried out for 20 years from 2010 up to 2030. This extended forecast was prepared by following the same trend for the forecast demand.

The average annual economic growth rate at national level is assumed to be in the same trend of GDP growth rate as referred to Table3-30 (Historical Census Data in Nigeria) of the projected peak demand, namely in the period of 2010 to 2015 it is 5 percent, in the period of 2016 to 2020 it is 6 percent and in the period of 2021 to 2030 it is 7 percent. System loss which includes technical loss and commercial loss in 2010 is estimated 32 percent and it is assumed to be improved by 1 percent per year up to 2020 and 0.5 percent per year up to 2030.

Annual power requirements are estimated by adding power losses worked out at the assumed loss rates to the projected power consumption. The annual peak demand is estimated with an assumed load factor.

Two cases of analysis are carried out under the scenarios of medium growth and high growth as follows:

Case-1: Not taking IPP projects into account because of the reasons of uncertainty of developing scale and implementation schedule

Case-2: Taking IPP projects into account to compensate the shortage of power supply capacity

(3) Results of the Power Demand Forecast

The maximum peak demand at the national level would be 10,179 MW in 2020 and 18,818 MW in 2030, and the average monthly energy consumption would be estimated around 4,830 GWh in 2020 and 8,929 GWh in 2030. The peak load of 0.046kW per capita in 2011 is expected to increase to 0.054kW per capita in 2020 and 0.089kW per capita in 2030. The average monthly power consumption is expected to increase from 22kWh per capita in 2011 to 26kWh in 2020 and 42kWh in 2030.

Table 3-28 Power Demand Forecast

Year		2011	2015	2020	2025	2030
Peak Demand	MW	7,074	8,128	10,179	13,834	18,818
Annual Growth Rate	%	5	5	6	6	7
Energy Requirement	GWh	40,280	46,278	57,961	78,769	107,149
Expected System loss	%	32	27	22	19.5	17

At the national level, by 2030 the total peak load will increase to 2.7 times of the 2011 level. The average annual growth rate for the total peak load over the same period is 5.3 percent, and the estimated peak load will be 18,818 MW in 2030 and the annual power demand will be 107,149 GWh. The power market in Nigeria is largely influenced by the industrial sector. Thus, the forecast demand should be frequently reviewed after any changes in socio-economic circumstances, changes in development plans of each sector and other related events.

The results of examining the demand and supply balance are as follows:

a) Annual balance for the entire country: In case without new IPP projects, supply capacity exceeds demand for both peak load and power consumption in 2023. Even though new IPP projects would be installed between 2015 and 2018, it will still be necessary to install the coal fired generation plants in 2023.

b) If NIPP Project is delayed in implementation, the balance in 2013 would fall in a slight shortfall in power supply. However, this shortfall will be fully offset by commissioning of new IPP projects, therefore, the decision making of introducing IPP is seriously considered.

c) In case without new IPP projects, if power shortage in 2013 would be resolved, the annual balance of power supply will be sufficient by 2023. In case with new IPP projects, the annual balance of power supply will be sufficient by 2024.

d) The following shortfalls are observed:

- Under the medium growth scenario (demand growth rate: 5 to 7%): The shortage of peak load is foreseen after 2028.
- Under the high growth scenario (demand growth rate: 5 to 9%): The shortage of peak load is foreseen after 2025.

Therefore, it is recommended that FMOP is required to start the preparation of installation of coal fired generation plants to resolve shortfall of power, to import power from the neighbouring countries or to take necessary recuperative measures in advance with due appropriation of his investment budget.

(4) Comparison of demand forecasting

The following data regarding power demand forecasting are available:

1) ROADMAP issued in August 2010 by FGN,
2) Capacity projection in September 2011 by FMOP,
3) Electricity demand and supply projections for Nigeria in July 2008 at National Workshop, and
4) MYTO2 (Multi Year Tariff Order 2) issued in May 2011 by NERC.

Table 3-29 shows comparison among these demand projections and JICA Survey Team forecasting.

Table 3-29 Comparison Table of Peak Demand Forecasting

	ROADMAP	Capacity Projection	Electricity Demand and Supply Projections for Nigeria		MYTO 2(Multi Year Tariff Order)		JICA Forecasting	
Published year	Aug. 2010	Sep. 2011	Jul. 2008		May 2011		Oct. 2011	
Published by	FGN	FMoP	National Workshop		NERC		JICA Survey Team	
	Installed capacity planned	Installed capacity planned	Demand	Installed capacity planned	Demand	Installed Capacity planed	Demand	Installed capacity planned
2005			5,746					
2010	7,033	4,337	15,730	17,303			6,836	6,054
2011	9,767	5,326	-	-	3,952		7,074	6,463
2012	11,879	7,731	-	-	4,096	5,750	7,322	7,698
2013	14,218	11,879	-	-	4,546	7,500	7,580	8,647
2014	-	16,646	-	-	8,288	9,061	7,848	8,879
2015	-	18,566	28,360	31,197	8,660	10,071	8,128	9,690
2020	-	-	50,820	55,903	10,062		10,179	12,308
2025	-	-	77,450	85,196			13,834	14,886
2030	-	-	119,200	131,122			18,818	17,436
Note	-	-	GDP growth rate 7%	-			GDP growth rate 5 - 7%	-
Annual average increment by 2015	2,395	2,846	2,526	2,779	1,177	1,440	258	727

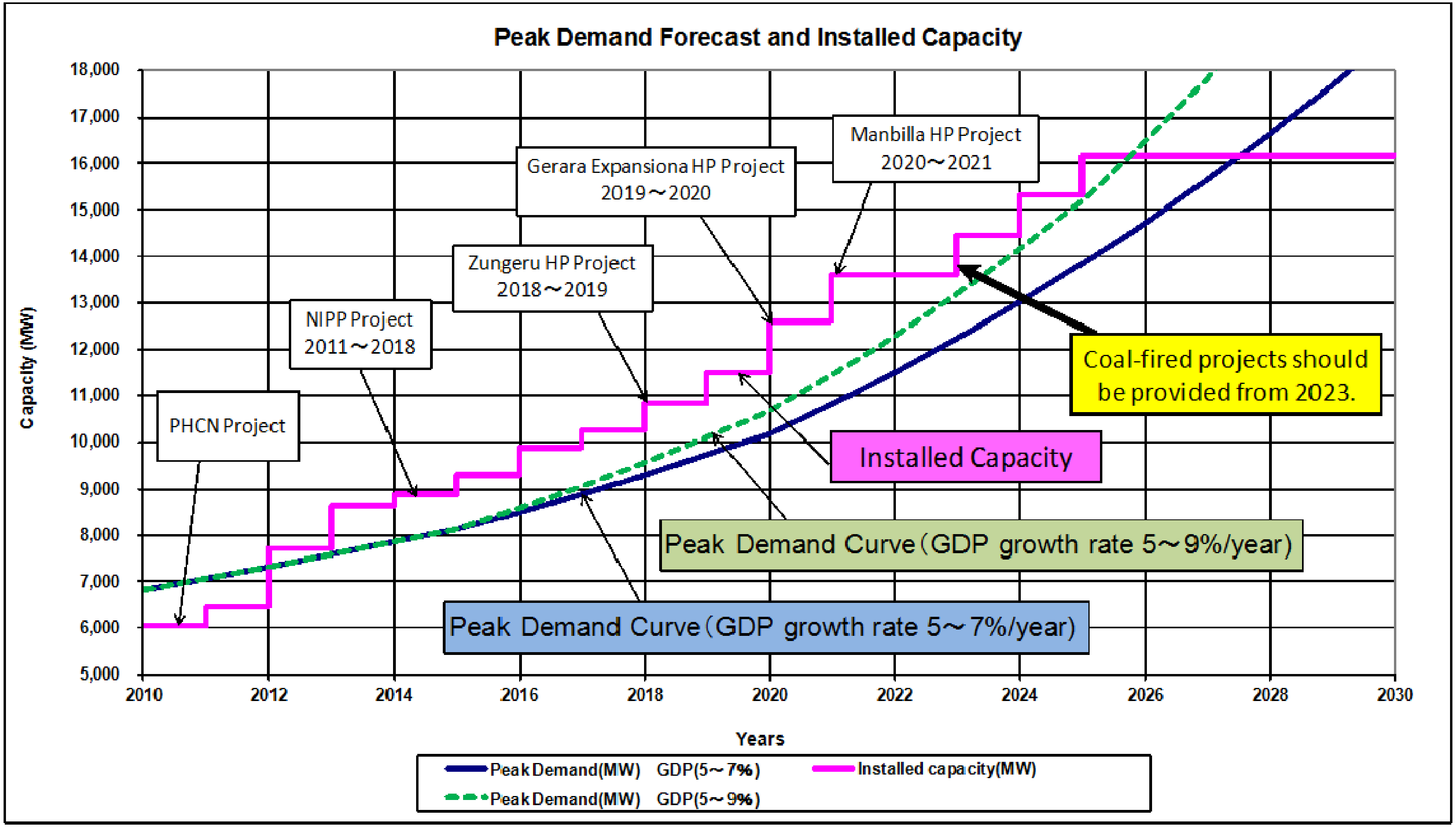


Figure 3-15 Demand Forecast not taking IPP Projects into account due to uncertainty of installation (Case-1)

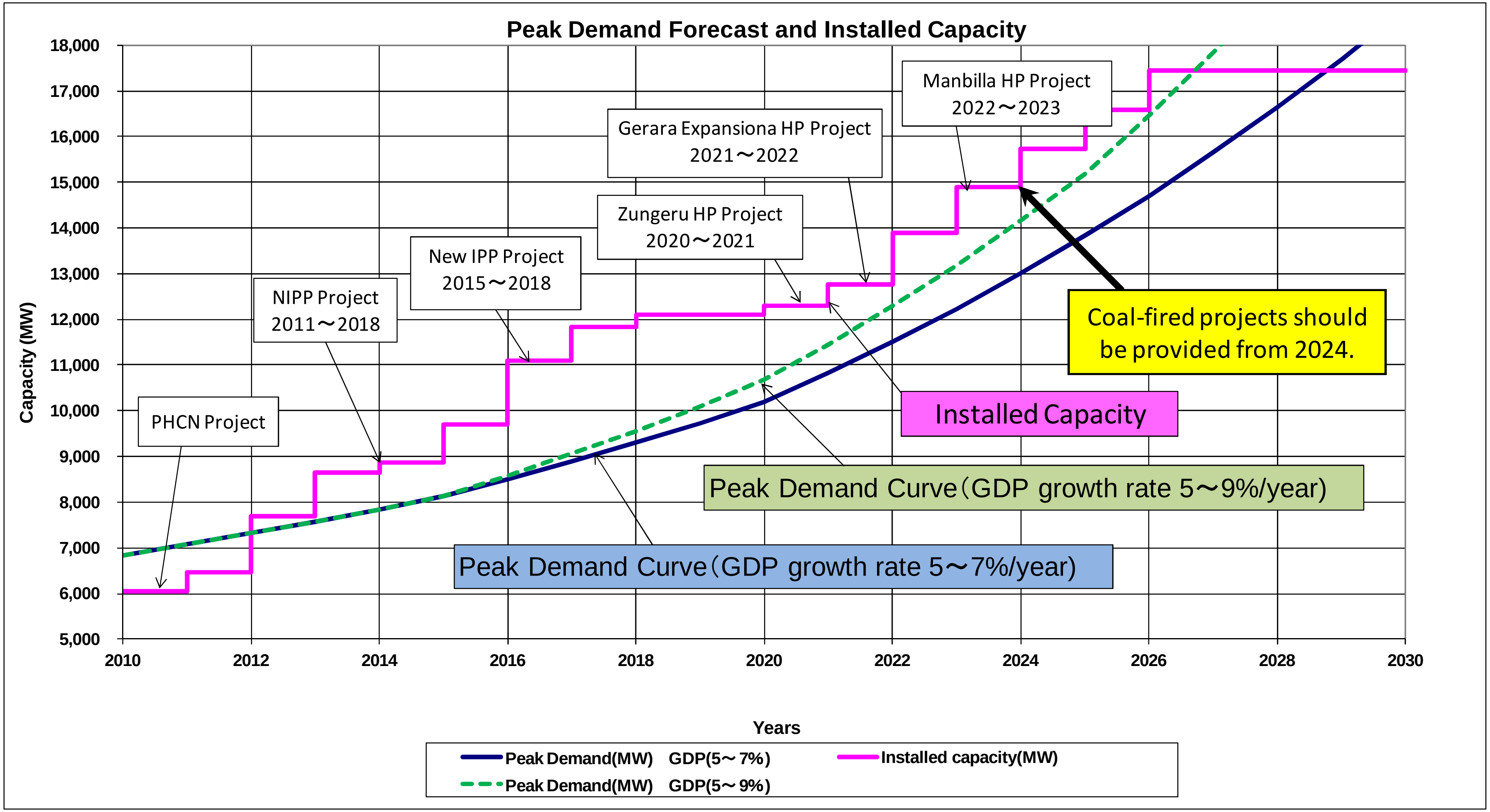


Figure 3-16 Demand Forecast taking IPP Projects into account (Case-2)

Table 3-30 Historical Census Data in Nigeria

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Mean Value
Population(×10^6person)	123.337	126.636	129.935	133.882	137.253	128.772	131.86	135.031	146.255	149.229	152.217	
Population Growth Rate(%)	2.67	2.61	2.54	2.53	2.45	2.37	2.38	3.38	2.03	2.00	1.97	2.45
Inflation Rate(%)	12.50	6.50	14.90	14.20	13.80	16.50	13.50	10.50	5.40	11.60	11.50	11.90
Industrial Production Growth Rate(%)		1.50	-0.30	0.40	2.30	1.80	3.80	-1.60	3.20	2.80	0.60	1.45
GDP Growth Rate(%)	2.70	3.50	3.50	3.00	7.10	6.20	6.90	5.30	6.40	5.30	5.60	5.05
Power Production(×10^9kWh)	14.75	18.7	15.9	15.67	15.67	19.85	15.59	19.06	22.11	22.11	21.92	
Growth Rate (%)		26.78	-14.97	-1.45	0.00	26.68	-21.46	22.26	16.00	0.00	-0.86	5.30
Power Consumption(×10^9kWh)	13.72	17.37	14.77	14.55	14.55	18.43	14.46	17.71	15.85	15.85	19.21	
Growth Rate (%)		26.60	-14.97	-1.49	0.00	26.67	-21.54	22.48	-10.50	0.00	21.20	4.84
Power Export(×10^6kWh)		19	19	20	20	30	40	20				
Actual Power Consumption(×10^9kWh)	13.72	17.35	14.75	14.53	14.53	18.4	14.42	17.69	15.85	15.85	19.21	
Growth Rate (%)		26.47	-14.98	-1.50	0.00	26.63	-21.63	22.68	-10.40	0.00	21.20	4.85
Per Capita Power Consumption (×10^9kWh)	111	137	114	109	106	143	109	131	108	106	126	
Growth Rate (%)		23.17	-17.14	-4.40	-2.46	34.97	-23.47	19.80	-17.28	-1.99	18.82	3.00

3.5 Expected Project Effect

Operation and effect indicators were conceived to quantitatively measure the Project's operational performance and effects in light of its objectives. These indicators, including target figures shall be subject to continuous follow-up at various stages of the project cycle, including intermediate supervision during implementation, and post completion monitoring and ex-post evaluation by JICA.

Generally speaking, equipment is rehabilitated as it approaches the service limit, and the potential effect indicators from the following improvement effects can be adopted for consideration. These effects are usually manifested in various combinations.

(1) Maintenance and improvement of plant safety and reliability

Risk of major accidents threatening human life and property and affecting stable operation can be reduced. As a result of higher reliability achieved through rehabilitation, forced shutdowns can be reduced and higher revenue can be anticipated from JHPS.

(2) Extension of the equipment service limit and recovery of performance

The service life of equipment can be extended through restoring degraded equipment and recovering performance. Rehabilitation sometimes gives rise to an incidence where problems exist in the initial performance but performance is enhanced through subsequent technical improvement.

(3) Reduction of maintenance cost

It is common knowledge that maintenance costs generally tend to rise in line with degradation of installed equipment over time. This is because it is necessary to conduct inspections at shorter intervals than usual in order to preserve a certain degree of performance and costs increase as more repair work is conducted each time. Moreover, it is necessary to implement more frequent special inspections and measurements geared to monitoring status and conducting preventive maintenance in line with degradation over time. Since this leads to higher maintenance costs and detracts from plant economy, the plant rehabilitation of this Project can be expected to reduce maintenance costs. Furthermore, through such measures as reducing the number of units, adopting oil-less instruments and using maintenance-free instruments, the resulting energy saving can be expected to reduce maintenance costs.

(4) Improvement in output, efficiency and generated power

Through restoring the performance of degraded equipment with reduced efficiency, reduced reliability, and limited operation, the power generation can be increased.

(5) Environmental improvement

Rehabilitation can be expected to reduce pollutants in water, mitigate hazardous wastes in the power station, improve oxygen concentration in water, alleviate impacts on fish and shellfish (reduction of water pressure changes), mitigate climate change through reduction of greenhouse emission and so on. Going by past examples, measures to conduct labour saving in maintenance have included adoption of oil-less bearings, adoption of powered hydraulic instruments and so on. Such measures also have an environmental positive effect in terms of preventing oil leaks at times of accidents.

(6) Revision of conditions of use and specifications

There are cases where equipment specifications need to be changed in line with climate changes or changes to operating conditions. There are also cases where rehabilitation needs to be conducted in response to revisions to regulations on the river maintenance flow and surrounding social factors. When the share of hydroelectric power within the general grid becomes smaller, it is sometimes necessary to limit functions and improve economy through enhancing efficiency. (For example, reduced generator output = higher power factor).

(7) Ratio of utilisation of the facilities

This indicator correlates to the stability of facilities. For example, breakdown can be considered as a main factor to reduce the utilisation of facilities. The reduction of possibility of breakdown which will be realised through the implementation of this Project will directly improve the ratio of utilisation of the facilities.

(8) Electric power at generation end

The quantity of electric power at generation end indicates a reliable generated power which leads to be transmitted to the national grid from the power plant. On the other hand, electric power at transmission end is affected by external factors such as power sending loss within the power station and loss caused by transformer which increases the voltage to the suitable level for transmission. Thus, the electric power at generation end is more suitable to measure the improvement of power generation, capability of the power plant through this Project.

(9) Unplanned stoppage-time of operation

Unplanned stoppage-time of operation is, in other words, an uncontrolled stoppage of operation of facility. However, due to some of causes derived from natural factors, it is difficult to prevent unplanned stoppage thoroughly. For example, ground fault led to loss of power supply to sustain auxiliaries, and failure of 330kV circuit breakers to open led to monitoring of units 2G4 and 2G6. However, there is still such an unplanned stoppage-time of operation which is preventable by prior action especially with regards to the stability of facilities.

In the rehabilitation of JHPS, it is anticipated that Project implementation will lead to (1) maintenance and improvement of plant safety and reliability, (2) extension of the equipment service limit and recovery of performance, (3) reduction of maintenance cost and (4) improvement in output, efficiency and generated electrical energy. Decrease in plant shutdown duration other than those under planning or in response to less power demand can also be a measure of the Project's effect. In terms of operation effect indicators, it will be appropriate to conduct assessment based on generated electrical energy (including output and efficiency), stoppage time, maintenance cost and profit.

The Result of the analysis is fully described in Chapter 8.

Chapter 4

Project Plan

Chapter 4 Project Plan

4.1 Site Conditions

4.1.1 Natural Conditions

(1) Climate Conditions

Nigeria's climate is divided into five climate zones. Distributions and characteristics of each zone are shown in Table 4-1. JHPS belongs to Guiana-Sudan Climate Zone.

Table 4-1 Climate Zones in Nigeria

Climate Zone	Distribution	Characteristic
Sahel	Northern end, approximately northern part from north latitude 12 degree	Annual precipitation 500~700mm
Sudan-Sahel	Southern part from North latitude 12 degree, including Abuja, Kaduna and Jos	Annual precipitation 1,000mm, 1,500mm in Jos Plateau
Guiana-Sudan	Southern part of Niger-Berue Trough and perimeter of Minna Basin	Annual precipitation 1,300~1,500mm, 1,000~1,200mm at Niger-Berue Trough
Forest Sahel	Approximately between North Latitude 7°30' and 6°30'	Annual precipitation 1,500~2,000mm
Forest belt	Approximately southern part of North latitude 6°30'	Annual precipitation is approximately 2,000mm, western part from East Longitude 5° is 1,500~2,000mm, eastern part from East Longiture 5° is 2,000~3,000mm

In Nigeria, a sand storm containing sand dust from Sahara desert called "Harmatthan" frequently blows throughout the country from December to next February every year. In this period, the visibility is around 200m and blasts of wind blowing with the speed of 30m/s can happen. During rainy season, south-west seasonal wind carries high-temperature and humid air from the gulf of Guinea and causes rain. From afternoon to evening, squalls with lightening can frequently happen. Moreover, since a blast of wind sometimes blows before squall starts in the same way as Harmatthan, it is necessary to prevent packages of materials carried in the site from scattering. Also, it is possible that heavy rain with lightening occurs from midnight to dawn. According to the data of the Federal Ministry of Aviation, the number of day with lightening is approximately 80 days on average per year. During squalls with lightening, the atmosphere becomes unstable, and lightning and thunderbolts happen continuously.

(2) Temperature

According to the statistics of the last five years from 2006 to 2010, the highest temperature of area surrounding JHPS is 40 ^{o}C and the temperature tends to be high during dry season and low during rainy season. Figure 4-1 indicates the monthly highest temperatures of the Project site.

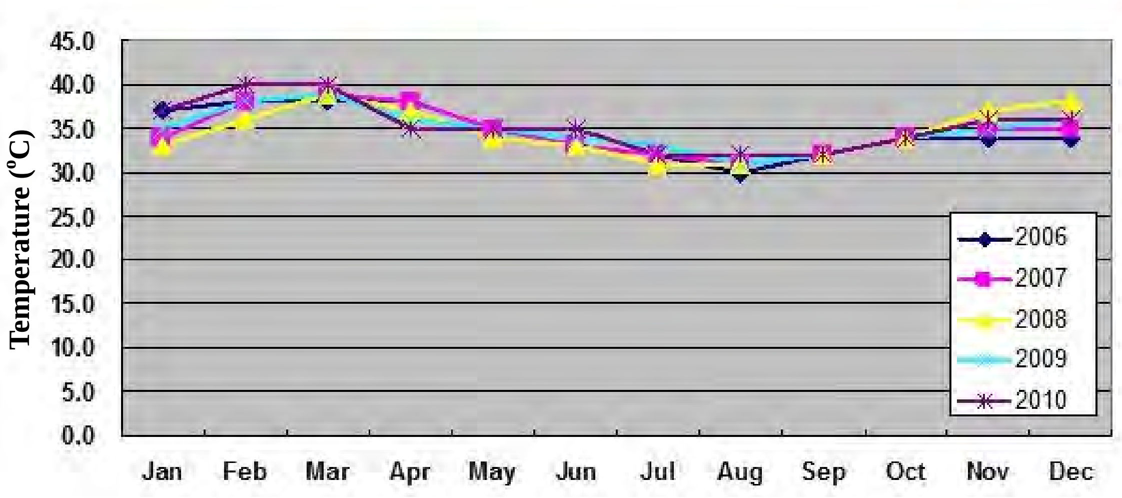


Figure 4-1 Monthly Highest Temperature at JHPS

(3) Precipitation

The average annual precipitation at Jebba in the last five years from 2006 to 2010 is 1,050.9mm. Generally, the period from November to next March is dry season. Although 30mm of precipitation was recorded in February 2006, it rarely rains in dry season. Rainy season ranges from April to October and especially monthly precipitation in July and August exceeds over 200mm. The precipitation of the Project site is illustrated in Figure 4-2.

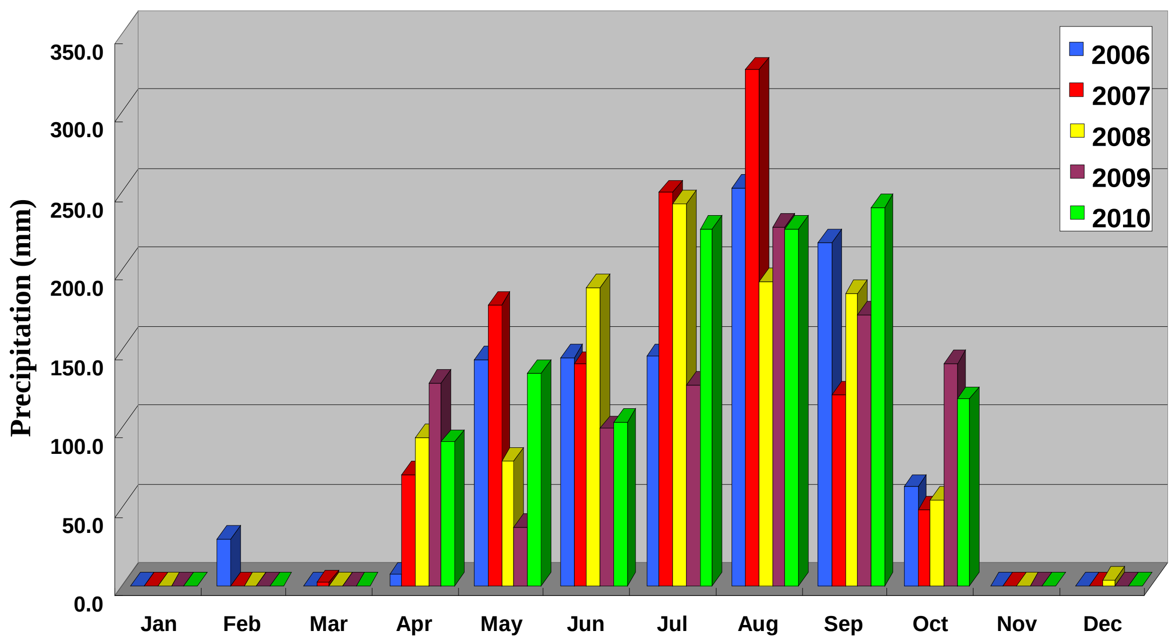


Figure 4-2 Precipitation

4.1.2 Related Infrastructure Conditions

(1) Power Supply

As mentioned earlier, power infrastructure in Nigeria is operated and managed by subsidiaries of PHCN under the supervision and responsibility of FMOP. Low-voltage distribution for general consumers is 415/240V and frequency is 50Hz. In Nigeria, short-term outage of power frequently happens due to shortage of distribution power and/or climatic conditions such as strong wind and rain, however, the power outage in and around JHPS is rare and it is relatively stable.

(2) Road

The road connecting capital city Abuja and regional capital city Minna has two lanes with complete asphalt pavement and there are two access ways from Minna to Jebba: North route via Tegina and South route passing through southern part of Niger State. In the South route, although the road until Bida is relatively fine, plenty of holes are observed on the road surface after Bida to Jebba whose distance is 169km in total due to peeling off the asphalt pavement of road and vehicles are forced to reduce the speed to avert these holes. Thus, it will require much time to pass. Therefore, although the total driving distance is longer, it is desirable to utilise the North route via Tegina to reach Jebba.

Road from Apapa port, Lagos to JHPS also has two traffic lanes paved with asphalt and is approximately 410km long. Quarter of the road is rough as the same condition as road to Abuja from Jebba.

(3) Communication

Fixed phones in Nigeria are operated and maintained by Nigeria Telecommunications Plc (NITEL) and as for mobile phones (GSM method), services operated by plural companies such as MTN Nigeria, M-Tel, and glo Mobile are prevalent. Also, several providers hold permission for internet and wireless broadband service is offered. As for mobile phone communication condition in Jebba, network coverage operated by MTN Nigeria, one of major communication companies is not covered and only a few communication companies such as glo Mobile are available. Also, as for the internet connection, suburbs of JHPS are out of coverage of wireless broadband, and internet connection through this service is impossible. Hence, because the environment of internet connection and email service is not prepared, in case that Japanese experts stay during the Project design and implementation period, it is desirable to secure communication devices such as Inmarsat for daily safety control and rapid/smooth contact to Japan side.

4.2 Scale of the Project

The target facilities of the Project are 2G1, 2G2, 2G3 and 2G5 at JHPS. When compiling the Project Plan for the target package of improvement of the target facilities, three optional packages will be proposed over the total project cost range of 5 to 10 billion yen. GOJ will decide the size of loan in consideration of degree of necessity and urgency.

4.3 Physical Planning of the Project

4.3.1 Policies for Physical Planning

4.3.1.1 Basic Policies

Concerning the target unit, the outline design is elaborated based on the information collected in the field surveys by the Team. The Survey aims to improve the generating capacity of 2G1, 2G2, 2G3 and 2G5 at JHPS and to confirm the validity of parts in need of repair taking into account the state of rehabilitation currently in progress on 2G6. Concerning repair of this hydroelectric power station, it is necessary to examine the following three features:

(1) Overhaul

JHPS started commercial operation in 1985 after two years of initial operation, however, the products and members used in it were manufactured around 1981 and have been passed for 30 years. Most products and members have already surpassed their useful service life and, even judging from the service life of commercial power generating facilities, JHPS is in need of major overhaul. The power station comprises electrical equipment such as generators, turbines, transformers and circuit breakers, as well as auxiliary equipment such as a regulator for adjusting the turbine speed and ensuring stable operation and a static exciter for stable electric power generation. As it is likely that primarily the moving parts of this equipment suffer from wear and tear so called mechanical stress, it is necessary to consider overhaul including replacement of parts and so on. Hydroelectric power stations in Japan adopt generally the Francis type turbine that utilises head of around 80 meters, and such facilities generally require major overhaul once every 10 years. However, since JHPS adopts fixed blade propeller turbines that utilize water from a low head dam and have slower rotation speeds, there is less wear and tear in the turbines and the overhaul interval can be extended.

(2) Restoration of areas damaged by accidents

Ground fault led to loss of power supply to station auxiliaries, and failure of 330kV circuit breakers to open led to motoring of units 2G4 and 2G6.

(3) Equipment improvement: renewal with more efficient and environmentally superior products

Assuming that it would cost around 2 billion yen to replace one stator and rotor coil in a target generator, it would be very costly to completely repair all four turbines and generators at the station. Therefore, it is necessary to enhance the Project effect through conducting investigation of the necessary areas and only repairing the minimum necessary parts.

4.3.1.2 Policies regarding Natural Conditions

(1) Design in consideration of temperature and humidity

Although the atmospheric temperature in the area around JHPS is as high at 30 ^{o}C to 40 ^{o}C throughout year, it is not necessary to consider atmospheric temperature and heat generated by operation of generation facility because parts procured under the Project will be furnished to generation units located in the powerhouse and under JHPS's long experience of plant operation over 27 years. Also, the Project does not require procurement of precision instruments/parts which need to be kept away from high temperature and high humidity.

(2) Design in consideration of precipitation

High precipitation is observed from May to October, however, the highest precipitation is limited to July and August. Since the deterioration of road condition is presumed on the roads connecting to JHPS, it is necessary to make a procurement schedule of equipment, devices and parts avoiding the said period as much as possible. However, most of installation work will be implemented inside the powerhouse, it is not necessary to consider the effects of precipitation in the outline design of these equipment, devices and parts procured under the Project.

4.3.1.3 Policies regarding Social and Economical Considerations

The contents of rehabilitation work do not substantially change the operational and environmental conditions of the power plant.

The Project site is situated far from town of Jebba and there are security gates to access the power station, thus, the influence to the Project by third parties is negligible. Also, there will be no influence to neighbouring residents because noise generated by the power station is small and the distance from residential areas is far enough.

It will be necessary to pay respect to religious festive days and national holidays when the implementation schedule is studied.

4.3.1.4 Policies regarding Installation/ Procurement and Local Contractor

(1) Policy regarding local conditions on installation/procurement

All large-scale hydropower stations in Nigeria, namely Kainji, Jebba and Shiroro, were constructed and commissioned by foreign enterprises and manufacturers. Even in recent years, there is still no record that power stations are constructed by domestic enterprises and manufacturers. Therefore, experts for the rehabilitation of equipment, devices and parts required for the project implementation will be dispatched from overseas countries and local staffs will be engaged to support these foreign experts and to provide skilled or unskilled labour as necessary.

As record of O & M of JHPS demonstrates, there are varieties of materials which can be procured locally. In the outline design of procurement for the Project, the use of local available materials shall be encouraged to maximise the local contents.

(2) Policy of utilising local enterprises

In Nigeria, there are local companies under foreign capital for general construction, mechanical and electrical works and others. Thus, it is relatively easy to procure labour, transportation vehicles and machinery and materials for installation works locally. Companies for inland transportation of machinery and materials from the port to JHPS are also available.

On the other hand, although there are some local enterprises and technicians available in handling installation of power station machinery, materials and auxiliary, they do not have experiences of rehabilitation works on the same scale as the Project, and highly skilled technicians are required for the rehabilitation of machinery and materials as well as adjustment and examination in the rehabilitation works. Hence, when such machinery and materials procured under the Project are installed, it will be necessary to dispatch technicians from overseas countries such as Japan and to provide management of quality and schedule and technical guidance to the local parties.

4.3.1.5 Policies regarding Operation and Maintenance

Since the commencement of operation in 1983, JHPS has an actual successful work record of O & M by its own staffs up to date, thus, technical staffs are highly skilled and experienced. Also, since the rehabilitation of generation units through the Project is mainly replacement and overhaul of existing materials, machinery and parts, O & M method that has already been established in JHPS can be sufficiently and fully utilised. However, in order to avoid the accident experienced in 2009, it will be required to conduct emergency-stop training of facilities on the assumption of various accidental situations. Also, daily maintenance and assurance activities will be required to make sure the normal operations of the rehabilitated generation units are organised and qualified at all times.

4.3.1.6 Policies regarding Scope of Procurement and Technical Level

In consideration of the above-mentioned conditions and policies, the procurement of machinery, materials and parts, and the scope of procurement and technical criteria shall be formulated based on the following basic principles:

(1) Policies regarding the scope of procurement of facilities, machinery and materials

To facilitate a technically and financially adequate outline design, specifications of materials shall be standard materials which comply with international specifications such as IEC. The minimisation of number of items and the high compatibility of materials and equipment shall result in the best selected components of rehabilitation works, specifications and quantities.

(2) Policies regarding technical level

Specifications of each machinery, material and equipment required for rehabilitation of the target generation units shall be designed in consideration of technical level of O&M Division of JHPS, which will be the implementation body of O & M after the completion of the Project, and avoidance of complicated structure and technical requirements.

4.3.1.7 Policies regarding Installation/Procurement Methods and Installation Period

Marine transportation shall be the main method to transport procured goods and materials from Japan or the third country to Nigeria. Inland transportation distance is approximately 410km from Apapa Port, Lagos to JHPS, the Project site. Since the transportation distance is long as such and quarter of the transportation road is rough, it will be necessary to pay extra attention for packing and protection of goods and materials, and implementing safe and secured procurement without causing any traffic hindrance.

Currently, generator parts and so forth are procured from Japan. Considering this situation, when the procurement schedule of goods and materials is formulated for the Project, since there is no direct shipment from from Japan to a port in Nigeria, it will be required to trans-ship at near foreign port such as Korea, China or Singapore, and thus the duration requires approximately two months. Two months of transportation period will be enough in the case where European contractor would be awarded.

Since the contents of procurement for the Project include long lead items (LLI) and short lead items (SLI), the Project Implementation Schedule shall be developed in consideration of such difference in procurement period per goods to be procured under the Project so as to minimise the overall Project period. In particular, rotor pole is one of the LLI and requires 10 months solely for manufacturing and will finally require in total approximately one year from the purchase order to arrival at site. Therefore, the procurement period of rotor poles dominates in the total Project Period, but at the same time it is necessary to minimise period required for preparation of drawings, their approval and factory inspection in order to minimise the overall Project Period.

4.3.2 Prioritisation of Parts to be Renovated under the Project

4.3.2.1 Specific Features of Deterioration of Parts of Generation Unit

(1) General

Deterioration of main parts of generation unit is classified in two types of deterioration, i.e. i) deterioration of dielectric strength for electrical insulation parts, and ii) deterioration caused by mechanical stress for mechanical supporting parts. As a result of combination of progress of the above two deteriorations, the generation unit has gradually declining performance and is approaching the end of its service life.

(2) Deterioration of dielectric strength for electrical insulation parts

Dielectric breakdown occurs when an applied voltage exceeds the electrical limit or dielectric strength of an electric insulation material. According to the manufacturer of the existing generation units, in assessment of insulation quality of the unit, dielectric strength is expressed as percentage of the remaining dielectric breakdown voltage to the test voltage. Initial dielectric strength of generation unit is 100 percent, which means that the remaining dielectric breakdown voltage is two times higher than the test voltage. When dielectric strength becomes lower than 50 percent, which means that the remaining dielectric breakdown voltage becomes lower than the test voltage due to deterioration, it is recommended to replace the deteriorated parts with new ones, considering insulation coordination with circuit breakers discharge starting voltage by lightning surge. According to IEC-60216, this 50 percent deteriorated point from initial value is applied as end-point of electrical insulation material. Moreover, when the remaining dielectric strength reaches 25 percent, which means that the remaining dielectric breakdown voltage becomes lower than the rated voltage including voltage fluctuation range, it is presumed that such equipment could not keep operation and reaches to the actual end of service life. The above discussion is summarised in Table 4-2, where the rate voltage of targeted generation unit is marked E = 16kV and test voltage is 33kV (2×16kV+1).

Table 4-2 Dielectric strength and the status of generator

Dielectric Strength (%)	Value of remaining dielectric breakdown voltage	Generator's status
100 to 50	66kV: (2 × (2E+1) × 100/100) or less	Normal operation
50 to 25	33kV: (2 × (2E + 1)× 50/100) or less	Replacement recommended
Less than 25	16.5kV: (2 × (2E + 1) × 25/100) or less	End of service life

Deterioration of dielectric strength for electrical insulation parts is caused by five factors: namely, thermal (chemical decomposing), mechanical (vibration) electrical, heat cycle, and environmental. According to a manufacturer of generator, thermal factor is the most influential one in deterioration of dielectric strength, followed by mechanical (vibration) factor and electrical factor. These five factors complexly affect the deterioration of dielectric strength for electrical insulation parts of generator.

4.3.2.2 Deterioration by mechanical stress for mechanical supporting parts

Deterioration by mechanical stress for mechanical supporting parts is caused by fretting wear of joint parts, wearing of rubbing parts, and cracking of fatigue failure parts, which are stressed by vibration, thrust bearing load, and centrifugal force, etc. occurred by normal or abnormal operation condition. As one of the actual deterioration results, some cracks and deformation of insulation cap at the coil-end were confirmed at the first site investigation. It is considered that, when copper constructing inside of coil repeats shrinking and stretching due to heat cycle (heating and cooling) during the operation, it evidently causes the deterioration of coil. And this internal influence finally appears as a deformation of coil-end part. At this part, the crack of insulation cap varnish, which proofs the progress of deformation and deterioration by mechanical stress, also occurs.

4.3.2.3 Basic Principles for Prioritisation

(1) Generators

Parts, which exhibited more than two of the following diagnostics in the site investigation by the Team, shall be given priority in rehabilitation under the Project:

1) Parts whose dielectric strength has been deteriorated (stator coil core, rotor pole), parts which have been deteriorated due to mechanical stress (bearing parts)

2) Parts with rehabilitation period more than one month

3) Parts which can only be renovated after extraction of rotor

4) Parts which have been malfunctioned, damaged and/or deteriorated and judged to need renovation urgently

(2) Turbines

Parts, which have been malfunctioned, damaged and/or deteriorated and judged to need renovation urgently, shall have priority in rehabilitation under the Project.

(3) Control/Equipment

Analogue control and protection systems and related facilities will be considered for rehabilitation under the Project depending on the total budget for the Project.

4.3.2.4 Basic Items to be Rehabilitated

(1) General

Scope of rehabilitation of 1) generators, 2) turbines and governors and 3) control equipment has been elaborated through discussion with the related officers in JHPS as follows:

(2) Generator

The following components have been proposed for rehabilitation based on the results of site investigation by the Team and discussions with JHPS:

Table 4-3 Details of Rehabilitation Items and Contents

Category	No.	Item	Rehabilitation contents	Remarks
1-1 Stator	1	Stator coil	Replacement for 4 units	Deterioration due to heat is significant. Also, the removal of asbestos is recommended.
	2	Stator Core	Replacement for 4 units	Deterioration of varnish caused by heat seems to be significant. Also, the removal of asbestos is recommended.
	3	Stator frame	One unit will be brand-new; the others will be reused (refurbished).	
1-2 Rotor	1	Pole	Replacement for 4 units Spare parts: 2 pcs of first end pole and 2 pcs of last end pole	If the Project budget is limited, replacement for 1 unit and reuse after maintenance for other 3 units. Also, the removal of asbestos is recommended.
	2	Countermeasure of Rotor Rim Support	Reinforcement for 2G1 and 2G2 only	Reinforcement for 2G3 and 2G5 has already been done in 2001.
1-3 Exciter	1	Collector Ring	Two brand new collector rings will be installed for 2G5 and 2G1. Replacement and maintenance of 2G3 and 2G2 will be included in the Project. No collector ring will be spared.	
1-4 Metal	1	Bearing Parts	Replacement for 4 units	
1-7 Others	1	Items 1 to 5	Replacement for 4 units	Removal of rotor is necessary since these parts exist inside of oil tank
		Items 10 to 11	Replacement for 4 units	
		Items 14 and 15	Replacement for 4 units	
	2	Item 1-4	Supply 1set for 4 units	
		Item 5	Procurement for 4 units	
	3	Training	Contents of training will be proposed by the Team.	
	4	Spare parts		
		Items 5 and 6	4 pcs and 22 pcs, respectively	
		Items 9	18 pcs	

(3) Turbines and Governors

The following components have been proposed for rehabilitation based on the results of site investigation and discussions with JHPS:

Table 4-4 Turbine and Governor

No.	Item	Remarks
Refurbish wicket gate levers, links and bushing, main shaft seal and regulating ring.		
1	Inspect the draft tube lining and runner blades for cavitations. Weld-fill, grind and paint the draft tube with high grade anti-rust paint.	
2	Complete maintenance of the wicket gate	The wicket gate bearing bushing and Pak-O-Pak seal should be replaced and new spring loaded safety levers installed.
3	Inspect runner, stay ring and discharge ring for cavitation and erosion and effect repair	
4	Replacement of all seals with new ones.	
5	Align Turbine shaft	
6	Complete maintenance of the turbine guide bearing	
7	Refurbish the spiral casing drain valve	
8	Comprehensive overhaul of the turbine head cover (shaft seal and stuffing box assembly)	
9	Replacement of the AC and DC inner head cover pumps	
10	Overhaul the existing 4 nos. Servo motors with provision of lifting device for seal replacement	
11	Service the hydraulic governor system: (1) Replacement of cooling oil duplex filter assembly (2) Replacement of governor oil (3) Replacement of pilot filter assembly	
12	Replacement of all gauges	
13	Replacement of complete shaft seal duplex filter assembly (DFLN330-50PN16)	
14	Digitalisation of electronic governor of 2G5	
15	Spare parts	

(4) Transformers

The following items are proposed to be rehabilitated:

1) Overhaul of four units will be done in the Project including replacement of diaphragms in conservator, insulation oil and gaskets. However, overhaul of transformer for 2G3 will be the top priority in consideration of actual oil leakage observed and needs urgent repair
2) Generator Circuit Breaker (GCB) 16kV is not required.

The scope of rehabilitation of generators, turbines and control/equipment was discussed between JHPS and the Team based on the findings in the Site Investigations conducted by the

Team in the Field Surveys. Basic scope of rehabilitation per generator unit is shown in Appendix-9.

4.3.2.5 Prioritisation of Generation Units for Rehabilitation

The priority of rehabilitation of four generation units, namely 2G1, 2G2, 2G3 and 2G5, are as follows:

1st priority: 2G5
2nd priority: 2G1
3rd priority: 2G3
4th priority: 2G2

The above priority is confirmed by JHPS and the Team in consideration of the following features for evaluation of urgency of rehabilitation:

(1) Station Power Supply Service
Station power supply service is very important to maintain the function of the hydroelectric power station. JHPS is of the opinion that the units in station power supply service shall have the top priority in rehabilitation. 2G1, 2G3 and 2G5 undertake the station power service, thus 2G2 shall be the last priority in rehabilitation among the four target units.

(2) Total Output; Reliability in power generation
The total output is a parameter to demonstrate the reliability in power generation. JHPS is of the opinion that the least reliable unit among the remaining units of 2G1, 2G3 and 2G5 shall have the highest priority. Therefore, since 2G5 demonstrated the lowest total output among the remaining three units in the last five years, 2G5 shall be rehabilitated first.

(3) Total Running Hours; Deterioration or fatigue of generation unit
The total running time (hours) is a parameter to indicate the degree of deterioration or fatigue of the unit. When total running hours are high, total output is also high. Noting that there is a contradiction between the criteria of total output (reliability) and total running hours (deterioration), JHPS is of the opinion that the most deteriorated or fatigued unit in terms of total running hours among the remaining two units of 2G1 and 2G3 shall take the second priority for rehabilitation. Therefore, 2G1 is the highest total running hours and shall be rehabilitated second.

4.4 Physical Design of the Project

4.4.1 Overall Plan

As mentioned in 4.3, the rehabilitation works for the Project will include renovation and overhaul of stator, rotor, exciter, metal, cooling system, hydraulic devices, instrument and overhaul parts for generators, refurbishment of wicket gate levers, links, bushing, main shaft seal and regulating ring for turbine and governor, and overhaul of main transformers.

4.4.2 Design Conditions

(1) General

In preparation for the determination of scale and specifications for the Project, the following design conditions have been elaborated based on the results of examination of the above mentioned policies, principles and conditions:

(2) Proposed place of rehabilitation work

Place of rehabilitation work: JHPS Existing generator unit 2G1, 2G2, 2G3, and 2G5

(3) Climate Conditions and Site Conditions

Designed atmospheric temperature: 40 degree Celsious (Highest)

Designed relative humidity: 95% (Highest: Dewfall shall not occur)

Site condition: Altitude (from the mean sea level): 100m

(4) Applicable Design Codes and Standards

Table 4-5 Applicable Design Codes and Standards

	Codes and Standards	Application
1	International Electrotechnical Commission (IEC)	General electric appliances
2	International Organisation for Standardisation (ISO)	General industrial products
3	Japanese Industrial Standards (JICS)	General industrial products
4	The Institute of Electrical Engineers of Japan, Japanese Electrotechnical Committee (JEC)	General electric appliances
5	The Japan Electrical Manufacturers' Association (JEM)	General electric appliances
6	The Japan Electric Association Committee (JEAC)	General electric appliances
7	Japanese Cable Makers' Association Standard (JCS)	Electric cable
8	Electronic Industries Association of Japan(EIAJ)	General electric appliances
9	Electric Technology Research Association	General electric appliances
10	National Electrical Manufacturers Association (NEMA)	General electric appliances

Other international design code and standards equivalent to the above can also be applied.

(5) Units

In principle, the international unit system (SI Unit) shall be applied.

4.4.3 Components to be rehabilitated

(1) Configuration of parts

Configuration of parts to be rehabilitated shall be as per Appendix-9.

(2) Parts Procurement Planning

Coil shall have class B insulation of IEC. Hazardous materials for insulation such as asbestos shall not be used.

4.4.4 Basic Options for Rehabilitation

For the purpose of securing reliability and effect of rehabilitation under the Project, the following options for rehabilitation are recommended by the Team in consideration of (1) rehabilitation per generation unit, (2) quantitative evaluation of rehabilitation effect, (3) present reliability in operation of existing generation unit, and (4) economic and financial aspects.

Option 1

Scope of Works	Quantity
1. Generator 2. Turbine and Governor	2 Units

Option 2

Scope of Works	Quantity
1. Generator 2. Turbine and Governor	3 Units

Option 3

Scope of Works	Quantity
1. Generator 2. Turbine and Governor	4 Units

Rehabilitation of control and protection system and related facilities will be included depending on the total budget for the Project.

The Project cost shall be estimated per options as mentioned above in Chapter 5.

Chapter 5

Project Cost and Financing Plan

Chapter 5 Project Cost and Financing Plan

5.1 General

The Project Cost includes the costs of material procurement, manufacturing, installation, consultant fees and contingency costs, etc. within the scope of Japanese ODA loan and shall be estimated based on confirmation of the conditions including the state of deterioration of the target generation units, missing items and the past records of repair and inspection. The Project cost estimation shall be made in consideration of the order of priority based on the need of repairs and restoration through observation of present conditions of generation units and the generating efficiency. The total Project costs for three options of the Project plans will be presented within the range of the Project scale between 5 billion Japanese yen (JPY) and 10 billion JPY.

The target generation units were installed and started operation in 1985. The turbines, which were made by Austrian manufacturer, and the generators, which were made by Japanese manufacturer, have not undergone overhaul in the past 28 years of operation. Accordingly, the basis of the Project cost will be elaborated through investigation of the availability and unit prices of parts and materials from the manufacturers of the original units by referring to the parts numbers identified in comparison with the existing maintenance manual.

Reference shall also be made to “ODA Inspection and Improvement 2007; Japan’s Ministry of Foreign Affairs” and “ODA General Improvement Program” and, based on the information and materials collected in the Preparatory Survey, examination of the methods and technology of rehabilitation works and the contract details, compare and examine the standard rehabilitation plan and alternative plans that will enable cost reduction, and compile the most efficient and optimum Project plan.

5.2 Project Cost

5.2.1 Fixed Percentage Financing

Developing countries often find it difficult to make public investments due to their domestic budgetary constraints. To meet part of local currency funding needs, JICA introduced fixed-percentage financing criteria in fiscal 1989.

The criteria set a certain percentage of the total Project cost as the upper limit of Japanese ODA loan financing regardless of the distinction between foreign and domestic currency components in the total Project cost. The percentage will vary depending on per capita GNI in the borrowing country.

However, when the proportion of foreign currency component in the total Project cost is greater than the percentage of Japanese ODA loan financing set by the criteria, the foreign currency cost, in principle, becomes the maximum amount of Japanese ODA loan to be provided for the projects.

In case of Nigeria, the proportion of JICA's lending in the total Project cost is maximum 85 percent, thus, minimum 15 percent of the total Project cost will be borne by FGN.

5.2.2 Composition of Project Cost

The Project cost, as is described above, consists of the ODA project loan portion provided by Japan and the local portion to be provided by FGN. The Project cost is used to achieve the objectives of the Project, namely to contribute to the stable power supply by rehabilitating 4 hydroelectric power generation units 2G1, 2G2, 2G3 and 2G5. The components of the Project cost are listed in Table 5-1.

Table 5-1 Project Cost Components

Funding Source	Type of currency	Cost components	Description of costs
Japan's Loan (JPY and/or NGN)	Yen or other major currency	Cost for procurement and rehabilitation works	Cost for procurement of materials and parts, and their installation for rehabilitation to be incurred in Japan or other overseas countries
		Consultant fee	Cost of consulting services for preparation of tender documents and tender evaluation, and site supervision, and direct costs to be incurred in Japan or other overseas countries
	Local currency	Cost for procurement and rehabilitation works	Cost for procurement of materials and parts, and their installation for rehabilitation to be paid in Nigeria
		Consultant fee	Cost for local consultants and local staff and direct costs to be paid in Nigeria
Nigeria's Counterpart Fund (NGN)	Yen or other major currency	Cost for purchase of Spare parts	Cost for partial purchase of spare parts for O & M of the rehabilitated generation units
	Local currency	Amount payable by Nigerian side to compensate exempted Import Duty	Equivalent amount to import duty to be imposed on imported electrical materials, equipment and parts
		Amount payable by Nigerian side to compensate exempted tax	Equivalent amount to tax and levies to be imposed to contractors and consultants and value-added tax on local contents
		Salaries and pensions for JHPS staffs in project implementation	Salaries and pensions for JHPS officers in charge of project implementation and for skilled staff to be engaged for rehabilitation work under responsibility of the contractor
		Internet System	Cost required for coverage of wireless internet service in offices and accommodations for staffs of consultant and contractor within the premises of JHPS
		Construction cost of Ware House	Cost for construction of warehouse for storage of materials, equipment and parts required for rehabilitation

Nigeria's Counterpart Fund (NGN)	Local currency	Construction cost of accommodation for consultant staff	Cost for construction of 5 houses (3 bed rooms per house) for the use of consultant staff
		Cost for purchase of Spare parts	Cost for partial purchase of spare parts for O & M of the rehabilitated generation units
		Land rent fee, cost for disposal of waste, cost for water, electricity and environmental inspector	- Land rent fee for the contractor's staff quarter ($100m^3$) to cater for 300 workers - Cost for water and electricity to be consumed by consultant and contractor - Cost for disposal and treatment of waste such as removed Stator Cores and Coils, which contain asbestos - Cost for engagement of environmental inspector
		Interest and commitment charge	0.1% per annum for undisbursed principal of the Japanese ODA loan

5.2.3 Conditions of Project Cost Estimation

The total Project cost was estimated in accordance with the procedures for Japanese ODA loan with reference to the Project cost components for the respective funding portion from Japan and Nigeria as described above.

The total Project costs for three options of the Project plans were estimated in the range of the project scale between 5 billion JPY and 10 billion JPY in due consideration of economy of costs of the components.

Project cost is to be estimated taking into account the condition listed below and being based on the rules and methods of Japanese ODA loan projects.

Items	Contents	Conditions
Rate of exchange	･ Japanese Yen ･ Nigeria Naira ･ United State Dollar	･ Yen/USD 1USD=80.51Yen ･ USD/Naira 1USD=151.57Naira ･ Naira/Yen 1Naira=0.532Yen
Reserve fund	･ Price Contingency ･ Physical Contingency	･ Price Escalation, FC:1.6%,LC:5.1% ･ Construction, Consultant:5%
Tax	･ Import Duty ･ Valuable Added Tax	･ 5% (Electrical Goods) ･ VAT 5%
Rate of Interest during construction	･ Construction ･ Consultant	･ 0.3% ･ 0.01%
Rate of Commitment Charge		･ 0.1%

5.2.4 Rehabilitation Cost

The materials, equipment and parts required for the rehabilitation of generation units under the Project are to be imported from outside of Nigeria and the cost for the rehabilitation is estimated in Japanese Yen or other major currency, i.e., US dollar, Euro and etc. The rehabilitation cost is estimated for the items listed below:

(1) procurement cost for members, parts and equipment,
(2) cost for transportation of the above items and insurance for transportation,
(3) cost for removal of the existing parts and equipment and assembly and installation of the new members, equipment and parts, and
(4) cost for test and commissioning after assembly and installation.

Project cost for each component is as listed below. Project cost refers to 4.3.2.4 Basic Items to be rehabilitated and Appendix-9.

Unit: Billion

Case	Project Component	PROJECT COST			
		Procurement and Installation (JPY)	Counterpart Fund (NGN)	Consultant Fee (JPY)	TOTAL of ODA Loan (JPY)
Option 1	Renovation work for: Unit 2G5 and 2G1, hydro turbine and governors for same units and main transformers of same number shall be renovated.	5.115	2.162 (JPY1.081)	0.410	5.525
Option 2	Renovation work for: Unit 2G5, 2G1, and 2G3, hydro turbine and governors for same units and main transformers of same number shall be renovated.	7.084	2.838 (JPY1.419)	0.520	7.604
Option 3	Renovation work for: Unit 2G5, 2G1, 2G3 and 2G2, hydro turbine and governors for same units and main transformers of same number shall be renovated.	9.095	3.514 (JPY1.757)	0.633	9.728

Notes: Above amount including the price escalation and physical contingency

5.2.5 Cost for Consulting Services

Table 5-2 summarises the cost required for the consulting services to execute and encompass the task assignment described in Section 6.1.2.

Table 5-2 Cost Items for Consulting Services

No.	Description	Items	Currency portion	
			Foreign	Local
1	Professional Staff Costs			
1)	Basic Design and Tender Stage	Manpower costs for international consultants, local consultants and local staff	○	○
2)	Site Supervising Stage			
3)	Defect Liability Period			
2	Reimbursable Costs			
1)	Basic Design and Tender Stage	- International travel costs - Miscellaneous travel expenses	○	○

2)	Site Supervising Stage	- Excess baggage cost		
3)	Defect Liability Period	- Per Diem allowance for consultant staff - Lodging allowance for consultant staff - Costs for local transport for consultant staff including purchase of vehicles - Communication costs - Costs for printing of documents and reports - Costs for office accommodation and consumables - Costs for training of JHPS staff including accommodation and subsistence costs, local travel and transport costs and costs for training materials		

5.2.6 Cost to be borne by Nigeria

The cost of the Project which FGN needs to budget is 15 percent of the total Project cost and will be properly appropriated and disbursed throughout the Project implementation period. Therefore, annual budgetary allocation shall be provided based on the cash flow plan per cost component as mentioned in Nigeria's Counterpart Fund in Table 5-1 in Sub section 5.2.2 Composition of Project Cost.

While budget of this Project by Nigeria side occupies 15 percent of the total Project cost, local currency is to be applied to the settlement of major components. As is described or listed already, the cost is embarked as direct staff fees, cost for tax, indirect cost and etc. Budget of Nigeria side is to be estimated following the applicability criteria and the rate of related items. Local currency portion of Nigeria side's budget follows what is mentioned as Counterpart Fund (Nigeria Naira) in 5.3.1 Schedule for annual fund requirement

5.2.7 Contingency

There are two types of contingency fund: provision for an increase in prices (price contingency) and provision for increase in physical works due to unforeseen factors (physical contingency). Price contingency is determined based on the trend of price indices, while physical contingency depends on the nature of the Project.

The cost estimation of the Project shall consider following values for such as contingency.

Price Contingency (Price Escalation): Foreign Currency 1.6 percent, Local Currency 5.1 percent

Physical Contingency: 5 percent (consultant fee shall apply same value)

5.3 Financing Plan

Since funding for the Project consists of Japanese ODA loan and domestic budget of FGN, close coordination among authorities concerned in particular in Nigerian side is important in order to make sure timely budgetary allocation and disbursement toward successful implementation and completion of the Project.

5.3.1 Schedule for annual fund requirement

Annual funding for the Project shall be allocated in accordance with the Project cost cash flow as shown in Table 5-3.

Table 5-3 Project Cost Cash Flow (Preliminary)

Unit: Billion

Items	2012	2013	2014	2015	2016	2017	2018	2019	2020	TOTAL	Remarks
Japan’s Loan (Japanese Yen: JPY, and Nigeria Naira: NGN)*											
Consultant Yen Portion	JPY0.060	JPY 0.160	JPY 0.080	JPY 0.080	JPY 0.080	JPY 0.080	JPY 0.070	JPY 0.010	JPY 0.010	JPY 0.630	*These amounts of Japan’s loan are tentatively calculated maximum amounts, and are subject to be changed by GOJ.
Consultant Naira Portion	NGN0.013	NGN 0.027	NGN 0.015	NGN 0.018	NGN 0.018	NGN 0.018	NGN 0.018	NGN 0.001	NGN 0.005	NGN 0.133	
Contractor Yen Portion		JPY 0.660	JPY 1.410	JPY 1.130	JPY 1.130	JPY 1.130	JPY 1.130			JPY 6.590	
Contractor Naira Portion		NGN 0.560	NGN 1.000	NGN 1.000	NGN 1.000	NGN 1.000	NGN 1.050			NGN 5.610	
Japan’s Loan Total of Yen Portion	JPY 0.060	JPY 0.820	JPY 1.490	JPY 1.210	JPY 1.210	JPY 1.210	JPY 1.200	JPY 0.010	JPY 0.010	JPY 7.220	JPY 10.14893
Japan’s Loan Total of Naira Portion	NGN 0.013	NGN 0.587	NGN 1.015	NGN 1.018	NGN 1.018	NGN 1.018	NGN 1.088	NGN 0.001	NGN 0.005	NGN 5.743	
Nigeria’s Counterpart Fund (Nigerian Naira: NGN)											
Import Duty (5%)			0.280	0.280						0.560	Electrical Goods
Estimated Tax Amount	0.006	0.099	0.177	0.153	0.153	0.153	0.154	0.001	0.001	0.895	30% taxation
Estimated VAT Amount	0.001	0.022	0.039	0.034	0.034	0.034	0.034	0.0002	0.0002	0.199	4% taxation
Manpower Cost	0.002	0.002	0.002	0.002	0.002	0.002	0.002			0.014	Administration
Internet System	0.010	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.018	
Construction of Accommodation	0.350	0.003	0.003	0.003	0.003	0.003	0.003			0.368	5 Houses
Ware House for Goods			0.093							0.093	
Land Rent Fee			0.070	0.070	0.070	0.070	0.070			0.350	300workers
Light and Water Expenses		0.025	0.025	0.025	0.025	0.025	0.025			0.150	193 workers
Disposal for Waste Material				0.003						0.003	100m3
Environmental Inspector				0.020	0.020	0.020	0.020			0.080	
Skilled Labor			0.031	0.074	0.074	0.074	0.050			0.303	
Spare Parts				0.080	0.080	0.070	0.070			0.300	
Commitment Charge	0.024	0.022	0.018	0.015	0.019	0.008	0.005			0.111	0.10%
Nigeria’s Counterpart Fund total	NGN 0.393	NGN 0.174	NGN 0.740	NGN 0.759	NGN 0.480	NGN 0.459	NGN 0.434	NGN 0.002	NGN 0.002	NGN 3.444	JPY 1.75669

5.3.2 Budgeting

The funding arrangements should be planned so as to ensure that costs not covered by Japanese ODA loan will be adequately funded from other financing sources, such as national or local budget, the implementing agency’s internal funds, borrowings form commercial financial sources or loans or grants from prospective co-financing institution(s). JICA studies the financial soundness and financing procedures of such sources to ascertain whether the funds required will certainly be available for the Project.

JHEP as implementing agency is required to apply for fund needed annually without delay to FMOP and FMOP is requested to apply to FMOF to budget the applied fund.

5.3.3 Re-lending

FMOF is the borrower of Japanese ODA loan lending and bears overall responsibility for smooth Project implementation, effective use of the fund and repayment. However there is no re-lending from FMOF to FMOP or JHEP since the facilities to be rehabilitated will remain the property of FGN.

Chapter 6

Project Implementation, Operation and Maintenance Plan

Chapter 6 Project Implementation, Operation and Maintenance Plan

6.1 Related Agencies for Project Implementation

6.1.1 Responsible Agency for Project Implementation

The borrower of the Project is FMOF with overall responsibility for smooth Project implementation, effective use of the fund and repayment. Executing and implementing agency is JHEP responsible for smooth implementation of the Project and appropriate O & M of the rehabilitated facility under the Project after completion of the Project. JHEP shall maintain close discussions and communications with the consultant and contractors selected by JHEP abiding by the cooperation scheme as stipulated in the loan agreement to be concluded between FMOF and JICA. JHEP is also responsible for liaison with JICA with assistance from the consultant. As the responsible agency for implementation of the Project, JHEP is responsible for obtaining the cooperation from residents around JHPS for the implementation of Project by explaining the contents of the Project sufficiently and obtaining the understanding.

6.1.2 Consulting Services

The consultant for the Project shall be selected through international competitive bidding based on Quality- and Cost-Based Selection (QCBS) in accordance with Nigerian regulations and practice and JICA's related guidelines for procurement of consultants. The consultant shall undertake the following services:

(1) Overall Project management,
(2) Review of pre-investment studies.
(3) Basic design reports,
(4) Preparation of documents for expression of interest (pre-qualification) and evaluation,
(5) Preparation of tender documents,
(6) Tender Assistance,
(7) Conclusion of contract with the successful tenderer,
(8) Renovation work supervision,
(9) Environmental monitoring,
(10) Capacity development,
(11) Institutional strengthening for project sustainability,
(12) Financial management,
(13) Liaison with JICA,
(14) Monitoring and evaluation,
(15) Documentation of replicable experiences, and
(16) Services during defect liability period (DLP).

Terms of Reference (TOR) of consulting services is attached in Appendix-11.

6.1.3 Contractor

The contractor for the Project shall also be selected through international competitive bidding in accordance with Nigerian regulations and practice, and JICA's related guidelines for procurement of contractor/ manufacturer. The contractor shall undertake the procurement of good and materials required for the renovation works, manufacturing equipment and parts, site renovation works and works required during defect liability period.

Rehabilitation of targeted facilities, generator unit 2G1, 2G2, 2G3, and 2G5 are large-scale generation units whose rated capacity is 96.4MW and are produced by Japanese manufacturer. Therefore, the qualified contractors/manufacturers for bidding for the Project shall be heavy industry hydropower electric machinery manufacturers with experiences in the similar scale of installation and/or rehabilitation of hydropower generation units.

The contractor shall also be responsible for after sales services such as to supply spare parts at commercial basis, to provide repair works in case of emergency, and to undertake overhauls upon request by JHPS. Therefore, the contractor shall maintain close communication with JHPS after completion of the Project.

6.2 Project Implementation

Target generator units of the Project are to be rehabilitated one by one in consideration of the following:

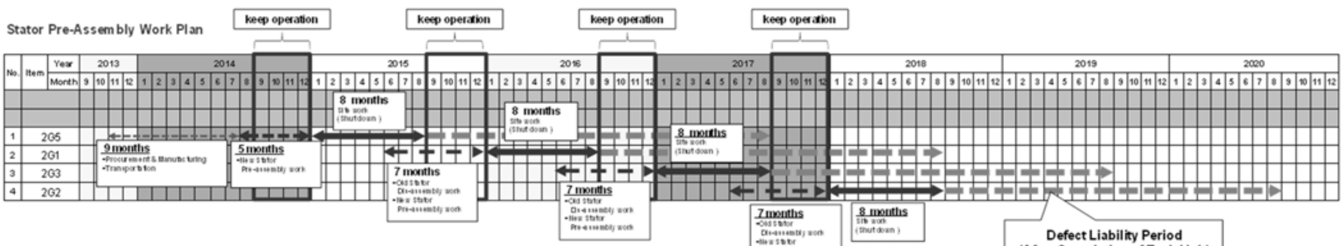
(1) Limited work space for pre-assembly at erection bay in the powerhouse,

(2) Time required for unit shut down for rehabilitation work at site, and

(3) Full units operation during peak months of generation in order to secure power supply and power sales revenue.

Prioritised order of rehabilitation of target units is in the order of 2G5, 2G1, 2G3 and 2G2 as described in 4.3.2.5. Stator frame of 2G5 which is the first stator to be rehabilitated will be replaced with new stator frame, while those for units 2G1, 2G3 and 2G2 are rehabilitated ones removed from the existing generator units after complete repair at the site so that the total Project Cost can be reduced. Project implementation schedule shown below is for the case that all four target units will be rehabilitated, namely for Option 3 in Sub section 4.4.4. The schedule for three units rehabilitation, i.e. Option 2, will be one year shorter than that of Option 3 and likewise the schedule for two units rehabilitation for Option 1 will be another one year shorter than Option 2.

Tentative Project Schedule for Renovation Work



(1 stator frame is brand new, and other 3 frames are re-used)

6.3 Implementation Programme

6.3.1 Development of Implementation Programme

The Project shall be implemented by Japanese ODA Loan scheme and it will be started after the conclusion of the Exchange of Notes (E/N) between both governments and Loan Agreement (L/A) between FGN and JICA. JHEP will engage the consultant and the contractor through the selection processes as stated in Sub sections 6.1.2 and 6.1.3 and the rehabilitation work will be commenced. The implementation of the Project is mainly divided into five stages; namely i) selection of the consultant, ii) selection of the contractor, iii) procurement and manufacturing of equipment and parts for renovation works, iv) site renovation works, and v) defect liability period.

Estimated milestones and periods for major activities in the Project implementation are as follows:

(1) Executed date of effectuation of L/A: March 2012
(2) Selection of consultant: eight months from April 2012 until November 2012
(3) Selection of contractor: 11 months from December 2012 until October 2013
(4) Procurement, manufacturing and transportation: nine months from November 2013
(5) Pre-assembly work of new stator frame: five months from August 2014
(6) Site renovation work of the unit 2G5: eight months from January 2015 until August 2015
(7) Full operation of all generation units available during peak months: four months from September 2015 until December 2015.
(8) DLP for the unit 2G5: 24 months from September 2015
(9) Rehabilitation work for the unit 2G1: 15 months from June 2015 in the same sequence of works as 1st unit
(10) DLP for the unit 2G1: 24 months from September 2016
(11) Rehabilitation work for the unit 2G3: 15 months from June 2016 in the same sequence of works as the unit 2G1 (Option 2 and Option 3 only)
(12) DLP for the unit 2G3: 24 months from September 2017 (Option 2 and Option 3 only)
(13) Rehabilitation work for the unit 2G2: 15 months from June 2017 in the same sequence of works as the unit 2G1 (Option 3 only)
(14) DLP for the unit 2G2: 24 months from September 2018 until August 2020 and the Project completion (Option 3 only)

It shall be noted that the delay in selections of the consultant and the contractor may easily lead to one year delay if JHEP will place priority on peak operation of the power plant with all available units in operation, therefore, the related agencies in Nigerian side shall properly monitor and manage the selection process so that the above proposed milestones can be completed as scheduled.

Project Implementation Schedule is as shown in Appendix-10.

6.3.2 Concurrence by JICA

The employment of consultants and procurement of goods and services under projects financed by ODA Loans from JICA are carried out in accordance with the general principles and procedures laid down in the Guidelines for the Employment of Consultants under Japanese ODA Loans (Consultant Guidelines) and the Guidelines for Procurement under Japanese ODA Loans (Procurement Guidelines) respectively.

In the course of implementation of Japanese ODA Loan projects, the following concurrence by JICA shall be obtained by JHPS:

(1) Short list of consultants
(2) Evaluation results of consultants
(3) Consultancy agreement
(4) P/Q documents for contractors/suppliers
(5) Evaluation results of P/Q of contractors/suppliers
(6) Tender Documents
(7) Evaluation results of tender
(8) Contractor/supplier agreement

6.4 Procurement

6.4.1 Procurement Procedure

6.4.1.1. Relevant Laws and Regulations

(1) Public Procurement Act (PPA) 2007
(2) Guidelines for the Employment of Consultants under Japanese ODA Loans, March 2009, JICA
(3) Guidelines for Procurement under Japanese ODA Loans, March 2009, JICA

6.4.2 Procurement Method

JHEP will procure consultant and contractor in conformity to PPA 2007. According to the PPA, procuring entity will be JHEP and approval will be needed by two levels of Tenders Board (TB). One is parastatal TB, which is internally organised in JHEP to be chaired by JHEP-CEO. All board members are from JHEP. The other is Federal TB which posits as the federal level, chaired by the President of FGN. All members of the Federal TB are federal ministers. Federal TB will be convened for the procurement with amount more than or equal to 1 billion NGN. Federal TB, i.e. Federal Executive Council will be held once in every two weeks.

In addition, approval by the BPP also required. The procuring entity (JHEP) shall forward the tender evaluation results of consultant and contractor for approval by Bureau of Public Procurement (BPP). BPP will issue the certificate of “No objection” upon approval of the evaluation results for contract award.

Judging from the contents of equipment and instruments procurement in the Project, since there will be a mixture of products with short delivery times and long delivery times, the Team will formulate a method for transporting when the short delivery time products are completed and consider the installation process according to this. Moreover, concerning the items that require long delivery times (rotor pole and so on), since manufacture alone will take around 10 months, when transportation is also taken into account, around one year will be required from ordering (contracting with the supplier). Therefore, since the overall schedule and works period will be influenced by the manufacturing lead time of such long delivery time products, it will be necessary to compile a schedule with no element of waste in preparation of shop drawings, approval work and plant inspections, etc.

(1) Target generation units

The Project will target 2G1, 2G2, 2G3 and 2G5 currently in operation in JHPS for rehabilitation. Accordingly, in the Survey, it was necessary to completely grasp the state of equipment, parts and instruments, etc. in need of replacement when the units have been totally stopped for annual inspections at the power station.

(2) Preconditions for selecting major equipment specifications

Since the Project rehabilitation will entail replacing equipment, parts and instruments that are already installed, the Team will basically adhere to existing specifications, however, it is possible that some equipment, parts and instruments are no longer in production because the existing equipment has been in operation over 27 years beyond the designated service life. Moreover, as it is likely that equipment and part materials have undergone revisions and improvements since initial installation, it will be necessary to compile specifications while taking manufacturer’s specifications into account.

(3) Transportation of procured equipment and materials

Japanese corporations and the generator manufacturer implemented the installation of equipment at JHPS before it was completed in 1985, and these Japanese corporations have continued to supply generator parts and instruments, etc. ever since. In view of this situation, since there are no ships travelling directly from Japan to Nigerian ports, when compiling the equipment and instruments procurement schedule, it will be necessary to assume around two months for transportation including reloading at nearby ports in South Korea, China or Singapore.

6.4.3 Tendering Package

Tendering package for the Project will be roughly divided into two.

(1) Selection of the Consultant

Nigeria Public Procurement Act 2007 and JICA Guidelines for the Employment of Consultants under Japanese ODA Loans must be applied for selection of the Consultant. Procedure such as solicitation, progress control, examination and employment with QCBS system must be carried out without delay as mentioned in the Guidelines above-mentioned. Moreover, examination and approval of Nigerian side, and approval by JICA shall be obtained at each process. It is necessary to satisfy the following contents for selection of the Consultant.

(a) Preparation of a short list of consultants;

(b) Preparation of the request for proposals;

(c) Invitation to submit proposals;

(d) Evaluation of proposals; and

(e) Negotiation and conclusion of a contract.

(2) Selection of the Contractor for Procurement and Installation

Nigeria Public Procurement Act 2007 and JICA Guidelines for the Employment of Contractor under Japanese ODA Loan must be applied for selection of the Contractor in the same way as for the Consultant. In order to select the Contractor, International Competitive Bidding (ICB) system is adopted in principle. However, it shall be possible to adopt other systems such as Local Competitive Bidding (LCB) for consideration of special reasons in consultation with JICA in advance.

It shall also be possible to select procurement system and services by leaving LCB with Counterpart Fund (Local Currency Portion) to Nigerian discretion. Moreover, examination and approval of Nigerian side, approval by JICA shall be obtained at each process. In order to secure appropriate qualification for the Project, PQ for the Tender shall be conducted.

Main component of the Project shall be procurement and installation of rehabilitation equipment and parts for generators and necessary adjustment and test for the facilities.

All the works above-mentioned shall be implemented as a blanket contract system on turnkey basis.

6.5 Rehabilitation Plan

6.5.1 Rehabilitation Method

General sequence of the on-site rehabilitation work for generator is shown as follows: The sequence of work outlines the magnitude of the basic work process to be followed in the disassembly and re-assembly of the generator. This is not purported to completely describe the work required or to be entirely accurate in its requirements.

(1) General sequence of on-site rehabilitation work

＜Stator pre-assembly work at the erection bay, before unit shut down＞

① Preparation of working area, facilities, utilities, tools, etc.
↓
② Disassembly of stator winding (for 2nd to 4th unit only)
↓
③ Disassembly of stator core laminations (for 2nd to 4th unit only)
↓
④ Roundness check and adjustment of stator frame
↓
⑤ Total re-stacking work of core laminations, and acceptance tests
↓
⑥ Winding work of stator coils, and acceptance tests after completion of stator

＜Rehabilitation work, after unit shut down＞

① Preparation of working area, facilities, utilities, tools and etc.
↓
② Disassembly of generator
↓
③ Disassembly of stator winding and exchange from old to new stator
↓
④ Trimming, finishing, inspection and cleaning of disassembled parts
↓
⑤ Disassembly of rotor pole and exchange from old to new rotor pole
↓
⑥ Modification of rotor rim support
↓
⑦ Assembly of the generator
↓
⑧ Commissioning tests of the generator
↓
⑨ Site clearance (demolition and close-out)
↓
⑩ Reporting at site

All equipment and materials shall be installed in accordance with the contract specifications, drawings, and instructions.

The contractor’s supervisor shall give the detailed instructions and may make changes or revisions in some parts of instructions for the purpose of making them conform to the circumstances specially arise in the site.

Should JHPS and/or the consultant disagree with some portions of instructions or have not well understood the same, the supervisor of the contractor is required to provide and additional information and cooperate with JHPS to achieve the successful completion of rehabilitation work. The contractor is requested not to start the site work before JHPS can comprehend the methods and procedures of the work. Otherwise the misunderstanding may result in the unexpected faulty assembly or installation.

The grade or standard of the work for the generator rehabilitation is JIS, ANSI, NEMA, IEEE, ASME, ASTM or equivalent international standards.

6.5.2 Supervision

(1) Planning on work supervision and procurement management

JHEP shall employ a consulting firm being in charge of implementation design and work supervision based on the institution of procurement of Nigeria and loan cooperation scheme of Japan, and implements the work smoothly. JHEP shall arrange implementation superintendent during the work period and carry out work schedule supervision, quality control, security management and fund management together with employed consultant. Moreover, expert technician participates in factory inspection and pre-delivery inspection depending on necessity so that some troubles after materials are transported to the project site can be prevented in advance.

(2) Basic principle of work supervision

JHEP shall monitor and manage the progress of work to complete the work by designated timeline, and manage and provide necessary instructions or take countermeasures to secure the quality stipulated in the contract and realise the safe implementation of work with the cooperation by the consultant.

Primary points for work management are shown below:

1) Work schedule management

Work schedule planned at the time of contract with a contractor shall be monitored in comparison with the actual progress of work based on the following items every month and week, and in case that delaying of actual work is observed, the contractor is warned and is requested to submit a recuperative plan and given directions to complete the work in accordance with the contract by the time for completion.

- Confirmation of amount of work done
- Confirmation of record of actual brought-in materials to the project site
- Confirmation of the actual unit work volume against planned ones for engineers and labours etc.

2) Quality management

Supervision shall be implemented for confirming whether quality of facilities and materials is secured by the contractor in accordance with technical specification and detailed design. When quality of work is not satisfactory to the consultant, the contractor is required to correct, change and modify the work to the satisfaction of the consultant.

- Verification of design drawings and specification of materials
- Verification of the result of factory inspection of parts and materials and/or witness to inspection
- Verification of installation manuals, trial operation at site, adjustment, inspection manuals and working drawings
- Supervision of installation work at site and witness to trial operation, adjustment and inspection

3) Safety management

JHPS with assistance by the consultant shall discuss and cooperate with the resident representative of the contractor to prevent labour disaster and accident at project site from occurring in advance. The followings are points to be considered for safety management at site.

- Establishment of safety management rule and appointment of person in charge
- Disaster prevention through implementation of regular inspection of construction machinery
- Establishment of operation routes of vehicles (mobile equipment) and construction machinery, and thorough operation of slow driving within the site
- Practice of welfare support and holiday acquisition to labours

4) Fund management

Total project cost stipulated in the E/N between FGN and GOJ shall be properly disbursed by JHEP, the implementing agency of the Project. After L/A is concluded, the project cost shall be transacted from the GOJ to FGN. Payment to the consultant and the contractor shall be made by the agency in accordance with the payment conditions in the contracts.

(3) Overall relation with regards to project implementation

Figure 6-1 illustrates the relationship among stakeholders regarding the Project, including the Project implementation stage.

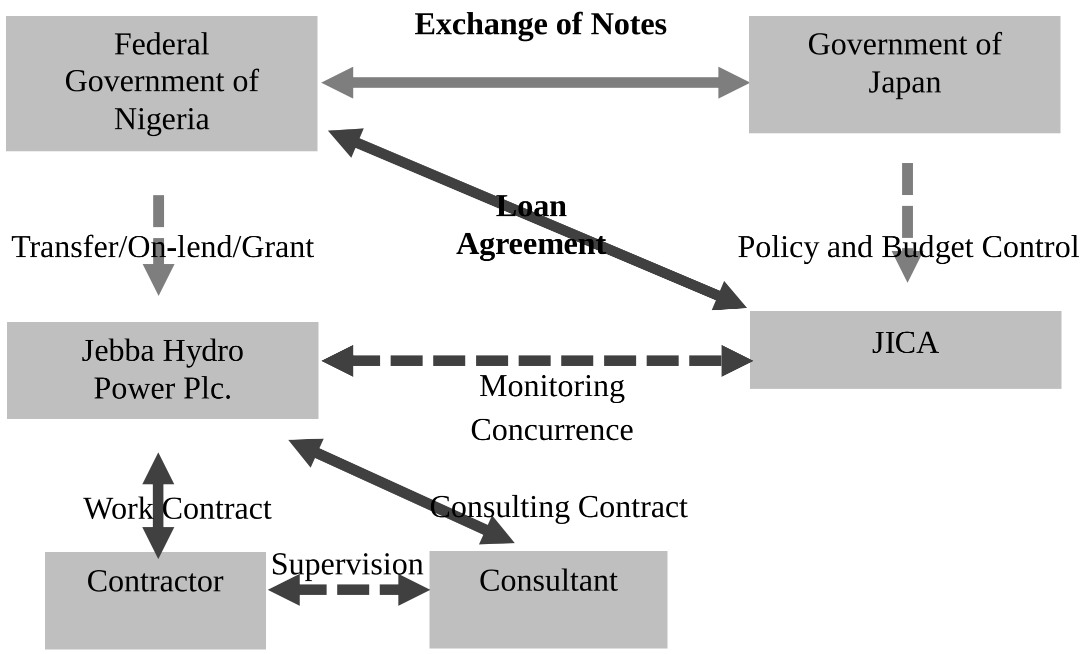


Figure 6-1 Stakeholders Relationship regarding to the Project Implementation

1) Superintendent of work implementation

Based on the contract with JHEP, the contractor shall implement procurement and rehabilitation work. Whilst the contractor is in charge of work schedule management, quality management and safety management, a consultant employed by JHEP shall assist JHEP to provide instructions to contractors as and when required to let them carry out necessary management.

2) Quality management organisation

A site resident engineer from the consultant shall supervise the quality of materials and works in accordance with stipulation in the contract documents such as technical requirement and detailed design are secured based on the following items: When quality of contractor’s work is not satisfactory to the consultant, the contractor shall be requested to rectify the work according to the consultant’s instruction. The consultant on behalf of JHEP assures the performance status of the work supervision and provides necessary instructions.

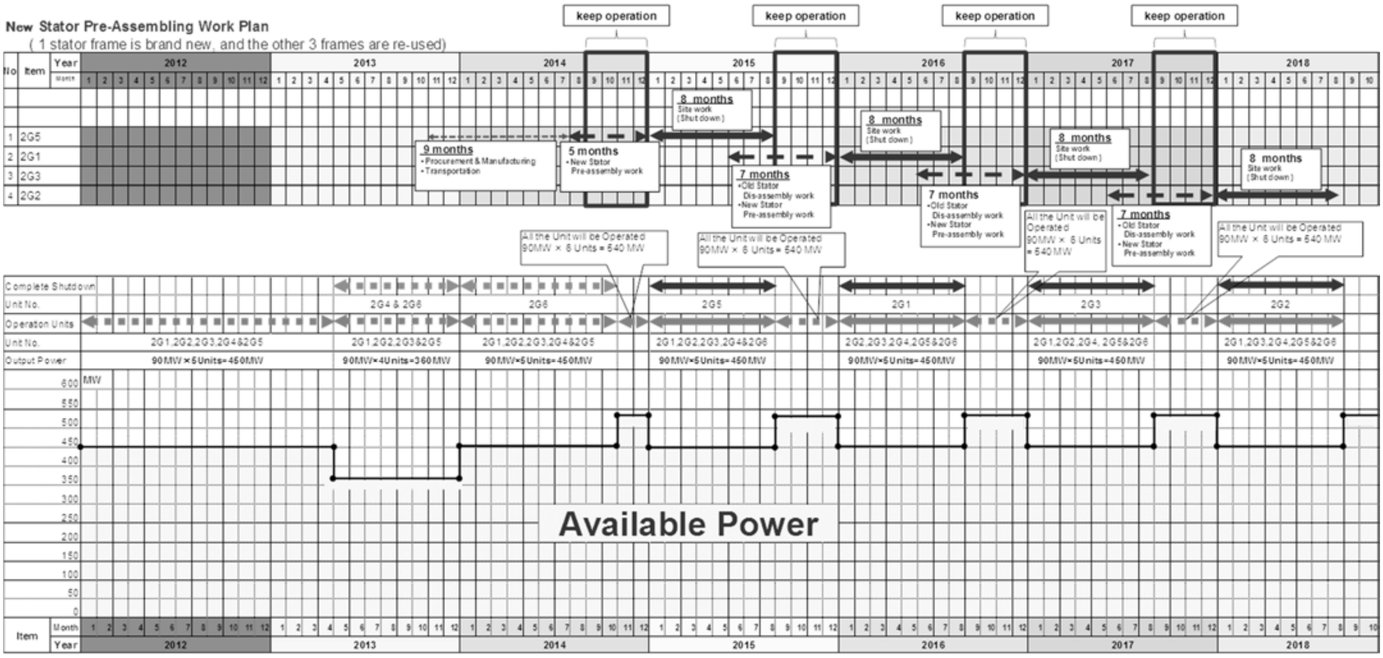
- Verifications of design drawings and specification of materials
- Attendance to factory inspection and/or verification of the report of factory inspection
- Verification of packing, transportation and tentative storage at site
- Verification of working drawings and installation manual for parts and materials
- Verification of manual regarding factory inspection and site inspection, trial operation, adjustment and inspection.
- Supervision of installation work of parts and materials at site and witness to trial operation, adjustment and site inspection.

· Verification of completion documents including as-built drawings.

6.5.3 Rehabilitation Schedule

The number of shutdown generators should be minimised because of limitation of the work field and necessity of power supply at peak demand. Therefore, rehabilitation work shall be executed one by one as following work plan in consideration of prioritisation.

Rehabilitation for the first shutdown generator shall be started after the period of peak demand in 2014 and make it possible to operate in eight months. Other generators shall be rehabilitated as same as the first shutdown generator, and are expected to be completed by August, 2018.



6.6 Operation and Maintenance System

(1) Basic principles

As some of the technical personnel of JHEP have worked there since the plant commenced operation, technical skills have been passed on to a certain degree. These employees have conducted O & M and all repairs at the station over 27 years and have kept the equipment in relatively good condition in spite of their long-term operation, However, for the purpose of securing more stable management of hydropower station, it is essential to execute appropriate O & M of generation units and to secure surrounding environment. Hence, proper implementation of preventive maintenance and O & M is required for reducing the occurrence of the accidents to enhance the reliability, safety and efficiency of management.

Figure 6-2 shows basic principle with regards to the O&M of hydropower station. Through this, O & M of facilities and materials which shall be procured and installed under the Project should be implemented mainly focused on preventive maintenance.

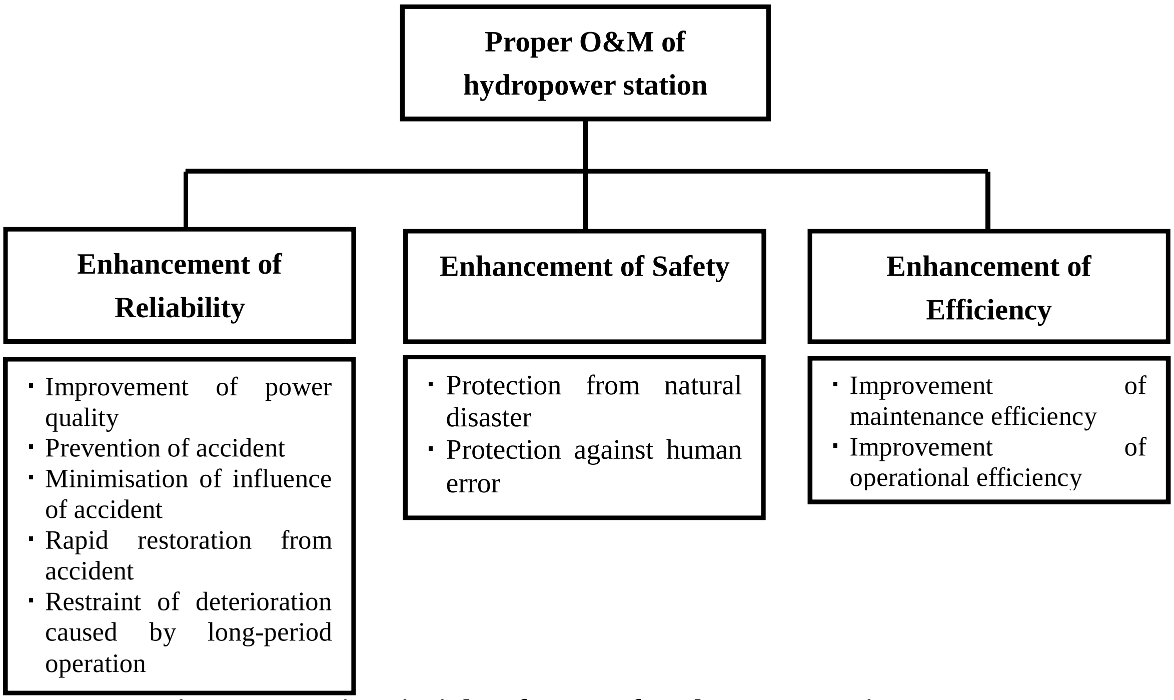


Figure 6-2 Basic Principles of O&M of Hydropower Station

During implementation of the Project, OJT to the staff of JHPS for O & M of the turbines and generators shall be implemented by technicians dispatched by the contractor during the period of rehabilitation work. In line with it, necessary spare parts, instruments for inspection and tools for maintenance, O&M manuals and suggestions on O&M system after the commencement of operation shall be provided by the contractor. This will make it possible to achieve the sufficient effect of training.

(2) O&M Management Structure

JHEP, which is in charge of O&M after the implementation of this project, is planning the O & M implementation system illustrated in 3.3.2 (2) 3) under the supervision of JHEP CEO. Thus organisation and structure which enable to operate a suitable power business is expected.

(3) Items of regular inspection

1) Regular inspection of generators and turbines

Standard items of regular inspection for generation units procured and installed by the Project are indicated in Table 6-2 The inspection of the facility is divided into three types: i) visual inspection which is conducted daily by maintenance staff through observing such as extraordinary heat and abnormal noises of facilities, ii) normal inspection which inspects electric charge parts that cannot be inspected by daily visual inspection, and iii) precise inspection which inspects functions such as stator rotor, guide vanes, bearing governors and exciter, and maintain the precision of metres.

Normal inspection shall be implemented once in one to two years and precise inspection shall be done once in four years. Also, it is desirable to change some parts, whose function, insulation performance are deteriorated, point of contact is worn out on characteristic performance changes, such as metres and relays if necessary during normal inspection and/or precise inspection.

Table 6-1 Regular Inspection Items for Standard Facilities: Generator

Parts	Name	Inspection item	Time					
			Installation	Before and/or Under Operation	Regular			
					Every 6 months	Every one year	Every 2 years	Every 5 years
1. Rotor hub		Cracking						○
2. Rotor	(1) Pole core	Rust				○		
	(2) Field coil	Dirt of windings			○			
		Insulation resistance	○	○				
	(3) Damper winding	Sparking at starting				○		
		Brazing strip					○	
		Cracking					○	
		Transformation of bars					○	
	(4) Fans	Tightness of bolts				○		
3. Air gap		Compare with the size at installation	○			○		
4. Stator	(1) Stator core	Transformation damage					○	
		Signs of overheat					○	
		Rust				○		
	(2) Stator winding	Dirt of surface of windings				○		
		Deterioration of insulating material				○		
		Insulation resistance		○				
	(3) Core ducts	Dirt of ducts		○				
	(4) Wedges	Tightness of wedges				○		
	(5) Frame	Looseness of base clamping bolts and foundation bolts	○			○		
5. Bearings	(1) Bearings	Damage or cracking	○		○			
		Operation temperature		○				
	(2) Oil boxes	Oil leakage	○	○				
	(3) Lubricating oil	Oil quantity (Standard oil level and oil flows)	○	○				
		Deterioration, mixture of water			○			
	(4) Shaft insulation	Insulation resistance	○			○		
		Inspect shaft voltage at shaft insulation parts	○	○				

Parts	Name	Inspection item	Time					
					Regular			
			Installation	Before and/or Under Operation	Every 6 months	Every one year	Every 2 years	Every 5 years
	(5) Bracket	Looseness of clamping bolts to stator frame	○		○			
		Vibration		○				
6. Space heater		Snapping of heater			○			
		Are there any inflammable matters such as oil near space heater?	○	○				
		Insulation resistance	○		○			
7. Oil or Air cooler		Air vent			○			
		Oil or water leakage			○			
		Rust and dirt				○		
8. Piping		Air, water or oil leakage	○	○				
9. Oil circulating pump		Oil leakage	○	○				
		Cleaning of filter			○			
		Temperature of pumps and motors	○	○				
		Pressure	○	○				
		Vibration of oil pipes and pumps	○	○				
		Insulation resistance of motors	○			○		
		Abnormal sound	○	○				
10. Break		Shoe wear				○		
11. Collector ring		Spark on brush		○				
		Brush pressure	○		○			
		Brush wear			○			
		Collector ring surface	○			○		
		Dust				○		
12. Others		Abnormal sound and vibration	○	○				
		Contacting with rotor and stator parts	○		○			
		Interlock circuit	○		○			
		Protective circuit	○		○			
		Stopper of rotor part	○		○			
		Storage of spare parts	○				○	

Table 6-2 Regular inspection items for standard facilities: Turbines

Inspection item	Contents (Method)	Visual inspection	Regular inspection	Precise inspection
Turbine	Guide vane operation	○	○	○
	Water leakage from guide vane bearing and condition of shear pin or shear bar		○	○
	Oil leakage from joint parts	○	○	○
	Oil level and quantity of supply oil to main guide bearing	○	○	○
	Temperature and quantity of cooling water supply to main guide bearing	○	○	○
	Abnormal vibration or noise	○	○	○
	Abnormal condition of temperature indicator's element, relay and wiring		○	○
	Relation between turbine output and guide vane opening angle		○	○
	Measurement of vibration		○	○
	Wear of main guide bearing metal			○
	Wear of main shaft sleeve and wear of shaft seal packing			○
	Wear on runner and measurement of gap between runner blade and discharge ring			○
	Measurement of guide vane shutter surface and gap between guide vane and top cover/ bottom ring			○
	Wear of guide bearing bush			○
Governor	Condition of governor potentiometre and dust on converter	○	○	○
	Excess heating, discoloration or wire breakage of governor resistor	○	○	○
	Condition of link pin and wiring tension in return mechanism		○	○
	Clogging of governor oil strainer			○
	Oil lubricating condition of governor moving portion		○	○
Oil pressure device	Operation of pressure oil pump, noise or unusual smell	○	○	○
	Oil level and pressure of pressure oil system	○	○	○
	Oil leakage from piping or cage	○	○	○
	Oil temperature and quantity of cooling water supply to oil sump tank	○	○	○
	Wear of gear pump and side gap measurement		○	○
	Wear of pressure oil pump bearing and motor bearing		○	○
	Wear and wrapping of pilot valve			○
	Contamination of foreign substances or existence of sludge in pressure oil			○
Other devices	Oil leakage from pipes and fittings in lubrication system	○	○	○
	Operation of level switch and limit switch for oil sump tank		○	○
	Quantity and level of lubrication oil supply device	○	○	○
	Clogging of strainer for water supply device			○
	Water leakage or clogging of pipes in water supply system		○	○
	Quantity of water from water supply device and operation of water flow relay			○
	Condition of water level detector in water discharge			○

Inspection item	Contents (Method)	Visual inspection	Regular inspection	Precise inspection
	system			
	Excess heating or vibration, water discharge performance and oil lubrication in water discharge system	○	○	○

6.7 Technical Assistance and Transfer

(1) General

Technical assistance in the framework of Japanese ODA loans is extremely useful for ensuring the sustainability of benefits and effects generated by the Project. Technical assistance and transfer in the implementation of the Project is planned based on the evaluation result of the O & M capacity of JHPS.

JHPS, since its commencement of operation in 1983, has an actual successful work record of O & M by its own staffs up to date, thus, technical staffs are highly skilled and experienced. Also, O & M method has already been established in JHPS. However, as described in Sub section 3.3.2, although station personnel possess routine O & M capacity through the established quality control efforts, they have also experienced the operating accident that made rehabilitation necessary in 2009 and they need to receive equipment operation training in predictive and preventive maintenance measures and based on simulations of various accident situations. Therefore, to ensure that the station personnel can operate and maintain the facilities immediately after rehabilitation by the Project, it is recommended for JHPS to implement equipment predictive and preventive maintenance measures and operation techniques. Training for daily maintenance and assurance activities are also required to make sure the normal operations of the rehabilitated generation units in organised and qualified manner at all times.

(2) Technical OJT for generator

OJT will be conducted during the implementation of the Project for the purpose of not only training and improving JHPS engineers’ technical skills and knowledge, but also proceeding the on-site work efficiently with JHPS engineers’ active participation on site.

OJT includes provision of technical advice on documentation, reporting, procedures and quality control/ management of on-going work and demonstration of the work procedure to JHPS engineers, upon request on site during the implementation of the Project.

(3) Technical Overseas Training for generator

The technical lecture course at manufacture’s shop will be executed for the purpose of training and improving JHPS engineers’ technical skills and knowledge such as,

1) Design and manufacturing method of a generator and components,
2) How to proceed with disassembly and re-assembly of generator and tolerances,

3) How to replace stator including use of jigs and work equipment,
4) How to replace rotor pole including use of jigs and work equipment,
5) How to repair components including use of jigs and work equipment,
6) How to perform tests,
7) Emergency response training, and
8) Others including Q&A.

Basically, this training will be performed through classroom lectures and some workshop tours. A total of fifteen (15) personnel will be made available to benefit from the training programme. The area covered by the training will be generator, turbine and governor and transformer within the scope of the contracts of the rehabilitation works to be implemented under the Project.

Chapter 7

Financial and Economic Evaluation

Chapter 7 Financial and Economic Evaluation

7.1 Method for Financial and Economic Evaluation

As for four generators namely 2G1, 2G2, 2G3 and 2G5, financial and economic evaluation is conducted by comparing the results of the following three options: i) rehabilitation of two units of the generators (Option 1); ii) rehabilitation of three units (Option 2); and iii) rehabilitation of four units (Option 4). The financial evaluation is aimed at analysing financial profitability from the viewpoint of the project implementer named Jebba Hydro Electric Plc. (JHEP), and financial internal rate of return (FIRR) is calculated. The economic evaluation is aimed at reviewing the Project implementation from the viewpoint of national economics. Through the analysis, effects with the Project implementation are compared with those without project implementation. To this end, economic internal rate of return (EIRR) is also calculated. Since the Project targets four units, even in Option 2 (three units rehabilitation) and Option 1 (two units rehabilitation), the financial and economic evaluation analysis is conducted on the basis of the cost for 4 units and revenue for numbers of units subject for rehabilitation respectively. Thereby, each case can be compared on the same basis. The evaluation targets a period of 37 years starting from the Project launching in 2018 until 2055.

Evaluation indices used for financial and economic analysis is defined as follows:

(1) NPV (Net Present Value):

Total of present value of cash inflow (benefit) caused from the Project, and cash outflow (cost) related to the Project. Present value is related with the value at the investment time by the expected rate of return acquired by investment. When NPV is higher than zero, it is considered that the Project is worth for being invested.

(2) B/C(benefit by cost):

The ratio of total of benefit divided by total of cost

(3) IRR

The discount rate when set to NPV=0. It is considered as the size of the benefit obtained from the Project.

(4) FIRR:

IRR calculated considering cash inflow as a financial benefit (income) from the Project.

(5) EIRR:

IRR calculated considering cash inflow as a benefit (increase in added value) to the national economy from the Project.

7.2 Financial Evaluation

7.2.1 JHEP's Management and Financial Status

As for before-tax profit/loss concerning JHEP's five year operation, each fiscal year indicates surplus (Refer to Appendix-5-1). JHEP therefore is regarded as a business body that has been steadily operating. According to JHEP's balance sheet in 2011, the proportion of debt to asset accounts for 63.5 percent. However, 95.7 percent of the debt comes from trade debtors for market operators (Refer to Appendix-5-2). As JHEP is scarcely indebted to financial markets, its financial constitution looks significantly sound. In light of its management and finance, no particular concerns are identified to implement the Project.

7.2.2 Costs

(1) Investment cost

Based on the Project cost and schedules set by the Team, the Project cost disbursement was estimated for each year. The Project cost disbursement schedules were proposed for the above 3 options. Since the consumer price index (CPI) has been increasing on average 10.65 percent for six years till 2009, this survey presumed that the Project cost disbursement would be increased at the same rate as the inflation rate. Any loss on disposal of remaining value of existing facilities after their depreciation was not included in the Project cost disbursement. The survey assumed that it would not influence this analysis because of the following reasons:

1) After almost 30 years have passed since the instalment of the power facilities, their depreciation has been almost completed. Even if it has not reached the end, the remaining proportion would be minuscule;

2) From the moment that the facilities were installed to the present, consumer prices of commodities in Nigeria reached about 150 times higher. The cost therefore accounts for only one one-hundred-fiftieth of the investment, when reviewed with the current value.

(2) Operation and maintenance cost

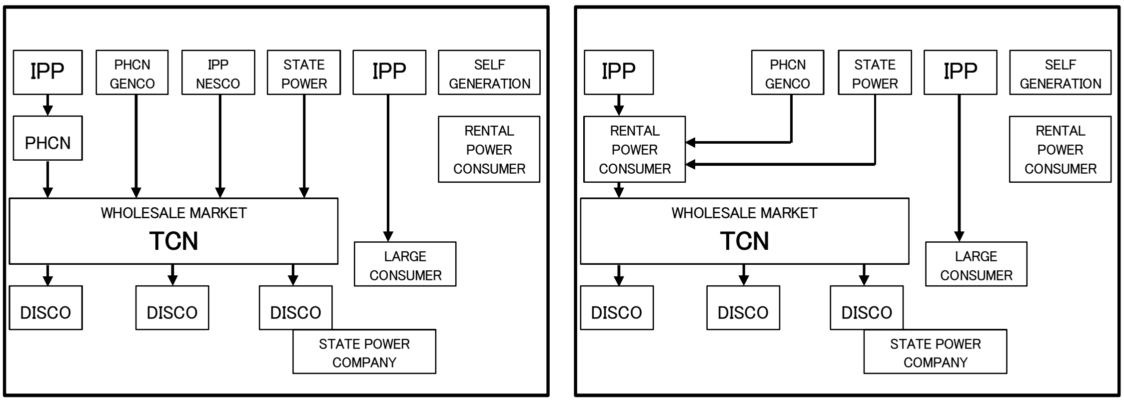
O&M cost in years 2009 and 2010 sharply increased compared with the previous years due to, for example, repair cost caused by troubles of generators 2G4 and 2G6. Taking this situation into consideration, the financial analysis was carried out based on the operating cost of the year 2008. The O&M cost involves not only JHEP's operating cost but also its administrative cost.

Applying a cost removing the depreciation cost from the O&M cost of 2008, one sixth of the total O&M cost was set as an O&M cost for one unit of generator (Refer to Appendix-5-1). Since the survey assumed that the total O&M cost would not fluctuate during the rehabilitation period, it included the estimated O&M unit cost (exclude maintenance and repairs costs) into the total costs to be incurred during the rehabilitation. Even if the generator without rehabilitation is not capable of generating electricity, the fixed cost except maintenance and repair costs of such generator shall be added up as cost to be considered in the survey. The above fixed costs consist of staff salaries and wages, administrative costs and so on. However, a decrease of 5 percent in the O&M cost after the completion of the rehabilitation would be foreseen thanks to the improvement of operating effectiveness as well as a decrease of maintenance and repair cost. The survey also estimated that the increase rate of the O&M cost would be 11.0%, adopting an annual average increase rate for the three years till 2008. In order to maintain a power generation function, the survey set to carry out overhaul after rehabilitation every ten years. Overhaul cost of 200million Yen at the present price is included in the financial evaluation.

7.2.3 Revenues

(1) Flow of Electric Power Supply and Receipts

According to PHCN, TCN and NERC, Nigerian electric power is supplied following the flow as shown in Figure 7-1. The flow of charges from power sales is indicated as the opposite direction of the electric power supply flow.



(a) Present Structure (b) Future Structure

Source: PHCN

Figure7-1 Nigerian Electricity Supply Industry Structure

Power distribution companies collect electricity charges and pay remaining charges to TCN after deducting their own revenue, and then TCN issues the receipts to each power generation company. Market operator in TCN is currently managing this flow. It is however intended that the Bulk Electricity Trader would holistically manage the transactions of the wholesale market in the future. FGN directly provides subsidies to the distribution companies. In principle, the distribution companies need to collect about 10N/kWh on average following their tariffs; however, in reality, they are able to collect only 7N/kWh. The difference is paid by FGN to the distribution companies as subsidies. FGN does not provide any subsidies to the generation companies in order to compensate their O&M costs regularly incurred. In case that the generation companies need large investment and the FGN's support is required, they apply for a governmental grant. If FGN decides to provide a grant, an amount of financial assistance is added to the budget and directly transfers to the generation companies as capital investment.

(2) Energy Supply

Table 7-1 indicates power generation performance of JHPS from 2007 to 2010. It shows that JHPS supplied almost all generated energy to the national grid except electricity consumed in JHPS.

Table 7-1 Generation Performance of JHPS

	Year	2007	2008	2009	2010
1.Power Generation Performance	Total Generation (MWh)	2,728,463	2,825,204	2,664,692	2,745,376
	Average Available Capacity (MW)	576	538	458	444
	Energy Delivered (MWh)	2,695,720	2,820,809	2,663,519	2,741,116
	Installed Capacity (MW)	578	553	578	578
	Average Actual Generation (MW)	357	373	342	379
2.Generation reliability Data	Number of Unit in Service	6	6	5	5
	Total Period of time in service (Hours)	8,782	8,832	8,760	8,736

Source:JHPS

Generators 2G4 and 2G6 suffered from troubles in 2009 and 2010, which halted 2G6's operation and hindered 2G4 from full operation. Given this circumstance, this survey considered that the data of the year until 2008 would indicate JHPS's regular situation of power generation and energy delivery. For this reason, the production of electricity of each option was set up based on the production of electricity in ten years from 1999 until 2008. First, generators are divided into the group of the generators 2G1, 2G3, 2G5 which supplies station power, and the other group of 2G2, 2G4, 2G6. The average value of the production of electricity for ten years of each group is calculated, and the production of electricity of each option is set up. The electricity sales are assumed to occupy 99.611 percent of generated electricity from the past record.

In case that the generators are not rehabilitated, energy supply decreases at the rate of 2 percent per year from the year 2008 due to the degradation of dielectric strength as explored. It means that the stability of the energy generation would be ensured only by 2020 when 37 years of service life will be over. The study therefore presumed that no electricity would be provided after 2021. For eight months during which each respective generator is being rehabilitated, it cannot perform and supply electricity. Figure 7-2 illustrates the two conditional scenarios, such as "without rehabilitation" scenario and "with rehabilitation" scenario.

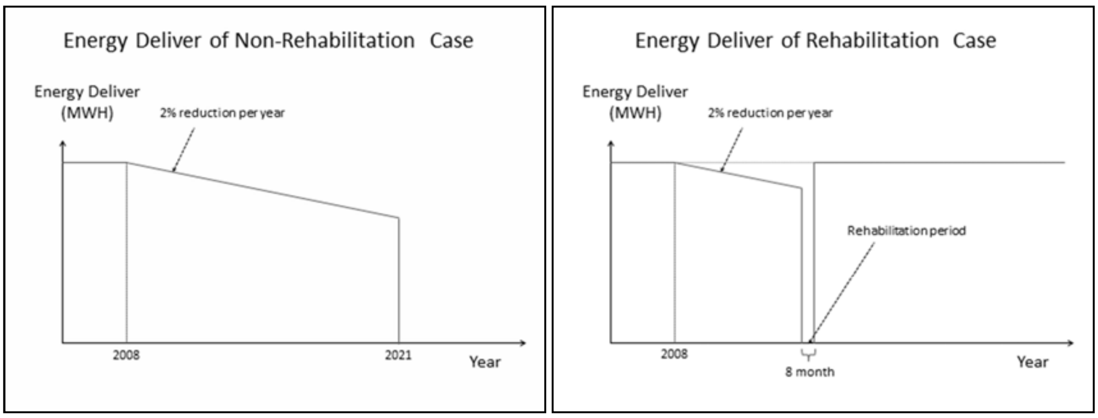


Figure 7-2 Energy Supply of Rehabilitation and Rehabilitation Cases

(3) Electricity Sales Income

The document entitled ”Multi-Year Tariff Order (MYTO) for The Determination of Charges and Tariffs for Electricity Generation, Transmission and Retail Tariffs” issued by NERC stipulates “Wholesale Generation Price” as follows:

According to this document, the wholesale contract price is decided as below.

> The wholesale contract price was calculated for each year in MWh per Naira as capacity and energy charges. The capacity charge comprises of i) fixed operation and maintenance cost, ii) capital cost, and iii) two thirds (2/3) of tax cost, while the energy charge comprises of i) fuel cost, ii) variable operation and maintenance cost, iii) the transmission loss cost and iv) one third (1/3) of tax cost. The capacity and energy charges will be included in the wholesale contract and are to be the basis of payments to the eligible generators.

Table 7-2 shows the wholesale generation price set by NERC. The wholesale contract price is reviewed every year in light of fluctuations of inflation rate, exchange rate as well as gas prices. The price reviewed for 2011 is found at the “New Rate (Wholesale Contract Price)” as shown in Table 7-2. In principle, if there is no change in the review, “total wholesale contract price” is adopted for generation price, according to NERC.

Table 7-2 Wholesale Generation Price by NERC

Year Commencing 1 July	2008	2009	2010	2011	2012
Total wholesale Contract price (NGN/MWh)	**3,104.1**	**3,179.1**	**3,364.6**	**3,570.7**	**3,777.4**
Capacity Charge (NGN’000/MW/month)	1,435.1	1,468.2	1,502.1	1,536.8	1,559.6
Energy Charge (NGN/MWh)	1,156.5	1,186.6	1,326.1	1,485.0	1,660.9
New Rate (Wholesale Contract Price)		**3,826.6**	**4,429.0**	**4,868.9**	**5,317.4**

Source: Multi-Year Tariff Order (MYTO) for The Determination of Charges and Tariffs for Electricity Generation

The rates provided from the actual data on JHEP’s past situation differ from NERC’s wholesale generation price. Table 7-3 shows the rates calculated from JHEP’s income.

Table 7-3 Electricity Distribution and Income of JHEP

SALES	2006	2007	2008	2009	2010
Energy sold (KWh)	2,138,780,000	2,698,296,000	2,762,190,160	2,381,249,922	2,365,316,993
Capacity charges (KWh)	6,612,067	6,537,536	6,003,956	3,917,582	4,232,694
Energy sold (NGN)	1,825,250,801	2,034,675,462	2,110,562,946	2,593,864,227	4,308,615,325
Capacity charges (NGN)	730,174,352	643,695,585	590,986,418	3,912,525,525	7,214,434,271
Total (NGN)	2,555,425,153	2,678,371,047	2,701,549,364	6,506,389,752	11,523,049,596
Energy sold (NGN/WMh)	853.41	754.06	764.09	1,089.29	1,821.58
Capacity charges (1000/GNN/MWh)	110.43	98.46	98.43	998.71	1,704.45
Wholesale contract price (NGN/KWh)	1,194.81	992.62	978.05	2,732.34	4,871.67

Source: JHPS

According to NERC, the wholesale generation price for fossil-fuel power generating companies is unified as shown in Table 7-2. However, the rates for the hydroelectric power plants are adjusted, respecting the price as the maximum, but depending on the costs incurred at each plant. As mentioned above, JHEP needed to deal with the troubles of the generators 2G4 and 2G6 in 2009 and 2010. The O&M cost in these years turned out to be higher than those in which the generators were operated without problems. The prices in 2009 and 2010 were therefore adjusted, being set at higher levels. Taking into account this situation, this survey estimated JHEP's income by using the data of the year 2008 during which the generators normally operated, as previously calculated in the O&M cost. As for the wholesale contract price provided by NERC from 2008 to 2012, 14.54 percent of the annual rate is going up. This increasing rate is for implementing the policy objective of MYTO which achieves the system of the wholesale contract price which covers cost. The policy objective of MYTO will be accomplished in 2012. For this reason, it is expected that it becomes the wholesale contract price increasing rate for covering the rise of cost after 2012. While the past increasing rate of wholesale contract price is 14.5 percent, the increase rate of the past O&M cost is 11.0 percent. Thus, as for a price increasing rate, it is recommendable to set up the rate within the range of 11.0 to 14.5 percent. The survey adopted the wholesale contract price increasing rate as 12.0 percent per year.

7.2.4 Result of Financial Evaluation

(1) Result of FIRR and B/C

This survey carried out a financial evaluation for the three options. As described in Table 7-4, the fact that FIRRs for options 2 and 3 are much higher than the loan interest rate indicates that the Project is feasible. However, in option 1, the result was not feasible. The result showing the highest FIRR under option 3 also indicates that the four generators should be rehabilitated, if possible. In options 2 and 3 the result concerning B/C with 1.4 percent of the loan interest rate also reaches much higher than 1.0, and option 3 provides the better result.

Table 7-4 Result of Financial Analysis

FIRR, NPV,B/C

	Option 1 2 units	Option 2 3 units	Option 3 4 units
FIRR (Project FIRR)	-	10.84%	12.93%
NPV under Loan Interest Rate (1.4%)	-155,502	335,919	694,029
B/C under Loan Interest Rate (1.4%)	0.86	1.27	1.49

(2) Sensitivity Analysis

Taking Option 3 as the basis, this survey carried out the sensitive analysis with assumptions that the O&M cost as well as the revenue are changed. Table 7-5 shows the result of all cases. If FIRR of the column is coloured, it means the number is minus meaning that these cells are not feasible. In Option 3, even if the revenue may decrease by 30 percent it will be feasible unless cost increase 10 percent. Even if conditions may change, the possibility of business success is high. In Option 2, the cell which is not feasible has increased. Option 1 is turned out to be unfeasible, unless there is reduction of cost and a rise of revenue.

Table 7-5 Result of Sensitivity Analysis

FIRR Sensitivity to Changes in Cost and Revenue (Option 1:2 units)

		Change in Cost				
		20% decrease	10% decrease	Base case	10% increase	20% increase
Change in Revenue	30% increase	16.6%	13.2%	9.3%	3.4%	-
	20% increase	13.7%	9.9%	4.5%	-10.8%	-
	10% increase	10.6%	5.4%	-8.1%	-	-
	Base case	6.3%	-5.6%	-	-	-
	10% decrease	-3.1%	-	-	-	-
	20% decrease	-	-	-	-	-
	30% decrease	-	-	-	-	-

FIRR Sensitivity to Changes in Cost and Revenue (Option 2:3 units)

		Change in Cost				
		20% decrease	10% decrease	Base case	10% increase	20% increase
Change in Revenue	30% increase	20.8%	19.1%	17.4%	15.7%	13.9%
	20% increase	18.9%	17.2%	15.4%	13.6%	11.7%
	10% increase	17.0%	15.2%	13.3%	11.3%	8.9%
	Base case	14.9%	13.0%	10.8%	8.4%	5.1%
	10% decrease	12.6%	10.4%	7.7%	3.9%	-4.1%
	20% decrease	9.9%	6.9%	2.4%	-11.4%	-
	30% decrease	6.0%	0.0%	-	-	-

FIRR Sensitivity to Changes in Cost and Revenue (Option 3:4 units)

		Change in Cost				
		20% decrease	10% decrease	Base case	10% increase	20% increase
Change in Revenue	30% increase	20.5%	19.2%	18.0%	16.8%	15.5%
	20% increase	19.0%	17.7%	16.4%	15.1%	13.8%
	10% increase	17.4%	16.1%	14.8%	13.4%	12.0%
	Base case	15.7%	14.4%	12.9%	11.4%	9.7%
	10% decrease	13.9%	12.4%	10.8%	9.0%	6.8%
	20% decrease	11.9%	10.1%	8.1%	5.5%	1.4%
	30% decrease	9.4%	7.0%	3.7%	-2.9%	-

7.3 Economic Evaluation

7.3.1 Costs

For the economic evaluation, this survey used the same investment cost and the O&A cost as adopted for the financial evaluation. The tax-related cost from 2006 to 2010 accounted for on average 1.58 percent of the O&M cost. For the economic analysis, the tax-related cost was removed from the O&M cost.

Table 7-6 Tax Payment of JHEP

(unit:NGN)

	VAT	WHT	Payee	Total tax payment	O&M cost	Tax rate in O&M
2006	13,975,699	15,647,494	12,131,261	41,754,455	2,047,028,967	2.04%
2007	14,332,561	14,332,561	14,376,222	43,041,345	2,264,167,476	1.90%
2008	13,210,226	12,556,286	16,717,617	42,484,128	2,521,018,918	1.69%
2009	6,188,156	12,318,033	18,524,836	37,030,984	3,292,091,609	1.12%
2010	30,725,802	29,215,940	19,264,780	79,206,521	6,872,547,853	1.15%
					Average	1.58%

Source: JHEP

7.3.2 Revenues

The economic evaluation is a tool to review projects from a viewpoint of the national economics. "Revenues" therefore should be the total amount of tariffs that end-consumers paid rather than the total amount of wholesale prices paid from TCN to PHCN. According to NERC, the average of the tariffs is about 10N/kWh although different tariffs are proposed depending on customer types. This survey therefore adopted for this analysis 10N/kWh as tariff. The survey also used 30 percent as a rate of transmission loss.

Table 7-7 Tariff in Nigeria

Tariff schedule or the year

(Unit: energy NGN/KWh)

Year	2008	2009	2010	2011	2012
Residential					
Residential R1	1.2	1.3	1.8	2.2	2.2
Residential R2	4.0	4.4	5.9	7.3	7.4
Residential R3	6.0	6.6	8.9	11.0	11.2
Residential R4	8.5	9.4	12.5	15.6	15.8
Residential R5	8.5	9.4	12.5	15.6	15.8
Commercial					
Commercial C1	6.5	7.4	9.4	11.1	11.3
Commercial C2	8.5	9.7	12.3	14.5	14.8
Commercial C3	8.5	9.7	12.3	14.5	14.8
Commercial C4	8.5	9.7	12.3	14.5	14.8
Industrial					
Industrial D1	6.5	7.9	9.8	11.7	12.1
Industrial D2	8.5	10.3	12.9	15.2	15.8
Industrial D3	8.5	10.3	12.9	15.2	15.8
Industrial D4	8.5	10.3	12.9	15.2	15.8
Industrial D5	8.5	10.3	12.9	15.2	15.8
Special					
Special A1	5.7	6.9	8.6	11.2	11.6
Special A2	5.7	6.9	8.6	11.2	11.6
Special A2	5.7	6.9	8.6	11.2	11.6
Special A2	5.7	6.9	8.6	11.2	11.6
Street Lighting					
Street Lighting S1	6.5	5.9	6.8	8.6	9.6

Source: Multi-Year Tariff Order (MYTO) for The Determination of Charges and Tariffs for Electricity Generation

This analysis is also intended to compare a case with the implementation of the Project to that without the implementation. For this purpose, this survey considered a gap between the total amount of the collected tariffs when the Project was implemented and that without the Project as benefit. Tariff is rising by 17.0 percent on the average till 2008 to 2012. This increasing rate is for implementing the policy objective of MYTO which achieves the tariff which covers cost. The policy objective of MYTO will be accomplished in 2012. For this reason, it is expected that it becomes the tariff increasing rate for covering the rise of cost after 2012. While the past increasing rate of tariff is 17.0 percent, the past O&M cost increasing rate is 11.0%. A price increasing rate is recommended to be in the range of 11.0 to 17.0 percent. The survey adopted the tariff increasing rate as 12.0 percent per year. The survey assumed, taking into account the case that rehabilitation was not carried out, that power generation stops from 2021. For this reason, the saving effect of alternative electricity purchase cost is included after 2021. The saving effect of alternative electricity purchase cost is considered as difference of wholesale contract price of MYTO and the sales electric charges of JHEP.

7.3.3 Result of Economic Evaluation

(1) Result of EIRR and B/C

An economic evaluation was carried out for the three options i.e. as described in Table 7-8, EIRRs in all cases highly exceed 12.0 percent which is the standard indicator for economic analyses. It implies that the economic benefit of the Project is significant. As the result shows the highest EIRR under Option 2, it would be desirable to rehabilitate three generators. The results concerning NPV and B/C with 12 percent of the discount rate also reach much higher than 1.0, and Option 3 provides the better result.

Table 7-8 Result of Economic Analysis

EIRR, NPV, B/C

	Option 1 2 units	Option 2 3 units	Option 3 4 units
EIRR (Project EIRR)	36.68%	40.97%	39.73%
NPV under 12% Discount Rate	360,186	596,973	737,756
B/C under 12% discount Rate	5.23	7.69	8.67

(2) Sensitivity Analysis

Taking Option 3 as the basis, the sensitive analysis was carried out with assumptions that the O&M cost as well as the revenue are changed. Table 7-9 shows the result of all cases. In all three options, EIRR highly exceeds 12.0 percent, in the condition that revenue decreases by 30 percent and cost increases by 20 percent. All three options show that sufficient economic benefit will be generated, even if conditions may change.

Table 7-9 Result of Sensitivity Analysis

EIRR Sensitivity to Changes in Cost and Revenue (Option 1:2 units)

		Change in Cost				
		20% decrease	10% decrease	Base case	10% increase	20% increase
Change in Revenue	30% increase	42.4%	41.7%	41.0%	40.3%	39.6%
	20% increase	41.1%	40.4%	39.6%	38.9%	38.2%
	10% increase	39.7%	39.0%	38.2%	37.5%	36.8%
	Base case	38.2%	37.4%	36.7%	35.9%	35.2%
	10% decrease	36.6%	35.8%	35.0%	34.3%	33.5%
	20% decrease	34.8%	33.9%	33.2%	32.4%	31.7%
	30% decrease	32.7%	31.9%	31.1%	30.3%	29.6%

EIRR Sensitivity to Changes in Cost and Revenue (Option 2:3 units)

		Change in Cost				
		20% decrease	10% decrease	Base case	10% increase	20% increase
Change in Revenue	30% increase	46.6%	46.0%	45.4%	44.8%	44.2%
	20% increase	45.3%	44.6%	44.0%	43.4%	42.8%
	10% increase	43.8%	43.2%	42.5%	41.9%	41.3%
	Base case	42.3%	41.6%	41.0%	40.3%	39.7%
	10% decrease	40.6%	39.9%	39.2%	38.6%	38.0%
	20% decrease	38.7%	38.0%	37.3%	36.7%	36.1%
	30% decrease	36.6%	35.9%	35.2%	34.6%	33.9%

EIRR Sensitivity to Changes in Cost and Revenue (Option 3:4 units)

		Change in Cost				
		20% decrease	10% decrease	Base case	10% increase	20% increase
Change in Revenue	30% increase	44.5%	44.0%	43.6%	43.1%	42.6%
	20% increase	43.4%	42.9%	42.4%	41.9%	41.4%
	10% increase	42.1%	41.6%	41.1%	40.6%	40.1%
	Base case	40.8%	40.2%	39.7%	39.2%	38.7%
	10% decrease	39.3%	38.7%	38.2%	37.7%	37.2%
	20% decrease	37.6%	37.1%	36.5%	36.0%	35.5%
	30% decrease	35.7%	35.2%	34.6%	34.1%	33.6%

Chapter 8

Project Effect Indicators

Chapter 8 Project Effect Indicators

8.1 Project Effect Indicators

8.1.1 Quantitative Effects

Generally speaking, equipment is replaced as it approaches the service limit, and the following improvement effects can be anticipated in line with the implementation of the rehabilitation work under the Japanese ODA Loan Scheme. These effects are usually manifested in various combinations.

At the initial stage of the Preparatory Survey, the Team held up the following nine Project effect indicators with potential quantitative nature for further study as stated in Section 3.5:

(1) Maintenance and improvement of plant safety and reliability,
(2) Extension of the equipment service limit and recovery of performance,
(3) Reduction of maintenance cost,
(4) Improvement in output, efficiency and generated power,
(5) Environmental improvement,
(6) Revision of conditions of use and specifications,
(7) Ratio of utilisation of the facilities,
(8) Electric power at generation end, and
(9) Unplanned stoppage-time of operation.

However, as a result of analysis of the data available in JHPS, it was found that some of the nominated indicators, namely (4), (6), (8) and (9) will not represent the quantitative improvement even after completion of the Project. Such Project effect will be evaluated as qualitative one if such effect is confirmed.

(1) Maintenance and improvement of plant safety and reliability

1) Maintenance of stabilization of power generation

Function of generating units is to be improved through the rehabilitation of the Project. Total output of the generator units can be used to assess the Project effect.

Meanwhile, the effective water volume which is used by one unit to generate power is 380m^3/s. The maximum water volume used by six units is 2,280m^3/s; however such volume cannot be obtained all through the year, since the inflow volumes into Jebba reservoir are less than the above maximum water volume for generation, as shown in Table 8-1.

Table 8-1 Average inflow from 1999 to 2008

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Inflow (m^3/s)	1,336	1,243	1,138	1,132	948	819	771	1,224	1,752	2,001	1,164	1,271
No. of unit	3.5	3.3	3.0	3.0	2.5	2.2	2.0	3.2	4.6	5.3	3.1	3.3

Although the situation implies that it is not necessary for all of the units to operate all the time, two units cannot cover the inflow of over $760m^3/s$. From the fact that four units shall prolong the service life as a result of implementation of the Project, the maintenance of stability in the power supply in 2020 can be the indicator of the project effect.

Table 8-2 shows total output of six units and water volume from 1999 to 2008. Total outputs are highly fluctuated because total output largely depends on inflow volume.

Table 8-2 Total Output of JHPS and the Water Volume used for Generation

Year	2G1	2G2	2G3	2G4	2G5	2G6	Total(MWh)	Net Water used for generation (m^3)
	Total output (MWh)	Total output (MWh)	Total output (MWh)	Total output (MWh)	Total output (MWh)	Total output (Mwh)		
1999	574,290	226,866	660,096	277,029	491,166	477,877	2,707,324	49,787,568,000
2000	674,290	334,640	647,169	119,518	480,061	258,406	2,514,084	38,389,766,400
2001	601,945	454,519	219,280	91,911	411,560	365,177	2,144,392	34,830,172,800
2002	374,805	256,224	679,216	101,652	471,573	203,030	2,086,500	30,658,089,600
2003	637,125	391,748	434,779	345,565	555,483	206,341	2,571,041	42,476,227,200
2004	540,013	427,028	575,118	435,629	431,192	294,769	2,703,749	40,158,720,000
2005	465,233	294,732	563,057	311,977	438,475	194,756	2,268,230	33,462,979,200
2006	563,904	259,643	444,490	177,331	448,556	277,823	2,171,747	32,597,164,800
2007	484,345	366,209	625,671	390,559	455,856	406,259	2,728,899	41,987,980,800
2008	614,190	368,472	528,796	418,801	505,718	358,997	2,794,974	42,067,684,800

For the purpose of proper evaluation of the maintenance of power generation amount as the Project effect indicator, fluctuation of inflow volume will have to be normalised. Total power outputs are normalised assuming that inflow in each year is the same as the inflow in 2005 as shown in Table 8-3. Table 8-3 shows that normalised total output is nearly stable.

Table 8-3 Total output of JHPS (Normalised)

Year	2G1	2G2	2G3	2G4	2G5	2G6	Total(MWh) /Net Water of 2005 (33,462,979,200m^3)
	Total output	Total output	Total output	Total output	Total output	Total output	
	(MWh)	(MWh)	(MWh)	(MWh)	(MWh)	(MWh)	
1999	385,989	152,480	443,661	186,195	330,120	321,188	1,819,634
2000	587,754	291,694	564,114	104,180	418,452	225,243	2,191,437
2001	578,317	436,678	210,673	88,303	395,405	350,843	2,060,218
2002	409,096	279,666	741,357	110,952	514,717	221,605	2,277,393
2003	501,930	308,621	342,521	272,238	437,612	162,556	2,025,479
2004	449,976	355,829	479,227	362,996	359,299	245,622	2,252,948
2005	465,233	294,732	563,057	311,977	438,475	194,756	2,268,230
2006	578,882	266,539	456,296	182,041	460,470	285,202	2,229,431
2007	386,006	291,856	498,638	311,262	363,302	323,774	2,174,839
2008	488,561	293,103	420,634	333,138	402,276	285,566	2,223,278
Average (1999-2008)	**483,174**	**297,120**	**472,018**	**226,328**	**412,013**	**261,636**	**2,152,288**

Looking at the Project's target units of 2G1, 2G2, 2G3 and 2G5, as shown in Table 8-4, there are some ups and downs for the total output of the four units in the range of plus or minus 15 percent even after normalisation.

Taking the situation into account, the baseline of the Project effect shall be set as the average of total output of 2G1, 2G2, 2G3 and 2G5 from 1999 to 2008 with the range of plus or minus 15 percent. The baseline per portion shall be compared with the total output of units concerned in the Ex-Post evaluation year which is two years after the completion of the rehabilitation work of the lat unit per option as shown in Table 8-4. The Project effect as maintenance of power output is to be confirmed if the total output of target units in evaluation year is in the range of plus or minus 15 percent of the average total output of four units from 1999 to 2008.

Table 8-4 Targeted total output of each option

Option	2G1	2G2	2G3	2G5	Targeted annual output (MWh)	Ex-Post evaluation year
	Total output	Total output	Total output	Total output		
	(MWh)	(MWh)	(MWh)	(MWh)		
Option 1	483,174	Out of scope	Out of scope	412,013	**896,000**	**2018**
Option 2	483,174	Out of scope	472,018	412,013	**1,368,000**	**2019**
Option 3	483,174	297,120	472,018	412,013	**1,665,000**	**2020**

The result shall be proved to be free from any accident by assessing the record of serious accident, which it takes more than one month to recover in the evaluation year, because there is a possibility for the total output to decrease in the range of 15 percent as described already and, if such serious accident occurs in the year, it can cause the reduction of power generation. In case there is any decrease in the total output in the year, the total output of six units and the operating record of each unit shall be properly assessed.

2) Risk of major accidents threatening human life and property and affecting stable operation can be reduced. As a result of higher reliability, stop by failure period can be reduced and higher revenue can be anticipated from the power station. After completion of the Project, the rehabilitated facilities will be operated and maintained by JHEP staffs. As JHEP assigns staffs as O & M personnel for its rehabilitation after OJT and overseas training to be provided by the consultant and the contractor for the Project, in particular junior JHEP staffs are inferred to possess advanced basic O & M skills. The technical levels of maximum 20 staffs will be improved through rehabilitation of four generation units, if realised, assuming that five staffs have opportunities to receive technological guidance and to acquire experiences in the rehabilitation of each generation unit.

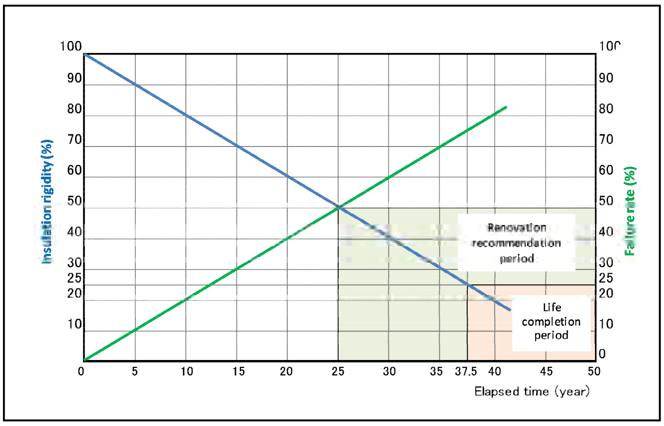
Therefore, the number of JHPS staffs who receive OJT and overseas trainings in the course of the Project implementation will be one of the quantitative Project effect indicators in terms of the increase in capacity development.

Improvement of the plant safety and reliability can also be achieved during implementation of the rehabilitation work at site through technology transfer as well as texts and OJTs offered by engineers from the consultant and the contractor to JHPS staffs as mentioned above. However, such effect will not be measurable quantitatively.

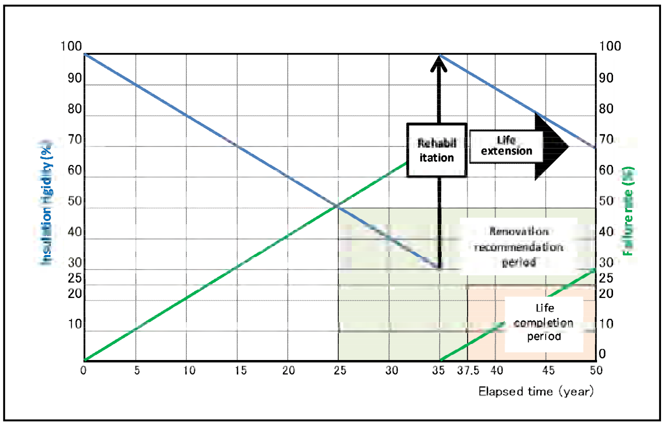
(2) Extension of the equipment service limit and recovery of performance

1) General

The service life of equipment can be extended through restoring degraded instruments and recovering performance. This includes cases where problems exist in the initial performance but performance is enhanced through subsequent technical improvement.



(a) Without rehabilitation



(b) With rehabilitation

Figure 8-1 Relation between Deterioration and Failure Rate

If the rehabilitation project were implemented, it would extend the life of the generator equipment to another 37 years as what was, if not carried out, the remaining life of the generator is considered to be about 10 years. The generator units are severely degraded and insulation aging occurred to the coils since the units have been in operation more than 25 years without any major overhaul. There is a latent risk for a serious accident to happen during operation. The functions of the generator units will be maintained and the lives of the units will be prolonged through the implementation of the rehabilitation and stable power supply to the grid in Nigeria will be expected.

Recovery of the dielectric strength, which means the remaining dielectric breakdown voltage, of stator coils can be assessed quantitatively by so-called “D-map method” or “Maximum partial discharge method”. The required data is measured by performing the non-destructive test of insulation diagnosis when the machine is not operating with at least about seven days short outage and partly disassembled condition, using special measuring equipment. The result of D-map method is derived from discharge parameters and maximum discharge amount while the result of maximum partial discharge method is derived from maximum discharge amount.

Confirmation of the estimated dielectric strength after the completion of rehabilitation will be one of the quantitative project effect indicator.

The measurement of dielectric strength for all of the units shall be done at the same time two years after the completion of the rehabilitation of the last unit, which means, if four units were rehabilitated, five years have passed since the completion of the rehabilitation of the first unit as shown in Figure 8-2.

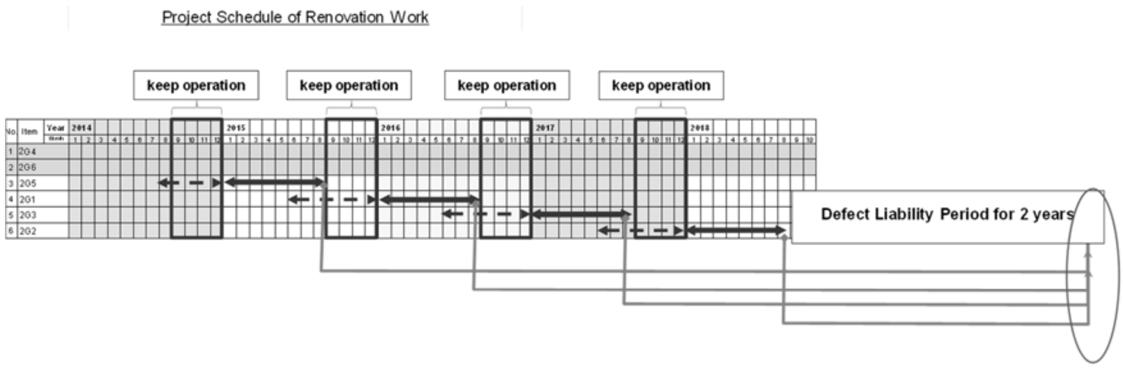


Figure 8-2 Schedule for Assessment

2) Recovery of Performance of Generation Facilities

As a result of implementation of the Project, the cooling function will be improved as described in the following clause: Therefore cooling efficiency of target generation facilities shall be adopted as a Project effect indicator. Although rehabilitation of the cooling system itself is not included in the Project, the cooling efficiency is to be recovered by removal of grease build-up and dust through the rehabilitation. Thus the temperature drop of main parts of generator during rated operation is to be achieved by the Project. Main parts of generating facilities are stator coil, stator core, rotor coil, thrust bearing shoe and guide bearing shoe. For this reason, the Team set the temperature increase of main parts during rated operation as a Project effect indicator. The baseline shall be the temperature increase of the main parts of generator in 2011 and Project effect shall be assessed by confirming the temperature increase of main parts in 2020 in case of Option 3. Since the temperatures measured in 2011 by the Team is not the values during rated operation, normalised values as during rated operation is adopted as the baseline. The target temperature increase in 2020 are estimated based on the record of temperature increase at the time of construction of JHPS in 1983. It shall also be taken into account the variation of some temperature indication because of aged deterioration of the indicators. Operation records of other years shall be also referred to in order to minimise the effect of such deterioration when the temperatures will be measured in 2020. The values of the base line in 2011 and the target values in 2020 are shown in Table 8-5.

Table 8-5 Baseline Value and Target Value of Temperature of Rehabilitated Parts

Indicator	Baseline; Temperature increase in 2011	Target value (Estimated values for 2 years after the Project); Temperature increase in 2020
Reduction of temperature increase (Recovery of cooling efficiency)	Stator coil: 63 K (Base temp. Temperature of outlet of air cooler)	Stator coil: 61 K (Base temp. Temperature of outlet of air cooler)
	Stator core: 54 K (Base temp. Temperature of outlet of air cooler)	Stator Core: 50K (Base temp. Temperature of outlet of air cooler)
	Rotor coil: 45 K (Base temp. Temperature of outlet of air cooler)	Rotor coil: 44.5 K (Base temp. Temperature of outlet of air cooler)
	Thrust bearing shoe: 9 K (Base temp. Temperature of Bearing oil)	Thrust Bearing shoe: 8 K (Base temp. Temperature of Bearing oil)
	Guide bearing shoe: 9K Base temp. Temperature of Bearing oil)	Guide bearing shoe: 8K (Base temp. Temperature of Bearing oil)

Recovery of performance of generation facilities in terms of cooling efficiency can be measured quantitatively as follows:

Temperature decrease during rated operation in stator coil, stator core, rotor coil, thrust bearing shoe and guide bearing shoe can be expected as a result of the Project since these equipment becomes cleaner by the replacement and/or repaired through the rehabilitation. For this reason, the degree of recovery of cooling efficiency can be taken as the Project Effect Indicator by comparing data recorded by JHPS during normal operation before the commencement of rehabilitation with those to be measured two years after the completion of rehabilitation.

i) Stator Coil

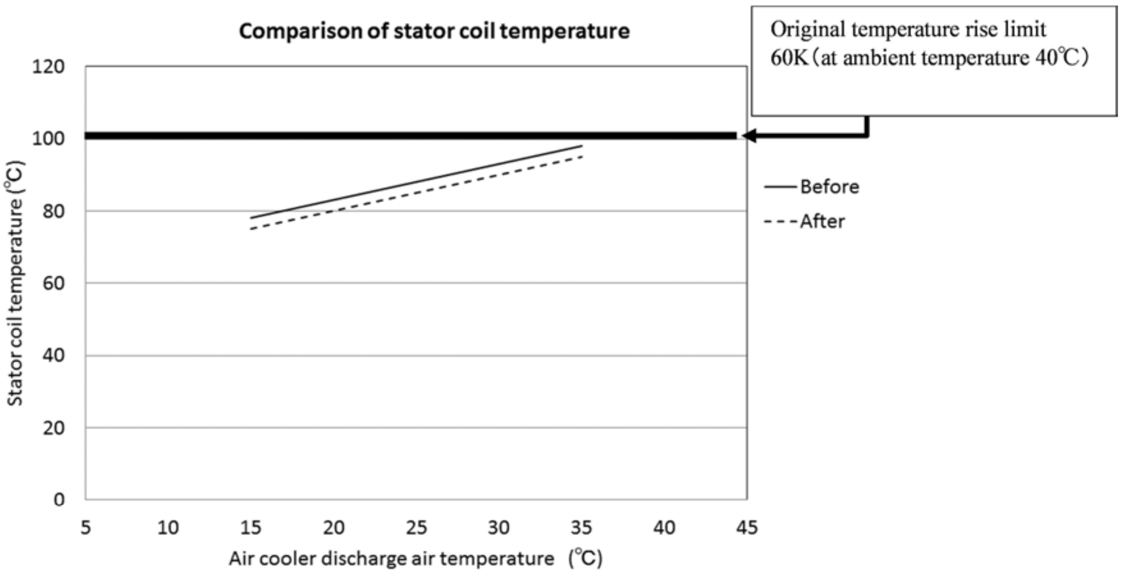


Figure 8-3 Temperature at Stator Coil

ii) Stator Core

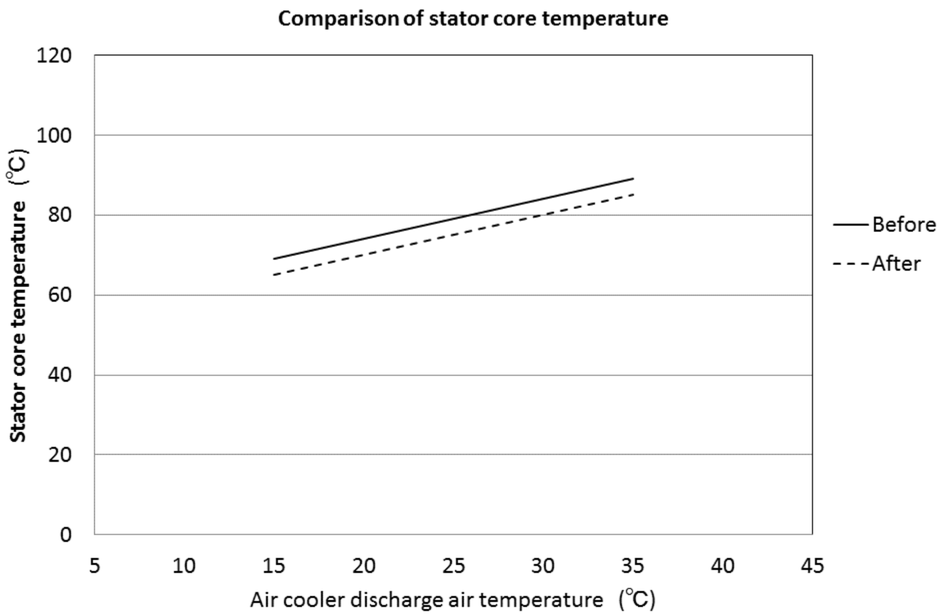


Figure 8-4 Temperature at Stator Core

iii) Rotor Coil

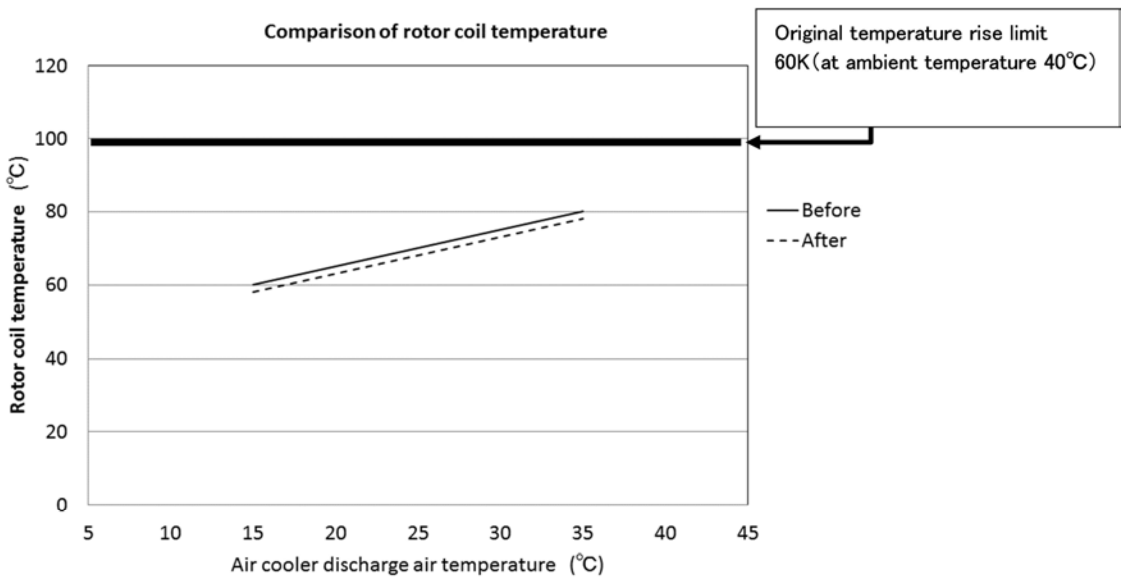


Figure 8-5 Temperature at Rotor Coil

iv) Thrust Bearing Shoe

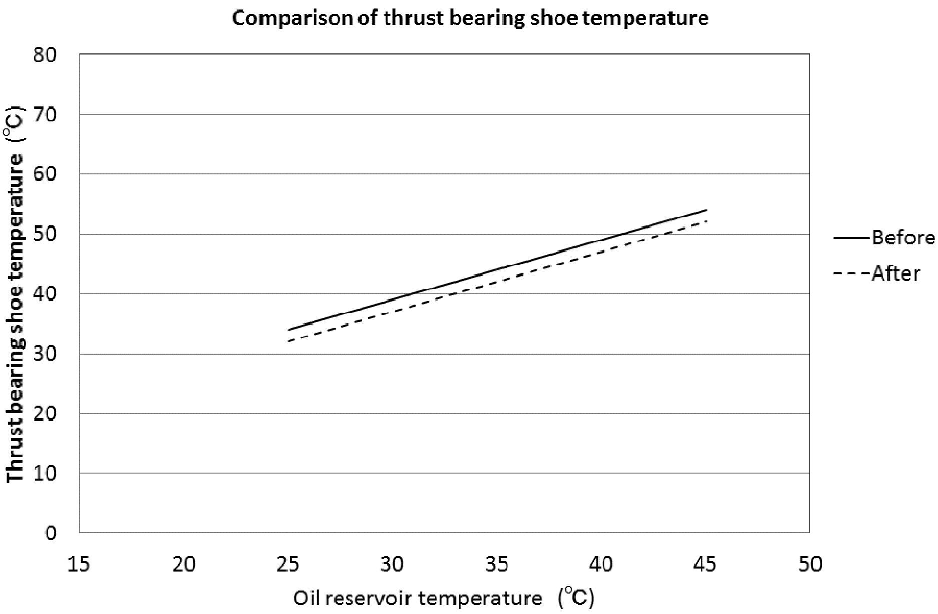


Figure 8-6 Temperature at Thrust Bearing Shoe

v) Guide Bearing Shoe

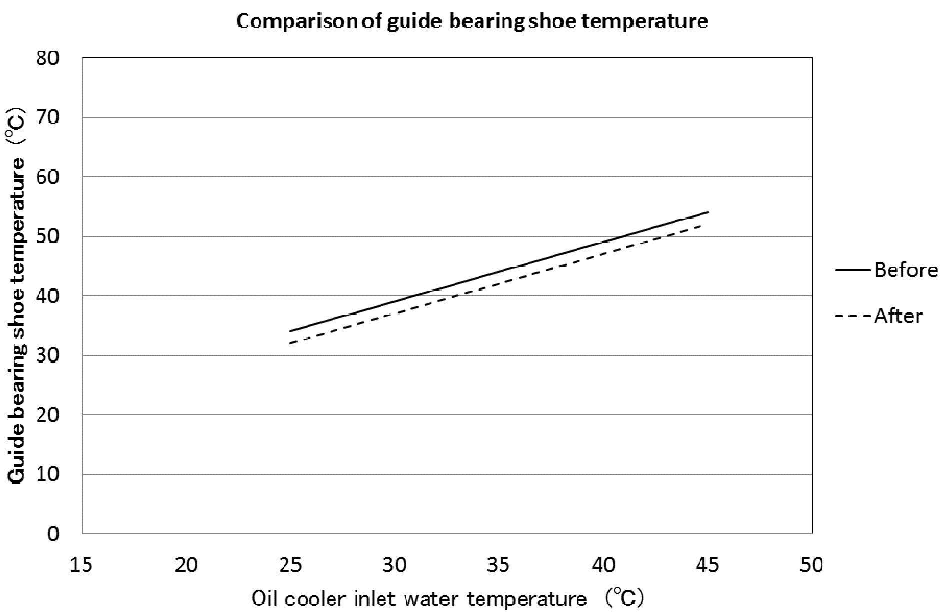


Figure 8-7 Temperature at Guide Bearing Shoe

(3) Reduction of maintenance cost

It is common knowledge that maintenance costs generally tend to rise in line with degradation over time. This is because it is necessary to conduct inspections at shorter intervals than usual in order to preserve a certain degree of performance and costs increase as more repair work is conducted each time. Moreover, it is necessary to implement more frequent special inspections and measurements geared to monitoring status and conducting preventive maintenance in line with degradation over time. Since this leads to higher maintenance costs and detracts from plant economy, the plant rehabilitation of this Project can be expected to reduce maintenance costs. Furthermore, through such measures as reducing the number of units, adopting oil-less instruments and using maintenance-free instruments, the resulting energy saving can be expected to reduce maintenance costs.

As Table 8-6 shows, maintenance and repair costs of JHPS in the last five years are in a trend of drastic increase. On 21st April 2009, ground fault let to loss of power supply to station auxiliaries, and failure of 330kV circuit breakers to open led to motoring of units 2G4 and 2G6. That is why the maintenance and repair cost in 2009 became extremely high. Happening of this accident cannot simply conclude the cause of the accident is due to deterioration of the facilities. However, this fact at least deduces the inclusion of functional and financial risk in the present operation of highly deteriorated generation facilities without any overhaul since start of operation in nearly 30 years. Therefore, the maintenance and repair cost of JHPS can be one of the Project Effect Indicators to account for the effect of the Project implementation.

Table 8-6 Maintenance and Repair Cost of JHPS

Year	2006	2007	2008	2009	2010
Maintenance and Repair cost	2,615,918	81,472,881	168,815,261	237,253,970	114,383

(4) Environmental improvement

1) CO_2 reduction

As discussed in 8.1.1(2) above, rehabilitation of the target generation units will extend the service life of the units. Since it will be necessary to compensate with power supply from other thermal power stations in the event where JHPS breaks down, the Project will help mitigate greenhouse gas emissions by alleviating the risk of breakdown at JHPS.

The emission reductions of the Project are deemed to be equal to the baseline emission because the Project itself does not produce any other emissions.

Table 8-7 CO_2 Emission Reduction

	Total Contributing Output for CO_2 Reduction (GWh)	Amount of baseline emissions (tCO_2/MWh)	Amount of emissions from project (tCO_2)	Leakage (tCO_2)	Total emission reductions (tCO_2)
Option 1 (2 Units Rehabilitation)	26,158	22,076,600	0	0	17,661,600
Option 2 (3 Units Rehabilitation)	38,870	32,805,170	0	0	26,244,800
Option 3 (4 Units Rehabilitation)	46,175	38,971,036	0	0	31,177,600

It is conservatively assumed that 80% of expected average power output will be generated for the prolonged period due to deterioration of turbine, because turbines are out of scope of this rehabilitation but the total life of turbine were also estimated for about 40 years. As a result, the emission reduction will be 17,661,600 tCO_2, 26,244,800 tCO_2, and 31,177,600 tCO_2 in case two units (Option 1), three units (Option 2) and four units (Option 3) are rehabilitated respectively.

2) Reduction of hazardous materials in generation facilities

Generator component will be free of asbestos by renovating insulating layer for joints of stator cores, high resistance corona shields for stator coils and layer insulation materials for rotor coils, all of which contain asbestos. As a result, use of asbestos free parts in the rehabilitation will be one of the Project effect indicators for environmental improvement by means of reduction of hazardous substances in the generation units.

Table 8-8 Reduction of Asbestos in Generation Facilities

(1) Before rehabilitation work

No.	Checked point	Unit	2G1	2G2	2G3	2G5
1	Asbestos material usage for stator core (Insulation sheets for joints)	set	1	1	1	1
2	Asbestos material usage for stator coil (High resistance corona shields)	set	1	1	1	1
3	Asbestos material usage for rotor coil (Layer insulation material)	set	1	1	1	1
4	Usage of asbestos material	set	3	3	3	3
5	Environment improvement	-	Required	Required	Required	Required

(2) After rehabilitation work

No.	Checked point	Unit	2G1	2G2	2G3	2G5
1	Asbestos material usage for stator core (Insulation sheets for joints)	set	0	0	0	0
2	Asbestos material usage for stator coil (High resistance corona shields)	set	0	0	0	0

3	Asbestos material usage for rotor coil (Layer insulation material)	set	0	0	0	0
4	Usage of asbestos material	set	0	0	0	0
5	Environment improvement	-	Improved	Improved	Improved	Improved

(5) Ratio of utilization of the facilities

Rate of utilization of facilities (rate of utilization of measuring instruments to monitor the status of generators)

The Project will renovate measuring instruments such as resistance temperature detector, thermocouple and dial thermometer to monitor the operational status of generators. Rate of utilization of such measuring instruments will be increased. Increase in quantity of renovated instruments before the Project implementation will be one of the Project effect indicators.

Table 8-9 Improvement of Utilization Rate of Monitoring Devices

(1) Before rehabilitation work

No.	Checked point	Unit	2G1	2G2	2G3	2G5
A1-A5	The number of installed instruments	pcs	33	33	33	33
B1-B5	The number of broken instruments	pcs	5	8	1	6
C	Instrument failure rate	%	15	24	3	18
D	Instrument availability ratio	%	85	76	97	82

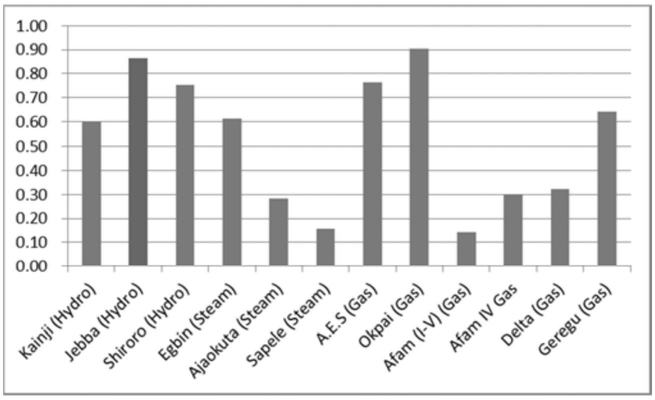
(2) After rehabilitation work

No.	Checked point	Unit	2G1	2G2	2G3	2G5
A1-A5	The number of installed instruments	pcs	33	33	33	33
B1-B5	The number of broken instruments	pcs	0	0	0	0
C	Instrument failure rate	%	0	0	0	0
D	Instrument availability ratio	%	100	100	100	100

8.1.2 Qualitative effects

(1) Maintaining Highly Reliable Operation

JHPS (rated output 578.4 MW) is a major facility that accounts for roughly 12.5 percent of Nigeria’s total generating capacity and is highly reliable in terms of Average Monthly MW Availability as shown in Figure 8-8. Maintenance of highly reliable operation and extension of service life as a result of the Project implementation will lead to the stabilisation of generating capacity of the target generation units in JHPS and will contribute to the state power policies of stabilising power supply and diversifying energy sources in Nigeria, where the power demand and supply situation is very tight.



source: NCC

Figure 8-8 Average Monthly MW Availability of Major Power Plants from 2007 to 2010

(2) Capacity development for self-help maintenance of the power plant

JHPS does not have an experience of rehabilitation and overhaul since start of its operation in 1985. As a result of Project implementation, through technical training and technology transfer to junior staffs of JHPS by engineers from the consultant and the contractor for the Project, the technical level of Nigerian staffs will expect to increase and thus it will be possible to lay the foundation for Nigerian staffs to be able to carry out the rehabilitation work by themselves in future. Thus, the Project will assist the self- help effort by Nigerian staffs in the power sector.

(3) Improvement in output, efficiency and generated electrical energy

In general, it is expected that through the rehabilitation of units' performance of degraded equipment with reduced efficiency and reliability, the power output in a year or efficiency can be increased. However, in case of JHPS, operating condition or performance of single generation unit may not necessarily be the determining factor in the total power output because of the following reasons:

1) Availability of water for power generation is less than the required water volume to sustain full units operation particularly in dry season as shown in Table 8-5.

Table 8-10 Inflow Rate of Water into Jebba Reservoir

(Average inflow rate from 2006 to 2010) (unit: m^3/sec)

	January	February	March	April	May	June
Inflow rate	1,270	1,226	1,195	1,245	1,141	833
	July	August	September	October	November	December
Inflow rate	753	1,242	2,184	2,138	1,401	1,341

Note: (1) Inflow from Kainji Dam and tributaries of Jebba Reservoir, and evaporation loss are taken into account.
(2) Effective water volume for 6 units: 2,280m^3/sec (6 units x 380m^3/sec)

2) Due to the limited storage capacity of water in Jebba reservoir, the discharge from Kainji reservoir is almost always regulated so as not to cause any unnecessary overflow from the

spillway of JHPS without any power generation.

3) Under such circumstances, the idling time of power generation units is long and even severe breakdown of one or two generation units occurs, the remaining generation units can manage to cover available water inflow for generation without any overflow. Thus, the extent of shutdown of generation units due to breakdown caused by deterioration of the units may not be the determining factor in shortage of power generation as compared with available water.

4) Therefore, even if the deteriorated generation units will be renovated through the Project implementation, it may not contribute to increase of power generation particularly in dry season.

Rehabilitation of stator coil and rotor coil by the Project will obviously improve the stability in operation and prolong the service life of the rehabilitated generation units, however, the Team does not possess any data to express such Project effect quantitatively.

(4) Unplanned stoppage-time of operation

Unplanned stoppage-time of operation is, in other words, an uncontrolled stoppage of operation of facility. However some of causes derived from natural factors and it is difficult to prevent thoroughly. For example, the adverse power flow caused by lightening will immediately shutdown and block the power system to protect the electrical facilities. However, there is still such an unplanned stoppage-time of operation which is preventable by prior action especially with regards to the stability of facilities.

Figure 8-9 shows the histogram of major troubles recorded by JHPS from 2004 to 2011. The frequency of occurrence of major troubles in the past was not in proportion to the age of the existing generation units. However, in general, such troubles are more or less in proportion to the degree of deterioration of the generation units, it is expected that the number of major troubles after the completion of the Project will be decreased.

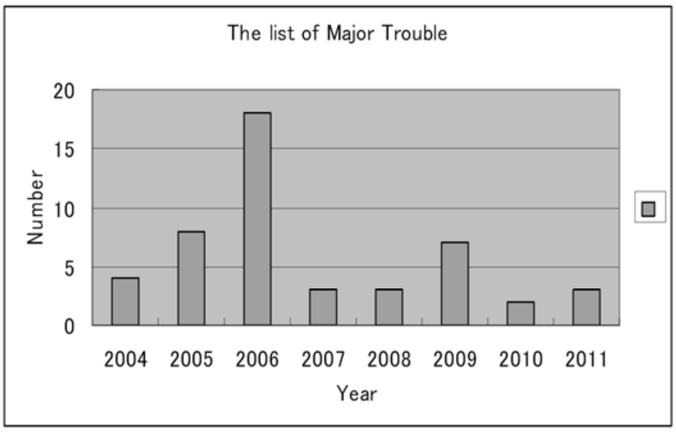


Figure 8-9 Histogram of Major Trouble from 2004 to 2011

For the detail of troubles and repairs in JHPS, reference shall be made to Appendix-8.

8.2 Reduction of Greenhouse Gas

Ex-ante estimation of emission reductions over the chosen period

8.2.1 Project boundary

Project's boundary includes all artificial greenhouse gas emission sources caused by the implementation of the Project which are under the supervision of the Project participants remarkably. Specifically, the Project boundary includes all power plants physically connected to the power grid, connected to the Project site of JHPS. The Project supplies the generated power to supply to Nigeria national power grid as Project boundary as shown in Figure 8-10.

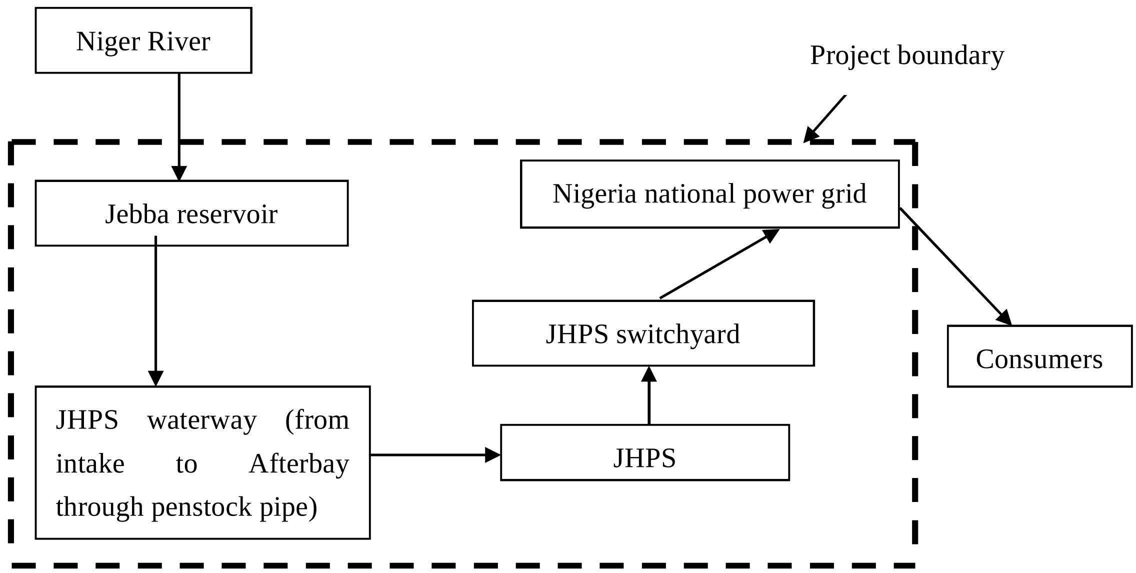


Figure 8-10 Project Boundary

8.2.2 Baseline and its development

A purpose of this estimation is to estimate CO_2 emissions reduction by trying to prolong the life of generators of JHPS. The reduction shall be achieved by supplying the power generated from JHPS instead of supplying the power generated with fossil fuels. It is important to assess carefully about which power source to substitute since the reduction largely depends on the baseline emission factor of the power plant substituted in the Project. However, it is very difficult to specify the alternative power source because the alternative power source is influenced by various factors, such as the power configuration of a target power grid, power demand-and-supply balance at present and in the future, the scale of the present Project and the influence on the power grid, future power prediction, management policy of the relevant power company, decision of the administrator of the power grid, etc. There are three simple methods to estimate the CO_2 emissions of the power plant to be substituted which are operating margin (OM), build margin (BM) and combined margin (CM). CM for presumption of the baseline emission factor is used to estimate CO_2 emission comprehensively. CO_2 emission reduction is to be estimated quantitatively from the base-line emission based on CM (Figure 8-11).

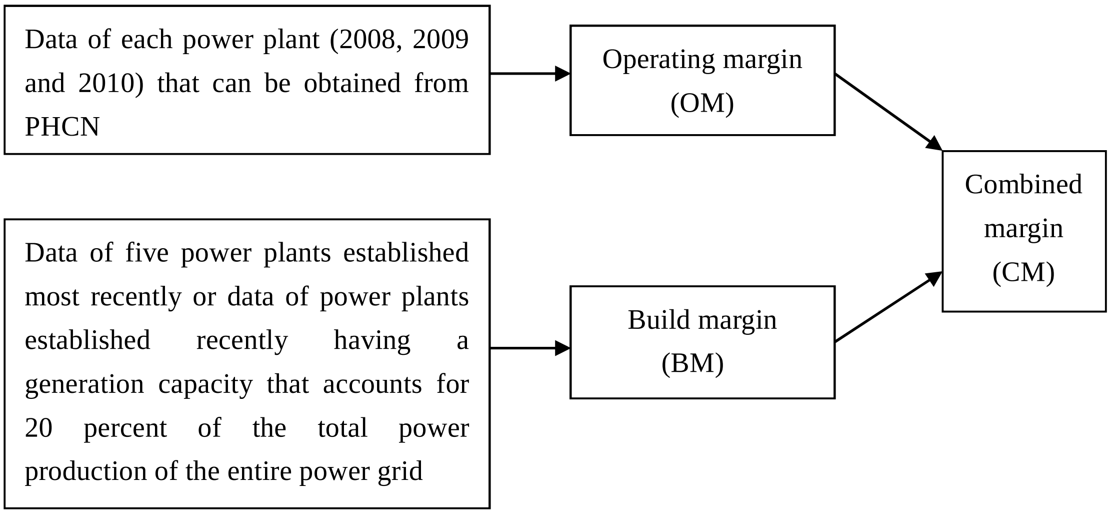


Figure 8-11 Operating Margin and Build Margin

8.2.3 Explanation of Methodology

Four methods, which are (1) Dispatch Data Analysis OM, (2) Simple OM, (3) Simple Adjusted OM and (4) Average OM, are proposed for estimation of OM as a part of constituting CM. An applicable method is selected based on the OM inspection flow as shown in Figure 8-13.

Dispatch Data Analysis OM is the best way having the highest priority. With Dispatch Data Analysis, the annual total CO_2 emission reductions of the Project is calculated for all time zones during which the power is supplied to the power grid through the implementation of the Project. Specifically, the CO_2 emission factor of Dispatch Data Analysis, OM is also calculated every hour. To calculate Dispatch Data Analysis OM, the first step is to determine the priority of power plant for all power plants based on the power supplied from in the relevant power grid, and then power plants generating 10 percent of supplied power in ascending order from the bottom. In this Project, however, it is difficult to collect hourly power data supplied from all power plants in the power grid in which the Project is working, and this is not realistic taking into account of the scale of the power grid which is very large compared with the scale of the Project. Therefore, it can be said that the application of Dispatch Data Analysis is very hard.

Generally, the low cost/must-run power source includes hydropower, wind power, biomass and photovoltaic etc. It is clear from the share of power sources that the average ratio of the low-cost/must-run power generation to the annual power production in the last five years is

50% or less. Therefore, gas thermal power is also included in the low-cost/must-run power source. From these situations, it is not desirable to apply Dispatch Data Analysis OM, Simple Adjusted OM or Average OM from OM inspection flow as shown in Figure 8-13 for OM estimation, and therefore Simple OM is applied.

The baseline is calculated from past records (for the last three years), and the configuration of national power grid in Nigeria is shown in Figure 8-12.

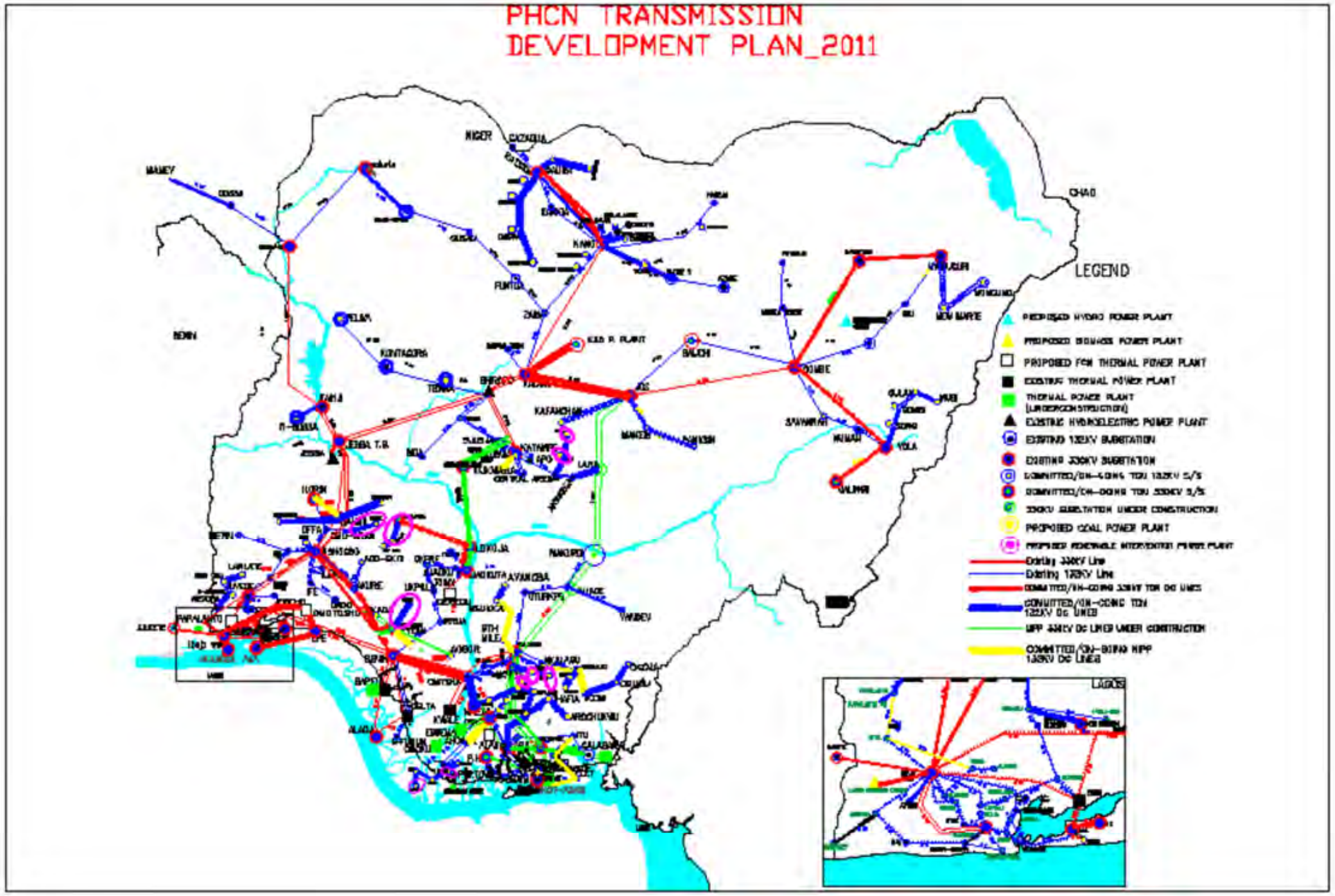
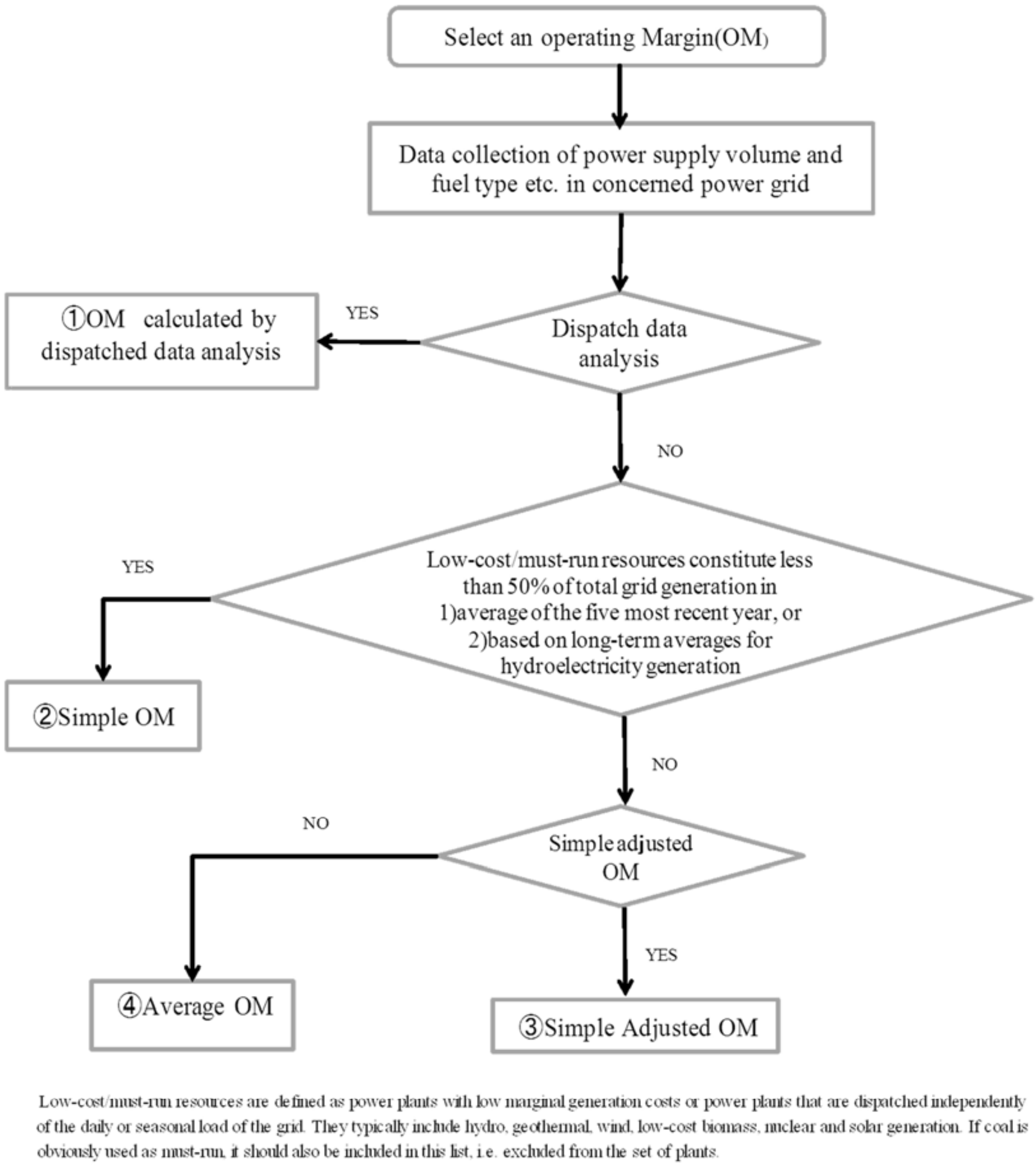


Figure 8-12 National Power Grid in Nigeria

Note: At present, transmission line is operated with 330KV and 132KV line, and in future 700KV line is considered as first transmission line.

Source: TCN, as of 2011



Source: ACM0002, UNFCCC

Figure 8-13 OM Flow Chart

8.2.4 Ex-ante Estimation of Emission Reductions

The amount of baseline emissions is estimated with the following steps: The amount of baseline emissions is represented by a combined value of the operating margin (OM) and the build margin (BM).

Step-1 Estimation of operating margin (OM)
Step-2 Estimation of build margin (BM)
Step-3 Estimation of baseline emission factor and combined margin (CM)
Step-4 Estimation of leakage
Step-5 Estimation of emission reductions

In estimations, sufficient data cannot be obtained for dispatch data analysis. The power production from low-cost/must-run power plants is 21.7 percent which means 50 percent or less of the annual total power production of the power grids. Therefore, estimations are performed based on Simple OM from the estimation tree of the operating margin (OM) referring to Figure 8-13.

Table 8-11 shows the records of thermal and hydro power generation from 2008 to 2010.

Table 8-11 Records of Thermal and Hydro Power Generation from 2008 to 2010

(Unit: GWh)

Year	2008	2009	2010
Thermal Total	13,866	13,429	17,604
Hydro Total	7,443	7,465	7,416
Hydro and Thermal Total	21,309	20,893	25,020
20% of Hydro and Thermal Total	4,262	4,179	5,004
20% Thermal Total	2,773	2,686	3,520

(1) Estimation of operating margin (OM)

Records for the last three years (2008, 2009 and 2010) are used as the total power production of national power grid. The purchased power is subtracted as it is, and the power for station service is subtracted from the power production of each power station.

The average of data announced is used for the average combustion characteristic value as Net Calorific Value (NCV).

Table 8-12 Average Net Calorific value (NCV)

Fuel type	Average Net Calorific Value (NCV)(Mcal/fuel t)	CO_2 Emission Factor (tCO_2/fuel t)
Natural gas (NG)	11,717	2.733
Diesel (light oil)	8,670	2.659

1) Amount of emissions from natural gas (NG) thermal power

Amount of CO_2 emissions from gas thermal power plant per unit (tCO_2/MWh)

=Gas consumption per unit (gas t/MWh)×CO_2 emission factor per unit of gas (tCO_2/gas t)

CO_2 emission factor (tCO_2/gas t) per unit of gas

=Average NCV of gas (M cal/gas t)×IPCC emission factor of gas (tCO_2/GJ)

×Oxidization coefficient of gas×Conversion factor from joule of calorie

＝11,717×0.056×0.995×0.004186=2.733(tCO_2/gas t)

Where, IPCC emission factor of gas=0.056 tCO_2/GJ

Oxidization coefficient of gas=99.5%

Conversion factor from joule to calorie=$4.186*10^{-3}$

(IPCC: Intergovernmental Panel on Climate Change)

Therefore, the default value of 2.733(tCO_2/gas t) is applied as CO_2 emission factor per unit of gas.

Thermal efficiency of gas (%)

= NCV of gas (M cal/gas t)/Theoretical calorific value of gas (M cal/gas t)

=11,717÷13,019=0.9

Therefore, Annual amount of emissions (tCO_2/y)

=2.733×Annual fuel consumption (M fuel t/year)÷Thermal efficiency of gas (%)

2) Amount of emissions from diesel (light oil) thermal power

IPCC emission factor of diesel=0.074 tCO_2/GJ

Oxidization coefficient of gas=99%

Conversion factor from joule to calorie=$4.186 * 10^{-3}$

Therefore, default value of 2.659 (tCO_2/fuel t) is applied as CO_2 emission factor per unit of diesel oil.

Thermal efficiency of diesel (%)

= NCV of diesel (M cal/fuel t)/Theoretical calorific value of diesel (M cal/fuel t)

=8,670÷9,126=0.95

Annual amount of emissions (tCO_2/y)

=2.659×Annual fuel consumption (M fuel t/year)÷Thermal efficiency of diesel (%)

3) Estimation of average operating margin (OM)

Average operating margin OM (EF_{OMy}) (tCO_2/MWh)

=Total amount of emissions ($ktCO_2$)÷Total power production (GWh)

Table 8-13 Average operating margin (OM)

	2008	2009	2010
Annual Power Production (GWh)	13,866*	13,429*	17,604*
Amount of CO_2 emissions ($ktCO_2$/MWh)	16,046	13,222	20,170
OM (tCO_2/MWh)	1.157	0.985	1.145
Average OM (tCO_2/MWh)	1.096		

*source: Table 8-11 Records of Thermal and Hydro power generation from 2008 to 2010

(2) Estimation of build margin (BM)

As for build margin (BM) estimation, BM is calculated in advance based on the latest information on power plants already constructed, because one period is applied due to generator's prolongation period of about seven years and there is much room for improvement of transmission loss in national power grid of Nigeria.

For power plants subjected to estimation, one of the following two options, whichever having a larger total annual power production, must be selected:

(a) Power production of five power plants recently constructed

(b) Power plants that account for 20 percent of the power production of the power grid out of power plants recently constructed and added to the power grid

As of 2010, the power production of five power plants recently constructed is 1,214GWh, and that accounts for 7 percent of the power production of the power grid, out of power plants recently constructed and added to the power grid, is 17,604GWh. Therefore, the build margin (BM) is calculated based on the value of (b).

Table 8-14 Five Power Stations Constructed Recently (as of 2011)

Name of Power Station	Power plant capacity (MW)	Annual power production (GWh)
Olorunsogo PS (thermal power)	225	270
Ajaokuta PS (thermal power)	55	266
Sapele PS (thermal power)	1,020	514
Calabar PS (thermal power)	6.6	32
Gurara HPS(hydropower)	30	132
Total	1,336.6	1,214

BM (EF_{OMy}) (tCO_2/MWh)

=Total amount of emissions ($ktCO_2$)÷Total power production (GWh)

Table 8-15 Build Margin (BM)

	2008	2009	2010
Annual Power Production(GWh)	4,262*	4,179*	5,004*
Amount of CO_2 emissions($ktCO_2$/MWh)	3,209	2,644	4,034
BM (tCO_2/MWh)	0.753	0.633	0.806
Average BM(tCO_2/MWh)	0.731		

*source: Table 8-11 Situation of Thermal and Hydro power generation from 2008 to 2010

(3) Estimation of baseline emission factor and combined margin (CM)

The baseline emission factor (EF) is calculated as a combined margin (CM) of the operating margin (OM) and the build margin (BM).

$CM=EF(tCO_2/Mwh) = w_{OM} \times EF_{BM} + w_{BM} \times EF_{OM\,y}$

$w_{OM}=w_{BM}=0.5$ is recommended for this estimation by ACM(Approved Consolidated Methodology) in IPCC.

Therefore, $EF(tCO_2/Mwh) = 0.5 \times 1.096 + 0.5 \times 0.731 = 0.913$

(4) Estimation of leakage

Leakage in rehabilitation work and operation periods of JHPS is not taken into consideration.

(5) Estimation of emission reductions

This Project is equivalent to replacing the power supplied from power plants using fossil fuel to the power grid with the power by hydropower generation at JHPS (using renewable energy).

ER=BE－PE－L

ER: Greenhouse gas emission reductions by the Project

BE: Amount of baseline emissions

PE: Amount of emissions from the Project (assumed to be 0 because of hydropower power generation)

L: Leakage (0)

Therefore, ER=BE

Amount of baseline emissions (BE)

=Baseline emission factor (EF)×Generated power from the Project (EG)

The power generated from the Project (EG) equals the sum of received power at grid stations, which is taking into consideration the power transmission loss in power grid with respect to JHPS power production (that is, the Station service and the transmission loss of power grid are deducted).

E_{BG}: Total JHPS power production (MWh)

TDL_b: Transmission loss in power grid (7.4%) + Station service at JHPS (0.16%) =7.56%

Amount of power received (E_{ER}) at grid stations= Power generated from the project (EG)

$= (1\text{-}TDL_b) \times E_{BG}$

Therefore, the estimated emission reductions are obtained from the following multiplication:

$$ER = BE = EF * EG = 0.913 \times (1 - TDL_b) \times E_{BG} = 0.844 E_{BG}$$

8.2.5 Summary of the Ex-ante Estimation of Emission Reductions

The emission reductions of the Project are deemed to be equal to the baseline emission because the Project itself does not produce any other emission. The expected reduction of CO2 of each option is shown in Table 8-16..

Table 8-16 Estimation of Emission Reduction

	Total Contributing Output for CO_2 Reduction (GWh)	Amount of baseline emissions (tCO_2/MWh)	Amount of emissions from project (tCO_2)	Leakage (tCO_2)	Total emission reductions (tCO_2)
Option 1 (2 Units Rehabilitation)	26,158	22,076,600	0	0	17,661,600
Option 2 (3 Units Rehabilitation)	38,870	32,805,170	0	0	26,244,800
Option 3 (4 Units Rehabilitation)	46,175	38,971,036	0	0	31,177,600

It is conservatively assumed that 80 percent of expected average power output would be generated for the prolonged period due to the deterioration of turbines, because turbines were out of scope of this rehabilitation project.

Chapter 9

Environmental and Social Considerations

Chapter 9 Environmental and Social Consideration

9.1 Environmental Consideration

9.1.1 Environmental Impact Assessment

(1) General

In principle, JHPS as the implementing agency for the Project is responsible for environmental impact surveys prior to implementing the Project in accordance with government directives. However, the Project implementation will not entail any major problems based on the fact that roads for the works are already in place, development of renewable energy is a national policy and the Project entails rehabilitation of a power station that was constructed 27 years ago.

(2) Assessment

Concerning the Project impact on the natural environment, the following examination was conducted by the Team over three phases, i.e. (1) before Project implementation, (2) during Project implementation, and (3) during Project operation.

1) Before Project implementation

The target generation facilities were constructed 27 years ago and have been continuously working in the enclosed environment in the power house. There is no emission of exhaust gas or waste water. Therefore, the environmental impact before Project implementation is minimal.

2) During Project implementation

The rehabilitation works itself will be done in the enclosed environment inside of the existing powerhouse in the premises of JHPS. The rehabilitation works will engage some welding machines and heavy equipment but such works will be done inside of the powerhouse. Therefore, there is no implication to the surrounding environment except the treatment and disposal of replaced parts which contain asbestos. Such hazardous materials shall be treated safely in accordance with Nigerian environmental standard with witness by the environmental inspector to be appointed by JHPS as the responsibility of the Project implementing body. JHPS will entrust such treatment and disposal to the qualified specialised company in Nigeria. Detailed implications of the disposal of waste containing asbestos are described separately in Section 9.3.

3) During Project operation

The Project is merely replacement of the existing deteriorated generation facilities with rehabilitated ones having the same function but improved performances. Therefore, there is no degradation in environmental impact after completion of the Project as compared to before Project implementation.

(3) JICA Environmental Requirement

1) General

JICA environmental standard categorised this Project as Category B. Therefore, it becomes obligatory for the project proponent to implement environmental monitoring in line with JICA's guideline.

2) Environmental Checklist

Environmental checklist was elaborated using JICA's format '19.Other Infrastructure Projects'. Impacts on environment by this Project are negligible because the rehabilitation work will be carried out by way of changing parts inside of the existing powerhouse. On the other hand, some parts include asbestos and it is necessary to treat these parts properly at the time of replacement work in conformity with the related Nigerian environmental regulation. Environmental checklist assesses environmental impacts caused by such hazardous materials. The environmental and social considerations including major impacts and mitigation measures for the Project especially appropriate treatment and disposal of asbestos-containing waste are summarised in this checklist as shown in Appendix-14.

3) Monitoring Form

Monitoring items reflects on items marked as 'Yes' in the above-mentioned checklist. The monitoring shall cover activities of international contractor for rehabilitation works and local professional treatment company for final disposal of asbestos-containing waste. After hazardous materials are passed on to the local company and brought outside of project site, monitoring will not be necessary any more. The results of monitoring will be provided to JICA on a quarterly basis until the completion of the work handling asbestos. Monitoring Form is attached in Appendix-15.

9.2 Social Consideration

Considering that the Project almost totally entails indoor work for replacement of turbines and generators, etc. in a hydroelectric power station that was built 27 years ago and the work period at site will be approximately four years, JHPS believes that impacts on the landscape and social environment in particular outside of the premises of JHPS will be negligible and local residents will give their consent. The Project site is located approximately 300 kilometres from the capital Abuja and is also remote from the nearest towns and the entrance to the power station is under constant guard, therefore, impacts on third parties will be negligible. Moreover, since most of the work will be conducted indoors, there will be little impact in terms of vibration, particulate or noise. In addition, since inhabited areas are far away from the station, there will be no impact on local residents.

9.3 Treatment and Disposal of Waste containing Asbestos

9.3.1 General

Since some wastes generated through disassembling generator parts contain asbestos, it is necessary to make a proper working plan against these wastes during the rehabilitation work. An international contractor appointed to this project will be responsible for establishing proper countermeasure of treatment of waste containing asbestos and safety measure during work as following sections describe: After these parts are removed, they will be carried away from the project site by a local professional treatment company.

Parts and materials to be procured by this Project do not contain any hazardous substances such as asbestos. Table 9-1 indicates the list regarding parts containing asbestos in the existing generation units.

Table 9-1 Parts and materials containing asbestos

Name	Q'ty	Purpose	Countermeasure
Joint insulation film installed between the contact surfaces of stator frame divided into six parts	1 set	Stator frame is divided into six parts and the film is used at joint surface of stator frame as insulator	It is presumed that asbestos can scatter when cores are dismantled. Wet dismantling operation is required. Sufficient attention shall be paid to operation including countermeasures against scattering of asbestos.
High-resistant Colona shield	1 set	Upper and lower parts of whole coil ends	Asbestos are stuck on the surface of coil with varnish, and are covered with exterior tapes. When coils are dismantled, it is probable that parts including asbestos will be damaged. Sufficient attention shall be paid to operation countermeasures against scattering of asbestos.
Layer insulation materials in field coils	1 set	Spaces between all coils	Asbestos is laminate-coated internally and external surface is covered with varnish. When field coils are dismantled, it is probable that parts including asbestos will be damaged. Sufficient attention shall be paid to operation including countermeasures against scattering of asbestos.

9.3.2 Environmental Regulations regarding Asbestos in Nigeria

National Environmental (Construction Sector) Regulation, 2011 is published in FGN Official Gazette No.46 Lagos-17th May, 2011 Vol.98. According to the contents, the following contents are stipulated with regards to the treatment of asbestos:

1. The use of asbestos at construction sites is prohibited.
2. The operator/facility shall remove all asbestos-containing materials from a structure

being demolished or renovated before any activity is carried out that would break up, dislodge or similarly disturb the materials or prevent access to materials for subsequent removal.

3. Prior to the commencement of any demolition or renovation, the affected structure or part of the structure where the work is to take place must be thoroughly inspected and assessed for the presence of asbestos by person(s) certified by NESREA and other relevant bodies.
4. The types and quantities of asbestos-containing materials shall be determined by the inspector who shall make recommendations for the need to remove and dispose appropriately, asbestos-containing materials.
5. Prior to all demolition activities, including those where no asbestos material is present, a notification by the demolishing contractor must be sent to NESREA.

9.3.3 Treatment of Waste

Treatment and disposal of asbestos will be carried out in accordance with the relevant regulations in a country where a selected international contractor belongs. The following procedure of treatment of asbestos-containing parts complies with Japan's relevant regulation:

i) The contractor will set up a temporary 'clean room' to cater for treatment of asbestos containing parts. The room will also be kept in high moisture content by humidifier to prevent from scattering of asbestos fibers.

ii) During a work, water mist is sprayed on asbestos containing parts to prevent asbestos from scattering. At the same time, the room is kept under negative-pressure by the above mentioned filter so that no air will leak out of the room.

iii) When the removal work of such parts finishes, asbestos containing waste are packed into plastic bags in twofold for disposal.

iv) Removed wastes which contain asbestos shall be kept at the designated place outside of the powerhouse until the local company will come to receive such waste for final treatment and disposal under responsibility of the local company.

9.3.4 Safety Measures during Work

As for treatment of parts including asbestos, it is necessary to establish a countermeasure to secure the safety of workers during the work implementation. In the Project, the work and inspection will be implemented by technicians from the contractor. In addition to the previous section, when workers enter into the clean room, they wear dust prevention gears against asbestosis fibres such as masks, glasses and clothes. All used gears will be packed into plastic bags in twofold for disposal. During the Project implementation, the removal work needs to be implemented under the instruction of NESREA, and the contractor shall adopt the safer method stipulated either in Nigerian regulations or those in country of the contractor.

Chapter 10

Concluding Remarks

Chapter 10 Concluding Remarks

10.1 Recommendations

It is recommended that the Nigerian side shall undertake the following works in order to ensure the smooth implementation of the Project through Japanese ODA Loan scheme, if it is approved by GOJ:

(1) FGN's budget allocation 2012-2020 for the counterpart fund

In accordance with JICA's criteria on application of Japanese ODA Loan to Nigeria, 15 percent of the total Project Cost, i.e. 3.45 billion Naira as a maximum, shall be borne by FGN as the counterpart fund for the Project. In consideration of the disbursement schedule for the Project developed by the Team, approximately 0.4 billion Naira will have to be provided by FGN in order to cater for the Project cost for 2012. Likewise FGN shall be responsible for appropriation of the budget for counterpart fund in the subsequent years properly so as not to hider the progress of the work due to lack of local fund. The related authorities, namely FMOF, FMOP and JHEP, shall coordinate closely to secure the local fund.

(2) Proposed High-Level Steering Committee

As the borrower of Japanese ODA loan project, FMOF bears overall responsibility for Project implementation. The Team proposed to constitute the High-Level Steering Committee with participation of FMOP, International Economic Relations Department of FMOF (Director), Budget Dapartment of FMOF (Director), JHEP (CEO), BPE (Director), National Planning Commission (NPC) (Director) under chairmanship by FMOF in order to coordinate among concerned organisations on pending issues which cannot be resolved in the lower level forums, to decide on policy matters and to monitor the Project overall. JICA Nigeria Office (Chief Representative) will attend the meeting as an observer.

(3) Project implementation schedule

FMOF placed the Project as a fast track project. If GOJ would approve the implementation of the Project early in 2012, the rehabilitation work of generators under the Project shall start from January 2015. In order to meet the said timeline in consideration of Loan Agreement (L/A) for the Project expected to be concluded in the first quarter of 2012, the procurement of the consultant and the contractor shall be completed by October 2013. The proposed duration of selection is very short and tight compared with other Japanese ODA loan projects. The concerned organisations shall take strong initiative with close coordination in expediting the process.

(4) Monitoring for environmental and social considerations

JHEP is requested to conduct monitoring for environmental and social considerations based on the environmental checklist and monitoring form attached in Appendix-14 and Appendix-15. JHEP agreed that JICA may disclose monitoring results and further information when third parties request, subject to approval of JHEP.

(5) Proper operation and maintenance of the rehabilitated facilities

To ensure that the station personnel can operate and maintain the facilities immediately after rehabilitation by the Project, it is recommended for JHPS to implement equipment predictive and preventive maintenance measures and operation techniques. Training for daily maintenance and assurance activities are also required to ensure the normal operations of the rehabilitated generation units in organised and qualified manner at all times.

(6) Proper involvement for auditing, submission of reports and evaluation made by JICA

To realise transparency of implementation of the Project, JHEP shall make necessary actions as agreed and/or requested by JICA. As an example, JHEP needs to provide necessary financial data to independent auditors appointed by JICA for implementation of auditing services. JHEP also requested to submit necessary information for evaluation activities and reports of progress and completion of the Project.

10.2 Concluding Remarks

The Preparatory Survey was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from July 2011 to December 2011. In conducting the survey, the Team has examined the feasibility and rationale of the Project with due consideration of the present situation of Nigeria and formulated the most appropriate design for the Project under Japanese ODA Loan scheme.

In the past, hydropower generation has maintained its constant level of total output of approximately 7,000GWh, however, since such constant contribution by hydropower relied on the existing highly deteriorated generation facilities without overhaul and the construction of new hydropower plants is far away, it is obvious that rehabilitation of the existing hydropower generation facilities is the only practical but indispensable way to sustain 30 percent of power generation in Nigeria by maintaining the present hydropower generation level in the hydropower generation stations.

The Hydro Power Rehabilitation Project in Nigeria aims to rehabilitate the existing hydro power generation units, namely 2G1, 2G2, 2G3 and 2G5 under Japanese ODA Loan scheme. Since JHPS has not undergone a full-scale overhaul since its operational start in 1983, the timing of the Project of which aims rehabilitation of JHPS is suitable for the stable power generation. This Project will renovate the existing old equipment and this method is quite suitable for JHPS since its staff knows the current equipment well. Hence, it is more sustainable than total replacement to brand-new generators, in terms of stable operation and maintenance.

The Team confirmed the necessity and feasibility of the Project and the importance of the security of maintenance of high reliability of the performance of the power generation units in JHPS in the Nigerian power sector. This Project will provide considerable benefit and effect as mentioned above to Nigeria and contribute to the stabilisation of power generation in the country.

Appendices

Appendix-1

Member List of the Survey Team

Member List of the Survey Team

(1) First Field Survey Team

Name	Assignment	Company
Mr. Toshio YANO	Team Leader / Chief Consultant / Operation and Maintenance	Yachiyo Engineering Co., Ltd.
Mr. Yuya WATANABE	Generator	Yachiyo Engineering Co., Ltd.
Mr. Satoshi ISHIKAWA	Turbine	Yachiyo Engineering Co., Ltd.
Mr. Katsuhiro MORIYAMA	Control / Equipment	Yachiyo Engineering Co., Ltd.
Mr. Kaoru NISHIWAKI	Civil / Demand Analysis	Yachiyo Engineering Co., Ltd.
Mr. Tetsuo YATSU	Procurement / Cost Estimation	Yachiyo Engineering Co., Ltd.
Mr. Yusuke HARADA	Economic Financial Analysis	Yachiyo Engineering Co., Ltd.
Mr. Iurii PIROZHKOV	Hydropower Facility	Yachiyo Engineering Co., Ltd.
Mr. Kazuaki KONDO	Coordinator / Assistant to Generator	Yachiyo Engineering Co., Ltd.

(2) Second Field Survey Team

Name	Assignment	Company
Mr. Toshio YANO	Team Leader / Chief Consultant / Operation and Maintenance	Yachiyo Engineering Co., Ltd.
Mr. Takashi TOBITA	Generator	Yachiyo Engineering Co., Ltd.
Mr. Katsuhiro MORIYAMA	Control / Equipment	Yachiyo Engineering Co., Ltd.
Mr. Kaoru NISHIWAKI	Civil / Demand Analysis	Yachiyo Engineering Co., Ltd.
Mr. Tetsuo YATSU	Procurement / Cost Estimation	Yachiyo Engineering Co., Ltd.
Mr. Yusuke HARADA	Economic Financial Analysis	Yachiyo Engineering Co., Ltd.
Mr. Kazuaki KONDO	Coordinator / Assistant to Generator	Yachiyo Engineering Co., Ltd.

(3) Third Field Survey Team

Name	Assignment	Company
Mr. Toshio YANO	Team Leader / Chief Consultant / Operation and Maintenance	Yachiyo Engineering Co., Ltd.
Mr. Katsuhiro MORIYAMA	Control / Equipment	Yachiyo Engineering Co., Ltd.
Mr. Yusuke HARADA	Economic Financial Analysis	Yachiyo Engineering Co., Ltd.
Mr. Kazuaki KONDO	Coordinator / Assistant to Generator	Yachiyo Engineering Co., Ltd.

Appendix-2

Field Survey Schedule

(1) First Field Survey

No.	Date	Day	Contents									Place to stay
			Mr. Toshio Yano	Mr. Tesuo Yatsu	Mr. Katsuhiro Moriyama	Mr. Satoshi Ishikawa	Mr. Kaoru Nishiwaki	Mr. Yusuke Harada	Mr. Kazuaki Kondo	Mr. Yuya Watanabe	Mr. Iurii Pirozhkov	
1	10-Jul	Sun	・Trip{Narita 11:45 → London 16:20 by JL401} ・Trip{London 22:15 → Abuja 04:35+1 by BA0083}									On board
2	11-Jul	Mon	・Trip{ → Abuja 04:35 by BA0083} ・Courtesy call: JICA Nigeria Office									Abuja
3	12-Jul	Tue	・Courtesy call: National Planning Commission (NPC) ・Meeting with Federal Ministry of Power (FMOP) and Jebba Hydro Electric Plc. (JHEP) regarding the field survey schedule including the adjustment with annual maintenance schedule for 2G1, 2G2, 2G3 and 2G5									Abuja
4	13-Jul	Wed	Field survey and technical discussion		Trip{ Abuja → Jebba by Car}							Jebba/Abuja
5	14-Jul	Thu	Field survey and technical discussion		Field survey and technical discussion with JHEP					・Trip{ Narita → London} ・Trip{London → Abuja}		Jebba/Abuja
6	15-Jul	Fri	・Discussion with JICA Nigeria Office ・Field survey and technical discussion		Field survey and technical discussion with JHEP					Trip{→Abuja}		Jebba/Abuja/On board
7	16-Jul	Sat	Field survey and technical discussion		・ All members: Data analysis and internal meeting ・ Ishikawa: Preparation for the inspection of the turbine 2G2					Trip{ Abuja → Jebba by Car}		Jebba/Abuja
8	17-Jul	Sun	Field survey and technical discussion		Data analysis and internal meeting							Jebba/Abuja
9	18-Jul	Mon	JHEP: Technical discussion		・Watanabe, Kondo:Preparation for the inspection of the generator 2G2 (Cooling down) ・Moriyama, Ishikawa, Nishiwaki, Harada: Field survey and technical discussion						・Trip{Moscow→ London} ・Trip{London→ Abuja}	Jebba/Abuja
10	19-Jul	Tue	FMOP and JHEP: Technical discussion	Trip{ Abuja → Jebba by Car}	・Watanabe, Kondo: Inspection of the generator 2G2 ・Moriyama, Ishikawa, Nishiwaki, Harada: Data collection and technical discussion						・Trip{→Abuja} ・Trip{ Abuja → Jebba by Car}	Jebba/Abuja
11	20-Jul	Wed	・Internal meeting ・Data collection	Field survey and technical discussion	・Trip{Jebba→ Abuja} ・Internal meeting	・ Watanabe, Kondo: Inspection of the generator 2G2 ・ Ishikawa, Iurii: Inspection of the turbine 2G2 ・ Nishiwaki, Harada: Data collection and technical discussion						Jebba/Abuja
12	21-Jul	Thu	Data collection	Field survey and technical discussion	・Trip{Abuja→ London} ・Trip{London→ Narita}	・ Watanabe, Kondo: Preparation for the inspection of the generator 2G5 (Cooling down), technical discussion ・ Ishikawa, Iurii: Inspection of the turbine 2G2 ・ Nishiwaki, Harada: Data collection and technical discussion						Jebba/On board
13	22-Jul	Fri	Discussion with FMOP and data collection	Field survey and technical discussion	・Trip{→Narita}	・ Watanabe, Kondo: Inspection of the generator 2G5 ・ Ishikawa, Nishiwaki, Harada, Iurii: Data collection and technical discussion						Jebba/Abuja
14	23-Jul	Sat	・Trip{Abuja→ Jebba} ・Internal meeting	Data analysis and internal meeting		・ All members: Data analysis and internal meeting ・ Watanabe, Kondo: Inspection of the generator 2G5						Jebba
15	24-Jul	Sun	Field inspection	Data analysis and internal meeting		Data analysis and internal meeting						Jebba
16	25-Jul	Mon	Field survey and technical discussion			・ Watanabe, Kondo: Preparation for the inspection of the generator 2G3 (Cooling down) ・ Ishikawa, Nishiwaki, Harada, Iurii: Data collection and technical discussion						Jebba
17	26-Jul	Tue	Field survey and technical discussion			・ Watanabe, Kondo: Inspection of the generator 2G3 ・ Ishikawa, Iurii, Nishiwaki, Harada: Data collection and technical discussion						Jebba
18	27-Jul	Wed	Trip{Jebba →Abuja}	Field survey and technical discussion		・ Watanabe, Kondo: Preparation for the inspection of the generator 2G1 (Cooling down) ・ Ishikawa, Nishiwaki, Harada, Iurii: Data collection and technical discussion						Jebba/Abuja
19	28-Jul	Thu	Report to JICA Nigeria Field Office and data collection at	Field survey and technical discussion		・ Watanabe, Kondo: Inspection of the generator 2G1 ・ Ishikawa, Iurii, Nishiwaki, Harada: Data collection and technical discussion						Jebba/Abuja
20	29-Jul	Fri	・Trip{Abuja→ London} ・Trip{London→ Narita}	Field survey and technical discussion		・ Watanabe, Kondo: Inspection of the generator 2G1 ・ Ishikawa, Iurii, Nishiwaki, Harada: Data collection and technical discussion						Jebba/On board
21	30-Jul	Sat	・Trip{→ Narita}	Refer to the right column		All members including Mr. Yatsu ・ Preparation of the Field Survey Report						Jebba
22	31-Jul	Sun		Leave the Team for a different survey		Leave the Team for a different survey	Internal meeting and data analysis					Jebba
23	1-Aug	Mon					Trip{Jebba→Abuja by car}					Abuja
24	2-Aug	Tue					・ Nishiwaki, Harada: Technical discussion and data analysis ・ Watanabe, Iurii: Data analysis and preparation for the report ・ Kondo: Prepartion for the Field Survey Report					Abuja
25	3-Aug	Wen					・ Nishiwaki, Harada: Technical discussion and data analysis ・ Watanabe, Iurii: Data analysis and preparation for the report ・ Kondo: Prepartion for the Field Survey Report					Abuja
26	4-Aug	Thu					・ Nishiwaki, Harada: Technical discussion and data analysis ・ Watanabe, Iurii: Data analysis and preparation for the report ・ Kondo: Prepartion for the Field Survey Report					Abuja
27	5-Aug	Fri					・ Harada, Watanabe, Iurii, Kondo: Courtesy call to JICA Nigeria Office, preparation for the report ・ Nishiwaki: Technical discussion with FMOP, preparation for the report					Abuja
28	6-Aug	Sat					Internal meeting and data analysis					Abuja
29	7-Aug	Sun					・Trip{Abuja 08:45 → London 15:05 by BA0082} ・Trip{London 19:15 → Narita 15:00+1 by JL402}				・Trip{Abuja → London} ・Trip{London→ Moscow}	On board
30	8-Aug	Mon					Trip{→ Narita 15:00}				Trip{→Moscow}	

(2)Second Field Survey

No.	Date (MM/DD/YY)		Consultant: Mr. Toshio YANO	Mr.Tetsuo YATSU	Mr. Katsuhiro MORIYAMA	Mr. Kaoru NISHIWAKI	Mr. Yusuke HARADA	Mr. Kazuaki KONDO	Mr. Takashi TOBITA	Stay at
1	09/18/11	Sun	Traveling：[Tokyo (11:45) JL401→London (16:20)/(22:15) BA083 →Abuja]							in Flight
2	09/19/11	Mon	・[Arrive Abuja 04:35]→Hotel Check In (Golden Gate Hotel, Abuja) ・Courtesy call to JICA Nigeria Office and explanation about First Interim Report							Abuja
3	09/20/11	Tue	・Mission move to Jebba Hydro Electric Plc. (JHEP) by Car (8 hrs) ・Courtesy call to JHEP(CEO)							Jebba
4	09/21/11	Wed	Explanation of the First Interim Report to JHEP (CEO and staffs) ・Nishiwaki, Tobita: Field survey at Kainji Dam			Field survey at Kainji Dam	Explanation of the First Interim Report to JHEP (CEO and staffs)		Field survey at Kainji Dam	Jebba
5	09/22/11	Thu	Field survey at National Control Centre in Osogbo	Field survey at National Control Centre in Osogbo				Field survey at National Control Centre in Osogbo	Technical discussion and data analysis	Jebba
6	09/23/11	Fri	Technical discussion and data analysis	Move to Abuja by Car (8Hrs)	Technical discussion and data analysis					Jebba Abuja
7	09/24/11	Sat	Technical discussion and data analysis	Data Arrangement and Preparing Report	Technical discussion and data analysis					Jebba Abuja
8	09/25/11	Sun	Data analysis and internal meeting	Data Arrangement and Preparing Report	Data analysis and internal meeting					Jebba Abuja
9	09/26/11	Mon	Technical discussion and data analysis	Data Arrangement and Preparing Report	Technical discussion and data analysis					Abuja
10	09/27/11	Tue	Technical discussion and data analysis	Data Arrangement and Preparing Report	Technical discussion and data analysis					Abuja
11	09/28/11	Wed	Move to Abuja by Car (8Hrs)	Data Arrangement and Preparing Report	Move to Abuja by Car (8Hrs)					Abuja
12	09/29/11	Thu	Technical discussion and explanation of the Interim Report at FMOP		Data Arrangement and Preparing Report					Abuja
13	09/30/11	Fri	Internal meeting and data arrangement			・Data arrangement ・Technical discussion with FMOP	Internal meeting and data arrangement		Traveling：[Abuja→London, London→Narita]	Abuja
14	10/01/11	Sat	Internal meeting and data analysis						Traveling：[→Narita]	Abuja
15	10/02/11	Sun	Internal meeting and data analysis							Abuja
16	10/03/11	Mon	Internal meeting and data analysis							Abuja
17	10/04/11	Tue	・Report to JICA Niegria Office ・Data arrangement and preparing report							Abuja
18	10/05/11	Wed	・Technical discussion with FMOP ・Technical discussion with TCN		Internal meeting and data analysis					Abuja
19	10/06/11	Thu	Technical discussion with FMOP and PTFP	Internal meeting and data analysis			Technical discussion with TCN	Technical discussion with FMOP and PTFP		Abuja
20	10/07/11	Fri	Technical discussion with FMOP and PTFP	Internal meeting and data analysis			Technical discussion with TCN	Technical discussion with FMOP and PTFP		Abuja
21	10/08/11	Sat	Internal meeting and data analysis							Abuja
22	10/09/11	Sun	Internal meeting and data analysis							Abuja
23	10/10/11	Mon	Data analysis and preparing for the Draft Final		Technical discussion with FMOP and PTFP	Data analysis and preparing for the Draft Final	Technical discussion with NERC	Technical discussion with FMOP and PTFP		Abuja
24	10/11/11	Tue	Data analysis and preparing for the Draft Final			Technical discussion with PHCN		Data analysis and preparing for the Draft Final		Abuja
25	10/12/11	Wed	Data analysis and preparing for the Draft Final		Technical discussion with FMOP	Data analysis and preparing for the Draft Final	Technical discussion with PHCN	Technical discussion with FMOP		Abuja
26	10/13/11	Thu	Technical discussion with CEO of JHEP at JICA Nigeria Office		Technical discussion with PHCN	Technical discussion with PHCN	Technical discussion with PHCN			Abuja
27	10/14/11	Fri	Technical discussion with the Embassy of Japan		Data analysis and preparing for the Draft Final	Technical discussion with the Climate Change Unit	Data analysis and preparing for the Draft Final			Abuja
28	10/15/11	Sat	Internal meeting and data analysis							Abuja
29	10/16/11	Sun	Internal meeting and data analysis							Abuja
30	10/17/11	Mon	Move to JHEP by Car (7Hrs)		Technical discussion with PHCN	Preparing for the draft final report	Technical discussion with PHCN	Move to JHEP by Car		Abuja
31	10/18/11	Tue	Technical discussion with JHEP		Preparing for the draft final report		Technical discussion with PHCN	Technica discussion with JHEP		Abuja
32	10/19/11	Wed	・Move to Abuja by Car (7Hrs) ・Technical discussion with JICA and FMOP		Technical discussion with JICA		・Technical discussion with PHCN and JICA	・Move to Abuja by Car ・Technical discussion with JICA and FMOP		Abuja
33	10/20/11	Thu	Preparing for the draft final report							Abuja
34	10/21/11	Fri	Technical discussion with FMOF		Preparing for the draft final report			Technical discussion with FMOF		Abuja
35	10/22/11	Sat	Traveling：[Abuja (08:45) BA082→London (15:05)/(19:15) JL402 →Narita]							in Flight
36	10/23/11	Sun	Arraive Narita Airport 15:00							

PTFP: Presidential Task Force on Power　　FMOP: Federal Ministry of Power　　FMOF: Federal Ministry of Finance

NERC: Nigerial Electricity Regulatory Commission　　JICA: JICA Nigeria Office

(3)Third Field Survey

No.	Date	Day	Contents of survey				Place to stay
			Mr. Toshio Yano	Mr. Katsuhiro Moriyama	Mr. Yusuke Harada	Mr. Kazuaki Kondo	
1	27-Nov-11	Sun	・Trip{Narita 11:45 → London 15:25 by JL401} ・Trip{London 22:15 → Abuja 05:35+1 by BA0083}				On board
2	28-Nov-11	Mon	・[Arrive Abuja 04:35]→Hotel Check In（Golden Gate Hotel, Abuja) ・Courtesy call to JICA Nigeria Office and explanation of the Draft Final Report				Abuja
3	29-Nov-11	Tue	・Mission move to Jebba Hydro Electric Plc.(JHEP) by Car (9 hrs)				Jebba
4	30-Nov-11	Wed	Field survey and data collection				Jebba
5	1-Dec-11	Thu	Technical discussion on the Draft Final Report with staff of JHEP Field survey and data collection				Jebba
6	2-Dec-11	Fri	Technical discussion with PM (Procurement)	Data collection and analysis		Technical discussion with PM (Procurement)	Jebba
7	3-Dec-11	Sat	Field survey and internal meeting				Jebba
8	4-Dec-11	Sun	Data analysis and internal meeting				Jebba
9	5-Dec-11	Mon	・All members: Mission move to Abuja by Car (8 hrs) ・All members: Technical discussion with JICA Nigeria Office ・Yano and Kondo: Courtecy call to Honourable Minister of Power ・Yano and Kondo: Technical discussion at the Federal Ministry of Power				Abuja
10	6-Dec-11	Tue	Data analysis and internal meeting				Abuja
11	7-Dec-11	Wed	Data analysis and preparation of Final Report (FR)	Trip：[Abuja（10:05）BA082→London（15:30）/(19:00) JL402 →Narita]		Data analysis and preparation of FR	Abuja/Onboard
12	8-Dec-11	Thu	Data analysis and preparation of FR	Arrival at Narita		Data analysis and preparation of FR	Abuja
13	9-Dec-11	Fri	Data analysis and preparation of FR			Data analysis and preparation of FR	Abuja
14	10-Dec-11	Sat	Data analysis on environmental checklist and monitoring form			Data analysis on environmental checklist and monitoring form	Abuja
15	11-Dec-11	Sun	Technical discussion with JICA			Technical discussion with JICA	Abuja
16	12-Dec-11	Mon	Data analysis on monitoring form			Data analysis on monitoring form	Abuja
17	13-Dec-11	Tue	Preparation of FR			Preparation of FR	Abuja
18	14-Dec-11	Wed	Preparation of FR			Preparation of FR	Abuja
19	15-Dec-11	Thu	Trip：[Abuja（10:05）BA082→ London（15:30）/(19:00) JL402 →Narita]			Trip：[Abuja（10:05）BA082→ London（15:30）/(19:00) JL402 →Narita]	On board
20	16-Dec-11	Fri	Arrival at Narita			Arrival at Narita	

Appendix-3

List of Parties Concerned in Recipient Country

Agency / Name	Position
National Planning Commission (NPC)	
Mr. Bassey Akpayumg	Director (International Cooperation)
Mr. Abdullahi Yakubu	Principal Planning Officer (Asia)
Ms. Blessing Ejeyeka	Planning Officer II (Asia)
Federal Ministry of Finance (FMOF)	
Ms. Ihechukwu-Madubuike Ada A.	Deputy Director, International Development Fund
Mr. Mgbenu D. O.	Assistant Director (International Economic Relations
Mr. Akiorolabu O. B.	Assistant Director (Policy)
Mr. Fagbade R. O.	Principal Administration Officer
Federal Ministry of Power (FMOP)	
Hon. Minister of Power	Prof. Barth Nnaji
Engr. Sanusi Garba	Director (Power)
Mr. Thelma Osuhor	Technical Assistant to The Hon. Minister
Mr. Greyne Chukwuka Anosike	Head Media/Public Relations
Engr. E. O. Ajayi	Deputy Director (Power)
Engr. Eugene Ejeregbe	Senior Engineer
Mr. Adamu David E.	Electrical Engineer
Presidential Task Force on Power	
Engr. Simeon Atakulu	Technical Advisor, Power Holding Company of Nigeria
Engr. Nasiru Y. Beli	Technical Advisor, Performance Monitoring Team on Generation
Power Holding Company of Nigeria	
Engr. J. K. Achife	General Manager (Gas/IPD)
Engr. J. O. Ebewele	General Manager (Generation)
Jebba Hydro Electric Plc. (JHEP)	
Engr. Lamu Audu	Chief Executive Officer
Engr. Felix U. Azogu	Assistant General Manager (Maintenance)
Engr. D. J. Obadote	Assistant General Manager (Operations)
Engr. O. G. Etibeng	Principal Manager (Technical Services)
Engr. B. J. Awoderu	Principal Manager (Procurement)
Engr. P. A. Ondachi	Principal Manager (Generator and Workshop)
Engr. W. A. Ilori	Principal Manager (Electrical)
Mr. Haji Gani Adesima	Principal Manager (Protection Control and Metering)
Mr. Gilbert Onwudegu	Principal Manager (Generation)
Mr. Umana M. D.	Principal Manager (Planning)
Engr. A. R. Adesina	Principal Manager (Estate and Civil Works)
Mr. M. A. Simon	Principal Manager (Geography)

Engr. Habib T. J	Principal Manager (Auxiliary)
Mr. Babade T. K	Principal Manager (Turbine/Governor)
Mr. S. A. Moreinkeyi	Principal Manager (Dam Instrument)
Mr. Ogwuru Danatus	Senior Manager (Operations)
Mr. G. O. Ogolekwu	Senior Manager (Hydrology)
Mr. J. O. Ademiyi	Senior Manager (Dam Instrument)
Engr. B. G. Kachalla	Manager (Procurement)
Mr. Y. M. Gano	Manager (Performance Management)
Mr. Baba M. J.	Manager (Planning)

Transmission Company of Nigeria (TCN)

Engr. U. D. Achinanya	Executive Director (Market Operations)

Embassy of Japan in Nigeria

Mr. Ryuichi Shoji	Ambassador Extraordinary and Plenipotentiary
Mr. Takeshi Hagino	First Secretary
Mr. Hiroshi Kawanobe	First Secretary
Mr. Yudai Maeda	First Secretary

JICA Nigeria Office

Mr. Yoshitaka Sumi	Chief Representative
Mr. Ken Fujie	Representative
Mr. Yoshiro Masuda	Representative
Ms. Elizabeth Uluvbo Ejeregbe	Consultant
Mr. Zacchaeus Ndaginusa Yisa	Consultant

Appendix-4

Japanese ODA Loan Scheme

1. Project Preparation

A developing country draws up medium- and long-term development plans and carries out project identification with due consideration for targets and strategies in these plans. JICA conducts macroeconomic and sector surveys and examines the urgency and priority of the identified projects through policy dialogue with the governments of developing countries. Before moving to implementation, the project plan comes under further analysis with respect to economic, social, technical and environmental aspects. This feasibility study (F/S) is either carried out by the government of the developing country on its own or through technical assistance from JICA or other international organizations.

The series of steps in providing an ODA loan consists of project preparation, appraisal, signing of a loan agreement, implementation, and ex-post evaluation and monitoring after the project completion.

2. Loan Request

The government of developing countries files a loan application to GOJ, accompanied by documents produced in the project identification and preparation stages.

3. Examination/Appraisal and Ex-Ante Project Evaluation

JICA examines the loan application documents submitted by the governments of developing countries. At this point, GOJ may send a mission, if necessary, to consult with the country requesting the loan. Subsequently, JICA sends an appraisal mission to the requesting country for discussions with officials involved in the project and for field visits. The mission studies economic, social, technical and environmental aspects of the project in detail. For all ODA loan projects for which appraisal is carried out after April 1, 2001, JICA prepares the Ex-Ante Project Evaluation Report and posts it on its website soon after the signing of a loan agreement.

JICA will carry out a supplemental Survey if it is judged that the loan application documents require further clarifications in terms of economic, social, technical or environmental aspects of the project prior to JICA's examination and appraisal.

4. Exchange of Notes and Loan Agreement

Based on the results of the appraisal conducted by JICA, GOJ makes a decision over loan provision as well as its amount, terms and conditions.

Based on the decision of the Cabinet, GOJ signs a diplomatic document, the exchange of notes (E/N), with the recipient government.

Thereafter, JICA and the borrower sign a loan agreement (L/A).

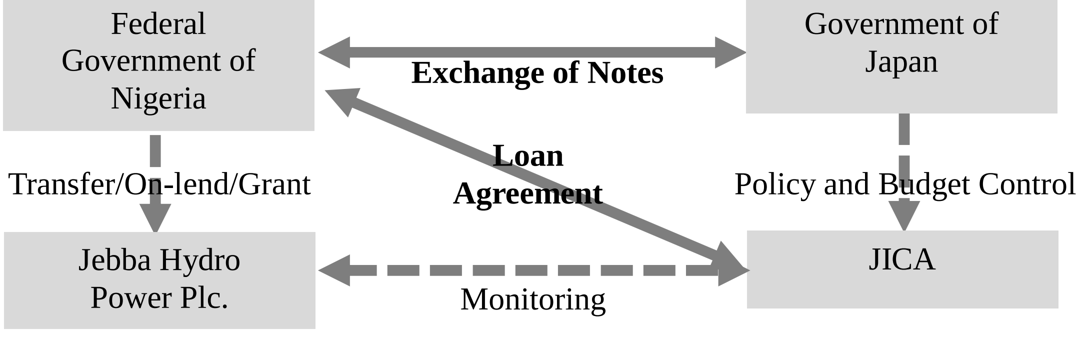


Figure AP4-1 Lending structure

5. Implementation

After the signing of the L/A, the project enters the implementation stage.

The employment of consultants and procurement of goods and services under projects financed by ODA Loans from JICA is carried out in accordance with the general principles and procedures laid down in the Guidelines for the Employment of Consultants under Japanese ODA Loans (hereinafter called Consultant Guidelines) and the Guidelines for Procurement under Japanese ODA Loans (hereinafter called Procurement Guidelines) respectively.

Essential inputs to the project—such as materials, equipment and civil works—will normally be procured through international competitive bidding, as it is the most economical and efficient method. Disbursements are made upon requests from the borrowing country. If deemed necessary, JICA conducts a Special Assistance for Procurement Management.

For the purpose of smooth preparation and implementation of selection of the contractor for the Project, it is recommended that the Borrower will use Sample Bidding Documents under Japanese ODA Loans for Procurement of Plant design, supply and Installation, which is provided by JICA in accordance with Procurement Guidelines.

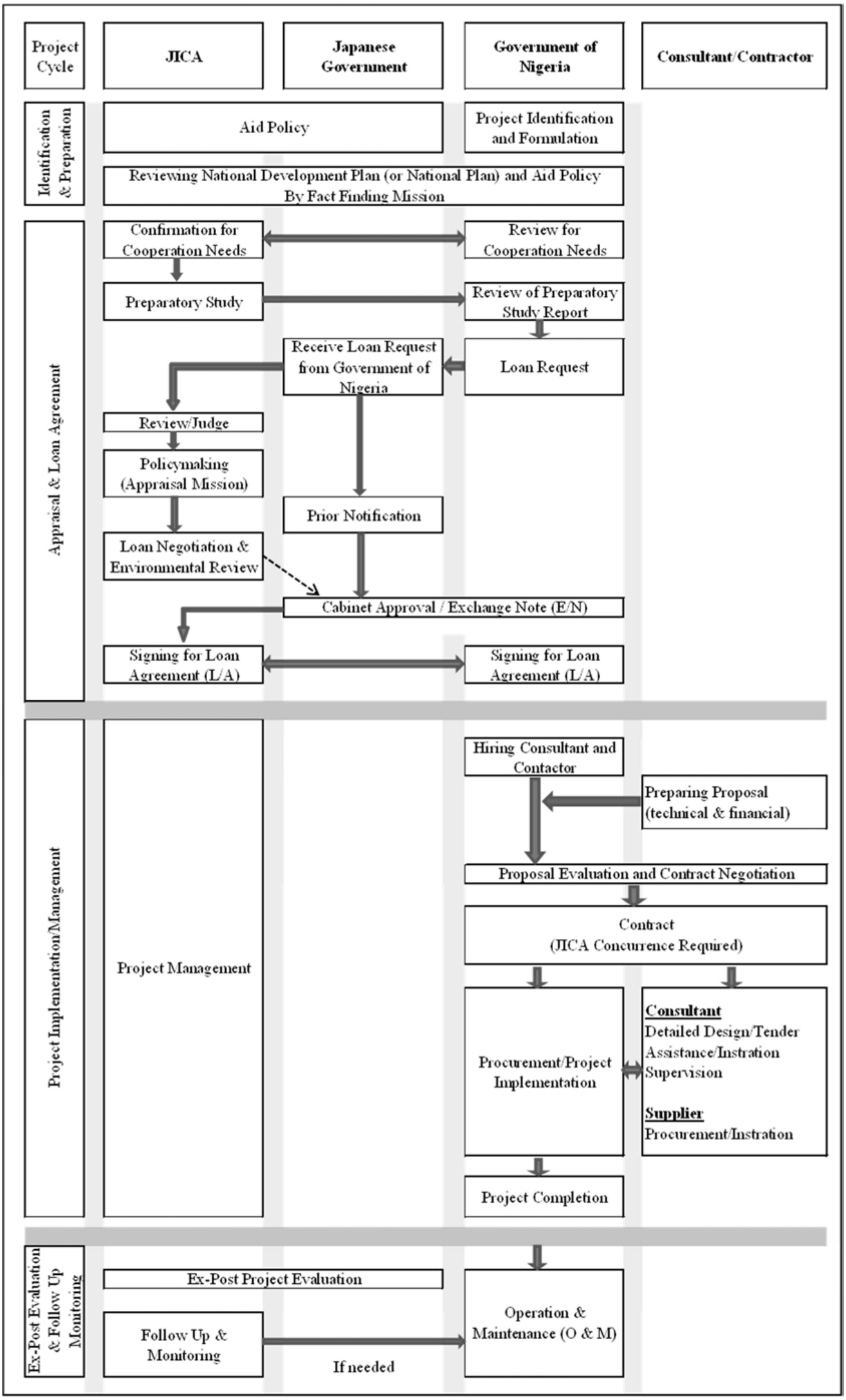
In principle, funds are released as their needs actually arise with the progress of the project. The borrowing country is responsible for carrying out the project, while JICA offers advice as necessary for smooth project implementation.

6. Project Completion/Ex-Post Evaluation and Follow-Up Monitoring

JICA conducts ex-post evaluation for completed projects in order to draw lessons for future projects. Ex-post evaluation assesses the project implementation, post completion O & M of project facilities and development effectiveness of ODA loan-financed projects in comparison with the initial plan. In addition to individual projects, evaluation takes place at the program level, making a comprehensive assessment with respect to the economic and social impact of the project portfolio on a given region or sector.

The experience and lessons drawn from ex-post evaluation have been accumulated inside JICA and effectively fed back to the borrowers and project executing agencies to increase the effectiveness of development assistance.

7. Flow of Japanese ODA Loan Scheme



8. **Tentative schedule and major milestones** (subject to GOJ's decision)

November 2010	Official request from FGN to GOJ
July 2011	**Preparatory Survey** (feasibility study) by JICA launched
December 2011	Preparatory Survey completed
	GOJ's approval for project appraisal
	Project appraisal by JICA (a Minutes of Discussion describing detailed project implementation plan will be signed)
January 2012	JICA's reporting to GOJ on appraisal results
February 2012	Pledge by GOJ
	Consultation on Exchange of Notes and Loan Agreement
March 2012	Exchange of Notes between FGN and GOJ
	Loan Agreement between FGN and JICA
= =	
2012	Signing of consultancy contract
2013	Signing of works/supply contracts

Appendix-5

Profit/Loss of Jebba Hydro Electric Power PLC

(latest 5 years)

APPENDIX-5.1

Table Profit/Loss of Jebba Hydro Electric Power PLC (latest 5 years)

	2,006	2,007	2,008	2,009	2,010
Opereting Revenue :					
Sale of electricity	2,555,425,153	2,678,371,047	2,701,549,364	6,506,389,752	11,523,049,596
Engergy sold	1,825,250,801	2,034,675,462	2,110,562,946	2,593,864,227	4,308,615,325
Capacity charges	730,174,352	643,695,585	590,986,418	3,912,525,525	7,214,434,271
Operating cost/overheads	927,364,147	1,083,868,981	1,320,122,845	2,111,718,944	3,158,672,474
Wheeling & system operation charges(Transysco)	671,202,119	735,974,208	757,209,127	188,823,222	0
Fuel	60,822,604	0	0	1,158,529,592	3,086,803,061
Salaries & Wages(operatin & maintenance)	44,095,778	107,601,577	187,841,862	216,666,086	22,172,883
Staff allowances associated with salaries	76,984,758	72,312,510	119,341,965	236,358,149	22,250,785
Depreciation	71,642,970	77,425,006	77,316,699	61,473,759	24,520
Maintenance and repaires costs	2,615,918	81,472,881	168,815,261	237,253,970	114,383
Others		9,082,799	9,597,931	12,614,166	27,306,842
Operating Profit Before Other Income	1,628,061,006	1,594,502,066	1,381,426,519	4,394,670,808	8,364,377,122
Sunmdry income	1,914,262	2,127,022	3,275,524	8,213,061	12,664,874
Bank interest received	175,482	219,505	323,220	335,403	201,774
School fees	212,982	0	0	0	0
Medical	654,800	0	0	0	0
Other income	870,998	1,907,517	2,952,304	7,877,658	12,463,101
Administrative overheads & costs:-					
Head office & market operator charges	857,071,929	725,982,692	706,810,411	492,584,399	3,633,740,748
Market operator's charges	4,603,249	7,153,541	8,449,449	2,107,016	0
Headquarter's administration charges	661,373,149	660,587,378	639,108,963	159,372,900	0
Pension charges (net)	56,298,511	0	59,251,999	316,328,971	3,633,740,748
Transition charges	112,597,020	0	0	0	0
National Electricity Regulatory Commission charges	22,200,000	58,241,773	0	14,775,512	0
The above charges/fees were deducted at source by the market operator from					
the proceed of energy sold for the year.					
Admin Staff cost	213,724,977	353,643,267	401,805,295	548,077,937	46,259,710
Salaries & wages	125,240,137	202,097,811	238,984,412	235,740,311	21,156,067
Allowances associated with salaries	88,484,840	151,545,456	162,820,883	312,337,626	25,103,643
ADMIN Depreciation	15,080,523	19,617,068	22,614,748	47,698,212	1,048,666
Building	955,514	955,514	1,423,977	1,786,443	781,696
Office building	77,601	77,601	77,601	77,601	0
Staff housing	1,774,182	2,256,222	2,256,222	2,476,761	13,700
Furniture & fittings	4,730,586	6,474,563	7,189,001	7,945,734	0
Hospital equipment	1,234,322	1,447,520	1,447,520	1,540,442	0
Motor vehicles	5,606,435	7,703,765	9,467,977	32,168,913	39,400
Communication equipment	483,325	483,325	533,892	537,264	4,585
Water supply scheme	218,558	218,558	218,558	1,165,054	209,285
Other admin expenses	120,510,884	178,097,542	169,597,066	201,184,088	33,899,441
Repairs & maintenance	37,700,828	69,229,575	55,762,230	49,829,168	4,342,083
Management courses & seminars	8,053,525	23,811,000	13,558,120	10,722,100	1,411,000
Security expenses	8,170,030	16,419,962	18,801,483	20,608,278	3,155,562
Corporate donation	539,000	1,828,000	1,771,600	1,072,500	170,000
Medical expenses	37,147,020	23,032,201	18,511,702	12,552,501	452,845
Transport & travelling	1,686,301	4,417,259	13,595,041	17,321,334	2,957,713
Hotel and accomodation	6,623,845	10,276,505	14,584,627	20,077,085	2,964,900
Printing & stationeries	3,248,603	2,446,721	3,843,510	8,958,563	697,881
Others/Sundries	17,341,732	26,636,319	29,168,753	20,888,874	7,987,322
Insurance				13,216,499	0
Employees welfare				25,937,186	9,760,133
PROFIT BEFORE TAXATION (TRANSFER TO REVENUE	423,586,955	319,288,519	83,874,523	3,113,339,233	4,662,093,431

APPENDIX-5.2

Table Blance sheet of Jebba Hydro Electric Power PLC

(As at 31st December, 2010)

		2 010		**2 0 0 9**	
	NOTES	**₦**	**₦**	**₦**	**₦**
ASSETS EMPLOYED					
Tangible fixed assets	8		2,071,656,228.00		2,025,798,219.00
CURRENT ASSETS					
Stocks	9	1,703,653,445.77		1,463,779,965.00	
Debtors	10	9,699,017,076.00		3,574,920,550.00	
Other debtors & prepayments	11	126,099,084.07		60,791,096.00	
Bank & cash balances	12	5,310,806,012.70		1,987,167,000.00	
		16,839,575,618.54			
CURRENT LIABILITIES:					
Trade creditors & other account payables	13	(3,476,262,989.60)		(296,938,140.00)	
Net Current Assets/(Liabilities)			13,363,312,628.94		(296,938,140.00)
			15,434,968,856.94		**8,815,518,690.00**
NET ASSETS					
FINANCED BY:-					
Accumulated fund	14	3,814,403,790.00			2,525,409,458.00
Capital grant	15	3,018,362,404.54			2,350,000,000.00
Revenue reserve	16	8,602,202,663.00			3,940,109,232.00
Capital & reserve		**15,434,968,857.54**			**8,815,518,690.00**

Appendix-6

Inspection Report of Generators

FEDERAL REPUBLIC OF NIGERIA
Jebba Hydro Electric PLC
Jebba Power Station

Table 1 Inspection results of generators

This inspection was performed at site limited to the visible area, from July 16 to 31, 2011 by Y. Watanabe.
Marked [grey] Part shows past inspection results for reference.

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
1	Condition before Inspection	Operation data	Recording Indication of meters in control panels	1) In operation 2) Refer to the Tables 2-1, 2-2 & 2-3.	At standstill (standby)	1) In operation 2) Refer to the Tables 2-1, 2-2 & 2-3.	At standstill (standby)	
1	Inspection Condition	Operation data	Recording Indication of meters in control panels	1) In operation 2) Refer to the Tables 2-1, 2-2 & 2-3.	1) In operation 2) Refer to the Tables 2-1 & 2-2.	1) In operation 2) Refer to the Tables 2-1 & 2-2.	Note: There was not enough time to check condition of Unit #2G5	2009 Report
2	General	1) Overall	Visually and the five senses	Followings have been observed during this site inspection on all units. (1) Not well adjusting of the oil flow control valves for thrust bearing shoes and one of broken flow control valeve for unit 2G2 was found. (2) Contamination by oil leakage and oil mist at the surface of the stator, rotor, and auxiliaries (3) The oil-leaking from each flange part, bulbs etc. of the oil circulation devices such as oil lubricating pumps and high pressure oil pump lifters occur. (4) Loosening of the stator wedge caused by the electro-magnetic vibration at normal operation. (5) Almost all insulation caps of turbine side end coils were found badly blistered (swelled) and broken by excessive heating. (6) Deviation on the instruments and breaking of thermal relay lead were found. Moreover, the following items are presumed to all the units due to the long-term operation for above thirty years. (1) Occurrence of the fretting wear on the thrust runner (2) Wearing off the rubbing parts on thrust bearings, guide bearings, brake ring, collector rings, and carbon brushe				

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
				(3) Occurrence of deterioration in functioning by hertz contact stress of 1,665 ton thrust bearing road on spring supports for Hitachi pivot spring (4) Performance degradation and/or the thickness decreasing of the cooling pipes on oil coolers and air coolers. (5) Performance degradation and/or the thickness decreasing of the circulating pipes on oil lubricating pumps and high pressure oil pump				
2	General	1) Overall	The five senses	Same as U#2G6↓ 1) The generator seems to have been maintained well except for dirt by oil . 2) Cleaning work must be planned and carried out at every maintenance work chance.	Same as U#2G6	Same as U#2G6		2009 Report
2	General	2) Others	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
2	General	2) Others		No further observations	No further observations	No further observations		2009 Report
3	Stator	1) Deformation of stator frame by heat cycle	Visually	Abnormal condition was not observed	Same as U#2G1	Same as U#2G1	Same as U#2G1	
					Since irregularity value of air gap between stator and rotor of 2G3 and 2G5 was close to the limit of installation criteria, stator frame roundness check and well adjustment is required in 2001 of Hitachi record.			
3	Stator	1) Deformation of stator frame by heat cycle	Visually	Slippage of the stator frame on stator stands was not observed.	Same as U#2G1	Same as U#2G1		2009 Report
3	Stator	2) Lock of foundation bolts and dowel pins	Visually	Abnormal condition was not observed	Nock pin was found to be pulled as shown in the Photo 2.11 in Appendix-6.2	Same as U#2G1	Nock pin was found to be pulled as shown in the Photo 5.8 in Appendix-6.2	
3	Stator	2) Lock of foundation bolts and dowel pins	Visually	Abnormal condition was not observed	Same as U#2G1	Same as U#2G1		2009 Report
3	Stator	3) Generation of rust	Visually	Condition of painting was good	Same as U#2G1	Same as U#2G1	Same as U#2G1	

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
3	Stator	3) Generation of rust	Visually	Condition of painting was good as shown in the Photos 136 and 138 in Appendix-6.2.	Condition of painting was good as shown in the Photo 135 in Appendix-6.2.	Same as U#2G1 and 2G2.		2009 Report
3	Stator	4) Dirt around the stator	Visually	1) Dirt by dust was not remarkable. 2) Dirt by oil was noticeable as shown in the Photos 1.1 to 1.18 in Appendix-6.2 3) Dirt by water leakage was not observed.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
3	Stator	4) Dirt around the stator	Visually	1) Dirt by dust was not remarkable. 2) Dirt by oil was noticeable as shown in the Photos 31, 136 and 138 in Appendix-6.2. 3) Dirt by water leakage was not observed.	1) Dirt by dust was not remarkable. 2) Dirt by oil was noticeable as shown in the Photo 135 in Appendix-6.2. 3) Dirt by water leakage was not observed.	Better than U#2G1 and 2G2 as shown in the Photo 133 in Appendix-6.2.		2009 Report
3	Stator	5) Evidence of overheating on fan guide (end cover)	Visually	Abnormal condition was not observed	Same as U#2G1	Same as U#2G1	Same as U#2G1	
3	Stator	5) Evidence of overheating on fan guide (end cover)	Visually	1) Lower fan guide looked sound. 2) Upper fan guide was not checked.	1) Lower fan guide looked sound as shown in the Photo 32 in Appendix-6.2. 2) Upper fan guide was not checked.	Same as U#2G1		2009 Report

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
3	Stator	6) Appearance of CTs, and line & neutral leads	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
3	Stator	6) Appearance of CTs, and line & neutral leads	Visually	Same as U#2G4	Same as U#2G4	Same as U#2G4		2009 Report In case of CTs, pairing is important to
3	Stator	7) Others	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
3	Stator	7) Others	Visually	No further observations	No further observations	No further observations		2009 Report
4	Stator core	1) Damage of core laminations	Visually	Serious damages of core end packets such as melting and breakage of core laminations were not observed.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
					Repair work for damaged stator core teeth lamination of 2G3 was recommended in 2001 of Hitachi record.			
4	Stator core	1) Damage of core laminations	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
4	Stator core	2) Loose core lamination	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
4	Stator core	2) Loose core lamination	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
4	Stator core	3) Loose core clamping plate	Visually	Abnormal condition was not observed	Same as U#2G1	Same as U#2G1	Same as U#2G1	
4	Stator core	3) Loose core clamping plate	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
4	Stator core	4) Waving/ deformation of stacked core lamination	Visually	As shown in the Photo 1.4 in Appendix-6.2, waving deformation was observed at joint face of the stator frame.	Same as U#2G1	Same as U#2G1	Same as U#2G1	

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
4	Stator core	4) Waving/ deformation of stacked core lamination	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
4	Stator core	5) Dirt	Visually	1) Slight dirt was found at inner circumference of the stator core as shown in the Photo 1.13 in Appendix-6.2 2) Many small particles and dust were found on the stator frame as shown in the Photo 1.13 in Appendix-6.2. 3) Stator core back was smeared with oil mist, and rust generation was found as shown in the Photo 1.4 in Appendix-6.2.	Same as U#2G1	Same as U#2G1	Same as U#2G1	4
4	Stator core	5) Dirt	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
4	Stator core	6) Air gap measurement	Motor gap gauge	Not applied (Not disassembly condition of upper covers)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
4	Stator core	6) Air gap measurement	Motor gap gauge	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
4	Stator core	7) Thermocouples	Recording Indication of meters in control panels	Looked sound.	As shown in the Tables 2.1, 2.2 and 2.3, thermocouples were in trouble.	Same as U#2G2	Same as U#2G2	

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
4	Stator core	7) Thermocouples	Recording Indication of meters in control panels	As shown in the Tables 2.1, 2.2 and 2.3, all monitored thermocouples were in trouble.	As shown in the Tables 2.1 and 2.2, one monitored thermocouple seemed to be in normal condition.	As shown in the Tables 21 and 2.2, one monitored thermo- couple seemed to be in trouble.		2009 Report
4	Stator core	8) Others	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
4	Stator core	8) Others	Visually	No further observation	No further observation	No further observation		2009 Report
5	Stator winding	1) Insulation resistance	1,000V megger / 1 min.	Not applied (Not disassembly condition of line lead terminal)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
5	Stator winding	1) Insulation resistance	1,000V megger / 1 min.	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
5	Stator winding	2) Grounding failure	Visually	No observation	Same as U#2G1	Same as U#2G1	Same as U#2G1	
5	Stator winding	2) Grounding failure	Visually	N/A	N/A	N/A		2009 Report
5	Stator winding	3) Looseness of stator wedges	Tapping	As the result of inspection as much as possible, loosening was found.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
5	Stator winding	3) Looseness of stator wedges	Tapping Rank	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
5	Stator winding	4) Migration of wedges /wedge stoppers	Visually	Abnormal condition was not found.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
5	Stator winding	4) Migration of wedges /wedge stoppers	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
5	Stator winding	5) Discoloration of insulation and evidence of corona discharge	Visually	Not applied (Not disassembly condition of generator rotor)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
5	Stator winding	5) Discoloration of insulation and evidence of corona discharge	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
5	Stator winding	6) Evidence of overheating	Visually	Abnormal condition was not found.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
5	Stator winding	6) Evidence of overheating	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
5	Stator winding	7) Generation of powder	Visually	Some powders were occurred as shown in the Photo1.13 in Appendix-6.2	Same as U#2G1	Same as U#2G1	Same as U#2G1	
5	Stator winding	7) Generation of powder	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
5	Stator winding	8) Loosen coil end lashing, coil end spacers and support rings	Visually	Same as U#2G2	Some crack of insulation cap were found as shown in the Photo2.6 in Appendix-6.2	Same as U#2G2	Same as U#2G2	
5	Stator winding	8) Loosen coil end lashing, coil end spacers and support rings	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
5	Stator winding	9) Loosen bus bar lashing and supports	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
5	Stator winding	9) Loosen bus bar lashing and supports	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
5	Stator winding	10) Dirt	Visually	Entire stator was slightly contaminated with oil mist.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
5	Stator winding	10) Dirt	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
5	Stator winding	11) Temperature detectors	Recording Indication of meters in control panels	Some RTDs were in trouble as shown in the Table 2.1, 2.2, and 2.3.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
5	Stator winding	11) Temperature detectors	Recording Indication of meters in control panels	1) Some RTDs were in trouble as shown in the Table 2.3.	1) As far as RTDs , which were being monitored in the control room, are concerned, those elements seemed to be in normal conditions as shown in the Table 2.1.	1) As far as RTDs, which were being monitored in the control room, are concerned, those elements seemed to be in normal conditions as shown in the Table 2.1.		2009 Report
5	Stator winding	12) Others	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
5	Stator winding	12) Others		No further observations	No further observation	No further observation		2009 Report
6	Rotor	1) Appearance of Rotor rim and rim support	Visually	Not applied (Not disassembly condition of generator rotor)	Same as U#2G1 Reinforced rotor of 2G4 was exchanged into 2G5 in 2001 Hitachi record because of the thrust bearing trouble of 2G4. (Operation of 2G5, whose thrust bearing condition was better than 2G4, was prioritized.) Not reinforced rotor of 2G5, which has cracks on the rotor rim support, was exchanged into 2G4.	Same as U#2G1	Same as U#2G1	Reinforcement of rim support was realized after troubles on U#2G3 and 2G4 in 2001.
6	Rotor	1) Appearance of Rotor rim and rim support	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report Reinforcement of rim support was realized after troubles on U#2G3 and 2G4 in 2001.

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
6	Rotor	2) Dirt	Visually	Not applied (Not disassembly condition of generator rotor)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
6	Rotor	2) Dirt	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
6	Rotor	3) Loosen T-shape cotters for rotor rim	Visually	Not applied (Not disassembly condition of generator rotor)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
6	Rotor	3) Loosen T-shape cotters for rotor rim	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
6	Rotor	4) Appearance of coupling bolts between spider and generator shaft	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
6	Rotor	4) Appearance of coupling bolts between spider and generator shaft	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
6	Rotor	5) Damage on brake ring surface	Visually	Wearing of brake ring surface was found as shown in Photo 1.10,1.11 in Appendix-6.2.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
6	Rotor	5) Damage on brake ring surface	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
6	Rotor	6) Loosen tightening nuts of brake ring	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
6	Rotor	6) Loosen tightening nuts of brake ring	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
6	Rotor	7) Loosen coupling bolts between generator shaft and turbine shaft	Visually Tapping	Not applied (Not disassembly condition of generator rotor)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
6	Rotor	7) Loosen coupling bolts between generator shaft and turbine shaft	Visually Tapping	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
6	Rotor	8) Others	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
6	Rotor	8) Others		No further observations	No further observation	No further observation		2009 Report
7	Filed Poles, and leads	1) Insulation resistance	500V megger / 1 min.	More than 200MΩ/ 1 min (Measured on the condition of removal of carbon brash)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
7	Filed Poles, and leads	1) Insulation resistance	500V megger / 1 min.	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
7	Filed Poles, and leads	2) Damage/ migration of insulation collar	Visually	Trace of migration was not so obvious at this inspection. (Visible area was limited)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
7	Filed Poles, and leads	2) Damage/ migration of insulation collar	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
7	Filed Poles, and leads	3) Migration of layer insulation and filed coil conductor	Visually	Trace of migration was not so obvious at this inspection. (Visible area was limited)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
7	Filed Poles, and leads	3) Migration of layer insulation and filed coil conductor	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
7	Filed Poles, and leads	4) Damage/ deformation of damper bars and damper connectors	Visually	Deformation of damper plates and damper connectors was not so obvious at this inspection. (Visible area was limited)	Same as U#2G1 Replacement of damaged damper connection bolts for 2G3 was recommended in 2001 Hitachi record.	Same as U#2G1	Same as U#2G1	
7	Filed Poles, and leads	4) Damage/ deformation of damper bars and damper	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
7	Filed Poles, and leads	5) Damage/ deformation of field coil connectors	Visually	Deformation of flexible connectors was not so obvious at this inspection. (Visible area was limited)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
7	Filed Poles, and leads	5) Damage/ deformation of field coil connectors	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
7	Filed Poles, and leads	6) Discoloration of pole surface	Visually	Discoloration of pole surface was not so obvious at this inspection. (Visible area was limited)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
7	Filed Poles, and leads	6) Discoloration of pole surface	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
7	Filed Poles, and leads	7) Damage/ Deformation of filed lead and flexible connectors on the spider and collector ring shaft	Visually	Damage/ Deformation of filed lead and flexible connectors on the spider and collector ring shaft was not so obvious at this inspection. (Visible area was limited)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
7	Filed Poles, and leads	7) Damage/ Deformation of filed lead and flexible connectors on the spider and collector ring shaft	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
7	Filed Poles, and leads	8) Loosen pole cotters	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
7	Filed Poles, and leads	8) Loosen pole cotters	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
7	Filed Poles, and leads	9) Dirt	Visually	Field leads on rotor spider were observed dirty	Same as U#2G1	Same as U#2G1	Same as U#2G1	
7	Filed Poles, and leads	9) Dirt	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
7	Filed Poles, and leads	10) Others	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
7	Filed Poles, and leads	10) Others		No further observations	No further observation	No further observation		2009 Report

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
8	Thrust bearing bracket	1) Oil leakage	Visually	1) Entire generator was smeared with oil which came mainly from the thrust tank as oil mist. 2) Oil leakage from several flanges of flow control check valves located under the thrust tank was observed	Same as U#2G1	Same as U#2G1	Same as U#2G1	
8	Thrust bearing bracket	1) Oil leakage	Visually	1) Same as U#2G6 item 1, and U#2G2 item 3). 2) Oil leakage from several flanges of flow control check valves located under the thrust tank was observed as shown in the Photo 30 in Appendix-6.2.	1) Same as U#2G6 item 1 and U#2G1 item 2. 2) Oil drops were found at split face of the lower fan guide segments as shown in the Photo 32 in Appendix-6.2.	1) Same as U#2G6 item 1, U#2G1 item 2 and U#2G2 item 3.		2009 Report
8	Thrust bearing bracket	2) Dirt around the thrust tank (lower end bracket)	Visually	1) Dirt by dust was not remarkable, but dirt by oil was noticeable as shown in the Photo 1.3 in Appendix-6.2. 2) Dirt by water leakage was not observed.	Same as U#2G1	Same as U#2G1	Same as U#2G1	

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
8	Thrust bearing bracket	2) Dirt around the thrust tank (lower end bracket)	Visually	1) Dirt by dust was not remarkable, but dirt by oil was noticeable as shown in the Photo 137 in Appendix-6.2. 2) Dirt by water leakage was not observed.	Same as U#2G1	Same as U#2G1		2009 Report
8	Thrust bearing bracket	3) Looseness of foundation bolts, and lock of dowel pins	Visually Tapping	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
8	Thrust bearing bracket	3) Looseness of foundation bolts, and lock of dowel pins	Visually Tapping	Looked sound as shown in the Photo 137 in Appendix-6.2.	Looked sound.	Looked sound.		2009 Report
8	Thrust bearing bracket	4) Air gap of oil deflector	Gap gauge	Not applied (Not disassembly condition of upper covers)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
8	Thrust bearing bracket	4) Air gap of oil deflector	Gap gauge	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
8	Thrust bearing bracket	5) Temperature detectors and thermal relays	Recording Indication of meters in control panels Visually	Looked sound	RTDs for Thrust bearing oil and Turbine guide bearing were in trouble as shown in the Table 2.3	Same as U#2G1	1) RTDs for Thrust bearing oil and Turbine guide bearing were in trouble as shown in the Table 2.3 2) Breaking of thermal relay lead was found as shown in the Photo 5.16 in Appendix-6.2.	

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
8	Thrust bearing bracket	5) Temperature detectors and thermal relays	Recording Indication of meters in control panels Visually	1) Dial thermometer for oil reservoir was in trouble as shown in the Tables 2.1 and 2.2. 2) RTDs for Thrust bearing oil and Turbine guide bearing were in trouble as shown in the Table 2.3	1) Dial thermo- meter for oil reservoir was in trouble as shown in the Tables 2.1 and 2.2. 2) RTDs for Thrust bearing oil and Turbine guide bearing were not checked.	1) Dial thermo- meters were in normal condition as shown in the Tables 2.1 and 2.2. 2) RTDs for Thrust bearing oil and Turbine guide bearing were not checked.		2009 Report
8	Thrust bearing bracket	6) Others	Visually	1) Condition of bearing, thrust runner, spring supports for Hitachi picot spring was not checked by both visually and other means. (Not disassembly condition of bearings) 2) Occurrence of the fretting wear on the thrust runner are assumed due to around 30 years' long operation. 3) Besides, looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
8	Thrust bearing bracket	6) Others		No further observations	No further observation	No further observation		2009 Report
9	Upper bracket	1) Looseness of tightening bolts	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
9	Upper bracket	1) Looseness of tightening bolts	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
9	Upper bracket	2) Lock of dowel pins	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	

1) Thrust bearing of 2G4 was exchanged to spare bearing because the damage ware found. The damaged thrust bearings were kept with no repair condition in 2001 of Hitachi record.

2) Countermeasure for the crack damage to the hertz contact surface of adjustment bolts of guide bearings was recommended in 2001 of Hitachi record.

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
9	Upper bracket	2) Lock of dowel pins	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
9	Upper bracket	3) Lock of bolts for upper fan guide	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
9	Upper bracket	3) Lock of bolts for upper fan guide	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
9	Upper bracket	4) Appearance of filed leads	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
9	Upper bracket	4) Appearance of filed leads	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
9	Upper bracket	5) Others	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
9	Upper bracket	5) Others		No further observations	No further observation	No further observation		2009 Report
10	Collector ring	1) Wearing of sliding surface of collector rings	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
10	Collector ring	1) Wearing of sliding surface of collector rings		[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
10	Collector ring	2) Appearance of insulations	Visually	Looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
10	Collector ring	2) Appearance of insulations		[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
10	Collector ring	3) Dirt	Visually	Insulation of filed leads at collector ring shaft was slightly dirty with oil mist and dust, but looked sound.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
10	Collector ring	3) Dirt		[N/CKD]	[N/CKD]	[N/CKD]		2009 Report

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
10	Collector ring	4) Others	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
10	Collector ring	4) Others		[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
11	Rocker device	1) Clearance between brush holders and collector rings	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
11	Rocker device	1) Clearance between brush holders and collector rings		[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
11	Rocker device	2) Pressure of brush holders	Measured by a spring balance	Not applied (No spring balance)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
11	Rocker device	2) Pressure of brush holders		[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
11	Rocker device	3) Dirt	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
11	Rocker device	3) Dirt		[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
11	Rocker device	4) Others	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
11	Rocker device	4) Others		[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
12	Air coolers	1) Water leakage from cooling tubes	Visually	No water leakage was observed	Same as U#2G1	Same as U#2G1	Same as U#2G1	
12	Air coolers	1) Water leakage from cooling tubes	Visually	No water leakage was observed as shown in the Photo 31 in Appendix-6.2.	No water leakage was observed as shown in the Photo 135 in Appendix-6.2.	No water leakage was observed as shown in the Photo 133 in Appendix-6.2.		2009 Report
12	Air coolers	2) Water leakage from headers	Visually	No water leakage was observed .	Same as U#2G1	Same as U#2G1	Same as U#2G1	

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
12	Air coolers	2) Water leakage from headers	Visually	Ditto	Ditto	Ditto		2009 Report
12	Air coolers	3) Damage of cooling fins	Visually	Minor deformation was found as shown in the Photo 1.5 in Appendix-6.2.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
12	Air coolers	3) Damage of cooling fins	Visually	Minor deformation was found.	Minor deformation was found.	Minor deformation was found.		2009 Report
12	Air coolers	4) Cleanliness (dirt)	Visually	Contaminated with oil as shown in the Photo 1.17 in Appendix-6.2.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
12	Air coolers	4) Cleanliness (dirt)	Visually	Contaminated with oil as shown in the Photo 31 in Appendix-6.2.	Contamination with oil was not observed as shown in the Photo 135 in Appendix-6.2.	Contamination with oil was not observed as shown in the Photo 133 in Appendix-6.2.		2009 Report
12	Air coolers	5) RTDs to measure air temperature	Visually	Some RTD were found not properly mounted as shown in the Photo 1.16 in Appendix-6.2.	Looked sound	Same as U#2G1	Same as U#2G1	
12	Air coolers	5) RTDs to measure air temperature	Visually	Some RTD were found not properly mounted as shown in the Photo 138 in Appendix-6.2.	Looked OK.	Looked OK.		2009 Report
12	Air coolers	6) Others	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
12	Air coolers	6) Others		No further observations	No further observations	No further observations		2009 Report
13	Piping for air coolers	1) Water leakage	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
13	Piping for air coolers	1) Water leakage	Visually	No leakage was observed.	No leakage was observed.	No leakage was observed.		2009 Report
13	Piping for air coolers	2) Generation of rust	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
13	Piping for air coolers	2) Generation of rust	Visually	Rust generation was not obvious as same as U#2G2 and 2G3	Rust generation was not serious as shown in the Photo 135 in Appendix-6.2.	Rust generation was not serious as shown in the Photo 133 in Appendix-6.2.		2009 Report
13	Piping for air coolers	3) Damage of dew proof insulation	Visually	Slightly damaged but not so serious	Same as U#2G1	Same as U#2G1	Same as U#2G1	
13	Piping for air coolers	3) Damage of dew proof insulation	Visually	Same as U#2G2.	Slightly damaged but not so serious as shown in the Photo 135 in Appendix-6.2.	Same as U#2G2.		2009 Report
13	Piping for air coolers	4) Loosen supporting bolts	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
13	Piping for air coolers	4) Loosen supporting bolts	Visually	Same as U#2G6.	Same as U#2G6.	Same as U#2G6.		2009 Report
13	Piping for air coolers	5) Others	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
13	Piping for air coolers	5) Others		No further observations	No further observations	No further observations		2009 Report
14	Oil coolers	1) Water leakage from cooling tubes	Pressure test	Not applied (No pressure test kit)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
14	Oil coolers	1) Water leakage from cooling tubes	Pressure test Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
14	Oil coolers	2) Water leakage from headers	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
14	Oil coolers	2) Water leakage from headers	Visually	Not checked.	Not checked.	Not checked.		2009 Report
14	Oil coolers	3) Cleanliness	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
14	Oil coolers	3) Cleanliness	Visually	Not checked.	Not checked.	Not checked.		2009 Report
14	Oil coolers	4) Oil circulating pump	Visually	Contaminated with oil as shown in the Photo 1.15 in Appendix-6.2.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
14	Oil coolers	4) Oil circulating pump	Recording operation data Visually	Not checked.	Not checked.	Not checked.		2009 Report
14	Oil coolers	5) Others	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
14	Oil coolers	5) Others		Not checked.	Not checked.	Not checked.		2009 Report
15	Piping for oil coolers Inside of generator housing	1) Water leakage	Visually	No leakage was observed.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
		2) Generation of rust	Visually	Rust generation was not obvious.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
15	Piping for oil coolers Inside of generator housing	1) Water leakage	Visually	No leakage was observed.	No leakage was observed.	No leakage was observed.		2009 Report
		2) Generation of rust	Visually	Rust generation was not obvious.	Rust generation was not obvious.	Rust generation was not obvious.		2009 Report
15	Piping for oil coolers Inside of generator housing	3) Loosen supporting bolts	Visually Tapping	Looked not loosen.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
15	Piping for oil coolers Inside of generator housing	3) Loosen supporting bolts	Visually Tapping	Looked not loosen.	Looked not loosen.	Looked not loosen.		2009 Report

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
15	Piping for oil coolers Inside of generator housing	4) Others	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
15	Piping for oil coolers	4) Others		No further observations	No further observations	No further observations		2009 Report
16	High pressure oil pump (Oil lifter), and its piping	1) Setting of flow control check valves	Visually	Opening of many flow control check valves shown in the were not set adequately as shown in the Table 3.	1) Opening of many flow control check valves shown in the were not set adequately as shown in the Table 3. 2) One of broken flow control valve was found	Same as U#2G1	Same as U#2G1	
16	High pressure oil pump (Oil lifter), and its piping	1) Setting of flow control check valves	Visually	Opening of many flow control check valves shown in the Photo 30 in Appendix-6.2 were not set adequately as shown in the Table 3.	Opening of many flow control check valves were not set adequately as shown in the Table 3.	Opening of many flow control check valves were not set adequately as like other units #2G1, 2G2 and 2G4.		2009 Report
16	High pressure oil pump	2) Operating pressure	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
16	High pressure oil pump	2) Operating pressure	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report .
16	High pressure oil pump	3) Dirt of oil filter	Visually	Not applied (No disassembly of oil lifter)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
16	High pressure oil pump	3) Dirt of oil filter	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
16	High pressure oil pump	4) Jacking up dimension of the generator rotor	Dial gauges by operation of the pump	Not applied (No Dial gauges)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
16	High pressure oil pump	4) Jacking up dimension of the generator rotor	Dial gauges by operation of the pump	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
16	High pressure oil pump	5) Oil leakage including piping and dirt	Visually	Oil leakage was found at various points as shown in the Photo 1.5 in Appendix-6.2.	Same as U#2G1	Same as U#2G1	Same as U#2G1	
16	High pressure oil pump	5) Oil leakage including piping and dirt		Same as U#2G2.	1) Oil leakage was found at various points as shown in the Photos 35 & 134 in Appendix-6.2. 2) Equipment was dirty with mixture of oil and brake dust as shown in the Photo 134 in Appendix-6.2.	Same as U#2G2.		2009 Report
16	High pressure oil pump	6) Others	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
16	High pressure oil pump	6) Others		No further observations	No further observations	No further observations		2009 Report
17	Brake & jacks	1) Timing of braking (% speed)	Hearing of setting data	[N/CKD]	Same as U#2G1	Same as U#2G1	Same as U#2G1	
17	Brake & jacks	1) Timing of braking (% speed)		[N/CKD]	[N/CKD]	[N/CKD]		2009 Report

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
17	Brake & jacks	2) Period until complete stop after braking (sec)	Recording operation data Visually	Not applied (No measurement))	Same as U#2G1	Same as U#2G1	Same as U#2G1	
17	Brake & jacks	2) Period until complete stop after braking		[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
17	Brake & jacks	3) Wearing of brake shoes	Measured by a scale	Not applied (No disassembly of brake & jack)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
17	Brake & jacks	3) Wearing of brake shoes		Looked not abnormal	Looked not abnormal	Looked not abnormal		2009 Report
17	Brake & jacks	4) Others	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
17	Brake & jacks	4) Others		No further observations	No further observations	No further observations		2009 Report
18	Space heater	1) Appearance	Visually	Cover (box) was found deformed as shown in the Photo 1.14 in Appendix-6.2	Same as U#2G1	Same as U#2G1	Same as U#2G1	
18	Space heater	1) Appearance	Visually	Cover (box) was found deformed as shown in the Photo 137 in Appendix-6.2.	Similar to U#2G1	Similar to U#2G1		2009 Report
18	Space heater	2) Temperature of air housing	Thermo-meter	Not in service	Same as U#2G1	Same as U#2G1	Same as U#2G1	
18	Space heater	2) Temperature of air housing	Thermo-meter	Not in service	Not in service	Not in service		2009 Report
18	Space heater	3) Others	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
18	Space heater	3) Others		No further observations	No further observations	No further observations		2009 Report

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
19	Exciter cubicles	1) Appearance	Visually	Not applied (Out of scope)	Same as U#2G1	Same as U#2G1	Same as U#2G1	
19	Exciter cubicles	1) Appearance	Visually	[N/CKD]	[N/CKD]	[N/CKD]		2009 Report
20	Others	1) Field lead inside of generator housing (enclosure)	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	
20	Others	1) Field lead inside of generator housing (enclosure)	Visually	At opening for the filed leads at wall of air housing, gap between the left side field leads and the wall was very small as shown in the Photo 29 in Appendix-6.2. This opening must be modified to have bigger gap at the next maintenance chance.	Same as U#2G4.	Same as U#2G4.		2009 Report
20	Others	2) Others	Visually	Looked sound	Same as U#2G1	Same as U#2G1	Same as U#2G1	

No.	Component	Inspection Item	By means of	Observations / Results				Remarks
				Unit 2G1	Unit 2G2	Unit 2G3	Unit 2G5	
20	Others	2) Others		No further observations	No further observations	No further observations		2009 Report
20	Others	3) Spare parts	Visually	See tables below. Almost of all spare parts are not found. The existing spare parts seems to be requited repair for use.				
20	Others	3) Spare parts		-				2009 Report

21. Spare parts for all generators

No.	Description
1	One (1) complete set of collector rings
2	90 sets of carbon brushes for ACG
3	2 sets of brush holders for ACG
4	8 spare brushes for creep indicator
5	Stator coils
	(i) 10 half top coils
	(ii) 5 half bottom coils
6	One (1) field coil
7	6 sets of guide bearing shoes
8	2 thrust bearing runner plates
9	6 complete sets of brake linings
10	One (1) of each current trans former
11	One (1) set of thrust bearing shoe
12	One (1) set of high pressure oil pump & motor

No.	Item	Num	unit	Number	Condition
1	Collector ring	1	set		
2	Carbon brush	90	pcs	72	
3	Brush holders	2	pcs		
4	Brush for creep indicators	8	pcs		
5	Stator coil (top coil)	10	pcs		
	Stator coil (bottom coil)	5	pcs		
6	Field coil	1	pc		
7	Guild bearing shoe	6	pcs	22	BAD
8	Thrust bearing runner plate	2	pcs		
9	Brake liner (shoe)	6	pcs		
10	Current trans former	6	pcs		
11	Thrust bearing shoe	18	pcs	6	BAD
12	High pressure oil lifter	1	set	2	BAD

Almost of all spare parts are not found. The existing spare parts seems to be requited repair for use.

Table 2.1 Operation and Temperature data (Before Inspection) (1/2)

No.	Item	Item	By means of	Unit	U#1	U#1	U#2	U#2	U#3	U#3
1	Operation			Date	June 24, '09	July 26, '11	June 24, '09		June 24, '09	July 23, '11
	Data			Time	15:23	16:20	15:24		15:38	14:00
		Output		MW	75	88	79	Stand by	78	82
				MVAR	12 (lag)	+32	4 (lag)		-24 (lead)	-3
		Terminal voltage		kV	16.8	15.2	16.8		17.0	16.3
		AC Current (Red phase)		A	2,700	3,300	2,700		3,000	3,150
		AC Current (Yellow phase)		A	2,800	3,450	2,900		3,000	3,150
		AC Current (Blue phase)		A	2,600	3,150	2,650		3,000	3,050
		Excitation Voltage		V		150	190		160	170
		Field Current		A	875	1,060	900		950	1,000
2	Temperature	Stator winding 1	RTD	℃	50	61	66		52	65
		Stator winding 2	RTD	℃	66	2	56		65	64
		Stator winding 3	RTD	℃	62	75	54		76	80
		Stator core	Thermo couple	℃	7	50	70		110	88
		Thrust bearing	Dial thermometer	℃	49	49	46		48	48
		Guide bearing	Dial thermometer	℃	46	46	49		49	51
3	Oil level	Oil reservoir		mm	-	+39	30		55	+43
4	Pressure	High pressure oil pump		kg/cm2G	0	0	0		0	0
		Air for Brakes		bar	13	–	11		10.8	–
	Oil Flow									
5	Vibration	Stator frame		μm p-p						
		Thrust tank		μm p-p						
		Upper bracket	Installed meter	μm p-p	–	12	75		30	20

※Unit 2G2 was no data because standby

Low temperature indication
Compared with other units

Table 2.1 Operation and Temperature data (Before Inspection 1) (2/2)

No.	Item	Item	By means of	Unit	U#4	U#4	U#5	U#5	U#6	U#6
1	Operation			Date	June 24, '09		June 24, '09		June 24, '09	
	Data			Time						
		Output		MW	Out of service		Stand by	Stand by	Out of service	
				MVAR						
		Terminal voltage		kV						
		AC Current (Red phase)		A						
		AC Current (Yellow phase)		A						
		AC Current (Blue phase)		A						
		Excitation Voltage		V						
		Field Current		A						
2	Temperature	Stator winding 1	RTD	℃						
		Stator winding 2	RTD	℃						
		Stator winding 3	RTD	℃						
		Stator core	Thermo couple	℃						
		Thrust bearing	Dial thermometer	℃						
		Guide bearing	Dial thermometer	℃						
		Oil reservoir	Dial thermometer	℃						
3	Oil level	Oil reservoir		mm						
4	Pressure	High pressure oil pump		kg/cm2G						
		Air for Brakes		bar						
	Oil Flow									
5	Vibration	Stator frame		μm p-p						
		Thrust tank		μm p-p						
		Upper bracket	Installed meter	μm p-p						

※Unit 2G5 was no data because standby

Table 2.2 Operation and Temperature data (After Inspection) (1/2)

No.	Item	Item	By means of	Unit	U#1	U#1	U#2	U#2	U#3	U#3
1	Operation			Date	June 25, '09	July,30, '11	June 25, '09	July 29, '11	June 25, '09	July 27, '11
	Data			Time	11:00	14:40	11:15	12:00	11:28	16:30
		Output		MW	76	88	71	88	74	84
				MVAR	-32 (lead)	-25	-15 (lead)	+45	0	-19
		Terminal voltage		kV	16.8	15.5	16.9	16.3	16.2	15.5
		AC Current (Red phase)		A	2,700	3,250	2,350	3,150	2,800	3,350
		AC Current (Yellow phase)		A	2,850	3,300	2,600	3,350	2,900	3,350
		AC Current (Blue phase)		A	2,620	3,100	2,320	3,000	2,820	3,200
		Excitation Voltage		V	150	150	150	150	190	170
		Field Current		A	820	920	950	1,000	1,000	950
2	Temperature	Stator winding 1	RTD	℃	50	60	65	52	65	65
		Stator winding 2	RTD	℃	56	2	50	58	62	61
		Stator winding 3	RTD	℃	62	69	58	48	75	79
		Stator core	Thermo couple	℃	8	50	67	>150	53	85
		Thrust bearing	Dial thermometer	℃	46	49	46	42	48	48
		Guide bearing	Dial thermometer	℃	50	45	50	42	49	50
3	Oil level	Oil reservoir		mm	+42	+42	+28	+53	+54	+43
4	Pressure	High pressure oil pump		kg/cm2G	0	0	0	0	0	0
		Air for Brakes		bar	13	–	11.2	–	10.7	–
	Oil Flow									
5	Vibration	Stator frame		μm p-p						
		Thrust tank		μm p-p						
		Upper bracket	Installed meter	μm p-p	15	10	72	73	33	28

Low temperature indication
Compared with other units

Abnormal temperature indication
(Disconnect or short condition)

Table 2.2 Operation and Temperature data (After Inspection) (2/2)

No.	Item	Item	By means of	Unit	U#4	U#4	U#5	U#5	U#6	U#6
1	Operation			Date	June 25, '09		June 25, '09	July28, '11	June 25, '09	
	Data			Time				14:15		
		Output		MW	Out of service		Stand by	84	Out of service	
				MVAR				-15		
		Terminal voltage		kV				15.4		
		AC Current (Red phase)		A				3,200		
		AC Current (Yellow phase)		A				3,250		
		AC Current (Blue phase)		A				3,200		
		Excitation Voltage		V				+180		
		Field Current		A				940		
2	Temperature	Stator winding 1	RTD	℃				26		
		Stator winding 2	RTD	℃				25		
		Stator winding 3	RTD	℃				50		
		Stator core	Thermo couple	℃				49		
		Thrust bearing	Dial thermometer	℃				47		
		Guide bearing	Dial thermometer	℃				45		
3	Oil level	Oil reservoir		mm				+48		
4	Pressure	High pressure oil pump		kg/cm2G				0		
		Air for Brakes		bar				–		
	Oil Flow									
5	Vibration	Stator frame		μm p-p						
		Thrust tank		μm p-p						
		Upper bracket	Installed meter	μm p-p				55		

Low temperature indication
Compared with other units

Table 2.3 Operation and Temperature data (Governor control panel) of Unit **2G1**

No.	Item	Item	By means of	Unit	U#1					
1	Operation			Date	June 26, '09					
	Data			Time	17:00					
		Output		MW	76.5					
				MVAR	+5 (lag)					
		Terminal voltage		kV	16.15					
		AC Current (Red phase)		A	2,580					
		AC Current (Yellow phase)		A	2,720					
		AC Current (Blue phase)		A	2,520					
		Excitation Voltage		V	–					
		Field Current		A	1030					
2	Temperature	Stator winding			Red Phase	℃	Yellow Phase	℃	Blue Phase	℃
			RTD	℃	PH1 SU1 (S#18)	59	PH2 SV1 (S#39)	2	PH3 SW1 (S#109)	59
			RTD	℃	PH1 SU2 (S#60)	>150	PH2 SV2 (S#80)	58	PH3 SW2 (S#189)	64
			RTD	℃	PH1 SU3 (S#130)	58.5	PH2 SV3 (S#160)	60.5	PH3 SW3 (S#267)	63
			RTD	℃	PH1 SU4(S#217)	60.5	PH2 SV4 (S#246)	61.5	PH3 SW4 (S#337)	62.5
			RTD	℃	PH1 SU5 (S#288)	60	PH2 SV5 (S#309)	55	PH3 SW5 (S#416)	88
			RTD	℃	PH1 SU6 (S#367)	53	PH2 SV6 (S#388)	56	PH3 SW6 (S#501)	80
			RTD	℃	PH1 SU7 (S#445)	59	PH2 SV7 (S#466)	68		
		Stator core	Thermo couple	℃	Stator core 1	13				
			Thermo couple	℃	Stator core 2	3				
			Thermo couple	℃	Stator core 3	8.5				
			Thermo couple	℃	Stator core 4	–				
		Thrust bearing oil	RTD	℃	Oil reservoir	0				
		Turbine guide bearing	RTD	℃	2720F1	11.5				
		Turbine guide bearing	RTD	℃	2720F2	–-				

Abnormal temperature indication
(Disconnect or short condition)

Low temperature indication
Compared with other units

All monitored thermocouples
were in trouble.
(Low temperature indication)
(Compared with other units)

Table 2.3 Operation and Temperature data (Governor control panel) of Unit **2G1**

No.	Item	Item	By means of	Unit	U#1					
1	Operation			Date	(Before Inspection) July,26,'11 ／ (After Inspection) July,30, '11					
	Data			Time	16:20／14:40					
		Output		MW	88／88					
				MVAR	+32／-25					
		Terminal voltage		kV	15.2／15.5					
		AC Current (Red phase)		A	3,300／3,250					
		AC Current (Yellow phase)		A	3,450／3,300					
		AC Current (Blue phase)		A	3,150／3,1					
		Excitation Voltage		V	−／−					
		Field Current		A	1,060／920					
2	Temperature	Stator winding			Red Phase	℃	Yellow Phase	℃	Blue Phase	℃
	@Governor		RTD	℃	PH1 SU1 (S#18)	61／60	PH2 SV1 (S#39)	2／2	PH3 SW1 (S#109)	75／69
	control panel		RTD	℃	PH1 SU2 (S#60)	>150／>150	PH2 SV2 (S#80)	56／60	PH3 SW2 (S#189)	75／68
			RTD	℃	PH1 SU3 (S#130)	59／59	PH2 SV3 (S#160)	62／62	PH3 SW3 (S#267)	82／72
			RTD	℃	PH1 SU4(S#217)	52／51	PH2 SV4 (S#246)	64／63	PH3 SW4 (S#337)	75／68
			RTD	℃	PH1 SU5 (S#288)	61／60	PH2 SV5 (S#309)	58／55	PH3 SW5 (S#416)	58／54
			RTD	℃	PH1 SU6 (S#367)	53／54	PH2 SV6 (S#388)	>15／40	PH3 SW6 (S#501)	>150／>150
			RTD	℃	PH1 SU7 (S#445)	62／62	PH2 SV7 (S#466)	86／78		
		Stator core	Thermo couple	℃	Stator core 1	50／50				
			Thermo couple	℃	Stator core 2	52／52				
			Thermo couple	℃	Stator core 3	50／51				
			Thermo couple	℃	Stator core 4	41／42				
		Thrust bearing oil	RTD	℃	Oil reservoir	40／40				

Abnormal temperature indication
(Disconnect or short condition)

Low temperature indication
Compared with other units

Abnormal temperature indication
(Disconnect or short condition)

Table 2.3 Operation and Temperature data (Governor control panel) of Unit **2G2**

No.	Item	Item	By means of	Unit	U#2					
1	Operation			Date	(Before Inspection) ／ (After Inspection) July,29,'11					
	Data			Time	／12:00					
		Output		MW	／88					
				MVAR	／+45					
		Terminal voltage		kV	／16.3					
		AC Current (Red phase)		A	／3,150					
		AC Current (Yellow phase)		A	／3,350					
		AC Current (Blue phase)		A	／3,000					
		Excitation Voltage		V	–／–					
		Field Current		A	／1,000					
2	Temperature	Stator winding			Red Phase	℃	Yellow Phase	℃	Blue Phase	℃
	@Governor		RTD	℃	PH1 SU1 (S#18)	／55	PH2 SV1 (S#39)	／57	PH3 SW1 (S#109)	／52
	control panel		RTD	℃	PH1 SU2 (S#60)	／57	PH2 SV2 (S#80)	／46	PH3 SW2 (S#189)	／59
			RTD	℃	PH1 SU3 (S#130)	／34	PH2 SV3 (S#160)	／58	PH3 SW3 (S#267)	／2
			RTD	℃	PH1 SU4(S#217)	／52	PH2 SV4 (S#246)	／62	PH3 SW4 (S#337)	／65
			RTD	℃	PH1 SU5 (S#288)	／52	PH2 SV5 (S#309)	／54	PH3 SW5 (S#416)	／144
			RTD	℃	PH1 SU6 (S#367)	／55	PH2 SV6 (S#388)	／47	PH3 SW6 (S#501)	／48
			RTD	℃	PH1 SU7 (S#445)	／61	PH2 SV7 (S#466)	／48		
		Stator core	Thermo couple	℃	Stator core 1	／–				
			Thermo couple	℃	Stator core 2	／57				
			Thermo couple	℃	Stator core 3	／137				
			Thermo couple	℃	Stator core 4	／–				
		Thrust bearing oil	RTD	℃	Oil reservoir	／0				

Low temperature indication
Compared with other units

All monitored thermocouples
were in trouble.
(Low temperature indication)
(Compared with other units)

※Unit 2G2 was no data because standby

Table 2.3 Operation and Temperature data (Governor control panel) of Unit **2G3**

No.	Item	Item	By means of	Unit	U#3					
1	Operation			Date	(Before Inspection) July,23.'11 ／ (After Inspection) July,27,'11					
	Data			Time	14:00／16:30					
		Output		MW	82／84					
				MVAR	-3／-19					
		Terminal voltage		kV	16.3／15.5					
		AC Current (Red phase)		A	3,150／3,350					
		AC Current (Yellow phase)		A	3,150／3,350					
		AC Current (Blue phase)		A	3,050／3,200					
		Excitation Voltage		V	－／－					
		Field Current		A	1,000／ 950					
2	Temperature	Stator winding			Red Phase	℃	Yellow Phase	℃	Blue Phase	℃
	@Governor		RTD	℃	PH1 SU1 (S#18)	66／65	PH2 SV1 (S#39)	64／61	PH3 SW1 (S#109)	80／79
	control panel		RTD	℃	PH1 SU2 (S#60)	59／59	PH2 SV2 (S#80)	60／50	PH3 SW2 (S#189)	25／25
			RTD	℃	PH1 SU3 (S#130)	64／50	PH2 SV3 (S#160)	62／61	PH3 SW3 (S#267)	85／85
			RTD	℃	PH1 SU4(S#217)	71／67	PH2 SV4 (S#246)	65／61	PH3 SW4 (S#337)	76／75
			RTD	℃	PH1 SU5 (S#288)	76／75	PH2 SV5 (S#309)	68／65	PH3 SW5 (S#416)	78／78
			RTD	℃	PH1 SU6 (S#367)	65／64	PH2 SV6 (S#388)	80／80	PH3 SW6 (S#501)	78／78
			RTD	℃	PH1 SU7 (S#445)	68／66	PH2 SV7 (S#466)	80／79		
		Stator core	Thermo couple	℃	Stator core 1	88／85				
			Thermo couple	℃	Stator core 2	55／53				
			Thermo couple	℃	Stator core 3	62／60				
			Thermo couple	℃	Stator core 4	53／52				
		Thrust bearing oil	RTD	℃	Oil reservoir	42／42				

Low temperature indication
Compared with other units

Table 2.3 Operation and Temperature data (Governor control panel) of Unit **2G5**

No.	Item	Item	By means of	Unit	U#5					
1	Operation			Date	(Before Inspection) ／ (After Inspection) July,22,’11					
	Data			Time	／14:15					
		Output		MW	／84					
				MVAR	／-15					
		Terminal voltage		kV	／15.4					
		AC Current (Red phase)		A	／3,200					
		AC Current (Yellow phase)		A	／3,250					
		AC Current (Blue phase)		A	／3,200					
		Excitation Voltage		V	−／−					
		Field Current		A	／940					
2	Temperature	Stator winding			Red Phase	℃	Yellow Phase	℃	Blue Phase	℃
	@Governor		RTD	℃	PH1 SU1 (S#18)	／26	PH2 SV1 (S#39)	／25	PH3 SW1 (S#109)	／50
	control panel		RTD	℃	PH1 SU2 (S#60)	／32	PH2 SV2 (S#80)	／>150	PH3 SW2 (S#189)	／39
			RTD	℃	PH1 SU3 (S#130)	／29	PH2 SV3 (S#160)	／31	PH3 SW3 (S#267)	／41
			RTD	℃	PH1 SU4(S#217)	／28	PH2 SV4 (S#246)	／35	PH3 SW4 (S#337)	／41
			RTD	℃	PH1 SU5 (S#288)	／27	PH2 SV5 (S#309)	／33	PH3 SW5 (S#416)	／41
			RTD	℃	PH1 SU6 (S#367)	／42	PH2 SV6 (S#388)	／42	PH3 SW6 (S#501)	／42
			RTD	℃	PH1 SU7 (S#445)	／34	PH2 SV7 (S#466)	／42		
		Stator core	Thermo couple	℃	Stator core 1	／49				
			Thermo couple	℃	Stator core 2	／0				
			Thermo couple	℃	Stator core 3	／0				
			Thermo couple	℃	Stator core 4	／48				
		Thrust bearing oil	RTD	℃	Oil reservoir	／94				

Abnormal temperature indication
(Disconnect or short condition)

All monitored thermocouples
were in trouble.
(Low temperature indication)
(Compared with other units)

※Unit 2G5 was no data because standby

Table 3 As found setting value of oil flow control check valves (1/2)

Not well adjusting of the oil flow control valves (unequal setting)

Unit 2G1

V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting
1-1	6.8	6.0	4-1	5.7	6.7	7-1	6.2	5.7	10-1	7.0	5.8	13-1	6.8	6.7	16-1	6.6	5.7
1-2	5.7	6.2	4-2	7.2	5.9	7-2	6.8	7.2	10-2	5.8	6.7	13-2	6.0	7.0	16-2	5.8	6.0
2-1	6.9	6.5	5-1	6.0	5.7	8-1	7.0	6.8	11-1	5.8	5.8	14-1	6.3	6.7	17-1	5.8	6.0
2-2	6.7	6.8	5-2	6.2	5.7	8-2	5.3	6.7	11-2	5.8	6.8	14-2	5.7	6.8	17-2	6.7	5.3
3-1	5.8	6.8	6-1	7.0	5.8	9-1	5.8	5.7	12-1	6.7	5.7	15-1	6.0	5.7	18-1	6.0	5.8
3-2	6.1	6.2	6-2	6.8	6.7	9-2	6.0	5.7	12-2	6.6	6.2	15-2	6.6	6.0	18-2	5.7	6.8

Broken valve was found

Unit 2G2

V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting
1-1	6.9	6.9	4-1	8.8	8.6	7-1	5.8	5.8	10-1	6.4	7.3	13-1	6.7	6.8	16-1	6.4	6.4
1-2	6.8	6.8	4-2	2.0	5.6	7-2	2.0	5.7	10-2	7.0	6.8	13-2	6.8	6.8	16-2	6.5	6.5
2-1	5.6	5.6	5-1	0	0	8-1	5.8	5.8	11-1	6.2	6.3	14-1	6.7	6.7	17-1	6.8	6.7
2-2	7.0	6.8	5-2	7.0	7.2	8-2	6.8	6.8	11-2	6.6	6.8	14-2	5.9	5.9	17-2	6.0	6.0
3-1	6.0	5.8	6-1	6.0	5.9	9-1	5.8	5.8	12-1	5.8	5.8	15-1	5.5	5.3	18-1	10.0	5.6
3-2	7.0	6.7	6-2	6.6	6.7	9-2	6.4	6.3	12-2	6.8	6.8	15-2	6.7	6.7	18-2	6.8	6.8

Unit 2G3

V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting
1-1	–	6.7	4-1	–	5.8	7-1	–	6.7	10-1	–	6.7	13-1	–	6.8	16-1	–	6.7
1-2	–	5.9	4-2	–	5.8	7-2	–	6.8	10-2	–	5.7	13-2	–	5.8	16-2	–	5.8
2-1	–	5.8	5-1	–	5.5	8-1	–	6.8	11-1	–	5.8	14-1	–	6.7	17-1	–	5.7
2-2	–	5.8	5-2	–	6.8	8-2	–	5.8	11-2	–	6.8	14-2	–	5.7	17-2	–	5.8
3-1	–	6.7	6-1	–	6.8	9-1	–	5.8	12-1	–	5.9	15-1	–	5.8	18-1	–	6.8
3-2	–	6.8	6-2	–	6.7	9-2	–	6.8	12-2	–	5.8	15-2	–	5.8	18-2	–	5.8

Not well adjusting of the oil flow control valves (unequal setting)

Table 3 As found setting value of oil flow control check valves (2/2)

Unit 2G5

V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting	V. No.	Setting (2009)	Setting
1-1	–	6.8	4-1	–	5.7	7-1	–	6.8	10-1	–	5.7	13-1	–	6.9	16-1	–	5.8
1-2	–	6.7	4-2	–	6.8	7-2	–	5.8	10-2	–	6.7	13-2	–	6.8	16-2	–	6.8
2-1	–	7.4	5-1	–	6.8	8-1	–	6.8	11-1	–	5.5	14-1	–	6.6	17-1	–	5.7
2-2	–	5.8	5-2	–	6.9	8-2	–	6.8	11-2	–	5.7	14-2	–	6.3	17-2	–	6.7
3-1	–	6.7	6-1	–	5.7	9-1	–	6.7	12-1	–	5.5	15-1	–	5.7	18-1	–	5.7
3-2	–	5.8	6-2	–	6.9	9-2	–	6.8	12-2	–	9.7	15-2	–	5.8	18-2	–	5.7

APPENDIX-6.2

<Point of photography>

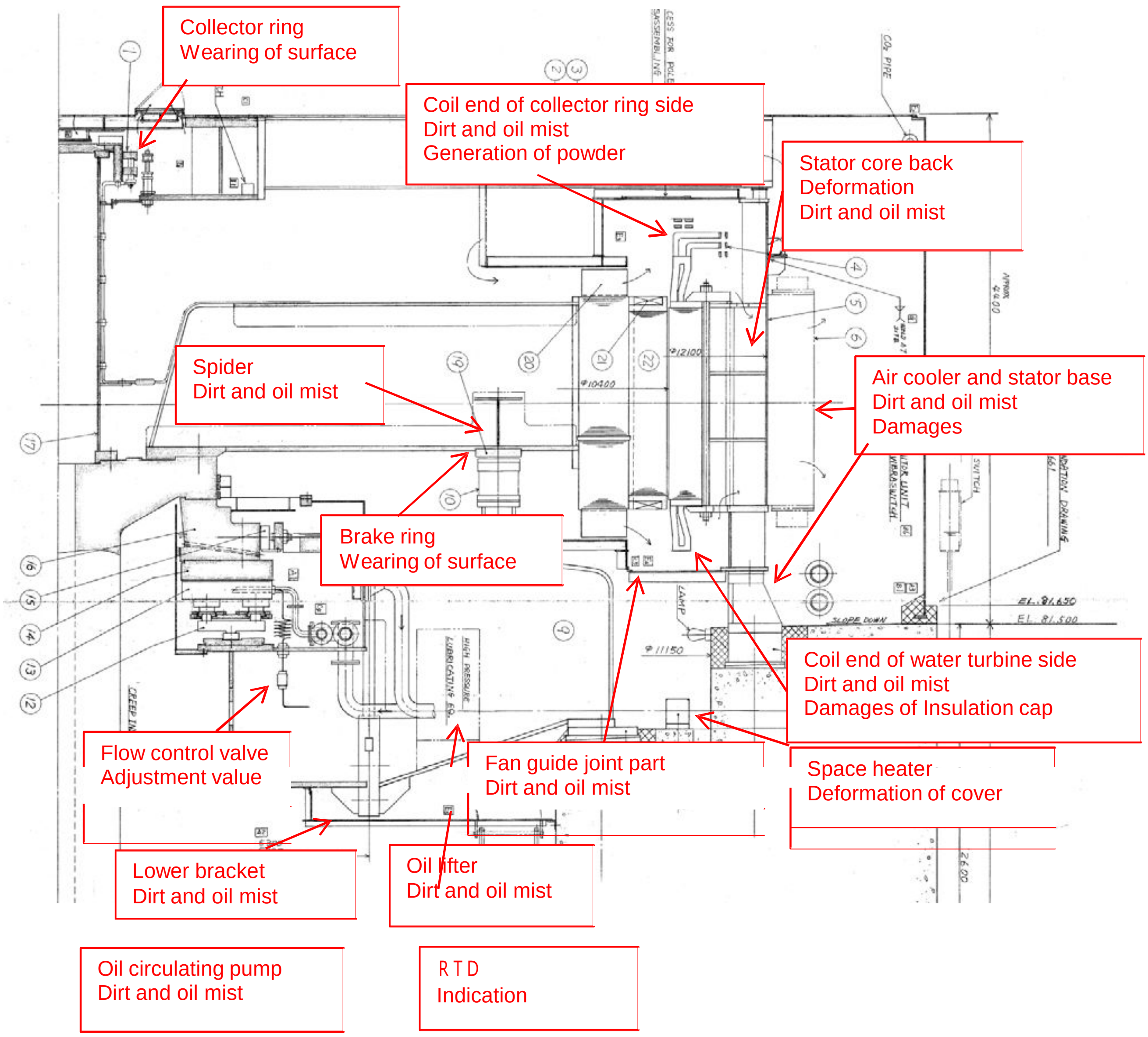


Photo 1.1 2G1 Lower fan guide

Oil drops were found at split face of the fan guide segments.

Photo 1.2 2G1 Oil lift pump

Oil gathering was found at a flange adjacent to the pump.

Photo 1.3 2G1 Around lower bracket

Oil gathering was found at the lower bracket

Photo 1.4 2G1 Stator core back

Oil stain was found at the stator core back.

Photo 1.5 2G1 Air cooler

Damages were found at an air cooler fin.

Photo 1.6 2G1 Stator coil end

Oil stain was found at
the turbine side of stator coil end.

Photo 1.7 2G1 Stator coil end

Insulation cap was transformed at
the turbine side of stator coil end.

Photo 1.9 2G1 Stator base

Oil stain was found at
the stator base.

Photo 1.10　2G1 Rotor spider

Oil gathering and dust accumulation were found on the rotor spider.

Photo 1.11　2G1 Break ring

Discoloration was found at the break ring.

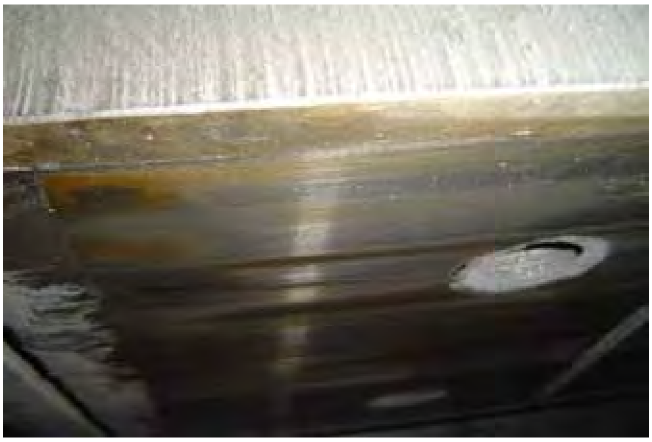


Photo 1.12　2G1 Break ring

Wearing was found at the surface of break ring.

Photo 1.13 2G1 Stator coil

Occurrence of powder was found at the collector ring side of stator coil.

Photo 1.14 2G1 Space heater

Transformation of cover was found at space heaters.

Photo 1.15 2G1 Oil cooler circulation pump

Oil leakage was found at the oil cooler circulation pump.

Photo 1.16 2G1 Control board

Deviation on the the RTD thermometer was found.

Photo 1.17 2G1 Air cooler

Oil stain was found at air cooler fins.

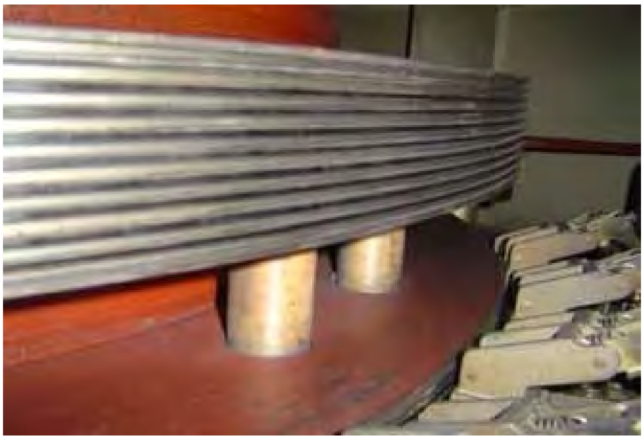


Photo 1.18 2G1 Collector ring

Wearing condition of the surface

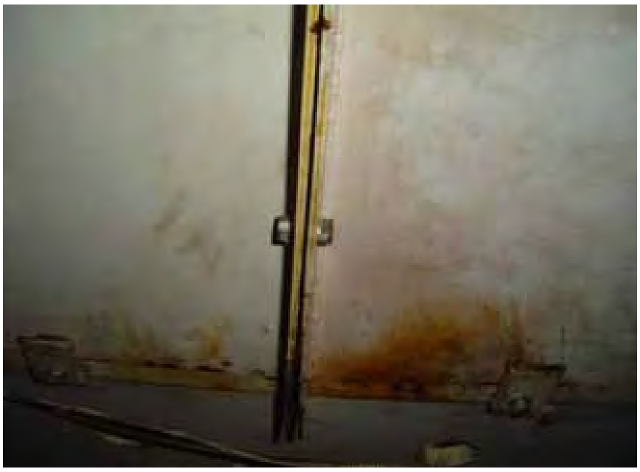


Photo 2.1 2G2 Lower fan guide

Oil drops were found at split face of the fan guide segments.

Photo 2.2 2G2 Oil lift pump

Oil gathering was found at a flange adjacent to the pump.

Photo 2.3 2G2 Around lower bracket

Oil gathering was found at
the lower bracket

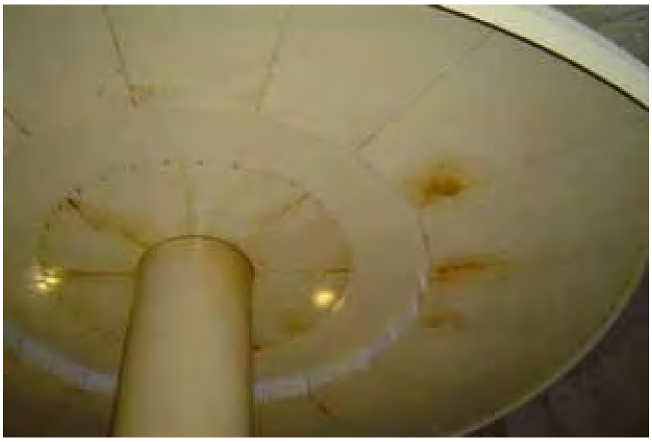


Photo 2.4 2G2 Stator core

Oil stain was found at
the stator core back.

Photo 2.5 2G2 Stator coil

Oil stain was found at
the turbine side of stator coil end.

Photo 2.6 2G2 Stator coil

Insulation cap was transformed at the turbine side of stator coil end.

Photo 2.7 2G2 Air cooler

Oil stain was found at air cooler fins.

Photo 2.8 2G2 Stator base

Oil stain was found at the stator base.

Photo 2.9 2G2 Break ring

Discoloration was found at the break ring.

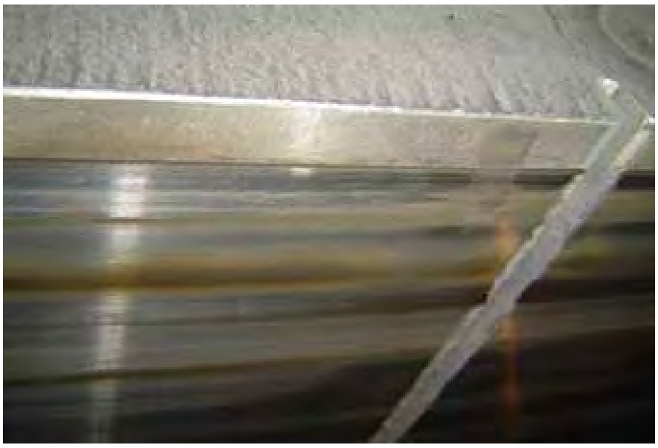


Photo 2.10 2G2 Break ring

Wearing was found at the surface of break ring.

Photo 2.11 2G2 Stator base

Nock pin's pulling was found at the stator base.

Photo 2.12 2G2 Control board

Deviation on the the RTD thermometer was found.

Photo 2.13 2G2 Space heater

Transformation of cover was found at space heaters.

Photo 2.14 2G2 Oil cooler circulation pump

Oil leakage was found at the oil cooler circulation pump.

Photo 2.15 2G2 Air cooler

Damages were found at an air cooler fin.

Photo 2.16 2G2 Rotor spider

Oil gathering and dust accumulation were found on the rotor spider.

Photo 2.17 2G2 Collector ring

Wearing condition of the surface

Photo 3.1 2G3 Lower fan guide

Oil drops were found at split face of the fan guide segments.

Photo 3.2 2G3 Oil lift pump

Oil gathering was found at a flange adjacent to the pump.

Photo 3.3 2G3 Around lower bracket

Oil gathering was found
at the lower bracket

Photo 3.4 2G3 Stator core

Waving deformation was
found at a stator core back

Photo 3.5 2G3 Air cooler

Damages were found
at an air cooler fin.

Photo 3.6 2G3 Stator coil

Oil stain was found at
the turbine side of stator coil end.

Photo 3.7 2G3 Stator coil

Insulation cap was transformed at
the turbine side of stator coil end.

Photo 3.8 2G3 Stator base

Oil stain was found at
the stator base.

Photo 3.9 2G3 Rotor spider

Oil gathering and dust accumulation were found on the rotor spider.

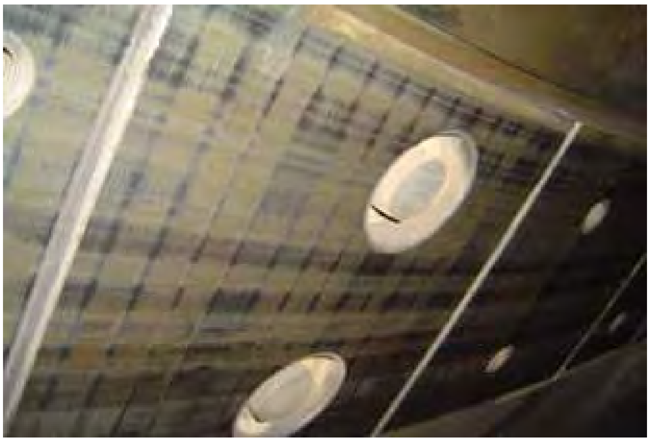


Photo 3.10 2G3 Break ring

Discoloration was found at the break ring.

Photo 3.11 2G3 Break ring

Wearing was found at the surface of break ring.

Photo 3.12 2G3 Stator coil

Occurrence of powder was found at the collector ring side of stator coil.

Photo 3.13 2G3 Air cooler

Bad attachment of thermometer tap was found at the air cooler.

Photo 3.14 2G3 Oil cooler circulation pump

Oil leakage was found at the oil cooler circulation pump.

Photo 3.15 2G3 Control board

Deviation on the the RTD thermometer was found.

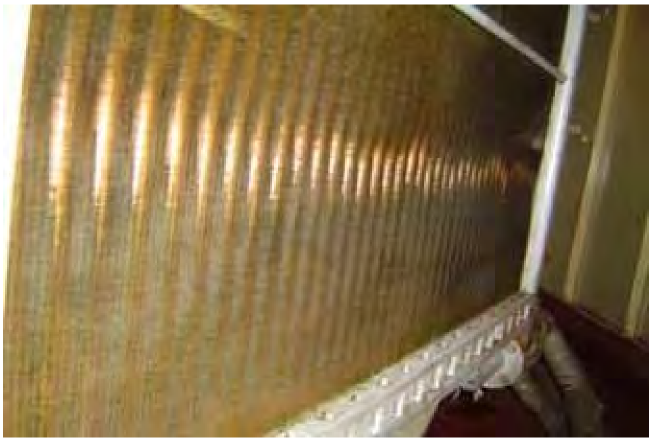


Photo 3.16 2G3 Air cooler

Oil stain was found at air cooler fins.

Photo 3.17 2G3 Space heater

Transformation of cover was found at space heaters.

Photo 3.18 2G3 Collector ring

Wearing condition of the surface

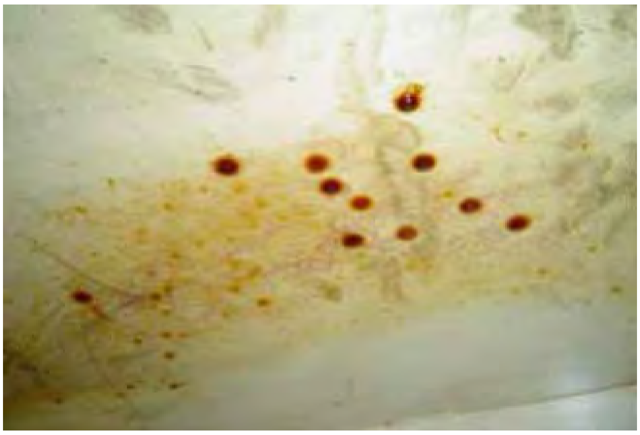


Photo 5.1 2G5 Lower fan guide

Oil drops were found at split face of the fan guide segments.

Photo 5.2 2G5 Oil lift pump

Oil gathering was found at a flange adjacent to the pump.

Photo 5.3 2G5 Around lower bracket

Oil gathering was found at the lower bracket

Photo 5.4 2G5 Stator core

Oil stain was found at the stator core back.

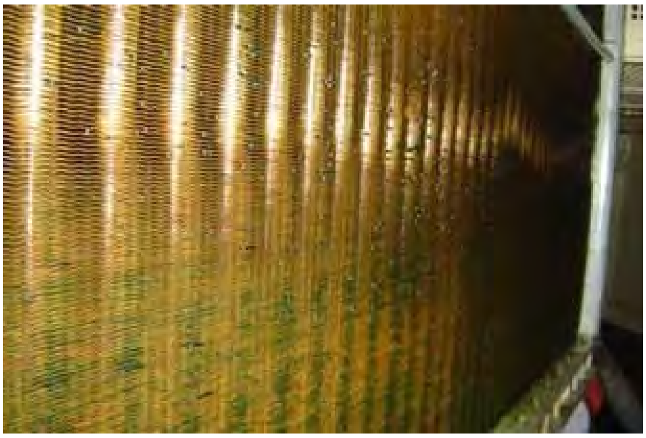


Photo 5.5 2G3 Air cooler

Oil stain was found at air cooler fins.

Photo 5.6 2G5 Stator coil

Oil stain was found at
the turbine side of stator coil end.

Photo 5.7 2G5 Stator coil

Insulation cap was transformed at
the turbine side of stator coil end.

Photo 5.8 2G5 Stator base

Nock pin's pulling was found at
the stator base.

Photo 5.9 2G5 Stator base

Oil stain was found at the stator base.

Photo 5.10 2G5 Break ring

Discoloration was found at the break ring.

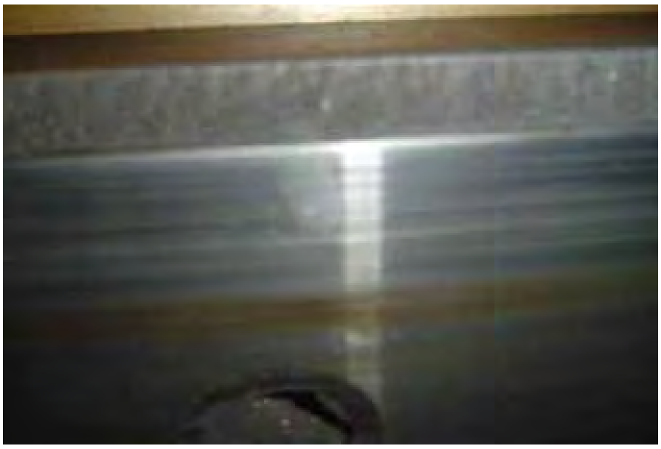


Photo 5.11 2G5 Break ring

Wearing was found at the surface of break ring.

Photo 5.12 2G5 Stator coil

Occurrence of powder was found at the collector ring side of stator coil.

Photo 5.13 2G5 Air cooler

Bad attachment of thermometer tap was found at the air cooler.

Photo 5.14 2G5 Oil cooler circulation pump

Oil leakage was found at the oil cooler circulation pump.

Photo 5.15   2G5 Control board

Deviation on the the RTD thermometer was found.

Photo 5.16   2G5 Thermal relay lead

Breaking Thermal relay lead was found.

Photo 5.17   2G5 Space heater

Transformation of cover was found at space heaters.

Photo 5.18 2G5 Air cooler

Damages were found at
an air cooler fin.

Photo 5.19 2G5 Rotor spider

Oil gathering and dust accumulation
were found on the rotor spider.

Photo 5.20

Wearing condition of the surface

Appendix-7

Inspection Report of Turbine and Governor

APPENDIX-7.1

Datum Inspection: July 20 – 31, 2011

Reported: August 04, 2011

Von NIGERIA

Visum:

Jebba inspection

Participant: Mr. Yuri. Pirozhkov
The trip purpose: Inspection of the current condition of the turbine equipment of unit of №1, 2, 3, 5 at Jebba Hydro power station (called as the HPS hereinafter).

The inspection program: - check unwater turbine (unit 2);
- check of the turbine №1, 3, 5 without unwater;
- collection of the operational data.

Description turbine:
Turbine Type: Propeller

D_1	=	7100 mm
H	=	27.65 m
Q	=	376 m^3/s
P	=	96.35 MW
n	=	93.75 min^{-1}

Feature of JEBBA HPS:
The HPS has been operating as one of the key stations to maintain the network Frequency (Hz).
The minimum Output should be 80 MW/unit in order to avoid cavitation on runner blades.
Note:
- Unit 2 unwater;
- Units 1, 2, 3, 5 in an operative mode

Check results :

1. Draft tube cone (Unit 2):

Flippers of cone have tracks to remove cavitation (photo-1).
Original paint on the liner of cone generally has remained.

Poho-1
Repair welded at Flipper on Draft Tube Core

Recommended repair (replacement):
Surfaces damages by cavitation should be restored to get original shape.

2. Runner chamber (Unit 2):

The chamber has circular mechanical damages (scratches) in area of blades.
Damages are caused by hit of firm particles in a gap between blades and chamber (Photo-2).
Original paint on the liner of chamber has remained except for area of blades.

Photo-2
Damages on Runner Chamber

Recommended repair (replacement):
Mechanical damages should be removed.
After repair, repaint to get original condition.

3. <u>Stay ring and spiral case (Unit 2):</u>

Original paint on stay ring has minor local damages but total area is not more than $1m^2$. (Photos 3, 4 &5)

Photo-3
Paint on Stay Ring and Stay Vane

Photo-4
Paint on Stay Vane

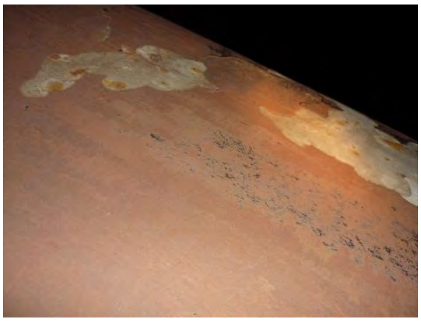


Photo-5
Paint on Stay Vane

e

On some places, the paint has separated from metal and formed water bubbles (Photo-6).

Photo-6
Stay Vane (Paint separation and water bubble is found)

Paint of the spiral case was not damaged. (Photo 7 & 8)

Photo-7
Spiral case and stay ring

Photo-8
V Bottom ring of stay ring Bottom ring of stay ring

<u>Recommended repair (replacement):</u>
Stay ring should be sandblasted, cleaned and repainted.
Fillets of vanes of stay ring are necessary to be checked to confirm that there are no cracks.

4. Bottom ring wicket gate (Unit 2):

Leaking water through bearings on bottom ring is not found out, but some rust tracks are visible. (Photo 9)
The paint on a surface of bottom ring in an area of movement of vanes is completely damaged. (Photo 10).
The reason: lowers end clearances = 0mm (vanes have sagged).

Photo-9
Bottom ring lower surface

Phote-10
Bottom Ring upper surface

The latest painted material is well visible (Photo 11) - where the paint is damaged, there is rust.

Photo-11
Rust on bottom ring

There is mechanical damage in depth up to 2mm on the bottom ring upper surface in the area of wicket gate movement.

Photo-12
Scratch by hit of firm particles in a gap between wicket gates and bottom ring.

Recommended repair (replacement):
Lower bearings should be checked, and all seals and teflons should be replaced.
Bottom ring should be sandblasted and painted again.
Wicket Gates vertical position should be adjusted according to the drawing

5. Turbine Top Cover (Unit 2):

There is no paint damage on the surface of turbine cover. (Photo 13)

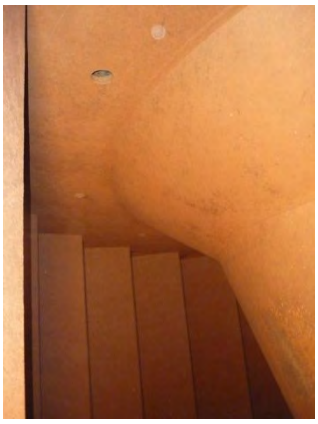


Photo-13: Turbine Cover

There are minor tracks of erosion (visually found but almost no depth) on the turbine top cover in the area of wicket gate movement. (Photo 14)

Photo-14
Turbine Top Cover and Wicket Gate Vane

Recommended repair (replacement):
To inspect a condition of major joining bolts.
Seals shall be replaced.

6. <u>Wicket gate vane (Unit 2):</u>

There are cling closes (one to another vanes) in wicker gate fully closed position. Erosion in area of vanes contact is not revealed, but only an easy trace. (Photo 15)

Photo-15: Vanes in contact place

Some trailing edges of vanes were injured. (Photo 16 and 17)

Photo-16
Trailing Edge of Wicket Gate Vane

Photo-17
Trailing Edge of Wicket Gate Vane

Obviously sometime one vane was out of control. (Photo 18)

Photo-18
Circular track was found on the top cover

Paint on vanes has well remained.
Where the paint has separated from metal, water bubbles were formed. (Photo 19)

Photo-19
Water bubbles on the vane

Recommended repair (replacement):
Damages at trailing edges of vanes should be repaired.
Uppers seals of vanes to be replaced.
Vanes should be sandblasted and to be repainted.

7. Runner (Unit 2):

Cavitation corrosion on bottom surface of the blade at the moment of survey was not found. Obviously, they have been repaired during recent maintenance. (Photo 20)

Photo-20
Bottom surface of the blade

Total cavitation area on the bottom surface of the blade is less than $0.3m^2$ on each blade.
Cavitation is visible on ledge (depth of damages is less 3mm. (Photo-21)

Photo-21
Ledge of Runner Blade

Recommended repair (replacement):
To check joining bolts (shaft - runner) to confirm that no cracks are exist by means of Non Destructive Inspection (NDI).
Runner blades fillets should be checked to confirm that no cracks are exist by means of NDI.
Surfaces damages by cavitation should be repaired.

The general conclusion in the water channel Unit 2 - quite satisfactory condition.

8. Wicket Gate (link mechanism, servomotor, regulation ring, locking device, etc.):

Regulation ring of Unit 2 is moving smoothly.
According to the Client information - stopper of regulation ring badly entered into the bush in all units. (Photo-22).

Photo-22
Stopper of Regulation Ring

There is leakage oil through servomotor seals at all units. (Photo 23)
Oil leakage through servomotor pistons is also increased; refer to "Operating modes of pumps" for pumps oil pressure units.
Leakage water through upper seals of vanes stems are as shown below.
-Unit-1: Approx. 0.15 litter/sec.
-Unit-2: practically not.
-Unit-3: Approx. 1.0 litter/sec.
-Unit-5: Approx. 0.3 litter/sec.
There is backlash in link №16 (joint with pin of regulation ring) at the Unit 1.

Photo-23
Oil on Turbine Cover.

Recommended repair or replacement (all Units):
Regulation ring – check wear of support elements.
Stopper - dismantle and execute fitting pin with bush of regulation ring.
Servomotors – dismantle and replace all seals.
Link mechanism – dismantle, check joints, adjust clearances as designed, checking up on presence of cracks
It is necessary to replace top stem seals of vanes.
Also to replace all washers and sealing rings.

9. Turbine Shaft (all Units):

Recommended repair or replacement (all units):
Shaft fillets should be checked on presence of cracks by means of NDI.
Bolts (turbine shaft to generator shaft) should be checked on presence of cracks.

10. Shaft seal (all Units):

Present status of shaft seal is not satisfactory condition. (Photo 24 - 27).
Much leakage water was found; refer to "Operating modes of pumps" for water drainage pumps described hereunder.
Discharge of water supply - 150 lit/min.
Pressure of supply of water is not measured continuously. Water pressure gauge is not installed in the pipeline.
There is uneven wear on the working surfaces of Teflon's Segments. (Photo 29 -32)

According to the Client information:
-Teflon segment has been replaced in every two-three years;
- Filter (Photo 28) does not fully clean the supply water to the shaft seal.
- Shaft seals are important parts for thrbine operation, but repaired seals in Unit 2 do not work properly.

Photo-24
Shaft Seal

Photo-25
Shaft Seal

Photo-26
Water level in shaft seal

Photo-27
Shaft Seal

Photo-28
Filter for Shaft Seal Supply Water

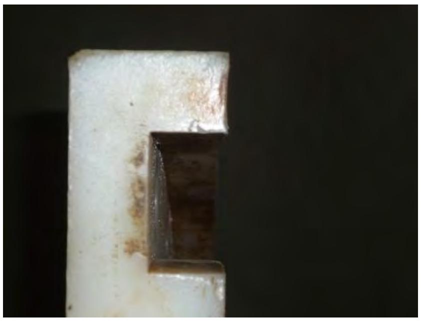


Photo-29
Teflon’s Segments

Photo-30
Teflon’s Segments

Photo-31
Teflon’s Segments

Photo-32
Teflon's Segments

<u>Recommended repair or replacement (all Units):</u>
Double filters must be replaced.
Clean water pressure must be higher than the pressure in the water channel.
Shafts seals should be completely checked up.
All worn out elements should be replaced
Repair seals should be completely checked up.

11. <u>Turbine guide bearing (all Units):</u>

There is no oil leakage through seals of guide bearing.
In this inspection, guide bearing was not disassembled.
Bearing temperatures are as shown below.
- Unit-1: 56 deg.C (Photo33)
- Unit-2: 40 deg.C
- Unit-3: 51 deg.C
- Unit-5: 50 deg C

Photo-33
Turbine Guide Bearing Temperature Meter

For comparison, Generator guide and thrust bearing temperatures are as shown below.
-Unit-1 guide bearing: 46 deg.C
-Unit-1 thrust bearing: 49 deg.C
-Unit-5 guide bearing: 44 deg.C
There are not complaints from the Customer.

Recommended repair (replacement):
After guide bearing dismantle:
Check clearance between shaft and segment.
Check condition of sliding surface of turbine shaft.
Change lubrication oil.
Continuously check the temperature of segments.

12. Auxiliary equipment (general)

According to the Client information:

Governors (all digital for Units 1, 2 & 3 and all analogue for Unit 4, 5, 6) have been operated without problem. Staffs have been satisfied in the governor performance. But the HPS management at a final meeting has declared desire to replace Governors on units 4, 5, 6 to the digital type.

Feedback (Photo 34) on the Unit 4 was damaged in the area of connection of rod with flexball.
It has been replaced with that on Unit 6 which turbine has been stopped.

Photo-34
Feedback

- Both drainage pumps (first-direct current: DC, second - alternating current: AC) were already worn. (Photo 35)

Photo-35
Drainage Pump

-Water supply pumps for ahaft seal do not provide required quantity of clean water. (Photo 36)

-A filter does not provide enough quantity of clean water to be supplied to the shaft seal.

Photo-36
Water supply pump

- Overspeed device on Units 1, 2, 3 & 5 are working without problems. (Photo 37)

Photo-37
Overspeed device

Recommended repair (replacement):
It is necessary to replace both drainage pumps.
It is necessary to replace water supply pumps on seals of shafts.

Operating modes of pumps:

	Operation	No operation	Working cycle – Operation/ No operation
U-1 pump oil pressure unit	56 second	12 minute	1/12
U-3 pump oil pressure unit	47 second	7 minute	1/9
U-1 water drainage pump	5 minute	8 minute	1/1,6
U-3 water drainage pump	1 hour and 24 minute	6 minute	14/1

APPENDIX-7.2

Turbine and Governor

Serial Number	Item	Remarks
-	Refurbish wicket gate levers, links and bushing, main shaft seal and regulating ring.	
(1)	Inspect the draft tube lining and runner blades for cavitations. Weld-fill, grind and paint the draft tube with high grade anti-rust paint.	
(2)	Complete maintenance of the wicket gate	The wicket gate bearing bushing and Pak-O-Pak seal should be replaced and new spring loaded safety levers installed.
(3)	Inspect runner, stay ring and discharge ring for caviation and erosion and effect repair	
(4)	Replacement of all seals with new ones.	
(5)	Align Turbine shaft	
(6)	Complete maintenance of the turbine guide bearing	
(7)	Refurbish the spiral casing drain valve	
(8)	Comprehensive overhaul of the turbine head cover (shaft seal and stuffing box assembly)	
(9)	Replacement of the AC and DC inner head cover pumps	
(10)	Overhaul the existing 4 nos. Servo motors	
(11)	Service the hydraulic governor system including all directional control valves and the pressure tank.	
(12)	Replacement of all gauges	
(13)	Replacement of complete shaft seal duplex filter assembly (DFLN330-50PN16)	

Appendix-8

The List of Major Trouble Record

Appendix-8

The List of Major Trouble Record

Jebba PS

No.	Date	Apparatus in Trouble	Description of Trouble	Reason for Failure	Repair carries out
1	9-Jun-04	2G3	The unit failed to pick load when synchronised and the alarm received at AVR is SSCF	Malfunctioning of relay K27, K28 and D.T.L	The relays were property serviced and D.T.L was reset with Life Book computer
2	13-Jul-04	DC System Bank "B"	DC ground fault alarm came and persist on Bank "B"	Bad Sump pump 3 switches due to corrosion	Replaced with new ones
3	14-Jul-04	2G6	Vibration level very high 120 @84MW	The vibration meter was changed yet reading remains the same (The unit was actually vibrating)	NIL. It was referred to mechanical maintenance department (MMD)
4	3-Dec-04	11kV Breaker SF6	Failed to close auto when 2G3 was synchronised to the grid	Breaker's auxiliary contact problem	Properly maintained by the Electrical maintenance department (EMD)
5	14-Feb-05	2G3 Field breaker	The breaker failed to open at unit shut down and excitation minor trouble (SSCF) came	Open circuit on the field circuit breaker auxiliary contact	The contact was re-adjusted and cleaned
6	25-Feb-05	Unit 2G4	The Turbine speed was observed at 118% when the unit was test run and making it impossible to synchronization	No output signal from speed pick-up -F1	The speed pick-up was properly re-adjusted
7	19-Jul-05	2G4 Loading system	The loading becomes very slugging when the unit attains 70MW	Speed set point card EMS12	The speed set point card EMS12 was recalibrated and tested O.K.
8	16-Sep-05	2G6 tripped on Load (90MW)	Turbine pit water level high alarm received and unit tripped on load (90MW)	Excessive leakage of water in the turbine pit	Additional pump required (Refer to MNS)
9	20-Sep-05	2G5 330kV circuit breaker	Failed to open when the stop button was depressed but later tripped on reverse power protection. LPA, LPM alarm also observed at the AVR	Refer to Transmission station PC& M Department	
10	19-Oct-05	2G56 speed detector failure alarm	The alarm comes up intermittently when the unit is in service and reset	The speed pick-up F3 got shifted from the set point.	Properly reset and tested O.K.
11	9-Nov-05	2G1 Vibro monitor	Registering zero value at 81MW machine load	The power supply MCB tripped in service due to fault	Fault cleared by EMD and MCB reset
12	20-Dec-05	2G2 Shaft Seal Cooling water flow rate meter	Fluctuating between zero and 750 L/min	Blockage along inlet and outlet water pipe line	The lines were bled and reading stabilized on 150 L/min

Appendix-8

The List of Major Trouble Record

Jebba PS

No.	Date	Apparatus in Trouble	Description of Trouble	Reason for Failure	Repair carries out
13	6-Jan-06	2G3 & 2G4 turbine air compressor #2	Observed not cutting out at 48bar	Faulty auxiliary Relay d2	Replaced with a new one.
14	15-Feb-06	2G3	The unit tripped on Generator Transformer differential protection alarm	As a result of surge from National grid	The necessary protective relays were checked and Confirmed O.K. The unit was re-synchronized
15	23-Jan-06	2G6 Governor Pressure tank	Governor oil pressure tank oil level high was received and persisted with oil level normal at 32 bar	The cam-switch B9 got off-set	Properly re-aligned
16	28-Feb-06	Fire booster pump 1 &2	Not cutting in auto after the jockey pump was shut down for complete 30 min.	Sticky pressure switch 9531e1 mechanism	Properly maintained
17	3-Mar-06	2G3	The unit tripped on unit vibration and the vibration level recorder 52μp-p 85MW	No fault was found	The unit was test run at various load up till maximum. No trip was recorded
18	25-Apr-06	2G1 and 2G2 Turbine Air Compressor #2	The compressor was observed running continuously	Fault timer Relay 2d8	It was replaced with a new one.
19	20-May-06	11kV circuit breaker SF 12	The breaker failed to close auto when unit 5 was shut down as unit 1 and 5 are in service.	Timer Relay X4 /24TB13 defective	Replaced with a new one
20	25-May-06	415V circuit breaker "B"	The breaker failed close on auto	Defective closing coil	Replaced with a new one by EMD
21	25-Jun-06	2G1 59/G Two level over voltage protect start indication	Failed to reset with the unit in service	Faulty Relay of 59/G type USX115	Replaced with a new ones
22	20-Jun-06	2G5 Gate limiter	The gate limiter was observed dropping to 68% while the gate position was increasing to 98% when opening command was given.	Discrepancy in the Governor Feed-back system	The Governor Feed-back system was properly re-aligned
23	14-Jul-06	2G1	The unit dropped load to 8MW and tripped on Two step reverse Power protection	Dirty servo-valve micro-filter which led drop in servo valve pressure.	MMD were invited to rectify the problem

Appendix-8

The List of Major Trouble Record

Jebba PS

No.	Date	Apparatus in Trouble	Description of Trouble	Reason for Failure	Repair carries out
24	30-Aug-06	2G6 Generator Transformer oil cooler leakage alarm	The Alarm came up and persisted.	Accumulation of water in the leakage detector compartment due to faulty heat exchanger #1 and #2 system	The water was drained, alarm reset and MMD were asked to effect necessary repair.
25	4-Oct-06	2G3	It failed to pick load when the unit was synchronized the associated breaker observed tripped immediately.	Faulty Relay K812 contacts	Relay replaces with a new one.
26	9-Oct-06	2G6 unit creep alarm	Above alarm cane up and failed to reset the unit was started	Faulty creep detector switch	Properly maintained and tested O.K.
27	15-Oct-06	2G4 control valve sensor failure alarm	The alarm comes up when the unit is started and persists.	Misalignment on the control valve position sensors	The sensors were properly re-alignmented and started O.K.
28	25-Oct-06	11kV breaker SF 5	The breaker was observed not closed when 2G1 was shutdown and 11kV breaker SF12 closed.(2G1 and 2G5 in service before 2G1 was shut down.	Checks Confirmed that the Problem was from the breaker SF3 auxiliary contact	EMD was invited to rectify the problem
29	12-Dec-06	2G5	The unit tripped on rapid shutdown	Blockage along pipe lines to the flow rate meter	Properly service and tested O.K.
30	16-Dec-06	2G6 Excitation system	The unit tripped on excitation Major trouble alarm (71F2) failed to reset	Brown 2 No thyristor fuses	Replaced with the unit's spare ones
31	17-Jan-07	2G4	The unit tripped on overspeed and head gate shut down	Pool of water found in the over speed detector switch compartment	Drained and properly serviced. The unit was tested O.K. Back to service
32	26-Feb-07	DC system ground fault alarm	The alarm came on and persisted	The turbine guide bearing oil proper was failed with water	Drained, cleaned and Confirmed O.K.
33	26-Feb-07	2G4 main bearing temperature meter	Permanently indicating 6˚C	The meter is found defective.	Replaced with a new one.
34	1-Jun-08	2G1	Tripped on loss of excitation	Transient fault	Necessary checks was carried out and no fault found. The unit was put back to service.

Appendix-8

The List of Major Trouble Record

Jebba PS

No.	Date	Apparatus in Trouble	Description of Trouble	Reason for Failure	Repair carries out
35	17-Jun-08	2G4 Generator protection trouble alarm	The alarm came up and failed to reset.	Relay Rut 414a Operated	The relay was reset and alarm cancelled
36	22-Aug-08	2G2 Turbine pit	Tripped on Turbine pit water level high.	Faulty AC inner head cover pump auto control start level switch	Replaced with a new one and the unit returned back to system.
37	26-Jan-09	2G4 speed monitoring system	Speed detector failure alarm came up and persisted turbine speed zero with the unit in service.	Blown fuse 6.3A supply to the speed monitoring unit	Replaced with a new one. Alarm reset and speed reading 100%
38	6-Feb-09	2G6	The unit suddenly reloaded to 0MW. Gate position was observed fluctuating between 20% and 60% and later tripped on reverse power protection.	1.Eractic bevavior of the electronic card RpV10 (Proportional control system) 2. Pole discordance also observed.	1. Card RPV10 was properly re-calibrated. 2. The pole discordance was maintained by the transmission maintenance men.
39	17-Feb-09	2G2 Generator housing vibro-monitor	Observed reading zero while the unit is in service	Faulty contact of Relay K175	Replace with a new one and the vibration reading 48 rep-p
40	25-Mar-09	Station service air compressor #2	Not cutting out on auto at 7 bar.	Timer 2-A was not timing as set.	It was properly re-calibrated.
41	26-Mar-09	2G1	The unit failed to synchronise auto	Deviation on the digital governor system settings	It was re-programmed and synchronised to the system.
42	27-Apr-09	2G5	The unit failed to pick load after synchronised and tripped on reverse power protection	Faulty Electronic Card E2DT22 in the electronic control cubicle	Replaced with a new one and unit tested. O.K.
43	21-Dec-09	2G1 Excitation system	The unit tripped on exciter exit air temperature high and excitation major trouble.	Dusty air filters (Inlet and outlet)	Properly cleaned the air filters and was restored back to service.
44	12-Feb-10	2G5 speed set point meter	Observed reading 49.4 Hz at Max load of 90MW.	Faulty analogue output isolator card EIM10	Replaced with a knew one and was tested. O.K.
45	14-Apr-10	2G2 H.P Pump	The pump was observed running continuously with the unit down.	Faulty Timer relay 2-2	Replaced and was tested. O.K.

Appendix-8

The List of Major Trouble Record

Jebba PS

No.	Date	Apparatus in Trouble	Description of Trouble	Reason for Failure	Repair carries out
46	5-Mar-11	2G5 and 2G6 Turbine Air compressor #2	Observed not picking load	Open circuit on the oil pressure switch	The pressure switch was properly re-calibrationed.
47	28-Feb-11	2G2 creep detector system	Unit creep alarm came up when the unit was started and persisted.	High contact resistance found on the creep detector switch	Properly maintained and tested. O.K.
48	22-Mar-11	2G3 Turbine pit water level alarm	No audible and visual alarm was received at the UCB when the above mentioned alarm came up at the control room	1. Faulty 7-channnel alarm card SB7/SQ2B2 2. Burnt alarm horn coil	1. Card replaced with a new one 2. Alarm hone also replaces

Appendix-9

Basic Scope of Rehabilitation

APPENDIX-9

FEDERAL REPUBLIC OF NIGERIA
Jebba Hydro Electric PLC
Jebba Power Station

Basic Scope of Rehabilitaion

						Requirement for change		Importance		Renovation Plan					
						Long period stoppage	Pulling off the rotor	Necessity	Urgency	1	2	3	4		
	No		Item	Q'ty	unit					2G5	2G1	2G3	2G2	Common	Remarks
1-1 Stator	①		Stator coil			Necessary	Necessary	High	High						
		1	Stator coil	1008	pcs					●	●	●	●		
		2	Wedge	1	set					●	●	●	●		
		3	Coil support ring	1	set					●	●	●	●		
		4	Bus bar	1	set					●	●	●	●		
		5	Insulation cap	1	set					●	●	●	●		
		6	Line and neutral lead	1	set					●	●	●	●		
		7	Accessories for the above	1	set					●	●	●	●		
		8	RTD for stator coil	20	pcs					●	●	●	●		
		9	CT	1	set					●	●	●	●		
	②		Stator Core			Necessary	Necessary	High	High						
		1	Stator core	1	set					●	●	●	●		
		2	Core duct	1	set					●	●	●	●		
		3	End duct	1	set					●	●	●	●		
		4	Core clamping plate	1	set					●	●	●	●		
		5	Accessories for the above	1	set					●	●	●	●		
		6	Thermo couple for stator core	4	pcs					●	●	●	●		
		7	Finishing varnish for stator	1	set					●	●	●	●		
	③		Stator frame			Necessary	Necessary	High							
		1	Stator frame×1unit (Brand new(	1	set					●					
		2	NDI of Stator frame at site	1	set						●	●	●		NDI : Non-Destructive Inspection
1-2 Rotor	①		Pole			Necessary	Necessary	High	High						
		1	Pole	64	pcs					●	Re-used	Re-used	Re-used		
		2	Field lead connector	1	set					●	Re-used	Re-used	Re-used		
		3	Damper winding connector	1	set					●	Re-used	Re-used	Re-used		
		4	Pole cotter and liner	1	set					●	Re-used	Re-used	Re-used		
		5	Field lead (on the rotor)	1	set					●	Re-used	Re-used	Re-used		
		6	Finishing Varnish for Rotor	1	set					●	●	●	●		
	②		Countermeasure of Rotor Rim Support												
		1	Reinforcement parts of Rotor Rim Support			Necessary	Necessary	High	High						Reinforcement of Rotor Rim support was
		1)	Special tool for Rim reinforcement	1	set									●	realized on unit 2G3 and 2G5 in 2001.
		2)	Repair material for damaged spider	1	set						●		●		
		3)	Rotor rim key	1	set						●		●		
		4)	Stopper for rotor rim key	1	set						●		●		
		5)	Distance piece (rotor rim support)	1	set						●		●		
1-3 Exciter	①		Collector Ring					High		1st unit	2nd unit				
		1	Collector ring (including shaft)	1	set					●	●				No spare is required (1-7 ④ No.1)
		2	Carbon brush	44	pcs					●	●	●	●		
		3	Carbon brush holder	44	pcs					●	●	●	●		
		4	Carbon brush holder support	1	set					●	●	●	●		
1-4 Metal	①		Bearing Parts			Necessary	Necessary	High	High						
		1	Thrust bearing shoe	18	pcs					●	●	●	●		
		2	Thrust bearing support (for HITACHI PIVOT SPRING)	18	pcs					●	●	●	●		
		3	Guide bearing shoe	22	pcs					●	●	●	●		
		4	Adjusting bolt and nut for guide bearing	22	pcs					●	●	●	●		
		5	Oil deflector	1	set					●	●	●	●		
		6	Spring support (for HITACHI PIVOT SPRING)	18	pcs					●	●	●	●		
1-5 Cooling	①		Oil cooler												
system		1	Oil cooler	4	pcs			High		Re-used	Re-used	Re-used	Re-used		
		2	Short piping for adjustment	1	set			High		Re-used	Re-used	Re-used	Re-used		
1-6 Hydraulic	②		Oil circulating system												
devices		1	Oil lubricating pump	1	set			High		Re-used	Re-used	Re-used	Re-used		
		2	High pressure oil lifter	1	set			High		Re-used	Re-used	Re-used	Re-used		
		3	Flow control Valve	36	pcs			High		Re-used	Re-used	Re-used	Re-used		
		4	High pressure oil pipe (in the thrust tank)	18	pcs		Necessary	High		Re-used	Re-used	Re-used	Re-used		
		5	Short piping for adjustment	1	set			High		Re-used	Re-used	Re-used	Re-used		
	③		Air Cooler												
		1	Air cooler	12	pcs			High		Re-used	Re-used	Re-used	Re-used		
		2	Thermostat for Air cooler	10	pcs			High		Re-used	Re-used	Re-used	Re-used		
		3	Dial thermometer for Air cooler	6	pcs			High		Re-used	Re-used	Re-used	Re-used		
		4	Short piping for adjustment	1	set			High		Re-used	Re-used	Re-used	Re-used		
1-7 Others	①		Instrument and Overhauling Parts												
		1	Dial thermometer (for bearing)	2	pcs		Necessary	High	High	●	●	●	●		
		2	Dial thermometer (for oil cooler)	2	pcs		Necessary	High	High	●	●	●	●		
		3	Thermal relay (for bearing)	2	pcs		Necessary	High	High	●	●	●	●		
		4	RTD for Thrust bearing oil tank	1	pc		Necessary	High	High	●	●	●	●		
		5	Installation materials for beatings	1	set		Necessary	High	High	●	●	●	●		
		6	Creep detector	1	pc			High		Re-used	Re-used	Re-used	Re-used		
		7	Vibration detector and monitor	1	pc			High		Re-used	Re-used	Re-used	Re-used		
		8	Water flow relay (for oil cooler and air cooler)	2	pcs			High		Re-used	Re-used	Re-used	Re-used		
		9	Oil flow meter	1	pc			High		Re-used	Re-used	Re-used	Re-used		
		10	Oil level gauge and switch	1	pc			High	High	●	●	●	●		
		11	Limit switch for brake and jack	8	pcs			High	High	●	●	●	●		
		12	Space heater (with reinforced cover)	12	pcs			High		Re-used	Re-used	Re-used	Re-used		Modification of setting place is planned.
		13	Brake liner (2pcs for 1 brake & jack)	**16**	pcs			High		Re-used	Re-used	Re-used	Re-used		
		14	Installation materials (Bolts, Nuts, etc)	1	set			High	High	●	●	●	●		
		15	Wiring material (inside of generator terminal box)	1	set			High	High	●	●	●	●		
	②		Tools for Assembly (including special tool)												
		1	Pole Lifting Rug	1	set			High						●	
		2	Tools for Erection and stator core assembly	1	set			High						●	
		3	Tools for Stator coil assembly	1	set			High						●	
		4	High Voltage Test Kit	1	set			High						●	
		5	Consumable materials	1	set			High		●	●	●	●		
	③		Training												
		1	Training	1	set			High						●	
	④		Spare Parts												
		1	Carbon brush	**180**	pcs			High						No supply	
		2	Brush holders	2	pcs			High						No supply	
		3	Stator coil (top coil)	10	pcs			High						No supply	
		4	Stator coil (bottom coil)	5	pcs			High						No supply	
		5	Pole	**4**	pcs			High						•	First End Pole×2pcs, Last End Pole ×2pcs
		6	Guide bearing shoe	22	pcs			High						•	
		7	Thrust bearing runner plate	1	pcs			High						No supply	
		8	Brake liner (shoe)	**32**	pcs			High						No supply	
		9	Thrust bearing shoe	18	pcs			High						•	
		10	High pressure oil lifter	1	set			High						No supply	
		11	Flow control Valve	36	pcs			High						No supply	
		12	Oil lifter suction line filter	50	pcs			High						No supply	
		13	Oil lifter discharge line filter	50	pcs			High						No supply	
		14	Brake ring	1	set			High						No supply	
		15	**Oil filter for oil circulation system**	**100**	pcs			High						No supply	
	⑤		Supervisor					High		●	●	●	●		
	⑥		Others (Transportation, etc.)					High		●	●	●	●		

FEDERAL REPUBLIC OF NIGERIA
Jebba Hydro Electric PLC
Jebba Power Station

Basic Scope of Rehabilitation (Turbine)

	No	Item	Q'ty	unit	Renovation Plan Priority → 1 2G5	2 2G1	3 2G3	4 2G2	Common	Remarks
Turbine	–	Refurbish wicket gate levers, links and bushing, main shaft seal and regulating ring.	1	set	●	●	●	●		
	(1)	Inspect the draft tube lining and runner blades for cavitations. Weld-fill, grind and paint the draft tube with high grade anti-rust paint.	1	set	●	●	●	●		
	(2)	Complete maintenance of the wicket gate	1	set	●	●	●	●		The wicket gate bearing bushing and Pak-O-Pak seal should be replaced and new spring loaded safety levers
	(3)	Inspect runner, stay ring and discharge ring for cavitations and erosion and effect repair	1	set	●	●	●	●		
	(4)	Replacement of all seals with new ones.	1	set	●	●	●	●		
	(5)	Align Turbine shaft	1	set	●	●	●	●		
	(6)	Complete maintenance of the turbine guide bearing	1	set	●	●	●	●		
	(7)	Refurbish the spiral casing drain valve	1	set	●	●	●	●		
	(8)	Comprehensive overhaul of the turbine head cover (shaft seal and stuffing box assembly)	1	set	●	●	●	●		
	(9)	Replacement of the AC and DC inner head cover pumps	1	set	●	●	●	●		
	(10)	Overhaul the existing 4 nos. Servo motors	1	set	●	●	●	●		・Provision of lifting device for seal replacement
	(11)	Service the hydraulic governor system including all directional control valves and the pressure tank.	1	set	●	●	●	●		・Replacement of cooling oil duplex filter assembly ・Replacement of governor oil ・Replacement of the pilot filter assembly
	(12)	Replacement of all gauges	1	set	●	●	●	●		
	(13)	Replacement of complete shaft seal duplex filter assembly (DFLN330-50PN16)	1	set	●	●	●	●		
	(14)	Digitalization of electronic governor of 2G5	1	set	●					
	(15)	Spare parts							●	

Basic Scope of Rehabilitation (Main Transformer)

	No	Item	Q'ty	unit	Renovation Plan Priority → 1 2G5	2 2G1	3 2G3	4 2G2	Common	Remarks
Main Transformer	(1)	Overhaul of Main Transformer	1	set	●	●	●	●		・Replacement of diaphragm in conservator ・Replacement of the insulation oil ・Replacement of Gaskets

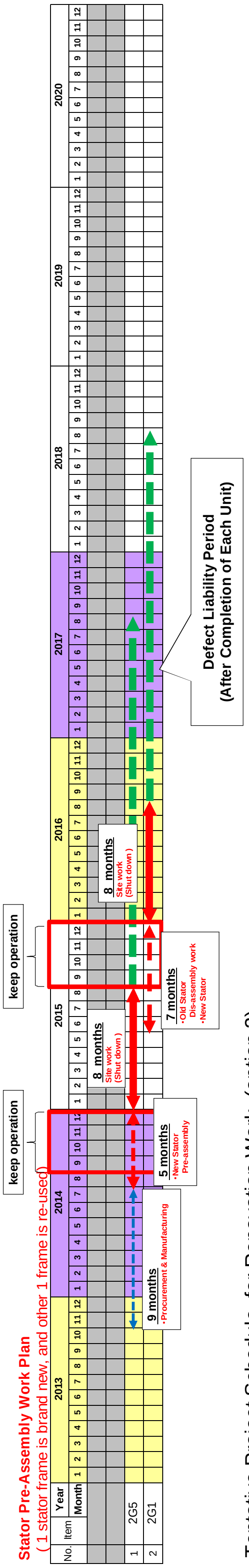
Appendix-10

Project Implementation schedule

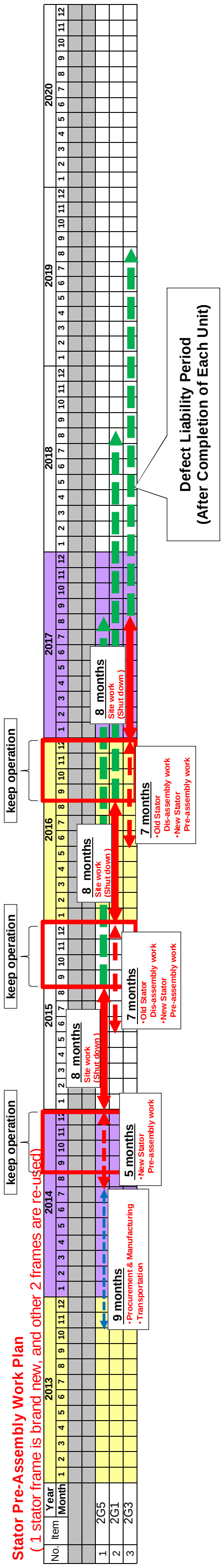
of Rehabilitation Work

APPENDIX-10-1

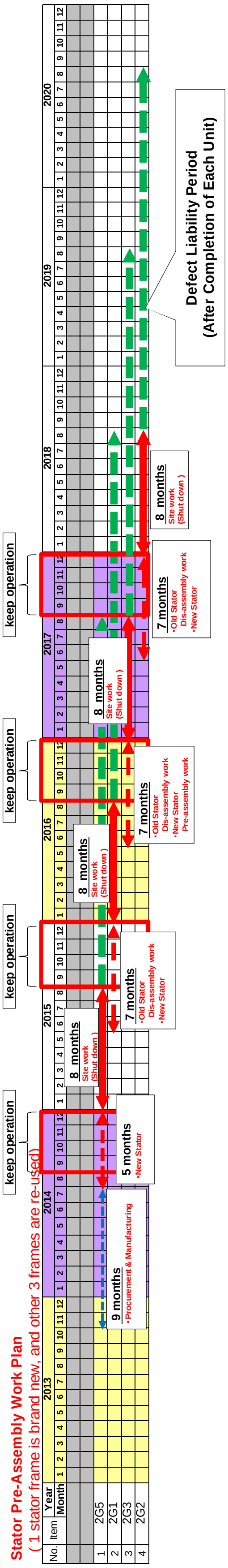
Tentative Project Schedule for Renovation Work (option 1)



Tentative Project Schedule for Renovation Work (option 2)

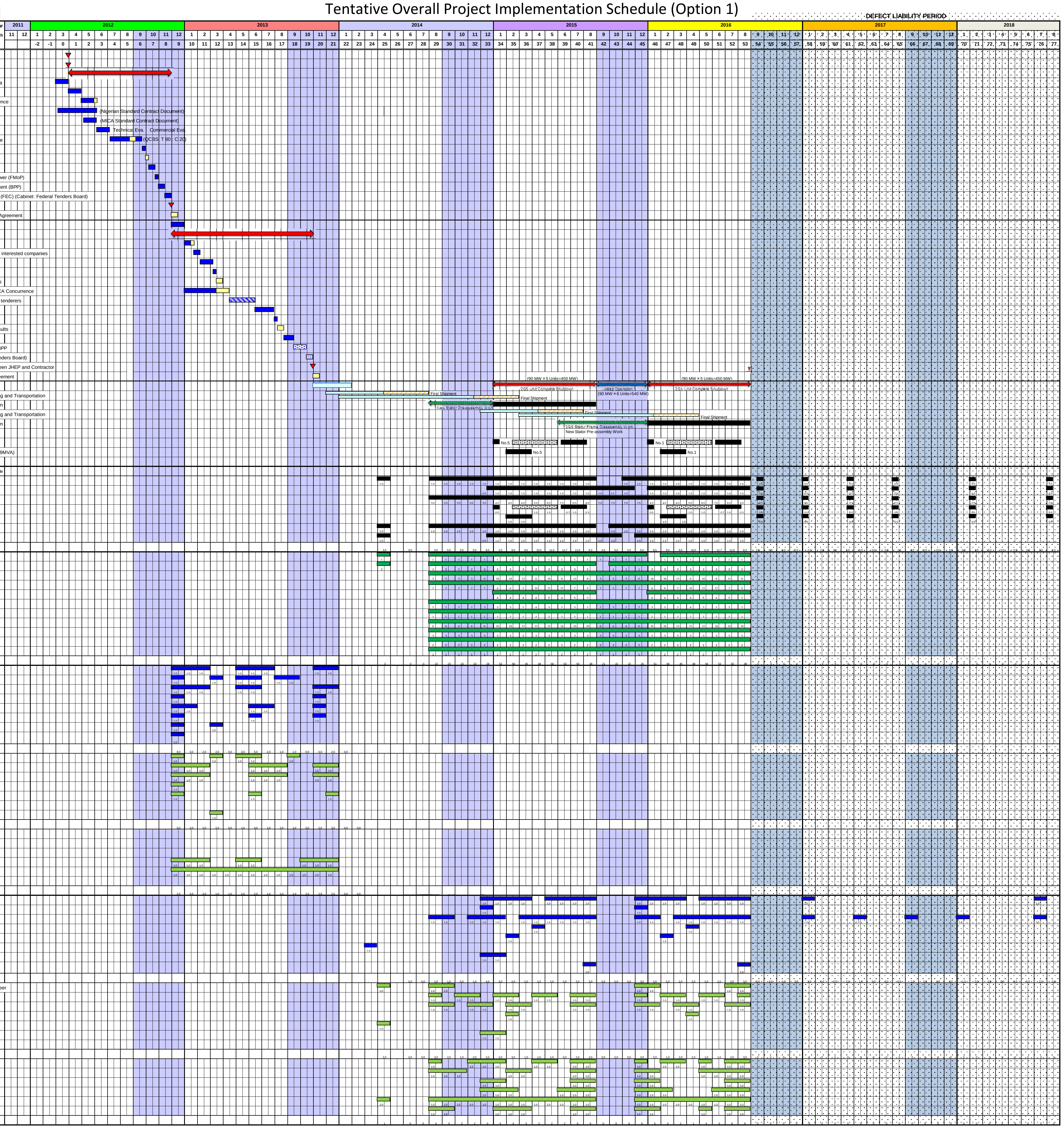


Tentative Project Schedule for Renovation Work (option 3)



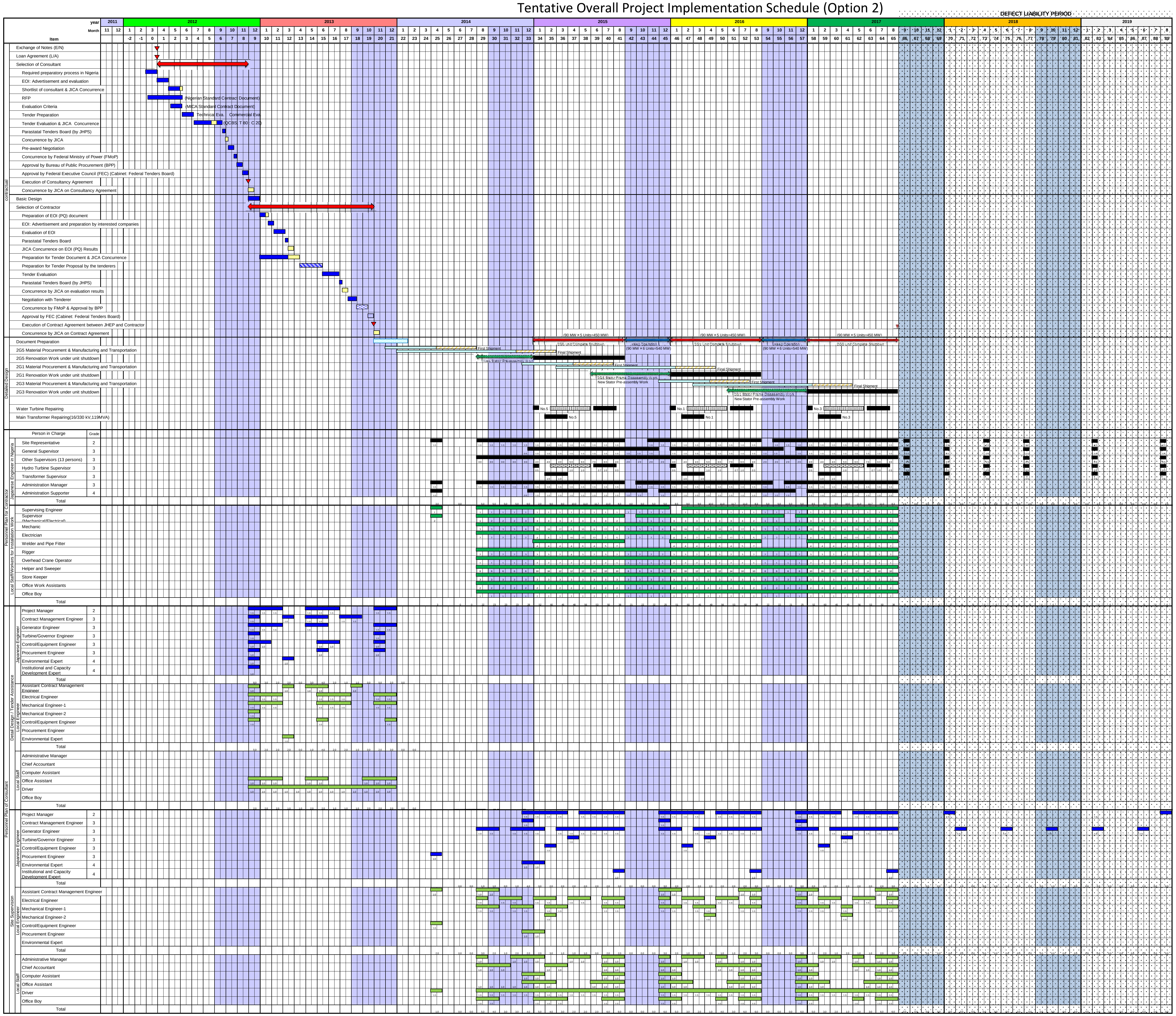
APPENDIX10-2

Tentative Overall Project Implementation Schedule (Option 1)



Section	Item	Grade	Japan (M/M)	Nigeria (M/M)	Local Staff (M/M)	TOTAL (M/M)
contractual	Exchange of Notes (E/N)					
	Loan Agreement (L/A)					
	Selection of Consultant					
	Required preparatory process in Nigeria					
	EOI: Advertisement and evaluation					
	Shortlist of consultant & JICA Concurrence					
	RFP					
	Evaluation Criteria					
	Tender Preparation					
	Tender Evaluation & JICA Concurrence					
	Parastatal Tenders Board (by JHPS)					
	Concurrence by JICA					
	Pre-award Negotiation					
	Concurrence by Federal Ministry of Power (FMoP)					
	Approval by Bureau of Public Procurement (BPP)					
	Approval by Federal Executive Council (FEC) (Cabinet: Federal Tenders Board)					
	Execution of Consultancy Agreement					
	Concurrence by JICA on Consultancy Agreement					
	Basic Design					
	Selection of Contractor					
	Preparation of EOI (PQ) document					
	EOI: Advertisement and preparation by interested companies					
	Evaluation of EOI					
	Parastatal Tenders Board					
	JICA Concurrence on EOI (PQ) Results					
	Preparation for Tender Document & JICA Concurrence					
	Preparation for Tender Proposal by the tenderers					
	Tender Evaluation					
	Parastatal Tenders Board (by JHPS)					
	Concurrence by JICA on evaluation results					
	Negotiation with Tenderer					
	Concurrence by FMoP & Approval by BPP					
	Approval by FEC (Cabinet: Federal Tenders Board)					
	Execution of Contract Agreement between JHEP and Contractor					
	Concurrence by JICA on Contract Agreement					
Detailed Design	Document Preparation					
	2G5 Material Procurement & Manufacturing and Transportation					
	2G5 Renovation Work under unit shutdown					
	2G1 Material Procurement & Manufacturing and Transportation					
	2G1 Renovation Work under unit shutdown					
	Water Turbine Repairing					
	Main Transformer Repairing(16/330 kV,119MVA)					
Personnel Plan for Contractor	Person in Charge	Grade				
Japanese Engineer in Nigeria	Site Representative	2		23.0		23.0
	General Supervisor	3		19.5		19.5
	Other Supervisors (13 persons)	3		103.0		103.0
	Hydro Turbine Supervisor	3		9.0		9.0
	Transformer Supervisor	3		4.0		4.0
	Administration Manager	3		24.0		24.0
	Administration Supporter	4		19.5		19.5
	Total			202.0		202.0
Local Staff/Workers for Installation Work	Supervising Engineer				25.0	
	Supervisor (Mechanical/Electrical)				60.0	
	Mechanic				217.0	
	Electrician				134.0	
	Welder and Pipe Fitter				66.0	
	Rigger				63.0	
	Overhead Crane Operator				39.0	
	Helper and Sweeper				246.0	
	Store Keeper				75.0	
	Office Work Assistants				50.0	
	Office Boy				41.0	
	Total				1,016.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance – Japanese Engineer	Project Manager	2		8.0		8.00
	Contract Management Engineer	3		6.0		6.00
	Generator Engineer	3	1.0	7.0		8.00
	Turbine/Governor Engineer	3	0.0	2.0		2.00
	Control/Equipment Engineer	3	1.0	5.0		6.00
	Procurement Engineer	3	1.0	3.0		4.00
	Environmental Expert	4		2.0		2.00
	Institutional and Capacity Development Expert	4		1.0		1.00
	Total		3.0	34.0		37.00
Local Engineer	Assistant Contract Management Engineer				5.0	
	Electrical Engineer				8.0	
	Mechanical Engineer-1				8.0	
	Mechanical Engineer-2				1.0	
	Control/Equipment Engineer				3.0	
	Procurement Engineer				0.0	
	Environmental Expert				1.0	
	Total		0.0	0.0	26.0	
Local Staff	Administrative Manager				0.0	
	Chief Accountant				0.0	
	Computer Assistant				0.0	
	Office Assistant				8.0	
	Driver				13.0	
	Office Boy				0.0	
	Total		0.0	0.0	21.0	
Site Supervision – Japanese Engineer	Project Manager	2		16.0		
	Contract Management Engineer	3		2.0		
	Generator Engineer	3		19.0		
	Turbine/Governor Engineer	3		2.0		
	Control/Equipment Engineer	3		2.0		
	Procurement Engineer	3		1.0		
	Environmental Expert	4		2.0		
	Institutional and Capacity Development Expert	4		2.0		
	Total		0.0	46.0		
Local Engineer	Assistant Contract Management Engineer				7.0	
	Electrical Engineer				15.0	
	Mechanical Engineer-1				14.0	
	Mechanical Engineer-2				2.0	
	Control/Equipment Engineer				1.0	
	Procurement Engineer				2.0	
	Environmental Expert				0.0	
	Total		0.0	0.0	41.0	
Local Staff	Administrative Manager				14.0	
	Chief Accountant				13.0	
	Computer Assistant				8.0	
	Office Assistant				12.0	
	Driver				23.0	
	Office Boy				12.0	
	Total		0.0	0.0	82.0	

Tentative Overall Project Implementation Schedule (Option 2)



Section	Group	Person in Charge	Grade	Japan (M/M)	Nigeria (M/M)	Local Staff (M/M)	TOTAL (M/M)
Personnel Plan for Contractor	Japanese Engineer in Nigeria	Site Representative	2		34.0		34.0
		General Supervisor	3		30.5		30.5
		Other Supervisors (13 persons)	3		151.0		151.0
		Hydro Turbine Supervisor	3		13.5		13.5
		Transformer Supervisor	3		6.0		6.0
		Administration Manager	3		35.0		35.0
		Administration Supporter	4		30.5		30.5
		Total			300.5		300.5
	Local Staff/Workers for Installation Work	Supervising Engineer				37.0	
		Supervisor (Mechanical/Electrical)				86.0	
		Mechanic				324.0	
		Electrician				200.0	
		Welder and Pipe Fitter				99.0	
		Rigger				93.0	
		Overhead Crane Operator				58.0	
		Helper and Sweeper				366.0	
		Store Keeper				111.0	
		Office Work Assistants				74.0	
		Office Boy				61.0	
		Total				1,509.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Japanese Engineer	Project Manager	2		8.0		8.00
		Contract Management Engineer	3		6.0		6.00
		Generator Engineer	3	0.0	6.0		6.00
		Turbine/Governor Engineer	3	0.0	2.0		2.00
		Control/Equipment Engineer	3	1.0	5.0		6.00
		Procurement Engineer	3	1.0	3.0		4.00
		Environmental Expert	4		2.0		2.00
		Institutional and Capacity Development Expert	4		1.0		1.00
		Total		2.0	33.0		35.00
	Local Engineer	Assistant Contract Management Engineer				5.0	
		Electrical Engineer				8.0	
		Mechanical Engineer-1				8.0	
		Mechanical Engineer-2				1.0	
		Control/Equipment Engineer				3.0	
		Procurement Engineer				0.0	
		Environmental Expert				1.0	
		Total		0.0	0.0	26.0	
	Local Staff	Administrative Manager				0.0	
		Chief Accountant				0.0	
		Computer Assistant				0.0	
		Office Assistant				8.0	
		Driver				13.0	
		Office Boy				0.0	
		Total		0.0	0.0	21.0	
Personnel Plan of Consultant – Site Supervision	Japanese Engineer	Project Manager	2		24.0		
		Contract Management Engineer	3		3.0		
		Generator Engineer	3		27.0		
		Turbine/Governor Engineer	3		3.0		
		Control/Equipment Engineer	3		3.0		
		Procurement Engineer	3		1.0		
		Environmental Expert	4		2.0		
		Institutional and Capacity Development Expert	4		3.0		
		Total		0.0	66.0		
	Local Engineer	Assistant Contract Management Engineer				11.0	
		Electrical Engineer				21.0	
		Mechanical Engineer-1				20.0	
		Mechanical Engineer-2				3.0	
		Control/Equipment Engineer				1.0	
		Procurement Engineer				2.0	
		Environmental Expert				0.0	
		Total		0.0	0.0	58.0	
	Local Staff	Administrative Manager				20.0	
		Chief Accountant				19.0	
		Computer Assistant				12.0	
		Office Assistant				22.0	
		Driver				32.0	
		Office Boy				17.0	
		Total		0.0	0.0	122.0	

Tentative Overall Project Implementation Schedule (Option 3)

DEFECT LIABILITY PERIOD

Legend :
Work in Japan

Years: 2011 (months 11–12), 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020. Month count: -2, -1, 0, 1 … 103.

Section	Group	Item	Grade	Japan (M/M)	Nigeria (M/M)	Local Staff (M/M)	TOTAL (M/M)
contractual		Exchange of Notes (E/N)					
contractual		Loan Agreement (L/A)					
contractual		Selection of Consultant					
contractual		Required preparatory process in Nigeria					
contractual		EOI: Advertisement and evaluation					
contractual		Shortlist of consultant & JICA Concurrence					
contractual		RFP (Nigerian Standard Contract Document)					
contractual		Evaluation Criteria (MICA Standard Contract Document)					
contractual		Tender Preparation (Technical Eva. Commercial Eva.)					
contractual		Tender Evaluation & JICA Concurrence (QCBS; T 80 : C 20)					
contractual		Parastatal Tenders Board (by JHPS)					
contractual		Concurrence by JICA					
contractual		Pre-award Negotiation					
contractual		Concurrence by Federal Ministry of Power (FMoP)					
contractual		Approval by Bureau of Public Procurement (BPP)					
contractual		Approval by Federal Executive Council (FEC) (Cabinet: Federal Tenders Board)					
contractual		Execution of Consultancy Agreement					
contractual		Concurrence by JICA on Consultancy Agreement					
contractual		Basic Design					
contractual		Selection of Contractor					
contractual		Preparation of EOI (PQ) document					
contractual		EOI: Advertisement and preparation by interested companies					
contractual		Evaluation of EOI					
contractual		Parastatal Tenders Board					
contractual		JICA Concurrence on EOI (PQ) Results					
contractual		Preparation for Tender Document & JICA Concurrence					
contractual		Preparation for Tender Proposal by the tenderers					
contractual		Tender Evaluation					
contractual		Parastatal Tenders Board (by JHPS)					
contractual		Concurrence by JICA on evaluation results					
contractual		Negotiation with Tenderer					
contractual		Concurrence by FMoP & Approval by BPP					
contractual		Approval by FEC (Cabinet: Federal Tenders Board)					
contractual		Execution of Contract Agreement between JHEP and Contractor					
contractual		Concurrence by JICA on Contract Agreement					
Detailed Design		Document Preparation					
Detailed Design		2G5 Material Procurement & Manufacturing and Transportation					
Detailed Design		2G5 Renovation Work under unit shutdown					
Detailed Design		2G1 Material Procurement & Manufacturing and Transportation					
Detailed Design		2G1 Renovation Work under unit shutdown					
Detailed Design		2G3 Material Procurement & Manufacturing and Transportation					
Detailed Design		2G3 Renovation Work under unit shutdown					
Detailed Design		2G2 Material Procurement & Manufacturing and Transportation					
Detailed Design		2G2 Renovation Work under unit shutdown					
Detailed Design		Water Turbine Repairing					
Detailed Design		Main Transformer Repairing(16/330 kV,119MVA)					
Personnel Plan for Contractor		Person in Charge	Grade				
Personnel Plan for Contractor	Japanese Engineer in Nigeria	Site Representative	2		45.5		45.5
Personnel Plan for Contractor	Japanese Engineer in Nigeria	General Supervisor	3		39.5		39.5
Personnel Plan for Contractor	Japanese Engineer in Nigeria	Other Supervisors (13 persons)	3		199.5		199.5
Personnel Plan for Contractor	Japanese Engineer in Nigeria	Hydro Turbine Supervisor	3		18.0		18.0
Personnel Plan for Contractor	Japanese Engineer in Nigeria	Transformer Supervisor	3		8.0		8.0
Personnel Plan for Contractor	Japanese Engineer in Nigeria	Administration Manager	3		46.0		46.0
Personnel Plan for Contractor	Japanese Engineer in Nigeria	Administration Supporter	4		41.5		41.5
Personnel Plan for Contractor	Japanese Engineer in Nigeria	Total			398.0		398.0
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Supervising Engineer				48.0	
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Supervisor (Mechanical/Electrical)				110.5	
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Mechanic				431.0	
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Electrician				266.0	
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Welder and Pipe Fitter				132.0	
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Rigger				123.0	
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Overhead Crane Operator				77.0	
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Helper and Sweeper				486.0	
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Store Keeper				147.0	
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Office Work Assistants				98.0	
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Office Boy				81.0	
Personnel Plan for Contractor	Local Staff/Workers for Installation Work	Total				1,999.5	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Japanese Engineer	Project Manager	2		8.0		8.00
Personnel Plan of Consultant – Detail Design / Tender Assistance	Japanese Engineer	Contract Management Engineer	3		6.0		6.00
Personnel Plan of Consultant – Detail Design / Tender Assistance	Japanese Engineer	Generator Engineer	3	1.0	7.0		8.00
Personnel Plan of Consultant – Detail Design / Tender Assistance	Japanese Engineer	Turbine/Governor Engineer	3	0.0	2.0		2.00
Personnel Plan of Consultant – Detail Design / Tender Assistance	Japanese Engineer	Control/Equipment Engineer	3	1.0	5.0		6.00
Personnel Plan of Consultant – Detail Design / Tender Assistance	Japanese Engineer	Procurement Engineer	3	1.0	3.0		4.00
Personnel Plan of Consultant – Detail Design / Tender Assistance	Japanese Engineer	Environmental Expert	4		2.0		2.00
Personnel Plan of Consultant – Detail Design / Tender Assistance	Japanese Engineer	Institutional and Capacity Development Expert	4		1.0		1.00
Personnel Plan of Consultant – Detail Design / Tender Assistance	Japanese Engineer	Total		3.0	34.0		37.00
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Engineer	Assistant Contract Management Engineer				5.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Engineer	Electrical Engineer				9.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Engineer	Mechanical Engineer-1				9.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Engineer	Mechanical Engineer-2				2.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Engineer	Control/Equipment Engineer				10.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Engineer	Procurement Engineer				6.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Engineer	Environmental Expert				1.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Engineer	Total		0.0	0.0	42.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Staff	Administrative Manager				0.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Staff	Chief Accountant				0.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Staff	Computer Assistant				0.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Staff	Office Assistant				8.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Staff	Driver				13.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Staff	Office Boy				0.0	
Personnel Plan of Consultant – Detail Design / Tender Assistance	Local Staff	Total		0.0	0.0	21.0	
Personnel Plan of Consultant – Site Supervision	Japanese Engineer	Project Manager	2		32.0		32.00
Personnel Plan of Consultant – Site Supervision	Japanese Engineer	Contract Management Engineer	3		4.0		4.00
Personnel Plan of Consultant – Site Supervision	Japanese Engineer	Generator Engineer	3		35.0		35.00
Personnel Plan of Consultant – Site Supervision	Japanese Engineer	Turbine/Governor Engineer	3		4.0		4.00
Personnel Plan of Consultant – Site Supervision	Japanese Engineer	Control/Equipment Engineer	3		4.0		4.00
Personnel Plan of Consultant – Site Supervision	Japanese Engineer	Procurement Engineer	3		1.0		1.00
Personnel Plan of Consultant – Site Supervision	Japanese Engineer	Environmental Expert	4		2.0		2.00
Personnel Plan of Consultant – Site Supervision	Japanese Engineer	Institutional and Capacity Development Expert	4		4.0		4.00
Personnel Plan of Consultant – Site Supervision	Japanese Engineer	Total		0.0	86.0		86.00
Personnel Plan of Consultant – Site Supervision	Local Engineer	Assistant Contract Management Engineer				15.0	
Personnel Plan of Consultant – Site Supervision	Local Engineer	Electrical Engineer				27.0	
Personnel Plan of Consultant – Site Supervision	Local Engineer	Mechanical Engineer-1				33.0	
Personnel Plan of Consultant – Site Supervision	Local Engineer	Mechanical Engineer-2				4.0	
Personnel Plan of Consultant – Site Supervision	Local Engineer	Control/Equipment Engineer				1.0	
Personnel Plan of Consultant – Site Supervision	Local Engineer	Procurement Engineer				2.0	
Personnel Plan of Consultant – Site Supervision	Local Engineer	Environmental Expert				0.0	
Personnel Plan of Consultant – Site Supervision	Local Engineer	Total		0.0	0.0	82.0	
Personnel Plan of Consultant – Site Supervision	Local Staff	Administrative Manager				26.0	
Personnel Plan of Consultant – Site Supervision	Local Staff	Chief Accountant				25.0	
Personnel Plan of Consultant – Site Supervision	Local Staff	Computer Assistant				16.0	
Personnel Plan of Consultant – Site Supervision	Local Staff	Office Assistant				24.0	
Personnel Plan of Consultant – Site Supervision	Local Staff	Driver				42.0	
Personnel Plan of Consultant – Site Supervision	Local Staff	Office Boy				22.0	
Personnel Plan of Consultant – Site Supervision	Local Staff	Total		0.0	0.0	155.0	

Appendix-11

Terms of Reference for Consulting Services

APPENDIX-11

Terms of Reference for Consulting Services

1. Project Information

1.1 Background Information

The Federal Republic of Nigeria (Nigeria) has been facing with an absolute shortage of electricity supply amidst burgeoning demand to sustain the living and activity of its population of approximately 150 million. Under a background of sluggish investment, existing facilities are becoming increasingly deteriorated and reliable plant capacity (average actual capacity in 2010) is only 3,825 MW with respect to estimated demand of 6,836 MW. Jebba Hydroelectric Power Station (JHPS) with rated output 578.4 MW is a major and most reliable facility that accounts for roughly 12.5 percent of Nigeria's total generating capacity, however, it hasn't undergone a full-scale overhaul since being its operational start in 1983 and the advancing deterioration of equipment at the station signifies that it is in urgent need of renovation. The Japan International Cooperation Agency (JICA) provides ODA Project Loan for the Project to renovate Jebba Hydroelectric Power Station in order to contribute to the state power policies of stabilizing power supply and diversifying energy sources in Nigeria and to mitigate greenhouse gas emissions by alleviating the risk of breakdown at the electric power station.

The Federal Government of Nigeria (FGN) shall use the proceeds of the Loan for purchase of goods and services (including consultant's services) for implementation of the Project.

1.2 Location of the Project

JHPS is located at N = 9°08′14.53″ and E = 4°47′32.89″ on the border between Kwara State and Niger State in the north central part of Nigeria.
Location map of the Project Site is as shown in Figure -1.

1.3 Executing and Implementing Agencies

Borrower:	Federal Ministry of Finance
Executing Agency:	Jebba Hydro Electric Plc.

2. Other Relevant Information

2.1 Financing

The proceeds of the loan will be allocated to:
- Consulting services,
- Procurement of domestic and imported equipments/materials, and
- Renovation works.

And not eligible for financing to:
- General administration expenses,
- Taxes and duties,
- Purchase of land and other real property,
- Compensation, and
- Other indirect items.

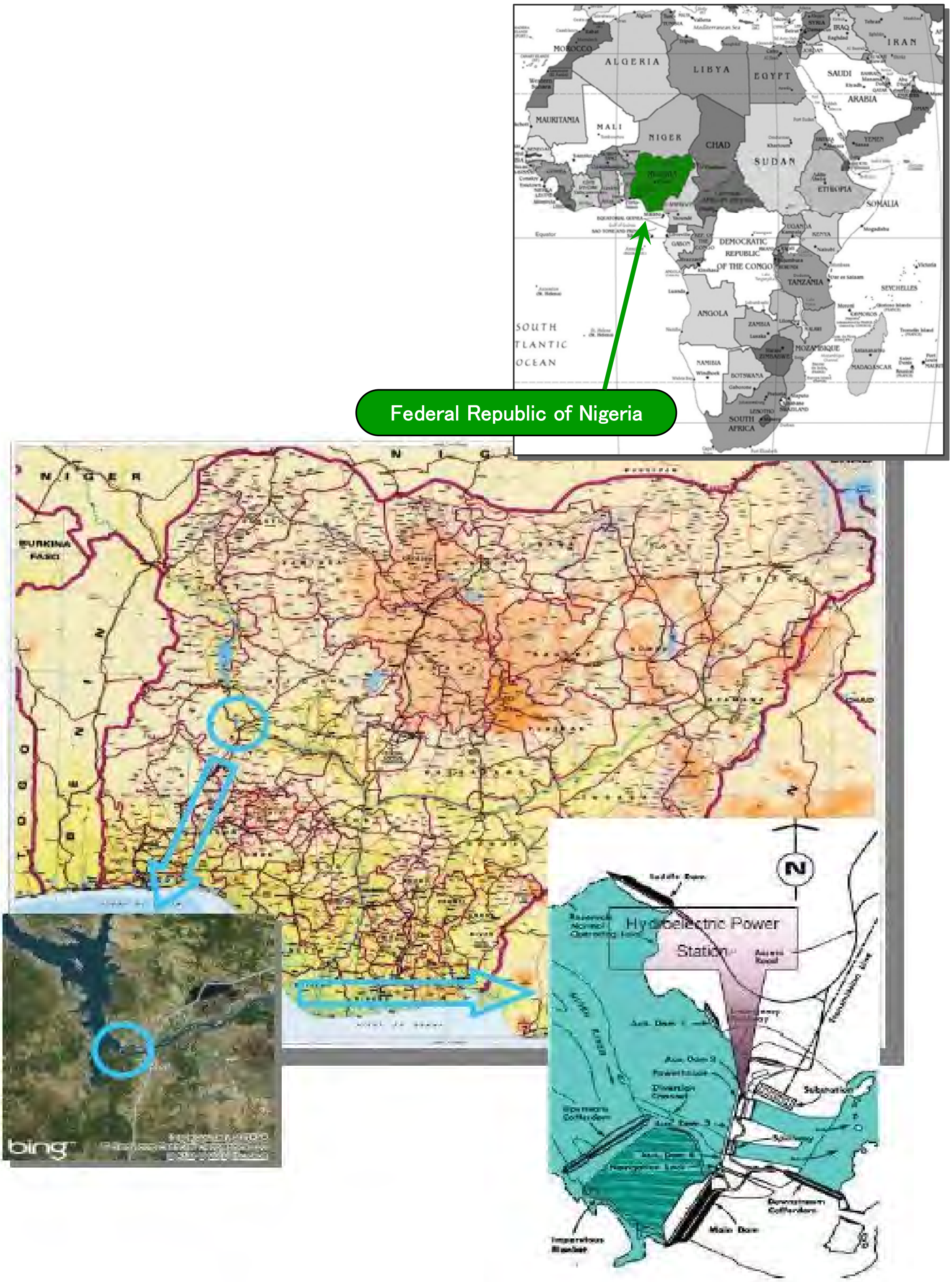


Figure -1: Location map of Jebba Hydroelectric Power Station

2.2 Relevant Laws and Regulations

The Project must be carried out in accordance with the terms and conditions of the Loan Agreement, Guidelines for Employment of Consultants and Procurement of Goods and Services by JICA and the rules and regulations relating to construction investment and procurement of FGN.

3. General Terms of Reference

3.1 Objectives of the Project

Rehabilitation of the hydroelectric power generation units of [*insert unit number from Note below depending on which option to be taken*] at JHPS and strengthening of the capacity of implementation agency

[Note]

Option 1: 2G1 and 2G5
Option 2: 2G1, 2G3 and 2G5
Option 3: 2G1, 2G2, 2G3 and 2G5

3.2 Scope of Services

To achieve the above objectives of the Project to contribute to the state power policies of stabilising power supply and diversifying energy sources in Nigeria and to mitigate greenhouse gas emissions by alleviating the risk of breakdown at the electric power station, the consultant will undertake the following services:

(1) Overall Project Management
The consultant shall assist JHPS in overall management of the Project for all components on physical, financial and institutional matters including formulation of project management plans and other plans, monitoring, supervision, preparation of various reports including construction monthly reports and completion reports, and advice on problems/ bottlenecks prevailing or anticipated and countermeasures/ corrective actions required.

(2) Review of Pre-investment Studies
The consultant shall assist JHPS in review of pre-investment studies, including the JICA related studies.

(3) Basic Design Reports
The consultant shall prepare Basic Designs for the Project, Basic Design Reports for the Project, based on field investigation on the latest conditions of generation facilities and thorough examination of adequate technology and implementation measures particularly on rehabilitation of hydropower generation facilities, environmental impacts countermeasures, and facilities operations systems and seek for JHPS's approval. During preparation of the Basic Design Reports the consultant shall seek concurrence from JHPS on every stage of preparation. Basic Design Reports shall include the contents described in Annex 1.

(4) Preparation of Documents for Expression of Interest (Pre-qualification) and Evaluation
The consultant shall assist JHPS in preparation of EOI (PQ) documents for the Project and seeking concurrence from JICA, evaluation of EOI proposals, preparation of EOI evaluation reports with recommendation for approval by JHPS and concurrence of JICA.

(5) Preparation of Tender Documents
The consultant shall assist JHPS in preparation of Tender documents for the Project based on Nigerian standard contract documents with adjustment if necessary to suit for JICA sample contract document

to facilitate concurrence from JICA. Tender Documents shall include the contents described in Annex 2.

(7) Tender Assistance
The consultant shall assist JHPS in handling tender procedures in accordance with JICA and Nigerian regulations. The services include preparation and arrangement for tender announcement, pre-bid meeting, site visit before tendering for interested tenderers, supply information or other necessary supports that tenderers may need including response to queries from tenderers and issuance of addendum if necessary, close and receipt of tender, tender opening, tender evaluation, clarification of tenders if required, preparation of tender evaluation report with recommendation for approval by JHPS and concurrence of JICA, preparation for tenders board and preparation of required documents for submission for approval to Bureau of Public Procurement and Federal Tenders Board and other documentations and actions as and when required by JHPS.

(8) Conclusion of contract with the successful tenderer
The consultant shall assist JHPS in conclusion of contract with the successful tenderer in accordance with JICA and Nigerian regulations. The services include preparation of draft contracts to be submitted to Nigerian authorities for approval and JICA for concurrence, support JHPS in contract negotiation with tenderes if necessary, preparation of all relevant contractual documents of works for the Project and assist in conclusion of contract between JHPS and the contractor.

(9) Renovation Work Supervision
The consultant shall assist JHPS in convening kick-off meetings for smooth commencement of the works, review of procedures, plan and detailed designs submitted by the contractor, suggestion of modifications and preparation of variation orders if required, monitoring of work progress, verification of invoices including measurement of works for payment, and dispute resolution.

(10) Environmental Monitoring
The consultant shall assist JHPS in preparation of JICA's Monitoring Form through monitoring and supervision of removal, internal transportation and temporary storage of asbestos-containing wastes by the contractor and monitoring and supervision of hand over to a local professional treatment company of the wastes in coordination with the National Environmental Standards and Regulations Enforcement Agency.

(11) Capacity Development
The consultant shall assist JHPS in preparation of annual plans, implementation of training and study tours held locally and abroad (coverage of costs to be separately supplied), establishment of the management system for the operation and maintenance of the Project facilities and monitoring and evaluation related to Capacity Development.

The capacity development components shall include operation and maintenance planning and implementation, and development of institutional and financial capabilities.

JHPS shall designate the necessary staff and allocate them the time to undergo the capacity development program with the consultant.

(12) Institutional Strengthening for Project Sustainability
The consultant shall assist JHPS in preparing a post-implementation management plan with suggestions for necessary institutional strengthening for project sustainability and operation and maintenance of the assets renovated under the Project.

(13) Financial Management
The consultant shall assist and advise JHPS on matters related to project accounts, their maintenance, and preparation of disbursement requests.

(l4) Liaison with JICA
The consultant shall assist JHPS in liaison with JICA including coordination between JICA and JHPS, providing advice on JICA's procedures and facilitating to expedite documents, such as application for concurrence by JICA with regard to the procurement procedures, the progress reports ("P/R") to JICA without delay on a quarterly basis until completion of the Project, and the project completion report ("PCR") to JICA promptly in any event not later than 6 months after completion of the Project.

(15) Monitoring and Evaluation
The consultant shall assist JHPS in evaluation of the Project implementation progress at different stages of the Project, including establishment of baseline data and preparation of reports.

(16) Documentation of Replicable Experiences
The consultant shall assist JHPS in documentation of the useful and replicable lessons and experiences as a first-ever model project in Nigeria to be disseminated to other similar projects in Nigeria by synthesising project experiences and lessons, generalising them to become model for the other areas and preparing effective presentation materials.

(17) Services during Defect Liability Period (DLP)
The consultant shall assist JHPS in monitoring the performance and condition of renovated parts of generation facilities under the Project periodically based on site investigations and routine reporting to be prepared by JHPS on the matter. If any defect or other fault in the renovated works appears at any time prior to the end of the Defect Liability Period, the consultant shall assist JHPS in searching the cause of any defect or other fault and settling the matter in accordance with the provision of the contract.

3.3 Reports

The consultant shall prepare the following reports and documents in English and submit to JHPS both in hard and soft copies:

(1) Inception Report
(2) Basic Design Reports
(3) EOI (P/Q) Documents
(4) Tender Documents
(5) Tender Evaluation Reports
(6) Construction Monthly Reports including quality analysis and quality control
(7) Completion Reports

Other necessary reports and documents may be provided as required.

3.4 Implementation Period for the Project

The Project is expected to be completed in [*insert number of months and completion year from Note below depending on which option to be taken*].

[Note]

Option 1: 34 months by the end of August 2016
Option 2: 46 months by the end of August 2017
Option 3: 58 months by the end of August 2018

3.5 Requirements by JICA

(1) Difference of Opinion between the Borrower and the Consultant

In case of a difference of Opinion between the Borrower and the consultant on any important matters involving professional judgment that might affect the proper evaluation or execution of the Project, the

Borrower shall allow the consultants to submit promptly to the Borrower a written report and, simultaneously, to submit a copy to JICA. The Borrower shall forward the report to JICA with its comments in time to allow JICA to study it and communicate with the Borrower before any irreversible steps are taken on the matter. In cases of urgency, a consultant shall have the right to request the Borrower and/or JICA that the matter be discussed immediately between the Borrower and JICA.

(2) Monitoring by JICA

(1) The Borrower is responsible for supervising the consultant's performance and ensuring that the consultant carries out the assignment in accordance with the contract. Without assuming the responsibilities of the Borrower or the consultant, JICA may monitor the work as necessary in order to satisfy itself that it is being carried out in accordance with appropriate standards and is based on acceptable data.

(2) As appropriate, JICA may take part in discussions between the Borrower and the consultant. However, JICA shall not be liable in any way for the implementation of the Project by reason of such monitoring or participation in discussions. Neither the Borrower nor the consultant shall be released from any responsibility for the Project by reason of JICA's monitoring or participation in discussion.

(3) This provision shall be clearly stated in the agreement between the Borrower and the consultant.

4. Specific Terms of Reference

4.1 Responsibility of the consultant

(1) Project Manager (International)

The Project Manager (PM) is responsible for overall delivery of the proposed Project's technical and contractual as well as managerial aspects, in addition to overall coordination as Team Leader. The roles of PM are, therefore, to assist JHPS in attaining smooth and efficient implementation of the Project and coordinating the activities of consultants in the respective expertise through the following services:

1) Review the deliverables to be prepared by the consultant,

2) Overview all activities to be performed by the consultant,

3) Assist JHPS in pre-qualification and selection through tender of the contractor for the Project,

4) Assist JHPS in negotiation and conclusion of the contract with the successful tenderer,

5) Assist JHPS in commencement of renovation works by the contractor,

6) Assist in monitoring and evaluation of the Project implementation including physical and financial progress,

7) Assist JICA loan procedures covering
   - Administration of the loan budget, and
   - Preparation of information and data for reporting to JICA,

8) Assist JHPS in conducting, monitoring and evaluating the training programs on Operation and Maintenance implementation for staffs of JHPS,

9) Assist JHPS in implementation, monitoring and evaluation of institutional and capacity development activities, and

10) Assist JHPS in monitoring of conditions and performance of the renovated parts under the Project during DLP, searching the cause of any defect or other default if appeared during DLP and settling the matter in accordance with the provision of the contract.

(2) Contract Management Engineer (International)/ Assistant Contract Management Engineer (Local)

The main objectives of the consulting services for the contract management engineer are to advise and assist JHPS in management of the contract for the Project. Contract management engineer shall compile tender document and contract document in viewpoint of contractual management, review and evaluate the compliance to the contract for the Project between JHPS and the contractor at the implementation stage to complete the renovation work. The main scope of work for the contract management engineer is as follows:

1) Review of the pre-investment study reports of the Project and provision of advice required for contract management of the Project,

2) Preparation of EOI (pre-qualification) documents, evaluation of the EOI documents submitted by interested companies and preparation of EOI evaluation reports,

3) Preparation of Tender documents and review of other part of Tender documents prepared by the assigned engineers of the consultant in terms of contractual consistency,

4) Assistance in commercial evaluation of tenders submitted by pre-qualified tenderers,

5) Assistance in negotiation with tenderers,

6) Assistance in preparation of contract document between JHPS and the contractor,

7) Assistance in monitoring and evaluation of the contractor’s compliance to the Contract for the Project,

8) Assistance in preparation of variation orders as and when required based on the review of the contractor’s claim evidence in compliance with the Contract, and

9) Assist JHPS in monitoring of conditions and performance of the renovated parts under the Project during DLP, searching the cause of any defect or other default if appeared during DLP and settling the matter in accordance with the provision of the contract.

(3) Generator Engineer (Internatinal)/ Electrical Engineer and Mechanical Engineer-1 (Local)

The main objectives of the consulting services for the generator engineer are to review the pre-investment study, to conduct field investigation of generators concerned, to prepare basic design, EOI (P/Q) documents and technical specification for tendering, to prepare evaluation report of EOI and tender, to review and evaluate the Project at the implementation stage to complete the renovation work with good quality and appropriate period, and to assist O&M planning for increase in sustainability of the Project. The main scope of work for the generator engineer is as follows:

1) Review of the pre-investment study reports of the Project and provision of advice for their improvement from a technical viewpoint, if necessary,

2) Conduct field investigation of generators subject for renovation under the Project in order to identify any additional recuperative measures to be included in the scope of the renovation works or not,

3) Review schedule and method of renovation work pertaining to generator including disassembly, internal transportation and temporary storage of asbestos-containing parts and wastes in the Project,

4) Preparation of basic design report and technical specifications in relation to renovation of generator including disassembly, internal transportation and temporary storage of asbestos-containing parts and wastes for tendering,

5) Preparation of EOI (pre-qualification) documents, evaluation of the EOI documents submitted by interested companies and preparation of EOI evaluation reports,

6) Assistance in pre-bid meeting, site visit before tendering for interested tenderers, supply information or other necessary supports that tenderers may need including response to queries

from tenderers and issuance of addendum if necessary in relation to generator including disassembly, internal transportation and temporary storage of asbestos-containing parts and wastes,

7) Assistance in evaluation and clarifications, if necessary, of technical proposals and preparation of tender evaluation report in relation to generator including disassembly, internal transportation and temporary storage of asbestos-containing parts and wastes submitted by pre-qualified tenderers,

8) Assistance in technical negotiation with tenderers in terms of generator including disassembly, internal transportation and temporary storage of asbestos-containing parts and wastes,

9) Assistance in preparation of technical portion of contract document,

10) Assistance in monitoring and evaluation of the Project implementation including performance, progress and quality control of the works undertaken by the contractor for the Project,

11) Assistance in assessment of variation orders in relation to generator if required,

12) Provide advice and support to the Project owners for effective operation and maintenance system,

13) Preparation of training program related to the Project, and

14) Assist JHPS in monitoring of conditions and performance of the renovated parts of generator under the Project during DLP, searching the cause of any defect or other default if appeared during DLP and settling the matter in accordance with the provision of the contract.

(4) Turbine/ Governor Engineer (International)/ Mechanical Engineer-2 (Local)

The main objectives of the consulting services for the turbine/ governor engineer are to review the pre-investment study, to conduct field investigation of turbines/ governors concerned, to prepare basic design, EOI (P/Q) documents and technical specification for tendering, to prepare evaluation report of EOI and tender, to review and evaluate the Project at the implementation stage to complete the renovation work with good quality and appropriate period, and to assist O&M planning for increase in sustainability of the Project. The main scope of work for the generator engineer is as follows:

1) Review of the pre-investment study reports of the Project and provision of advice for their improvement from a technical viewpoint, if necessary,

2) Conduct field investigation of turbines/ governors subject for renovation under the Project in order to identify any additional recuperative measures to be included in the scope of the renovation works or not,

3) Review schedule and method of renovation work pertaining to turbines/ governors in the Project,

4) Preparation of basic design report and technical specifications in relation to renovation of turbines/ governors for tendering,

5) Preparation of EOI (pre-qualification) documents, evaluation of the EOI documents submitted by interested companies and preparation of EOI evaluation reports,

6) Assistance in pre-bid meeting, site visit before tendering for interested tenderers, supply information or other necessary supports that tenderers may need including response to queries from tenderers and issuance of addendum if necessary in relation to turbines/ governors,

7) Assistance in evaluation and clarifications, if necessary, of technical proposals and preparation of tender evaluation report in relation to turbines/ governors submitted by pre-qualified tenderers,

8) Assistance in technical negotiation with tenderers in terms of turbines/ governors,

9) Assistance in preparation of technical portion of contract document,

10) Assistance in monitoring and evaluation of the Project implementation including performance, progress and quality control of the works undertaken by the contractor for the Project,

11) Assistance in assessment of variation orders in relation to turbines/ governors if required,

12) Provide advice and support to the Project owners for effective operation and maintenance system,

13) Preparation of training program related to the Project, and

14) Assist JHPS in monitoring of conditions and performance of the renovated parts of turbine/ governor under the Project during DLP, searching the cause of any defect or other default if appeared during DLP and settling the matter in accordance with the provision of the contract.

(5) Control/ Equipment Engineer (International and Local)

The main objectives of the consulting services for the control/ equipment engineer are to review the pre-investment study, to conduct field investigation of control/ equipment concerned, to prepare basic design, EOI (P/Q) documents and technical specification for tendering, to prepare evaluation report of EOI and tender, to review and evaluate the Project at the implementation stage to complete the renovation work with good quality and appropriate period, and to assist O&M planning for increase in sustainability of the Project. The main scope of work for the control/ equipment engineer is as follows:

1) Review of the pre-investment study reports of the Project and provision of advice for their improvement from a technical viewpoint, if necessary,

2) Conduct field investigation of control/ equipment subject for renovation under the Project in order to identify any additional recuperative measures to be included in the scope of the renovation works or not,

3) Review schedule and method of renovation work pertaining to control/ equipment in the Project,

4) Preparation of basic design report and technical specifications in relation to renovation of control/ equipment for tendering,

5) Preparation of EOI (pre-qualification) documents, evaluation of the EOI documents submitted by interested companies and preparation of EOI evaluation reports,

6) Assistance in pre-bid meeting, site visit before tendering for interested tenderers, supply information or other necessary supports that tenderers may need including response to queries from tenderers and issuance of addendum if necessary in relation to control/ equipment,

7) Assistance in evaluation and clarifications, if necessary, of technical proposals and preparation of tender evaluation report in relation to control/ equipment submitted by pre-qualified tenderers,

8) Assistance in technical negotiation with tenderers in terms of control/ equipment,

9) Assistance in preparation of technical portion of contract document,

10) Assistance in monitoring and evaluation of the Project implementation including performance, progress and quality control of the works undertaken by the contractor for the Project,

11) Assistance in assessment of variation orders in relation to control/ equipment if required,

12) Provide advice and support to the Project owners for effective operation and maintenance system,

13) Preparation of training program related to the Project, and

14) Assist JHPS in monitoring of conditions and performance of the renovated parts of control/ equipment under the Project during DLP, searching the cause of any defect or other default if appeared during DLP and settling the matter in accordance with the provision of the contract.

(6) Procurement Engineer (International and Local)

The main objectives of the consulting services for the procurement engineer are to review the pre-investment study, to conduct market research for project costs estimation, to prepare basic design and technical specification for tendering, to review and evaluate the Project at the implementation stage to complete the renovation work with good quality under appropriate period and reasonable Project cost. Procurement engineer will be assigned only for basic design / tendering stage. The main scope of work for the procurement engineer is as follows:

1) Review of the pre-investment study reports of the Project in consideration of market and economical conditions surrounding the Project at the time of basic design / tendering stage and provision of advice for their improvement from a viewpoint of procurement, if necessary,

2) Review schedule and method of renovation work pertaining to procurement for the Project,

3) Assistance in estimating the Project Cost to formulate the owner's budget for Tendering,

4) Preparation of basic design report and technical specifications in relation to procurement for Tendering,

5) Preparation of EOI (pre-qualification) documents, evaluation of the EOI documents submitted by interested companies and preparation of EOI evaluation reports,

6) Assistance in pre-bid meeting, site visit before tendering for interested tenderers, supply information or other necessary supports that tenderers may need including response to queries from tenderers and issuance of addendum if necessary in relation to procurement,

7) Assistance in evaluation and clarifications, if necessary, of technical proposals and preparation of tender evaluation report in relation to procurement submitted by pre-qualified tenderers,

8) Assistance in technical negotiation with tenderers in terms of procurement, and

9) Assistance in preparation of technical portion of contract document.

(7) Environmental Expert (International and Local)

The main objectives of the consulting services for the environmental expert are to review the pre-investment study, to conduct field investigation regarding environmental protection and occupational health, to prepare basic design, EOI (P/Q) documents and technical specification for tendering, to prepare evaluation report of EOI and tender, to review and evaluate the Project at the implementation stage to complete the renovation work in terms of environmental and occupational health including asbestos-containing parts/wastes. The main scope of work for the environmental expert is as follows:

1) Review of the pre-investment study reports of the Project and provision of advice for their improvement from an environmental viewpoint, if necessary,

2) Conduct field investigation regarding environmental protection and occupational health associated with renovation work under the Project in order to identify any additional recuperative measures to be included in the scope of the renovation works or not,

3) Review schedule and method of renovation work pertaining to environmental protection and occupational health in the Project,

4) Preparation of basic design report and technical specifications in relation to environmental protection and occupational health associated with renovation work for tendering,

5) Assistance in preparation of environmental and occupational health portion of contract document,

6) Assistance in monitoring and evaluation of the Project implementation including performance, progress and quality control of the works in relation to environmental protection and occupational health undertaken by the contractor for the Project, and

7) Provide advice and support to the Project owners for effective transportation, disposal and treatment of hazardous waste, if necessary, in particular asbestos contained parts.

(8) Institutional and Capacity Development Expert (International)

The main objectives of the consulting services for the institutional and capacity development expert are to review the pre-investment study, to conduct investigation of latest situation of institution and capacity of staff in JHPS, to prepare basic design and technical specification for tendering, to assist JHPS for preparation of capacity development programs covering national workshop and training, overseas training and other programs related to the Project implementation, and operation and maintenance of the station. The main scope of work for the expert is as follows:

1) Review of the pre-investment study reports of the Project and provision of advice for their improvement from a viewpoint of institutional and capacity development, if necessary,
2) Conduct field investigation regarding institutional and capacity development necessary for effective utilization of generation facilities after renovation work under the Project,
3) Review schedule and method of renovation work from a viewpoint of effective and timely execution of institutional and capacity development in the Project,
4) Preparation of basic design report and technical specifications in relation to institutional and capacity development program and training to be proposed by the tenderers along with the progress of renovation work, training including seminars, domestic trainings, on-the-job training, overseas trainings and other trainings, if necessary,
5) Assistance in preparation of technical portion of contract document in terms of institutional and capacity development / training,
6) Assistance in monitoring and evaluation of the Project implementation including performance, progress and quality control of the institutional and capacity development / training works undertaken by the contractor for the Project,
7) Assistance in assessment of variation orders in relation to institutional and capacity development / training,
8) Assist JHPS to implement and evaluate the capacity development programs, and
9) Prepare the training program reports using available information.

5. Staffing and Schedule

5.1 Staffing

It is estimated that the international and local consultants who shall be required for providing consulting services to implement the Projects are shown in the following table: However, the specialists proposed could be modified based on the actual requirement of the consulting services.

Table - 1 Estimated Input of International and Local Consultants and Local Staffs

Positions	No.	Option 1		Option 2		Option 3	
		Person-months	Total	Person-months	Total	Person-months	Total
1. Basic Design / Tender Assistance Stage							
International Consultants							
1) Project Manager	1	6.0	6.0	6.0	6.0	6.0	6.0
2) Contract Management Engineer	1	6.0	6.0	6.0	6.0	6.0	6.0
3) Generator Engineer	1	5.0	5.0	5.0	5.0	5.0	5.0
4) Turbine/ Governor Engineer	1	1.0	1.0	1.0	1.0	1.0	1.0
5) Control/Equipment Engineer	1	4.0	4.0	4.0	4.0	4.0	4.0
6) Procurement Engineer	1	2.0	2.0	2.0	2.0	2.0	2.0
7) Environmental Expert	1	2.0	2.0	2.0	2.0	2.0	2.0
8) Institutional and Capacity Development Expert	1	1.0	1.0	1.0	1.0	1.0	1.0
Sub-total	8	-	27.0	-	27.0	-	27.0

Local Consultants							
1) Assistant Contract Management Engineer	1	5.0	5.0	5.0	5.0	5.0	5.0
2) Mechanical Engineer 1	1	6.0	6.0	6.0	6.0	6.0	6.0
3) Mechanical Engineer 2	1	1.0	1.0	1.0	1.0	1.0	1.0
4) Electrical Engineer	1	6.0	6.0	6.0	6.0	6.0	6.0
5) Control/Equipment Engineer	1	2.0	2.0	2.0	2.0	2.0	2.0
6) Environmental Expert	1	1.0	1.0	1.0	1.0	1.0	1.0
Sub-total	6	-	21.0	-	21.0	-	21.0
Local Staff							
1) Office assistant	1	6.0	6.0	6.0	6.0	6.0	6.0
2) Driver	1	11.0	11.0	11.0	11.0	11.0	11.0
Sub-total	2	-	17.0	-	17.0	-	17.0
International Consultants			27.0		27.0		27.0
Local Consultants			21.0		21.0		21.0
Local Staff			17.0		17.0		17.0

Table - 1 Estimated Input of International and Local Consultants and Local Staffs (cont'd)

Positions	**No.**	**Option 1**		**Option 2**		**Option 3**	
		Person-months	**Total**	**Person-months**	**Total**	**Person-months**	**Total**
2. Site Supervision Stage							
International Consultants							
1) Project Manager	1	18.0	18.0	26.0	26.0	34.0	34.0
2) Contract Management Engineer	1	2.0	2.0	3.0	3.0	4.0	4.0
3) Generator Engineer	1	21.0	21.0	29.0	29.0	37.0	37.0
4) Turbine/ Governor Engineer	1	3.0	3.0	4.0	4.0	5.0	5.0
5) Control/Equipment Engineer	1	3.0	3.0	4.0	4.0	5.0	5.0
6) Procurement Engineer	1	2.0	2.0	2.0	2.0	2.0	2.0
7) Environmental Expert	1	2.0	2.0	2.0	2.0	2.0	2.0
8) Institutional and Capacity Development Expert	1	2.0	2.0	3.0	3.0	4.0	4.0
Sub-total	8	-	53.0	-	73.0	-	93.0
Local Consultants							
1) Assistant Contract Management Engineer	1	7.0	7.0	11.0	11.0	15.0	15.0
2) Mechanical Engineer 1	1	16.0	16.0	22.0	22.0	28.0	28.0
3) Mechanical Engineer 2	1	2.0	2.0	3.0	3.0	4.0	4.0
4) Electrical Engineer	1	17.0	17.0	23.0	23.0	29.0	29.0

5) Control/Equipment Engineer	1	2.0	2.0	2.0	2.0	2.0	2.0
6) Procurement Engineer	1	2.0	2.0	2.0	2.0	2.0	2.0
Sub-total	6	-	46.0	-	63.0	-	80.0
Local Staff							
1) Administrative manager	1	14.0	14.0	20.0	20.0	26.0	26.0
2) Chief accountant	1	13.0	13.0	19.0	19.0	25.0	25.0
3) Computer Assistant	1	8.0	8.0	12.0	12.0	16.0	16.0
4) Office assistant	1	14.0	14.0	20.0	20.0	26.0	26.0
5) Driver	1	25.0	25.0	34.0	34.0	43.0	43.0
6) Office Boy	1	12.0	12.0	17.0	17.0	22.0	22.0
Sub-total	6	-	86.0	-	122.0	-	158.0
International Consultants			53.0		73.0		93.0
Local Consultants			46.0		63.0		80.0
Local Staff			86.0		122.0		158.0

Table - 1 Estimated Input of International and Local Consultants and Local Staffs (cont'd)

Positions	No.	Option 1		Option 2		Option 3	
		Person-months	Total	Person-months	Total	Person-months	Total
3. Defect Liability Stage							
International Consultants							
1) Project Manager	1	2.0	2.0	2.0	2.0	2.0	2.0
3) Generator Engineer	1	5.0	5.0	5.0	5.0	5.0	5.0
Sub-total	2	-	7.0	-	7.0	-	7.0
International Consultants			7.0		7.0		7.0
Grand Total			257.0		330.0		403.0
International Consultants			87.0		107.0		127.0
Local Consultants			67.0		84.0		101.0
Local Staff			103.0		139.0		175.0

5.2 Qualifications

5.2.1 International Consultants

(1) Project Manager is professional engineer with at least 15 years in general and 10 years in design and construction supervision in power sector projects. Project Manager shall have been engaged as team leader or project manager in at least 2 international projects in design and construction supervision in power sector projects.

(2) Contract Management engineer is professional engineer with at least 10 working years and 7 years in design or supervision in international projects. Contract Management Engineer shall have work experience as contract engineer for at least 3 international projects of design and/or construction supervision projects.

(3) Generator Engineer is professional electro-mechanical engineer with at least 10 working years and 7 years in design and/or supervision of installation works of power generator. Generator Engineer shall have work experience as electro-mechanical engineer for at least 3 design and/or installation supervision projects.

(4) Turbine/ Governor Engineer is professional mechanical engineer with at least 10 working years and 7 years in design and/or supervision of installation works for water turbine/ governor. Turbine/ Governor Engineer shall have work experience as mechanical engineer for at least 3 design and/or installation supervision projects.

(5) Control/ Equipment Engineer is professional electrical engineer with at least 10 working years and 7 years in design and/or supervision of installation works of control/ equipment. Control/ Equipment Engineer shall have work experience as electrical engineer for at least 3 design and/or installation supervision projects.

(6) Procurement Engineer is professional engineer with at least 10 working years and 7 years in design and Tender assistance in the related installation field. Procurement Engineer shall have work experience as procurement engineer for at least 3 design and/or installation supervision projects.

(7) Environmental Expert is professional environment expert with at least 10 working years and 7 years in design and/or construction supervision for construction works. Environmental Expert shall have work experience as environmental expert for at least 3 design and/or construction supervision projects.

(8) Institutional and Capacity Development Expert is professional expert with at least 7 working years and 5 years in design and/or supervision for construction projects. Institutional and Capacity Development Expert shall have work experience as institutional and/or capacity development expert for at least 2 design and/or construction supervision projects.

(9) Other requirements: International Engineers and Experts must be proficient in English to express his professional views and advices, and prepare reports.

5.2.2 Local Consultants

(1) Assistant Contract Management engineer is local professional engineer with at least 7 working years and 5 years in design and/or supervision in domestic projects. Assistant Contract Management Engineer shall have been work experience as contract engineer for at least 2 projects of design and/or construction supervision.

(2) Mechanical Engineers 1 and 2 are local professional mechanical engineers with at least 7 working years and 5 years in design and/or supervision of installation works. Mechanical Engineers 1 and 2 shall have work experience as mechanical engineer for at least 2 design and/or installation supervision projects in Nigeria.

(3) Electrical Engineer is local professional electrical engineer with at least 7 working years and 5 years in design and/or supervision of installation works. Electrical Engineer shall have work experience as electrical engineer for at least 2 design and/or installation supervision projects.

(4) Procurement Engineer is local professional engineer with at least 5 working years and 3 years in design and Tender assistance in similar field. Procurement Engineer shall have work experience as procurement engineer for at least 2 design and/or installation supervision projects.

(5) Environmental Expert is local professional environment expert with at least 5 working years and 3 years in design and/or construction supervision works. Environmental Expert shall have work experience as environmental expert for at least 2 design and/or construction supervision projects.

Annex 1

Main Contents of the Basic Design Reports (BD/R)

Basic Design Report Contents
1. General 1.1 Background of the Project 1.2 Present Situation and Planning Framework of Power Sector in Nigeria 2. Basic Project Description 2.1 Objectives of the Project 2.2 Basic Specification 2.3 Physical Features of the Power Plant 3. Basic Design 3.1 Technical Outline of the Plant 3.2 Present status of the generation facilities 3.3 Criteria for selection of Renovation details 3.4 Generator 3.5 Turbine / Governor 3.6 Control / Equipment 4. Relevant Safety Measures 5. Operation and Maintenance 5.1 Operation and maintenance of the Plant 5.2 Operational and Institutional Framework 6. Renovation Works of the Generation Facilities 6.1 General 6.2 Preliminary Works 6.3 Manufacture Works 6.4 Generator Renovation Works 6.5 Turbine/ Governor Renovation Works 6.6 Control/ Equipment Renovation Works 6.7 Renovation Work Schedule 6.8 Safety, Security and Quality Assurance 7. Estimated Project Cost and Implementation Schedule 7.1 Estimated Project Cost to be covered by JICA ODA Loan 7.2 Estimated Project Cost to be covered by JHPS 7.3 Operation and Maintenance Cost 7.4 Implementation Schedule 8. Economic and Financial Analysis 8.1 Economic Analysis 8.2 Financial Analysis

Basic Design Report Contents	
9. Appendices	
Appendix-1	Field Investigation Result: Generator
Appendix-2	Field Investigation Result: Turbine/ Governor
Appendix-3	Field Investigation Result: Control/ Equipment
Appendix-4	Field Investigation Result: Institutional Framework and Capacity

Annex 2

Sample of Tender Documents PART 1

Item	**Contents**
PART 1 – TENDERING PROCEDURES	
Invitation for Tenders	Standard form of Invitation for Tenders
Section I. Instructions to Tenderers (ITT)	A. General Scope of Tender; Source of Funds; Fraud and Corruption; Eligible Tenderers; Eligible Renovation Services B. Contents of Tender Documents Sections of Tender Documents; Clarification of Tender Documents; Site Visit; Pre-Tender Meeting; Amendment of Tender Documents C. Preparation of Tenders Cost of Tender; Language of Tender; Documents comprising the Tender; Letter of Tender and Schedules; Alternative Tenders; Documents Establishing the Eligibility of the Renovation Services; Documents Establishing the Eligibility and Qualification of the Tenderer; Documents Establishing Conformity of the Renovation Services; Tender Prices and Discounts; Currencies of Tender and Payment; Period of Validity of Tenders; Tender Security; Format and Signing of Tender D. Submission and Opening of Tenders Submission, Sealing and Marking of Tenders; Deadline for Submission of Tenders; Late Tenders; Withdrawal, Substitution, and Modification of Tenders; Tender Opening E. Evaluation and Comparison of Tenders Confidentiality; Clarification of Tenders; Deviations, Reservation, and Omissions; Determination of Responsiveness; Nonmaterial Nonconformities; Correction of Arithmetical Errors, Conversion to Single Currency; Evaluation of Tenders; Comparison of Tenders; Eligibility and Qualification of the Tenderer; Employer’s Right to Accept Any Tender, and to Reject Any or All Tenders F. Award of Contract Award Criteria; Notification of Award; Singing of Contract; Performance Security
Section II. Tender Data Sheet	JICA Standard Form which contains the following information: A. General B. Contents of Tender Documents C. Preparation of Tenders D. Submission and Opening of Tenders E. Evaluation and Comparison of Tenders
Section III. Evaluation and Qualification Criteria	1. Evaluation Technical Evaluation; Economic Evaluation(Time Schedule; Operation and Maintenance Costs; Functional Guarantees of the Renovation Services; Work, services, facilities, etc., to be provided by the Employer; Specific additional criteria); Technical Alternatives 2. Qualification Update of Information; Financial Resources; Personnel; Equipment; Subcontractors/ manufacturers

Item	Contents
Section IV. Tendering Forms	1. Letter of Tender 2. Schedules of Rates and Prices Mandatory Parts Supplied from Abroad; Mandatory Parts Supplied from Nigeria; Design Services; Renovation and Other Services; Grand Summary; Recommended Spare Parts; Price Adjustment 3. Technical Proposal Site Organisation; Method Statement; Mobilisation Schedule; Construction Schedule; Renovation Details; Equipment; Functional Guarantee; Safety Plan; Proposed Personnel; Resume of Proposed Personnel; Proposed Subcontractors for Major Renovation Items and Services; Time Schedule 4. Tenderers Qualification following PQ Tenderer Information Sheet; JVA Partner Information Sheet; Historical Contract Non-Performance; Current Contract Commitments/ Works in Progress; Historical Financial Performance; Average Annual Turnover; Financial Resources; Acknowledgement of Compliance with Guidelines for Procurement under Japanese ODA Loans 5. Form of Tender Security (Bank Guarantee or Tender Bond) 6. Manufacturer's Authorisation
Section V. List of Eligible Countries of Japanese ODA Loans	All countries

Sample of Tender Documents PART 2 and PART 3

Item	Contents
PART 2 – EMPLOYER'S REQUIREMENTS	
Section VI. Employer's Requirements	1. Scope of Supply of Renovation Services by the Contractor 2. Specification 3. Forms and Procedures Form of Completion Certificate; Form of Operational Acceptance Certificate; Change Order Procedure and Forms; Change Order Procedure 4. Drawings 5. Supplementary Information
PART 3 – CONDITIONS OF CONTRACT AND CONTRACT FORMS	
Section VII. General Conditions of Contract	A. Contract and Interpretation Definitions; Contract Documents; Interpretation; Communications; Law and Language; Fraud and Corruption B. Subject Matter of Contract Scope of Facilities; Time for Commencement and Completion; Contractor's Responsibilities; Employer's Responsibilities C. Payment Contract Price; Terms of Payment; Securities; Taxes and Duties D. Intellectual Property License/ Use of Technical Information

Item	Contents
	Confidential Information E. Execution of the Facilities Representatives; Work Programme; Subcontracting; Design and Engineering; Procurement; Installation; Test and Inspection; Completion of Facilities; Commissioning and Operational Acceptance F. Guarantees and Liabilities Completion Time Guarantee; Defect Liability; Functional Guarantee; Patent Indemnity; Limitation of Liability G. Risk Distribution Transfer of Ownership; Care of Facilities; Loss or Damage to Property, Accident or Injury to Workers, Indemnification; insurance; Unforeseen Conditions; Change in Laws and Regulations; Force Majeure; War Risk; H. Change in Contract Elements Change in the Facilities; Extension of Time for Completion; Suspension; Termination; Assignment I. Claims, Disputes and Arbitration Contractor7s Claims; Disputes and Arbitration
Section VIII. Particular Conditions of Contract	The Particular Conditions (PC) complement the General Conditions (GC) to specify data and contractual requirements linked to the special circumstances of Nigeria, the Employer, or the overall project. Whenever there is a conflict, the provisions herein shall prevail over those in the GC. Clause numbers in the PC correspond to those in the GC.
Section IX. Contract Forms	1. Notification of Award – Letter of Acceptance 2. Contract Agreement Appendices: Terms and Procedures of Payment; Price Adjustment; Insurance Requirements; Time Schedule; List of Major Items of Renovation Services and List of Approved Subcontractors; Scope of Works and Supply by the Employer; List of Documents for Approval or Review; Functional Guarantees 3. Performance Security Forms – Bank Guarantee 4. Bank Guarantee - Conditional 5. Bank Guarantee Form for Advance Payment

Appendix-12

Scope of Rehabilitation works

Preliminary

1. SCOPE OF WORK

Replacement parts at this renovation work are shown as listed below.

Basic Plan of Renovation (Generator)

	No		Item	Q'ty	unit	Requirement for change: Long period stoppage	Requirement for change: Pulling off the rotor	Importance: Necessity	Importance: Urgency	Renovation 1 (2G5)	Renovation 2 (2G1)	Renovation 3 (2G3)	Renovation 4 (2G2)	Common	Remarks
				Priority →											
1-1 Stator	①		Stator coil			Necessary	Necessary	High	High						
		1	Stator coil	1008	pcs					●	●	●	●		
		2	Wedge	1	set					●	●	●	●		
		3	Coil support ring	1	set					●	●	●	●		
		4	Bus bar	1	set					●	●	●	●		
		5	Insulation cap	1	set					●	●	●	●		
		6	Line and neutral lead	1	set					●	●	●	●		
		7	Accessories for the above	1	set					●	●	●	●		
		8	RTD for stator coil	20	pcs					●	●	●	●		
		9	CT	1	set					●	●	●	●		
	②		Stator Core			Necessary	Necessary	High	High						
		1	Stator core	1	set					●	●	●	●		
		2	Core duct	1	set					●	●	●	●		
		3	End duct	1	set					●	●	●	●		
		4	Core clamping plate	1	set					●	●	●	●		
		5	Accessories for the above	1	set					●	●	●	●		
		6	Thermo couple for stator core	4	pcs					●	●	●	●		
		7	Finishing varnish for stator	1	set					●	●	●	●		
	③		Stator frame			Necessary	Necessary	High							
		1	Stator frame×1 unit (Brand new(	1	set					●					
		2	NDI of Stator frame at site	1	set						●	●	●		NDI : Non-Destructive Inspection
1-2 Rotor	①		Pole			Necessary	Necessary	High	High						
		1	Pole	64	pcs					●	Re-used	Re-used	Re-used		
		2	Field lead connector	1	set					●	Re-used	Re-used	Re-used		
		3	Damper winding connector	1	set					●	Re-used	Re-used	Re-used		
		4	Pole cotter and liner	1	set					●	Re-used	Re-used	Re-used		
		5	Field lead (on the rotor)	1	set					●	Re-used	Re-used	Re-used		
		6	Finishing Varnish for Rotor	1	set					●	●	●	●		
	②		Countermeasure of Rotor Rim Support												
		1	Reinforcement parts of Rotor Rim Support			Necessary	Necessary	High	High					←	Reinforcement of Rotor Rim support was realized on unit 2G3 and 2G5 in 2001.
		1)	Special tool for Rim reinforcement	1	set									●	
		2)	Repair material for damaged spider	1	set						●		●		
		3)	Rotor rim key	1	set						●		●		
		4)	Stopper for rotor rim key	1	set						●		●		
		5)	Distance piece (rotor rim support)	1	set						●		●		
1-3 Exciter	①		Collector Ring					High		1st unit	2nd unit				
		1	Collector ring (including shaft)	1	set					●	●			←	No spare is required (1-7 ④ No.1)
		2	Carbon brush	44	pcs					●	●	●	●		
		3	Carbon brush holder	44	pcs					●	●	●	●		
		4	Carbon brush holder support	1	set					●	●	●	●		
1-4 Metal	①		Bearing Parts			Necessary	Necessary	High	High						
		1	Thrust bearing shoe	18	pcs					●	●	●	●		
		2	Thrust bearing support (for HITACHI PIVOT SPRING)	18	pcs					●	●	●	●		
		3	Guide bearing shoe	22	pcs					●	●	●	●		
		4	Adjusting bolt and nut for guide bearing	22	pcs					●	●	●	●		
		6	Oil deflector	1	set					●	●	●	●		
		7	Spring support (for HITACHI PIVOT SPRING)	18	pcs					●	●	●	●		
1-5 Cooling system	①		Oil cooler												
		1	Oil cooler	4	pcs			High		Re-used	Re-used	Re-used	Re-used		
		2	Short piping for adjustment	1	set			High		Re-used	Re-used	Re-used	Re-used		
1-6 Hydraulic devices	②		Oil circulating system												
		1	Oil lubricating pump	1	set			High		Re-used	Re-used	Re-used	Re-used		
		2	High pressure oil lifter	1	set			High		Re-used	Re-used	Re-used	Re-used		
		3	Flow control Valve	36	pcs			High		Re-used	Re-used	Re-used	Re-used		
		4	High pressure oil pipe (in the thrust tank)	18	pcs		Necessary	High		Re-used	Re-used	Re-used	Re-used		
		5	Short piping for adjustment	1	set			High		Re-used	Re-used	Re-used	Re-used		
	③		Air Cooler												
		1	Air cooler	12	pcs			High		Re-used	Re-used	Re-used	Re-used		
		2	Thermostat for Air cooler	10	pcs			High		Re-used	Re-used	Re-used	Re-used		
		3	Dial thermometer for Air cooler	6	pcs			High		Re-used	Re-used	Re-used	Re-used		
		4	Short piping for adjustment	1	set			High		Re-used	Re-used	Re-used	Re-used		
1-7 Others	①		Instrument and Overhauling Parts												
		1	Dial thermometer (for bearing)	2	pcs		Necessary	High	High	●	●	●	●		
		2	Dial thermometer (for oil cooler)	2	pcs		Necessary	High	High	●	●	●	●		
		3	Thermal relay (for bearing)	2	pcs		Necessary	High	High	●	●	●	●		
		4	RTD for Thrust bearing oil tank	1	pc		Necessary	High	High	●	●	●	●		
		5	Installation materials for beatings	1	set		Necessary	High	High	●	●	●	●		
		6	Creep detector	1	pc			High		Re-used	Re-used	Re-used	Re-used		
		7	Vibration detector and monitor	1	pc			High		Re-used	Re-used	Re-used	Re-used		
		8	Water flow relay (for oil cooler and air cooler)	2	pcs			High		Re-used	Re-used	Re-used	Re-used		
		9	Oil flow meter	1	pc			High		Re-used	Re-used	Re-used	Re-used		
		10	Oil level gauge and switch	1	pc			High	High	●	●	●	●		
		11	Limit switch for brake and jack	8	pcs			High	High	●	●	●	●		
		12	Space heater (with reinforced cover)	12	pcs			High		Re-used	Re-used	Re-used	Re-used	←	Modification of setting place is planned.
		13	Brake liner (2pcs for 1 brake & jack)	16	pcs			High		Re-used	Re-used	Re-used	Re-used		
		14	Installation materials (Bolts, Nuts, etc)	1	set			High	High	●	●	●	●		
		15	Wiring material (inside of generator terminal box)	1	set			High	High	●	●	●	●		
	②		Tools for Assembly (including special tool)												
		1	Pole Lifting Rug	1	set			High						●	
		2	Tools for Erection and stator core assembly	1	set			High						●	
		3	Tools for Stator coil assembly	1	set			High						●	
		4	High Voltage Test Kit	1	set			High						●	
		5	Consumable materials	1	set			High		●	●	●	●		
	③		Training												
		1	Training	1	set			High						●	
	④		Spare Parts												
		1	Carbon brush	180	pcs			High						No supply	
		2	Brush holders	2	pcs			High						No supply	
		3	Stator coil (top coil)	10	pcs			High						No supply	
		4	Stator coil (bottom coil)	5	pcs			High						No supply	
		5	Pole	4	pcs			High						●	First End Pole×2pcs, Last End Pole ×2pcs
		6	Guide bearing shoe	22	pcs			High						●	
		7	Thrust bearing runner plate	1	pcs			High						No supply	
		8	Brake liner (shoe)	32	pcs			High						No supply	
		9	Thrust bearing shoe	18	pcs			High						●	
		10	High pressure oil lifter	1	set			High						No supply	
		11	Flow control Valve	36	pcs			High						No supply	
		12	Oil lifter suction line filter	50	pcs			High						No supply	
		13	Oil lifter discharge line filter	50	pcs			High						No supply	
		14	Brake ring	1	set			High						No supply	
		15	Oil filter for oil circulation system	100	pcs			High						No supply	
	⑤		Supervisor					High		●	●	●	●		
	⑥		Others (Transportation, etc.)					High		●	●	●	●		

2. ON-SITE WORK PLAN

(1) General sequence of on-site work

＜Stator pre-assembly work at the erection bay, before unit shut down＞

① Preparation of working area, facilities, utilities, tools, etc.
↓
② Disassembly of stator winding (for 2nd to 4th unit only)
↓
③ Disassembly of stator core laminations (for 2nd to 4th unit only)
↓
④ Roundness check and adjustment of stator frame
↓
⑤ Total re-stacking work of core laminations, and acceptance tests
↓
⑥ Winding work of stator coils, and acceptance tests after completion of stator

＜Renovation work, after unit shut down＞

⑦ Preparation of working area, facilities, utilities, tools and etc.
↓
⑧ Disassembly of generator
↓
⑨ Disassembly of stator winding and exchange from old to new stator
↓
⑩ Trimming, finishing, inspection and cleaning of disassembled parts
↓
⑪ Disassembly of rotor pole and exchange from old to new rotor pole (for 1st unit only)
↓
⑫ Modification of rotor rim support
↓
⑬ Assembly of the generator
↓
⑭ Commissioning tests of the generator
↓
⑮ Site clearance (demolition and close-out)
↓
⑯ Reporting at site

(2) On-site work plan

In this section, procedure of the on-site work plan is described. The content of these plans is included to indicate the outlined magnitude of the work plan to be followed in the disassembly and re-assembly of the generator. This is not purported to completely describe the work required or to be entirely accurate in its requirements.

All equipment and materials shall be installed in accordance with the contract specifications, drawings, instructions and these work plans.

The contractor's supervisor shall give the additional detailed instructions and may make change or revisions in some parts of instructions for the purpose of making them conform to the special arising circumstances in the field. The instructions issued by the supervisor shall form part of these plans.

Should JHEP disagree with some parts of instructions or have not well understanding of them, the supervisor shall give the required information and cooperate with JHEP to achieve the construction successfully. Do not start work before JHEP can comprehend the methods and procedures of the work to be performed. Otherwise the misunderstanding may result in the unexpected faulty assembly or installation.

Where the grade or standard of the work for the generator is not specifically indicated in the drawings or in thee specifications including these plans, the JIS, ANSI, NEMA, IEEE, ASME, ASTM or equivalent are applicable.

＜Stator pre-assembly work at the erection bay, before unit shut down＞

① Preparation of working area, facilities, utilities, tools, etc.

One of the main tasks of this renovation work is the stator pre-assembly work. This task must be performed at the erection bay while generator unit keeping operation, and completed before the renovation work starts.

101) Planning about time schedule of the site work, work procedures, work facilities, working space, temporary storage area and lay down of disassembled equipment and components in the Power House.

102) To supply special lifting device and slings by Contractor.

103) After the renovation work has been finished, the special lifting device and slings must be properly stored and controlled by JHEP.

104) To make necessary working floor with scaffolding material and floor protection along with necessary stand blocks to support generator components at the erection bay and in the Power House for the renovation work. Basic idea is to be discussed later with JHEP.

105) To install the working floor with scaffolding and floor protection at the erection bay and the Power House with suitable lighting and ventilation system along with electric power supply.

106) To prepare work facilities, equipment, electrical test equipment and tools.

107) To store the work facilities, electrical test equipment and tools in the Power House for the next renovation work chance unless otherwise instructed to store in the warehouse or to remove from the Power House by JHEP. To move and store in designated area or warehouse nearby the Power House, if requested to remove them from the Power House.

② Disassembly of stator winding (for 2nd to 4th unit only)

201) Planning of the actual work such as preparation of hand tools, work equipment, consumable material and organization of work team must be done jointly with JHEP based on work procedures, time schedule, labor schedule.

202) To prepare and install of necessary working floor with scaffolding material and floor protection at the erection bay. Basic idea is to be discussed later with JHEP.

203) To prepare work facilities, equipment, tools, safety equipment and material for the work of the stator rewinding work shall be provide by Contractor.

204) To prepare work facilities and utilities other than the above item 203, and working area and temporary storage area.

205) To supply of disposable working wear, masks, gloves, etc. for all JHEP's personnel to work with dirt.

206) Prepare necessary facilities, safety equipment and safety goods for Asbestos Abetment to follow at least the related laws/regulations of Japan.

207) To perform seal wrapping of every stator bar with a plastic bag for storage/disposal.

208) To perform demolition, removal and disposal of coils, scrap and waste in an appropriate manner following the local rules and regulations by JHEP.

209) To perform disassembly work of the coils with phase connection bus rings and terminal leads, jumpers, wedges, coil end bracing and RTDs.

210) Careful attention and precaution must be paid to minimize scattering of dust and dirt during the disassembly work at the erection bay.

211) Necessary and mandatory safety pre-caution and safety measures must be taken place at all the time during the disassembly work and its preparation work including storage of parts and material in order to protect personnel, environment and already installed equipment inside of the site. The site manager must be responsible to induct all personnel to follow the site safety regulations and guidance.

212) To store the work facilities, equipment and tools and surplus materials in the Power House for

the re-winding work unless otherwise instructed to store in the warehouse by JHEP.

213) Other activities than the above mentioned must be done by mutual consent with JHEP.

③ Disassembly of stator core laminations (for 2nd to 4th unit only)

301) Planning of the actual work such as preparation of hand tools, work equipment, consumable material and organization of work team must be done jointly with JHEP based on work procedures, time schedule, labor schedule.

302) To prepare and install of necessary working floor with scaffolding material and floor protection at the erection bay. Basic idea is to be discussed later. The working floor must be changed while the disassembly work is proceeding.

303) To assembly & maintenance of a temporary enclosure for Asbestos Abetment, if required additionally, during disassembly work of existing core laminations, and removal of the temporary enclosure after the work.

304) To prepare necessary facilities, safety equipment and safety goods for Asbestos Abetment to follow at least the related laws/regulations of Japan.

305) To prepare work facilities, equipment, tools, safety equipment and material for the stator core restacking work.

306) To supply of disposable working wears, masks, gloves, etc. for all JHEP's personnel to work with dirt

307) To prepare work facilities and utilities other than the above items 304, 305 and 306, and working area and temporary storage.

308) To perform disassembly work of the core laminations as following work sequence.

1) To prepare necessary working platform and skids to keep disassembled core laminations.
2) To remove nuts for core tightening bolts.
3) To disassemble stator clamping plates at collector end.
4) To disassemble core laminations while changing elevation of the working floor.
5) To remove core end duct fingers at turbine end, and core keys.
6) Cleaning of the stator frame.

309) To perform seal wrapping of disassembled insulation sheets, which contain Asbestos, with a plastic bag for storage/disposal.

310) To perform demolition, removal and disposal of disassembled stuff including core laminations from the stator in an appropriate manner following the local rules and regulations by JHEP.

311) Careful attention and precaution must be paid to minimize scattering of dust and dirt during the

disassembly work at the erection bay.

312) Necessary and mandatory safety pre-caution and safety measures must be taken place at all the time during the disassembly work and its preparation work including storage of parts and material in order to protect personnel, environment and already installed equipment inside of the site. The site manager must be responsible to induct all personnel to follow the site safety regulations and guidance.

313) To store the work facilities in the Power House for the re-stacking work unless otherwise instructed to store in the warehouse by JHEP.

314) Other activities than the above mentioned must be done by mutual consent with JHEP.

④ Roundness check and adjustment of stator frame

401) Planning of the actual work such as preparation of hand tools, work equipment, consumable material and organization of work team must be done jointly with JHEP based on work procedures, time schedule, labor schedule.

402) To prepare work facilities, equipment, and tools for the stator frame work.

403) To prepare work facilities and utilities including working area and temporary storage area at the erection bay.

404) To deliver temporary stored components, parts, materials and tooling from the storage area to the working area.

405) To assemble temporary work platform with scaffolding.

406) To perform centering/adjustment check and roundness measurement of the stator frame as specified in the Inspection and test plan (hereafter “ITP”), then necessary adjustment must be performed to adjust the stator in acceptable condition for the core stacking work. Final measured data must be recorded on the QC record sheet. In case actual reading is out of tolerance, remedial adjustment work must be done by mutual consent with JHEP.

407) To perform touch −up painting for the stator frame by brushing or spraying.

408) To make the work area clean to proceed the core stacking work.

409) Careful attention and precaution must be paid to minimize scattering of dust and dirt.

410) Necessary and mandatory safety pre-caution and safety measures must be taken place at all the time during the exchange work and its preparation work including storage of parts and material in order to protect personnel, environment and already installed equipment inside of the site. The site manager must be responsible to induct all personnel to follow the site safety regulations and guidance.

411) To store the work facilities in the Power House for the next renovation work unless otherwise instructed to store in the warehouse by JHEP.

412) Other activities than the above mentioned must be done upon mutual consent with JHEP.

⑤ Total re-stacking work of core laminations, and acceptance tests

501) Planning of the actual work such as preparation of hand tools, work equipment, consumable material and organization of work team must be done jointly with JHEP based on work procedures, time schedule, labor schedule .

502) To prepare work facilities, equipment, electrical test equipment and tools for the stator core restacking work.

503) To prepare work facilities and utilities including working area and temporary storage area in the Power House bay.

504) To deliver temporary stored components, parts, materials and tooling from the storage area to the working area upon request.

505) To perform inspection of the temporarily stored components, parts and material prior to their assembly.

506) To perform assembly of core keys and core end duct fingers at turbine end as following work sequence:

1) To install new core keys while adjusting their pitch and verticality by welding, then apply paint to the welded parts by brushing (touch-up).
2) To perform alignments check of the core keys.
3) To install new core end duct fingers at turbine end, then apply paint to the welded parts by brushing (touch-up).

507) To perform core re-stacking work as following work sequence:

1) Every preparation work to start the core stacking work.
2) To stack core laminations having the dovetailed slots, which have interchangeability and compatibility with original designed stator frame, by half lapping method using the core keys and slot gauges as a guide, while checking if stacked laminations are exactly in a half lap.
3) To tighten stacked core laminations temporarily at every 500mm thickness by using hydraulic jacks and special clamping jigs.
4) To perform heating of the stacked core laminations, after having reached at specified total thickness.
5) To finally tighten the core with new core clamping plates, new tightening bolts and new nuts.

6) To perform visual check, dimension and roundness check of inner diameter, and tightness check of core teeth, then tag weld tightening bolts as specified in the ITP.

7) To apply core varnish by spraying to the entire stator core, and dry in an atmospheric condition and semi-conductive varnish to slots by brushing or spraying.

508) To supply of disposable working wear, masks, gloves, etc. for all JHEP’s personnel to work with solvent, paint and varnish.

509) Surplus material must be kept in the Power House or disposed depending upon JHEP's instruction.

510) All work and test data must be recorded on the QC record sheets timely during the work.

511) To perform technical advice about such as procedures and quality of on-going work, and demonstration of the work procedure to JHEP, upon request and as an OJT or if required.

512) To maintain the erection bay as clean as possible during the entire work period for the purpose of avoiding a trouble and/or a failure specially caused by foreign metallic particles. Working shoes exclusive use for inside of the work platform must be prepared, and everyone must be instructed to use them.

513) Careful attention and precaution must be paid to minimize scattering of dust and dirt during the work.

514) Necessary and mandatory safety pre-caution and safety measures must be taken place at all the time during the work and its preparation work including storage of parts and material in order to protect personnel, environment and already installed equipment inside of the site. The site manager must be responsible to induct all personnel to follow the site safety regulations and guidance.

515) To store the work facilities in the Power House for the next renovation work unless otherwise instructed to store in the warehouse by JHEP.

516) Other activities than the above mentioned must be done by mutual consent with JHEP.

⑥ Winding work of stator coils, and acceptance tests after completion of stator

601) Planning of the actual work such as preparation of hand tools, work equipment, consumable material and organization of work team must be done jointly with JHEP based on work procedures, time schedule, labor schedule .

602) To prepare work facilities, equipment, electrical test equipment and tools for the generator stator rewinding work.

603) To prepare work facilities and utilities including working area and temporary storage area in the

Power House.

604) To prepare and install of necessary working floor with scaffolding material and floor protection.

605) To make clean flooring on the working floor, and to maintain cleanliness. All goods and stuff must be kept free from foreign particles during the entire work period for the purpose of avoiding a trouble and/or a failure. Working shoes exclusive use for on the working floor must be prepared, and everyone must be instructed to use them.

606) To deliver temporary stored components, parts, materials and tooling from the storage area to the working area upon request.

607) To perform inspection of the temporarily stored components, parts and material prior to their assembly.

608) To supply of disposable working wear, masks, gloves, and clean safety shoes etc. for all personnel to work.

609) To perform stator winding work as following work sequence:

1) To perform visual inspection of the stator core, and every preparation work to start the winding work.
2) To assemble new coil end support rings, which have interchangeability and compatibility with original designed stator frame, with brackets while binding with glass fiber cord applying air dry varnish, and to lay RTD leads.
3) To assemble bottom bars with slot bottom fillers and side ripple springs by pressing with temporary tapered wedges, while binding coil ends to the support rings, then to tie edge of the side ripple spring with glass fiber tape applying air dry varnish.
4) To perform DC Hi-Pot test to all bottom bars.
5) To assemble RTDs and slot center fillers.
6) To assemble top bars with side ripple springs by pressing with temporary tapered wedges.
7) To drive slot wedges with top fillers.
8) To perform DC Hi-Pot test to all top & bottom bars while grounding RTDs.
9) To braze series connections, and insulate every series connections applying air dry varnish.
10) To assemble and braze jumpers and phase connection bus rings and terminal leads, then to insulate every brazed connection applying air dry varnish.
11) To tie top coil ends, jumpers and leads while fitting coil end spacer and applying air dry varnish.
12) To fix wedge stoppers, then to tie edge of the side ripple spring with glass fiber tape applying air dry varnish.
13) To perform cleaning and perform visual inspection for the purpose of checking integrity of

the work done.

14) To apply varnish to the entire stator winding by spraying, then dry-out at an atmospheric condition.

15) To perform electrical tests after completion of stator as specified in the ITP.

610) Brazing work must be performed only by skilled winders or welders who belong to JHEP. Brazing method will be “Gas burner torch”. Those who are going to do brazing work must receive a training of brazing with sample joints.

611) To supply of electrical tests equipment with certificate for;

a) Insulation resistance measurement, and Polarization Index test of the winding.

b) Winding resistance measurement

c) Polarity check

d) tan δ(Power Factor Tip Up) up to AC 16kV

e) Partial Discharge test up to AC 16kV

f) Dielectric test (DC Hi-Pot test) up to DC 56.1kV (=1.7x(2x16+1)kV)

g) AC Hi-Pot test up to AC 33kV.

612) To perform electrical tests mentioned in the item 611 while paying the most carefully attention and taking necessary precautions to personnel around the stator and test equipment. If failed, necessary actions must be determined by mutual consent with JHEP.

613) To supply of electricity (electric power supply) for the tests up to a distribution panel.

614) To perform cabling work and removing cables between the distribution panel and test equipment.

615) To prepare electrical test equipment and instruments including necessary cables and FFBs

616) Surplus material must be kept in the power station or disposed depending upon JHEP's instruction.

617) All work and test data must be recorded on the QC record sheets timely during the work.

618) To perform technical advice about such as procedures and quality of on-going work, and demonstration of the work procedure to JHEP, upon request or if required.

619) To maintain the erection bay as clean as possible during the entire winding work period for the purpose of avoiding a trouble and/or a failure specially caused by foreign metallic particles. Working shoes for everybody must be exclusively used only for on the working floor.

620) Careful attention and precaution must be paid to minimize scattering of dust and dirt during the work in the generator pit.

621) Necessary and mandatory safety pre-caution and safety measures must be taken place at all the time during the winding work and its preparation work including storage of parts and

material in order to protect personnel, environment and already installed equipment inside of the site. The site manager must be responsible to induct all personnel to follow the site safety regulations and guidance.

622) To remove the temporary working floor with scaffolding material and floor protection along with stairs/ladders and hand rails

623) To store the work facilities, equipment and tools in the Power House for the next renovation work chance unless otherwise instructed to store in the warehouse by JHEP.

624) Surplus material must be kept in the Power House or disposed depending upon JHEP's instruction.

625) Other activities than the above mentioned must be done by mutual consent with JHEP.

<Renovation work, after unit shut down>

⑦ Preparation of working area, facilities, utilities, tools, etc.

One of the main tasks of this renovation work is the stator pre-assembly work and replace work. This task must be performed at the erection bay and in the generator pit, therefore, the generator rotor and lower bearing bracket will be removed from the generator pit. Adequate working floor and temporary turbine pit cover will be prepared and set for the purpose of realizing efficient stator replace work while the renovation work for the turbine is proceeding in parallel, if required.

701) Planning about time schedule of the site work, work procedures, work facilities, working space, temporary storage area and lay down of disassembled equipment and components in the Power House.

702) Special lifting device and slings will be supplied by Contractor.

703) After the renovation work has been finished, the special lifting device and slings must be properly stored and controlled by JHEP.

704) Making necessary working floor with scaffolding material and floor protection along with necessary stand blocks to support generator components at the erection bay, in the generator pit and in the Power House for the renovation work. Basic idea is to be discussed later with JHEP.

705) To install the working floor with scaffolding and floor protection at the erection bay, in the generator pit and the Power House with suitable lighting and ventilation system along with electric power supply.

706) To prepare work facilities, equipment, electrical test equipment and tools.

707) To store the work facilities, electrical test equipment and tools in the Power House for the next renovation work chance unless otherwise instructed to store in the warehouse or to remove from the Power House by JHEP. To move and store in designated area or warehouse nearby the Power House, if requested to remove them from the Power House.

⑧ Disassembly of generator

801) To disassemble oil defector from lower bearing bracket. To perform tests and measurement of various dimension data as specified in the ITP, prior to starting disassembly work.

802) To identify every part by numbering and match- marking prior to starting disassembly.

803) To disassemble instruments with wiring, and to store in the designated place.

804) All work and test data must be recorded on the QC record sheets timely during the work as specified in the ITP.

805) To disassemble space heaters.

806) To remove top cover. The disassembled top cover must be checked thoroughly.

807) To disassemble field leads on both upper bracket and generator rotor. Disassembled field leads and brush holder gear must be properly packed for temporary storage purpose.

808) To drain bearing lubricating oil and disassemble oil piping. Opening (flange faces) of the disassembled pipes must be temporarily covered or plugged properly to prevent inside of the pipes from contamination with foreign particles and dust, and from generation of rust by moisture.

809) To remove and dispose old lubricating oil must be done by JHEP

810) To drain cooling water and disassemble water piping. Opening (flange faces) of the disassembled pipes must be temporarily covered or plugged properly to prevent inside of the pipes from contamination with foreign particles and dust, and from generation of rust by moisture.

811) To disassemble upper shaft with collector rings, and place it in the Power House with a temporary cover for renovation work and temporary storage.

812) To disassemble air coolers from the stator, and place them in the Power House, with a proper covers and seals to prevent them (specially cooling fins and inside of pipes) from contamination with foreign particles and dust for maintenance work and temporary storage.

813) To disconnect damper connectors and field coil connectors, then to remove pole cotters and disassemble field poles from rotor rim, and place the field poles in the erection bay with a temporary cover.

814) To disassemble rotor spider with rotor rim, then to place it on rotor pedestal in the erection bay for work and temporary storage. This task may be done after disassembly of existing stator winding and core have been completed.

815) To drain oil and disassemble piping for brake & jacks, then store in the designated place. Opening (flange faces) of the disassembled pipes must be temporarily covered or plugged properly to prevent inside of the pipes from contamination with foreign particles and dust, and from generation of rust by moisture.

816) To disassemble lower guide bearing and guide bearing frame, then place them in the Power House with a temporary cover for maintenance work and temporary storage. The guide bearing shoes must be coated with grease and properly packed. The other parts must be temporarily covered or sealed properly to prevent surface of each part from contamination with foreign particles and dust, and from generation of rust by moisture, then must be stored properly at designated place.

817) To prepare tools for the shaft coupling work. This work will be done by turbine side.
818) To disconnect the generator shaft from turbine shaft. This work will be performed under supervision of the turbine supervisor.
819) To disassemble the generator shaft, then place it in the erection bay with a temporary cover and rust proof treatment of the machined surface for maintenance work and temporary storage.
820) To disassemble lower (thrust) bearing bracket together with many parts, and place it in the erection bay with a temporary cover for maintenance work and temporary storage.
821) To disassemble bearing parts inside of the lower bearing bracket, then place each part in proper places or boxes with a temporary cover and rust proof treatment of the machined surface of each component for maintenance work and temporary storage.
822) To disassemble line and neutral leads with CTs and their protection covers (fence) inside of the generator pit, then place them in a proper place in the Power House with a temporary cover for renovation work and temporary storage.
823) To assemble and install temporary turbine pit cover with the working platform and temporary hand rails, for safety measure and efficient work.
824) To set up necessary working platform by scaffolding with stairs/ladders and hand rails.
825) To open and close the temporary turbine pit cover (temporary work floor for the generator) to allow access to the turbine pit using overhead crane, if necessary.
826) To supply necessary tools, temporary covers, seals, plugs, parts boxes, temporary storage boxes and consumable material.
827) During disassembly work, most careful attention must be paid not to overlook (miss) any abnormal phenomenon such as flaw, cracking, wearing, displacement or deformation of each component. Once it has been found, immediate report and necessary inspection must be taken place. Necessary action (remedial work) to solve the trouble, which appeared as an abnormal phenomenon, will be determined by mutual consent with JHEP.
828) To store the work facilities, equipment, tools in the Power House for re-assembly work and the next renovation work unless otherwise instructed to store in the warehouse by JHEP.
829) Necessary and mandatory safety pre-caution and safety measures must be taken place at all the time during the disassembly work and its preparation work including storage of parts and material in order to protect personnel, environment and already installed equipment inside of the site. The site manager of each party must be responsible to induct all personnel to follow the site safety regulations and guidance.
830) Other activities than the above mentioned must be done by mutual consent with JHEP.

⑨ Disassembly of stator winding and exchange from old to new stator

901) To prepare and install of necessary working floor with scaffolding material and floor protection at the erection bay. Basic idea is to be discussed later with JHEP.

902) To prepare work facilities, equipment, tools, safety equipment and material for the work of the stator rewinding work shall be provide by Contractor.

903) To prepare work facilities and utilities other than the above item 902, and working area and temporary storage area.

904) To supply of disposable working wear, masks, gloves, etc. for all JHEP's personnel to work with dirt.

905) Prepare necessary facilities, safety equipment and safety goods for Asbestos Abetment to follow at least the related laws/regulations of Japan.

906) To perform seal wrapping of every stator bar with a plastic bag for storage/disposal.

907) To perform demolition, removal and disposal of coils, scrap and waste in an appropriate manner following the local rules and regulations by JHEP.

908) To perform disassembly work of the coils just for the six segment slit part of stator with phase connection bus rings and terminal leads, jumpers, wedges, coil end bracing and RTDs.

909) To perform removal of the disassembled six segment stator one by one to the erection bay

910) To perform level check of stator base as specified in the ITP, then necessary adjustment must be performed to adjust the stator base in acceptable condition for the stator exchange work. Final measured data must be recorded on the QC record sheet. In case actual reading is out of tolerance, remedial adjustment work must be done by mutual consent with JHEP.

911) To perform removal of new complete stator from erection bay into the generator pit, and fix to the stator base with fixing bolts. After this stator exchange work, turbine disassembly work is to be started by opening and closing the temporary turbine pit cover (temporary work floor for the generator) to allow access to the turbine pit using overhead crane.

912) Careful attention and precaution must be paid to minimize scattering of dust and dirt during the disassembly and exchange work in the generator pit.

913) Necessary and mandatory safety pre-caution and safety measures must be taken place at all the time during the disassembly and exchange work and its preparation work including storage of parts and material in order to protect personnel, environment and already installed equipment inside of the site. The site manager must be responsible to induct all personnel to follow the site safety regulations and guidance.

914) To store the work facilities, equipment and tools and surplus materials in the Power House for the next renovation work unless otherwise instructed to store in the warehouse by JHEP.

915) Other activities than the above mentioned must be done by mutual consent with JHEP.

⑩ Trimming, finishing, inspection and cleaning of disassembled parts

1001) Entire generator: To perform renovation work such as cleaning, trimming, inspection and test, and touch-up painting at site for entire generator. All work and test data must be recorded on the QC record sheets timely during the work as specified in the ITP.

1002) To install temporary working floor with scaffolding material and floor protection along with stairs/ladders and hand rails in the Power House including the erection bay, if necessary.

1003) Air coolers: To clean headers, cooling pipes and cooling fins of the air coolers. To plug some cooling pipes of the air coolers, if necessary as a result of the hydrostatic pressure tests. The air coolers must be cleaned carefully.

1004) Water piping: To check condition inside of cooling pipes, and perform cleaning inside of the pipes if requested by mutual agreement with JHEP. To replace all packing and gasket for every flange. Because of replacement of water flow meters, minor modification work may be required for water pipes. This modification work must be done during reassembly period of said components if required.

1005) Hydrostatic pressure tests on;

a) Thrust bearing (external) existing oil coolers,

b) The air coolers, including preparation of stop flanges and test pump with a calibrated pressure meter, if requested by JHEP.

1006) Finishing machined surface: To perform finishing machined surface of disassembled components and parts to be re-used by oil stone and file, performing necessary NDI, according to ITP, and cleaning, then applying rust preventive treatment for temporary storage for such as;

a) Generator shaft and thrust collar

b) Thrust runner

c) Rotor spider

d) Upper shaft

e) Other parts specified in the ITP.

1007) Calibration of temperature instrument: Calibration of new dial thermometers and thermal relays including preparation of necessary oil bath and calibrated thermometers.

1008) Rotor rim and spider: To perform modification of rotor rim support based on the instruction prepared separately.

1009) To perform cleaning and visual inspection of the rotor rim and spider. If additional abnormality is observed, its remedial work will be decided upon mutual consent with JHEP.

1010) Brake ring: To perform cleaning and visual inspection of the brake ring.

1011) Field leads: To disassemble existing field leads on the rotor, which are located between field coils and collector rings, and to perform cleaning and visual inspection of insulation of the re-used field leads on the stator, which are located on the upper bracket arm and air housing wall.

1012) Collector rings: To disassemble existing collector rings, and install for new collector ring for 1st and 2nd unit and re-used for 3rd and 4th unit must be cleaned carefully and visual inspected.

1013) Brake & jacks: To replace gaskets inside of cylinder of the brake & jacks, then to perform any test to check integrity of the cylinders according to the ITP.

1014) Disposal of the worn brake gaskets will be done by JHEP.

1015) Oil piping: To disassemble all oil pipes and perform cleaning for every pipe. Opening (flange faces) of disassembled pipes must be temporarily covered or plugged properly to prevent inside of the pipes from contamination with foreign particles and dust, and from generation of rust by moisture. Because of replacement of oil flow meters and oil lift pump set, minor modification work will be required for oil pipes. This modification work must be done during reassembly period of said components.

1016) Oil lift pump set: To disassemble existing oil lift pump set, and cleaning and visual inspection.

1017) Oil cooling system: To perform cleaning and visual inspection.

1018) Lower bearing bracket: To perform renovation work of the lower bearing bracket while disassembling all components. To clean and finish machined surface of bearing components with oil stone and other appropriate means, and to apply touch-up paint to un-machined surface of bearing components and thrust tank, then to re-assemble the bearing components. The thrust bearing shoes must be coated with grease and properly packed. The other parts must be temporarily covered or sealed properly to prevent surface of each part from contamination with foreign particles and dust, and from generation of rust by moisture, then must be stored properly at site.

1019) To perform oil flushing of oil pipes and inside of thrust tank of the lower bearing bracket in the erection bay prior to installing the bracket in the generator pit. For this flushing purpose, temporary distant pieces will be used instead of oil flow control check valves. After finishing the oil flushing, such distant pieces will be replaced with re-used oil flow control check valves.

1020) CTs: To perform cleaning and visual inspection of the re-used CTs.

1021) Space heaters: To perform cleaning and visual inspection. Existing cable inside of the generator housing will be re-used. Modification of setting place is planned to prevent being stepped and damaged.

1022) Upper bracket and top cover: To perform cleaning and repair of one set of dowelling pin of the upper bracket arm. The upper bracket must be touch-up painted after cleaning.

1023) CO2 Fire extinguishing system: To perform cleaning and touch-up paint CO2 extinguishing system including piping inside of the generator housing, and to perform trial operation, if requested by mutual agreement with JHEP.

1024) General: During the work, most careful attention must be paid not to overlook (miss) any abnormal phenomenon such as flaw, cracking, wearing, displacement or deformation of each component. Once such indication has been found or defects have been observed by inspection, immediate report must be addressed to JHEP. Its remedial work will be decided by mutual consent with JHEP.

1025) During the work and storage, necessary measures must be taken place to protect the components and parts from contamination with foreign particles and dust, and from generation of rust by moisture to protect insulation material from deterioration by moisture or ultra violet rays.

1026) To supply necessary tools, temporary covers, seals, plugs, parts boxes, temporary storage boxes and consumable material.

1027) Necessary and mandatory safety pre-caution and safety measures must be taken place at all the time during the trimming & inspection work and its preparation work including storage of parts and material in order to protect personnel, environment and already installed equipment inside of the site. The site manager must be responsible to induct all personnel to follow the site safety regulations and guidance.

1028) To store the work facilities equipment, tools in the Power House for the next renovation work chance unless otherwise instructed to store in the warehouse by JHEP.

1029) Other activities than the above mentioned must be done by mutual consent with JHEP.

⑪ **Disassembly of rotor pole and exchange from old to new rotor pole** (for 1st unit only)

1101) Planning of the actual work such as preparation of hand tools, work equipment, consumable material and organization of work team must be done jointly with JHEP based on work procedures, time schedule and labor schedule. This work should be performed and scheduled in the period of between rotor pole disassembly and re-assembly work.

1102) To prepare work facilities, equipment, and tools for the modification of rotor rim support work.

1103) To prepare work facilities and utilities including working area and temporary storage area at the erection bay.

1104) To deliver temporary stored components, parts, materials and tooling from the storage area to the working area.

1105) To assemble temporary work platform with scaffolding.

1106) To perform the rotor pole disassembly and re-assembly work as following work sequence for 1st unit.:

1) Disconnect the field coil connectors and damper connectors.
2) Remove the rotor pole and pole cotter from rotor rim using special lifting devises.
3) To perform cleaning and visual inspection of reused rotor rim dovetail slot.
4) To start the replace work after the modification of rotor rim support work is finished.
5) Insert field coil pushing springs and new rotor pole, which have interchangeability and compatibility with original designed rotor rim, into rotor rim carefully. After the pole cotters are tightened, the excess length should be cut off and the locked plates should be installed over the dovetail slots.
6) Connect the field coil connectors and damper connectors and fixing the accessories.
7) To perform cleaning and perform visual inspection for the purpose of checking integrity of the work done.
8) To apply varnish to the entire rotor pole, rotor rim and spider by spraying, then dry-out at an atmospheric condition.
9) To perform electrical tests after completion of rotor as specified in the ITP.

1107) To perform cleaning and necessary inspection of the re-used field winding, according to ITP.

1108) To make the work area clean to proceed the other renovation work.

1109) Careful attention and precaution must be paid to minimize scattering of dust and dirt.

1110) Necessary and mandatory safety pre-caution and safety measures must be taken place at all the time during the work and its preparation work including storage of parts and material in order to protect personnel, environment and already installed equipment inside of the site.

The site manager must be responsible to induct all personnel to follow the site safety regulations and guidance.

1111) To store the work facilities in the Power House for the next renovation work unless otherwise instructed to store in the warehouse by JHEP.

1112) Other activities than the above mentioned must be done upon mutual consent with JHEP.

⑫ Modification of rotor rim support

1201) Planning of the actual work such as preparation of hand tools, work equipment, consumable material and organization of work team must be done jointly with JHEP based on work procedures, time schedule, and labor schedule. This work should be performed and scheduled in the period of between rotor pole disassembly and re-assembly work.

1202) To prepare work facilities, equipment, and tools for the modification of rotor rim support work.

1203) To prepare work facilities and utilities including working area and temporary storage area at the erection bay.

1204) To deliver temporary stored components, parts, materials and tooling from the storage area to the working area.

1205) To assemble temporary work platform with scaffolding.

1206) To perform the modification of rotor rim support work, which have interchangeability and compatibility with original designed rotor rim and spider, as following work sequence:

1) Scatter sand on the floor for leveling.
2) Arrange concrete blocks, jacks and pipe jacks.
3) Check level and height of upper shaft surface
4) Taking care of the reamer bolts, arrange jacks and pipe jacks under of the rotor rim for supporting the rotor.
5) Check the level of the lower surface of rotor rim by adjusting the jacks and pipe jacks.
6) After removing field leads, pull the rotor rim keys.
7) Cut off by gas flame the spider key support part and replace new one.
8) Lift up the rotor spider and set the spider arm to the rotor spider.
9) Insert the lower rotor rim key to rotor spider and weld the spider arm.
11) To perform tests under this modification work as specified in the ITP.

1207) To make the work area clean to proceed the rotor pole re-assembly work.

1208) Careful attention and precaution must be paid to minimize scattering of dust and dirt.

1209) Necessary and mandatory safety pre-caution and safety measures must be taken place at all the time during the work and its preparation work including storage of parts and material in order to protect personnel, environment and already installed equipment inside of the site. The site manager must be responsible to induct all personnel to follow the site safety regulations and guidance.

1210) To store the work facilities in the Power House for the next renovation work unless otherwise instructed to store in the warehouse by JHEP.

1211) Other activities than the above mentioned must be done upon mutual consent with JHEP.

⑬ Assembly of the generator

1301) Planning of the actual work such as preparation of hand tools, work equipment, consumable material and organization of work team must be done jointly with JHEP based on work procedures, time schedule, labor schedule.

1302) To prepare work facilities, equipment, electrical test equipment and tools for the generator assembly and installation work.

1303) To prepare work facilities and utilities including working area and temporary storage area in the Power House.

1304) To prepare and install of necessary working floor with scaffolding material and floor protection inside of the generator pit.

1305) To make clean flooring on the lower bracket and the rotor, and to maintain cleanliness inside of the generator. All goods and stuff must be kept free from foreign particles, and number of all tools must be controlled strictly and properly during the entire work period for the purpose of avoiding a trouble and/or a failure. Working shoes exclusive use for on the lower bracket, rotor, stator and upper bracket must be prepared, and everyone must be instructed to use them.

1306) To deliver temporary stored components, parts, materials and tooling from the storage area to the working area.

1307) To perform inspection of the temporarily stored components, parts and material prior to their assembly.

1308) To supply of disposable working wear, masks, gloves, and clean safety shoes etc. for all JHEP's personnel to work in the generator pit.

1309) To supply of written instruction of the work procedures and QC forms which cover

a) Welding,

b) Assembly and installation of the stator, thrust bearing, lower bearing bracket, poles, rotor, upper shaft, collector rings, brush holder gear, piping, wiring, and etc.

c) Assembly and installation of auxiliary equipment.

d) Alignment and centering work, oil flushing, and etc. as specified in the ITP.

1310) To perform technical advice about such as procedures and quality of on-going work, and demonstration of the work procedure to JHEP, upon request or if required.

1311) To perform generator re-assembly work as following work sequence;

1) To perform visual inspection of every component, and every preparation work to start the reassembly work.

2) To pre-assemble bearing components in the lower bearing bracket, and to perform cleaning and oil flushing. To install thrust runner in place, and check gaps between the thrust runner and thrust bearing shoes.

3) To assemble and install generator auxiliary equipment.

4) To install and do centering of the lower bearing bracket and re-assemble oil piping after the turbine shaft has been installed and aligned.

5) To assemble the generator shaft and thrust collar. Then to install to the lower bearing bracket, and runout and alignment check of the generator shaft.

6) To adjust center and height of the stator frame, if necessary.

7) To assemble lower guide bearing and to perform oil flushing of the lower bearing bracket, then to perform run-out check.

8) To connect the generator shaft with the turbine shaft and to check run-out and alignment (plumbing) of the combined shafts. The coupling work must be performed by turbine side.

9) To adjust center and level of the lower bearing bracket.

10) To install the rotor with rotor rims.

11) To assemble the rotor poles, and to perform run-out and alignment check of the combined shafts again.

12) To measure air gap, and to adjust center and level of the stator if required.

13) To assemble the upper shaft with collector rings.

14) To assemble and install the upper bracket, and to assemble brush holder gear.

15) To connect the field leads,

16) To assemble line and neutral leads with CTs and their protection covers.

17) To restore instrumentation and wiring.

18) To assemble the air coolers and to restore cooling water piping.

19) To assemble miscellaneous parts and the top cover.

20) To apply touch-up painting

21) To perform final cleaning and to perform visual inspection as specified in the ITP.

1312) To connect the generator shaft with the turbine shaft.

1313) Welding work must be performed only by qualified skilled welders.

1314) To perform necessary checks and tests based on the ITP and the QC record sheets. If obtained data are out of tolerance, necessary remedial actions must be determined by mutual consent with JHEP.

1315) All work and test data must be recorded on the QC record sheets timely during the work as specified in the ITP.

1316) To perform technical advice about such as procedures and quality of on-going work, and demonstration of the work procedure to JHEP, upon request or if required.

1317) To maintain inside of the generator pit as clean as possible during the entire renovation work period for the purpose of avoiding a trouble and/or a failure specially caused by foreign metallic particles.

1318) Careful attention and precaution must be paid to minimize scattering of dust and dirt during the work in the generator pit.

1319) Necessary and mandatory safety pre-caution and safety measures must be taken place at all the time during the assembly and installation work and its preparation work including storage of parts and material in order to protect personnel, environment and already installed equipment inside of the site. The site manager must be responsible to induct all personnel to follow the site safety regulations and guidance.

1320) To store the equipment, tools and surplus material in the Power House for the next renovation work unless otherwise instructed to store in the warehouse by JHEP.

1321) To remove waste, packing material and surplus materials from the Power House to the designated place for disposal.

1322) Site clearance after the assembly and installation work.

1323) Control of the work progress to keep and minimize the period of the work.

1324) Other activities than the above mentioned must be done by mutual consent with JHEP.

⑭ Commissioning tests of the generator

1401) To supply of the ITP, written instruction of the test procedure and test record forms on the generator.

1402) To perform test without water under support by JHEP, under presence of Commissioning engineer.

1403) To confirm completion of the installation work prior to starting the commissioning tests

1404) To perform test with water under presence of Commissioning engineer. Operation of the generator and exciter under necessary control of associated equipment and facilities, for the purpose of securing safety for the personnel and other area than the unit to be tested and commissioned, under responsibility of JHEP.

1405) To perform field balancing of the rotor. Determine balancing weights, if out of tolerance.

1406) To fix balancing weights under advice.

1407) To develop a Punch List.

⑮ Site clearance (demolition and close-out)

1501) To store the work facilities in the Power House for the next renovation work chance unless otherwise instructed to store in the warehouse by JHEP.

1502) To clear work site and site office, after removing all material, facilities, tools, equipment prepared from the work site. Prior to removal of the above stuff from the work site, it is necessary to obtain a written instruction issued by JHEP.

1503) Other activities than the above mentioned must be done by mutual consent with JHEP.

⑰ Reporting at site

1601) Submittal of the report of disassembly, inspection, assembly and installation work progress to JHEP.

1602) Submittal of weekly work report to JHEP.

1603) Timely submittal of report of the work including the QC record sheets such as disassembly, inspection, assembly and installation work.

1604) To prepare and submit of the site work report to JHEP.

1605) Making and submittal of the commissioning test reports to JHEP.

1606) To prepare the punch list

1607) In case that any un-anticipated damage or defect has been found on existing equipment, components, parts and incoming goods, immediate report must be required for the purpose of confirming it by Supervisors, specialists and commissioning engineers, and, if required, JHEP. Then necessary report will be prepared for reporting/submitting to the insurance company.

1608) To prepare a loss and damage report during disassembly, assembly and installation work to JHEP, if such occasion happens

END

Attachment: INSPECTION AND TEST PLAN

Preliminary

INSPECTION AND TEST PLAN FOR GENERATOR

Generator specification

103,500 kVA, 16,000 V, 50 Hz, 3,735 A, 93.75 r/min, 64 poles, Power actor 0.85, VTFKW-RD1

Applied standard

Material	:	JIS or equivalent
Performance/Test	:	ANSI, NEMA, IEEE, JIS or equivalent
Criteria	:	Manufacture’s standard

Test Classification

Symbols of the test / inspection classification in this document are defined as follows.

W	: (1) The test/inspection shall be performed under witness of the Customer. (2) The test/inspection reports shall be submitted to the Customer.
C	: (1) The test/inspection shall be performed by manufacturer himself. (2) The test/inspection reports shall be submitted to the Customer.
I	: (1) The test/inspection will be done internally with no reports submission.
NA	: (1) The test/inspection shall not be applied.

Preliminary

Material Inspection

No.	Components	Test Item	Standard	T/C	Remarks
1	Copper strand for stator bars	Dimension Appearance (Visual inspection) Dielectric strength	JIS or equivalent	C	Double glassfiber covered rectangular copper magnet wire
2	Stator core	Size Core loss (W15/50) Magnetic Induction (B 50)	JIS or equivalent	C	Non-oriented magnetic steel sheet
3	Copper conductor for field coils	Dimension Appearance (Visual inspection) Tensile strength	JIS or equivalent	C	Copper strip bar
4	Pole core **For 1st unit only**	Size Magnetic Induction (B 50)	JIS or equivalent	C	Hot Rolled steel sheet
5	Thrust bearing pad	Size Tensile strength Chemical composition	JIS or equivalent	C	Hot Rolled steel plate
6	Guide bearing pad	Size Tensile strength Chemical composition	JIS or equivalent	C	Hot Rolled steel plate

Preliminary

Fabrication Inspection and Test (before shipping)

No.	Components	Test Item	Test Procedure	T/C	Remarks
1	Stator bar	Strand insulation check	Test voltage: 100V, 50 Hz, 1min	I	
		Appearance	Visual inspection	I	
		Insulation resistance	To be measured by 1000V megger, 1min	C	3 bars (spot-sampling)
		Tan δ test	Test voltage: 2kV, 9.2kV, 16kV	C	
		Dimension	Main dimension	C	
		Dielectric test	Test voltage: 33kV, 50 Hz, 1min	C	
2	Rotor pole and Field coil **For 1st unit only**	Dimension	Main dimension	C	
		Insulation resistance	To be measured by 500 V megger, 1min	C	
		Dielectric test	Test voltage: 3750V, 50Hz, 1min	C	
		Appearance	Visual inspection	I	
3	Stator core lamination	Appearance	Visual inspection	I	
		Dimension	Main dimension	C	3 sheets (spot-sampling)
4	Thrust bearing shoe	Appearance	Visual inspection	I	
		Dimension	Main dimension	C	
		Non-destructive Inspection	Inspection method: Liquid penetrate examination	C	
5	Guide bearing shoe	Appearance	Visual inspection	I	
		Dimension	Main dimension	C	
		Non-destructive Inspection	Inspection method: Liquid penetrate examination	C	
6	RTD	Temperature resistance characteristics	Resistance measurement of Cu element	C	
		Insulation resistance	To be measured by 500 V megger	C	
		Dielectric test	Applied voltage: 1500 V, 50 Hz, 1min	C	
7	Temperature relay	Operation test	Manufacture's standard	C	
		Insulation resistance	To be measured by 500 V megger	C	
		Dielectric test	Applied voltage: 1500 V, 50 Hz, 1min	C	
		Appearance	Visual inspection	I	

Preliminary

No.	Components	Test Item	Test Procedure	T/C	Remarks
8	Dial thermometer	Operation test	Manufacture’s standard	C	
		Insulation resistance	To be measured by 500 V megger	C	
		Dielectric test	Applied voltage: 1500 V, 50 Hz, 1min	C	
		Appearance	Visual inspection	I	
9	Oil level relay	Operation test	Manufacture’s standard	C	
		Insulation resistance	To be measured by 500 V megger	C	
		Dielectric test	Applied voltage: 1500 V, 50 Hz, 1min	C	
		Appearance	Visual inspection	I	
10	CT	Characteristic test	Manufacture’s standard	C	
		Insulation resistance	To be measured by 500 V megger	C	
		Dielectric test	Applied voltage: 1500 V, 50 Hz, 1min	C	
		Appearance	Visual inspection	I	
~~11~~	~~High pressure oil lifter pump~~	~~Oil pumping characteristics~~	~~Manufacture’s standard~~	~~C~~	
		~~Pressure test~~	~~Test pressure;~~ ~~for high pressure side: 20.6MPa,10min~~ ~~for low pressure side: 4.9MPa,10min~~	~~C~~	
		~~Appearance~~	~~Visual inspection~~	~~I~~	
~~12~~	~~High pressure oil lifter motor~~	~~Motor characteristics~~	~~According to JIS or equivalent~~	~~C~~	
		~~Appearance~~	~~Visual inspection~~	~~I~~	
~~13~~	~~Creep detector~~	~~Dimension~~	~~Main dimension~~	~~I~~	
	~~(Creep indicator)~~	~~Appearance~~	~~Visual inspection~~	~~I~~	
~~14~~	~~Vibration detector and monitor~~	~~Operation test~~	~~Manufacture’s standard~~	~~C~~	
		~~Insulation resistance~~	~~To be measured by 500 V megger~~	~~C~~	
		~~Dielectric test~~	~~Applied voltage: 1500 V, 50 Hz, 1min~~	~~C~~	
		~~Appearance~~	~~Visual inspection~~	~~I~~	
~~15~~	~~Water flow relay~~	~~Operation test~~	~~Manufacture’s standard~~	~~C~~	
		~~Insulation resistance~~	~~To be measured by 500 V megger~~	~~C~~	

Preliminary

No.	Components	Test Item	Test Procedure	T/C	Remarks
		~~Pressure test~~	~~Test pressure: 1.7MPa,10min~~	~~C~~	
		~~Appearance~~	~~Visual inspection~~	~~I~~	
~~16~~	~~Oil flow meter~~	~~Operation test~~	~~Manufacture's standard~~	~~C~~	
		~~Insulation resistance~~	~~To be measured by 500 V megger~~	~~C~~	
		~~Pressure test~~	~~Test pressure:1.0MPa,10min~~	~~C~~	
		~~Appearance~~	~~Visual inspection~~	~~I~~	
17	Limit switch for brake and jack	Operation test	Manufacture's standard	C	
		Insulation resistance	To be measured by 500 V megger	C	
		Dielectric test	Applied voltage: 1500 V, 50 Hz, 1min	C	
		Appearance	Visual inspection	I	
~~18~~	~~Carbon brush~~	~~Appearance~~	~~Visual inspection~~	~~I~~	
		~~Dimension~~	~~Main dimension~~	~~I~~	
~~19~~	~~Space heater~~	~~Insulation resistance~~	~~To be measured by 500 V megger~~	~~C~~	
		~~Dielectric test~~	~~Applied voltage: 1500 V, 50 Hz, 1min~~	~~C~~	
		~~Appearance~~	~~Visual inspection~~	~~C~~	
		~~Dimension~~	~~Main dimension~~	~~I~~	
~~20~~	~~Brake shoe~~	~~Appearance~~	~~Visual inspection~~	~~I~~	
		~~Dimension~~	~~Main dimension~~	~~C~~	
21	Oil deflector	Appearance	Visual inspection	I	
		Dimension	Main dimension	C	
22	Slip ring	Dimension	Main dimension	C	
	(Collector ring)	Runout check	Manufacture's standard	C	
	For 1st unit only	Appearance	Visual inspection	I	
22	Spring support	Appearance	Visual inspection	I	
	(for HITACHI PIVOT SPRING)	Dimension	Main dimension	C	
23	Stator frame	Appearance	Visual inspection	I	
	For 1st unit only	Dimension	Main dimension	C	

Preliminary

Before Disassembling and Disassembled Parts Inspection and Test at Site

No.	Components	Test Item	Test Procedure	T/C	Remarks
1	Upper and Generator shaft	Appearance	Visual inspection	C	
2	Thrust collar	Appearance	Visual inspection	C	
3	Thrust runner	Appearance	Visual inspection	C	
4	Thrust oil tank	Inspect thrust oil tank	Visual inspection	C	
5	Brakes & Jacks	Visual and dimensional inspection	Visual inspection Main dimension	C	
		Operation check test	Normal working pressure for air : 1.0MPa Normal working pressure for oil : 16.7MPa	C	Before disassembly
6	Stator frame **Except for 1st unit**	Inspection and NDI of main welded area	PT (Penetrant examination test) or MT (Magnetic particle examination test)	C	
7	Rotor spider **For 2G1, 2G3 only**	Inspection and NDI of rotor spider reinforced area	PT (Penetrant examination test) or MT (Magnetic particle examination test)	C	
8	Rotor rim	Appearance	Visual inspection	C	
9	Field winding	Appearance	Visual inspection	C	
		Insulation resistance test	To be measured by 500V megger, 1min	C	
		Voltage drop test	Test voltage: 230 V, 50 Hz, 1min	C	
10	Pipings for oil cooler	Leakage check test	Maximum working pressure for water : 0.6MPa Normal working pressure for oil : 0.3 MPa	C	Test pressure of reused parts shall be discussed later.
11	Pipings for High pressure oil lifter	Leakage check test	Maximum working pressure for high : 13.7MPa Test pressure for low : 4.9MPa	C	
12	Pipings for air cooler	Leakage check test	Maximum working pressure for water : 0.6MPa	C	These test will be performed before disassembly.
13	Pipings for Brake & Jack	Leakage check test	Normal working pressure for air : 1.0 MPa Normal working pressure for oil : 16.7MPa	C	
14	Other disassembled and reused parts	Appearance	Visual inspection	C	

Preliminary

Under Disassembling of Generator Inspection and Test at Site

No.	Articles	Standard value not less or more than	T/C	Remarks
1	Level cheek	1.1 Lower bracket base	C	Straight edge and level gauge
		1.2 Stator base	C	
		1.3 Upper surface of main shaft	C	Level gauge
		1.4 Lower bearing bracket	C	
2	Height check	2.1 Lower bearing bracket to Lower bracket	C	Level and scale
3	Center check	3.1 Lower bearing bracket	C	Micrometer
		3.2 Stator core	C	
		3.3 Upper bracket	C	
		3.4 Lower bracket to shaft	C	
		3.5 Turbine shaft coupling to Generator shaft coupling face	C	
4	Clearance check	5.1 Generator air gap	W	Gap gauge
		5.2 Gap between brake ring and brake shoe	C	Scale
		5.3 Brush holder to collector ring	C	
		5.4 Oil deflector of lower guide bearing to shaft	C	
		5.5 Lower guide bearing to shaft	C	Gap gauge
		5.6 Gap between lower shaft and CO_2 cover	C	Gap gauge
		5.7 Gap between upper fan guide and rotating parts	C	Scale
		5.8 Gap between lower fan guide and rotating parts	C	
		5.9 Other minimum clearance between stationary part and rotating part	C	

Preliminary

Under Assembling (Stator Core Restacking and Stator Coil Rewinding) Inspection and Test at Site

No.	Components	Test Item	Test Procedure	T/C	Remarks
1	Stator core	Appearance	Visual inspection	C	
		Core teeth stiffness check	Manufacture’s standard	C	
		Dimension check	Main dimension	C	
		Roundness check	Manufacture’s standard	C	
2	Stator coil	Dielectric test	Test voltage: DC 56.1 kV, 1min	C	Before connecting stator bars
3	RTD for stator coil	Dielectric test	Test voltage: 1500 V, 50 Hz, 1min	C	Before connecting stator bars

Preliminary

After Completion of Stator Rewinding Inspection and Test at Site

No.	Components	Test Item	Test Procedure	T/C	Remarks
1	Stator winding	Appearance	Visual inspection	C	
		Tapping test of wedges	To be measured by tapping tool	C	
		Winding Resistance test	Design value ±%	C	
		Insulation resistance test	To be measured by 1000V megger, 1min	C	
		Dielectric test	Test voltage: 33 kV, 50 Hz, 1min	W	
		Polarity check	To be measured by DC method and compass	C	

After Completion of Rotor Assembling Inspection and Test at Site

No.	Components	Test Item	Test Procedure	T/C	Remarks
1	Field winding	Appearance	Visual inspection	C	
		Winding Resistance test	Design value ±%	C	
		Insulation resistance test	To be measured by 500V megger, 1min	C	
		Dielectric test	Test voltage: 3750 V, 50 Hz, 1min	W	**For 1st unit only**
		Voltage drop test	Test voltage: 230 V, 50 Hz, 1min	C	
		Polarity check	To be measured by DC method and compass	C	

Preliminary

Under Assembling of Generator Inspection and Test at Site

No.	Articles	Standard value not less or more than	T/C	Remarks
1	Level cheek	1.1 Lower bracket base	C	Straight edge and level gauge
		1.2 Stator base	C	
		1.2 Upper surface of main shaft	C	Level gauge
		1.3 Lower bearing bracket	C	
2	Height check	2.1 Lower bearing bracket to Lower bracket	C	Level and scale
3	Center check	3.1 Lower bearing bracket	C	Micrometer
		3.2 Stator core	C	
		3.3 Upper bracket	C	
		3.4 Lower bracket to shaft	C	
		3.5 Turbine shaft coupling to Generator shaft coupling face	C	
4	Runout check	4.1 Turbine shaft at guide bearing: with NEMA standard	W	Dial indicator
		4.2 Generator lower shaft at guide bearing journal: with NEMA standard	W	
5	Clearance check	5.1 Generator air gap	W	Gap gauge
		5.2 Gap between brake ring and brake shoe	C	Scale
		5.3 Brush holder to collector ring	C	
		5.4 Oil deflector of lower guide bearing to shaft	C	
		5.5 Lower guide bearing to shaft	C	Gap gauge
		5.6 Gap between lower shaft and CO2 cover	C	Gap gauge
		5.7 Gap between upper fan guide and rotating parts	C	Scale
		5.8 Gap between lower fan guide and rotating parts	C	
		5.9 Other minimum clearance between stationary part and rotating part	C	
6	Hydraulic pressure test	6.1 Air cooler: Maximum working pressure for water side: 0.6MPa, 10min	C	
		6.2 Oil cooler: Maximum working pressure for water side: 0.6MPa, 10min	C	

Preliminary

No.	Articles	Standard value not less or more than	T/C	Remarks
7	Proof of thermometers	6.1 Temperature relay	C	
		6.2 Dial thermometer	C	

Dry Test at Site after Completion of Assembling

No.	Test Item	Test Procedure	T/C	Remarks
1	Stator winding Insulation resistance test	To be measured by 1000V megger, 1min	W	
2	Field winding Insulation resistance test	To be measured by 500V megger, 1min	W	
3	RTD Temperature resistance test	Resistance measurement of Cu element	W	
4	Oil level relay operation check	Operation check with power supply	W	
5	Brake & Jack operation check	Operation check with power supply	W	
6	High pressure oil lifter operation check	Rotor lift up check	W	
7	Protection setting point operation check	Operation check with power supply	W	
8	CT polarity check	To be measured by DC method and compass	W	
9	CO2 fire protection system operation check	Operation check with power supply	W	
10	Thrust oil pump operation check	Operation check with power supply	W	
11	Creep detector operation check	Operation check with power supply	W	
12	Vibration detector and monitor	Operation check with power supply	W	
13	Water flow relay operation check	Operation check with power supply	W	
14	Oil flow meter operation check	Operation check with power supply	W	
15	Space heater operation check	Operation check with power supply	W	

Preliminary

Wet Test at Site after Completion of Assembling

No.	Test Item	Test Procedure	T/C	Remarks
1	Vibration measurement	To be measured by vibration monitor	W	
2	Bearing run	Bearing temperature check	W	
3	Measurement of oil deflector air seal pressure	Air seal pressure check	W	
4	Brake operation	To be Applied from% of rated speed	W	
5	Open circuit characteristics curve	Up to 120% of rated voltage	W	
6	Voltage balance test	To be checked in Item No.5	W	
7	Phase sequence test	To be checked with residual voltage of generator unexcited condition using phase rotation meter	W	
8	Measurement of shaft voltage	To be checked at collector ring and lower shat	W	
9	Heat run	To be carried out using actual transmission lines Stator, Field winding, bearing temperature check	W	
10	Load rejection test	To be carried out at selected loads using actual transmission lines	W	Performed by Water turbine supplier

Appendix-13

Power Sector Rehabilitation Plans

(1) Power Generation Plants

(2) Transmission Facilities

(1) Power Generation Plants

LOCATION	UNIT	TYPE	RATED CAPACITY (MW)	AVAILABLE CAPACITY (MW)	CASE OF DEFICIENCY	RESTORATION PLANS	ESTIMATED RECOVERY TIMELINES	REMARKS
SHIRORO	411G1	HYDRO-TURBINE PLANT	150	150	NIL	IN SERVICE	IN SERVICE	THERE IS NEED TO SUSTAIN THE INITIATIVES FOR PLANNED OVERHAUL OF ALL THE UNITS ONE AFTER THE OTHER AS CURRENTLY UNDERTAKEN IN THE STATION
	411G2		150	0	GENERATOR EARTH FAULT AND NEED FOR COMPREHENSIVE OVERHAUL	UNDERGOING REPAIRS AND OVERHAUL	NOV., 2011	
	411G3		150	150	NIL	INSERVICE BUT PLANNED FOR OVERHAUL IN Q1/2012	3 MONTHS AFTER TAKE OFF	
	411G4		150	150	NIL	IN SERVICE		
KAINJI	1G05	HYDRO-TURBINE PLANT	120		AWAITING REHABILITATION	COMPREHENSIVE OVERHAUL/RETROFFITING REQUIRED	WORLD BANK PHASE I PROJECT BUT DELIVERY TIMELINE NOT AVAILABLE YET	THERE IS NEED FOR COMPREHENSIVE OVERHAUL/RETROFFITTING OF ALL THE UNITS IN THIS PLANT. THE WORLD BANK HAS UNDERTAEN TO RECOVERED SOME OF THE UNITS ON THE PHASE 1 PLAN.
	1G06		120	0	EXCESSIVE WATER LEAKAGE FROM CRACKED THROAT RING	COMPREHENSIVE OVERHAUL/RETROFFITING REQUIRED	WORLD BANK PHASE I PROJECT BUT DELIVERY TIMELINE NOT AVAILABLE YET	
	1G07		80		OUT ON ROTOR EARTH FAULT & STATOR WINDING INSULATION RESISTANCE FAULURE	RECOVERY CONTRACT TO BE HANDELD PARTLY BY ALSTOM BUT THE PROCESS IS ON	TIMELINE DEPENDS ON AWARD OF PROCUREMENT CONTRACT AND THE ASSEMBLY PROCESS BUT EXPECTED TO BE COMPLETED BY Q4/2012	
	1G08		80		OUT ON GOVERNOR FAULT	COMPREHENSIVE OVERHAUL/RETROFFITING REQUIRED	Q2/2013	
	1G09		80	20	DERATED DUE TO AGEING AND OBSOLETE COMPONENTS	COMPREHENSIVE OVERHAUL/RETROFFITING REQUIRED	OVERHAUL CONTRACT YET TO BE AWARDED DUE TO FUNDING ISSUES	
	1G10		80	20	LIMITED TO LOW LOAD DUE TO HIGH THRUST BEARING TEMPERATURE	COMPREHENSIVE OVERHAUL/RETROFFITING REQUIRED	OVERHAUL CONTRACT YET TO BE AWARDED DUE TO FUNDING ISSUES	
	1G11		100	ON FREE GOVERNOR	NONE EXCEPT PLAN FOR SUSTENANCE	REQUIRES OVERHAUL TO ENHANCE AND SUSTAIN PERFORMANCE	OVERHAUL CONTRACT YET TO BE AWARDED DUE TO FUNDING ISSUES	
	1G12		100	100	NONE EXCEPT PLAN FOR SUSTENANCE	REQUIRES COMPREHENSIVE OVERHAUL/RETROFFITING TO ENHANCE PERFORMANCE	OVERHAUL CONTRACT YET TO BE AWARDED DUE TO FUNDING ISSUES	
Jebba	2G01	HYDRO-TURBINE PLANT	94	90	AVAILABLE	REQUIRES OVERHAUL BUT NOT PLANNED YET	IN SERVICE	REPAIR OF THE SPILLWAY GATE IN THE DAM STRUCTURE IS CURRENTLY BEING UNDERTAKEN BY THE WORLD BANK WHLE OTHER FUNCTIONAL UNITS ARE EXPECTED TO UNDERGO UNPRECEDENTED STATUTORY OVERHAUL TO ENHANCE PERFORMANCE
	2G02		94	90	AVAILABLE	REQUIRES OVERHAUL BUT NOT PLANNED YET	IN SERVICE	
	2G03		94	90	AVAILABLE	REQUIRES OVERHAUL BUT NOT PLANNED YET	IN SERVICE	
	2G04		94	90	AVAILABLE	REQUIRES OVERHAUL BUT NOT PLANNED YET	IN SERVICE	
	2G05		94	90	AVAILABLE	REQUIRES OVERHAUL BUT NOT PLANNED YET	IN SERVICE	
	2G06		94	NIL	DOWN DUE TO BURNT AVR	PROCUREMENT PROCESS FOR FINAL AWARD OF RECOVERY CONTRACT IN PROGRESS	Q2/2012	
EGBIN	ST01	STEAM TURBINE PLANT	220	220	AVAILABLE	IN SERVICE		REHABILITATION WORKS FOR THE RECOVERY OF UNIT ST06 ONGOING. FUNDING AWAITED FOR AWARD OF REASSEMBLY CONTRACT TO MARUBENI BUT THERE ARE NO ISSUES OF GAS SUPPLY OR EVACUATION CONSTRAINTS
	ST02		220	220	AVAILABLE	IN SERVICE		
	ST03		220	220	AVAILABLE	IN SERVICE		
	ST04		220	220	AVAILABLE	IN SERVICE		
	ST05		220	220	AVAILABLE	IN SERVICE		
	ST06		220	NIL	UNDERGOING LP ROTOR REPAIR	LP ROTOR REPAIRS AND OTHER VITAL WORKS TO FAST TRACK DELIVERY	Q2/2012	
DELTA	GT03	GAS TURBINE PLANT	25	NIL	GENERATOR WINDING FAULT	PLANT AUDIT REQURED TO ESTABLISH DELIVERY TIMELINE	2012	THERE ARE NOISSUES WITH GAS SUPPLY AND EVACUATION BUT A COMPREHENSIVE PLANT AUDIT TO ASCERTAIN THE

LOCATION	UNIT	TYPE	RATED CAPACITY (MW)	AVAILABLE CAPACITY (MW)	CASE OF DEFICIENCY	RESTORATION PLANS	ESTIMATED RECOVERY TIMELINES	REMARKS
	GT04		25	NIL	STATOR MOTOR ANDOTHER STATUTORY INSPECTION REQUIRED	IN-HOUSE RECOVERY WORKS ONGOING	DECEMBER, 2011	HEALTH AND POSSIBILITY OF RECOVERY OF NONFUNCTIONAL UNITS URGENTLY REQUIRED, GOING FORWARD
	GT05		25	NIL	GENERATOR WINDING FAULT	PLANT AUDIT REQURED TO ESTABLISH DELIVERY TIMELINE	2012	
	GT06		25	NIL	HIGH VIBRATION TROUBLE	PLANT AUDIT REQURED TO ESTABLISH DELIVERY TIMELINE	2012	
	GT07		25	NIL	EXCESSIVE OIL LEAKAGE AT THE GENERATOR END	PLANT AUDIT REQURED TO ESTABLISH DELIVERY TIMELINE	2012	
	GT08		25	NIL	MECHANICAL OVERSPED BOLT TROUBLE	PLANT AUDIT REQURED TO ESTABLISH DELIVERY TIMELINE	2012	
	GT09		25	NIL	HIGH VIBRATION TROUBLE	PLANT AUDIT REQURED TO ESTABLISH DELIVERY TIMELINE	2012	
	GT10		25	NIL	HIGH VIBRATION TROUBLE	PLANT AUDIT REQURED TO ESTABLISH DELIVERY TIMELINE	2012	
	GT11		25	25	NIL	IN SERVICE	N/A	
	GT12		25	25	NIL	IN SERVICE	N/A	
	GT13		25		HIGH VIBRATION TROUBLE	PLANT AUDIT REQURED TO ESTABLISH DELIVERY TIMELINE	2012	
	GT14		25	0	UNDERGOING REPAIRS	PLANT AUDIT REQURED TO ESTABLISH DELIVERY TIMELINE	2012	
	GT15		100	0	TURBINE BLADE FAILURE	MAJOR REHABILITATION REQUIRED	2013	
	GT16		100	100	RUNNING ON GOVERNOR CONTROL	IN SERVICE	N/A	
	GT17		100	0	ACCESSORY GEAR BOX AND MAJOR REHABILITATION WORKS	HIGH AND OTHER VITAL RECOVERY WORKS	Q2/2012	
	GT18		100	0	HGPI AND OTHER MAJOR REPAIR WORKS	HGPI AND OTHER MAJOR REPAIR WORKS	DECEMBER, 2011	
	GT19		100	100	ON FREE GOVERNOR	IN SERVICE	N/A	
	GT20		100	100	ON FREE GOVERNOR	IN SERVICE	N/A	
AFAM	GT17	GAS TURBINE PLANT	75	0	UNDERGOING REPAIRS	DEC., 2011	COMPONENT UPGRADE FOR OPERATIONAL ENHANCEMENT MAY BE EFFECTED IN Q2/2012	PERENNIAL SYSTEM DISTURBANCES DUE TO INADEQUATE EVACUATION INFRASTRUCTURE MAJOR CAUSES OF LOW PRODUTIVITIY AND TROUBLES WITH INSTRUMENTATION/ELECTRICAL DEVICES
	GT18		75	60	OBSOLETE INSTRUMENTATION DEVICES	INSERVICE BUT REQUIRES UPGRADE OF INSTRUMENTATION AND OTHER MAJOR COMPONENTS TO ENHANCE PERFORMANCE	IN SERVICE BUT COMPONENT UPGRADE WILL GUARANTEE OPERATIONAL ENHANCEMENT. MAY BE EFFECTED IN Q2/2012	
	GT19		138	0	MAJOR REHABILITATION REQUIRED	PLANNED FOR MAJOR OVERHAUL BUT DELIVERY LIKELY IN Q4/2012 IF RECOVERY PROCESS IS INITIATED IN GOOD TIME		
	GT20		138	0	MAJOR REHABILITATION REQUIRED	PLANNED FOR MAJOR OVERHAUL BUT DELIVERY LIKELY IN Q4/2012 IF RECOVERY PROCESS IS INITIATED IN GOOD TIME	Q4/2012	

LOCATION	UNIT	TYPE	RATED CAPACITY (MW)	AVAILABLE CAPACITY (MW)	CASE OF DEFICIENCY	RESTORATION PLANS	ESTIMATED RECOVERY TIMELINES	REMARKS
OLORUNSOGO	GT01	GAS TURBINE PLANT	38	30	GAS CONSTRAINTS	ADEQUATE GAS SUPPLY	Q1/2012	GAS PIPELINE CONTRACT PUT IN PLACE TO INCREASE QUANTITY OF GAS AT THE PRESENT LEVEL TO ADEQUATE LEVEL NEEDED TO RUN PLANTS WITHIN THIS CLUSTER
	GT02		38	30	GAS CONSTRAINTS	ADEQUATE GAS SUPPLY	Q1/2012	
	GT03		38	30	GAS CONSTRAINTS	ADEQUATE GAS SUPPLY	Q1/2012	
	GT04		38	30	GAS CONSTRAINTS	ADEQUATE GAS SUPPLY	Q1/2012	
	GT05		38	30	GAS CONSTRAINTS	ADEQUATE GAS SUPPLY	Q1/2012	
	GT06		38	0	GAS CONSTRAINTS	ADEQUATE GAS SUPPLY	Q4/2012	
	GT07		38	30	TURBINE BLADE FAILURE	REHABILITATION CONTRACT TO BE PUT IN PLACE. MAY BE RECOVERED BY Q4/2012		
	GT08		38	0	GAS CONSTRAINTS	ADEQUATE GAS SUPPLY	DECEMBER, 2011	
OMOTOSHO	GT01	GAS TURBINE PLANT	38	30	POOR AIR INTAKE FILTERS	IN SERVICE	N/A	THERE IS A SUBSISTING CONTRACT FOR 100% RESTORATION OF THIS PLANT AWARDED TO CMEC AND EXPECTED TO BE CONCLUDED BY DECEMBER, 2011. HOWEVER, THIS PLANT DOES NOT HAVE CONSTRAINTS OF EVACUATION AND GAS SUPPLY
	GT02		38	0	GENERATOR DIFFERENTIAL	RECOVERY WORKS	DECEMBER, 2011	
	GT03		38	0	HIGH VIBRATION TROUBLE	RECOVERY WORKS	DECEMBER, 2011	
	GT04		38	0	GENERATOR DIFFERENTIAL	RECOVERY WORKS	DECEMBER, 2011	
	GT05		38	0	HIGH VIBRATION TROUBLE	RECOVERY WORKS	DECEMBER, 2011	
	GT06		38	0	HIGH VIBRATION TROUBLE	RECOVERY WORKS	DECEMBER, 2011	
	GT07		38	30	POOR AIR INTAKE FILTERS	IN SERVICE	N/A	
	GT08		38	30	POOR AIR INTAKE FILTERS	IN SERVICE	N/A	
GEREGU	GT11	GAS TURBINE PLANT	138	138	AVAILABLE	STATUTORY INSPECTION BASED ON THE EOH TO BE PLANNED FOR INCREASED OPPERATIONAL EFFICENCY		CONSTRAINTS OF EVACUATION AND GAS SUPPLY MAJOR CAUSES OF DROP IN PRODUCTIVITY
	GT12		138	0	UNDERGOING RECOVERY WORKS	MAJOR HGPI BASED ON EOH REQUIRED	Q1/2012	
	GT13		138	138	AVAILABLE	STATUTORY ISPECTION BASED ON THE EOH TO BE PLANNED FOR INCREASED OPERATIONAL	Q2/2012	
SAPELE	ST01	STEAM TURBINE PLANT	120	90	DERATED DUE TO AGEING AND OBSOLETE INSTRUMENTATION DEVICES	FUNDING PROVISION REQUIRED TO ENABLE NECESSARY UPGRADE FOR PERFORMANCE ENHANCEMENT IN Q2/2012	Q3/2012	COMPREHENSIVE PLANT AUDIT ON A NUMBER OF NON-FUNCTIONAL UNITS PLUS DETAILED UPGRADE OF INSTRUMENTATION DEVICES ON FUNCTIONAL ONES REQUIRED BUT THERE ARE NO ISSUES WITH GAS SUPPLY OR TRANSMISSION EVACUATION INFRASTRUCTURE
	ST02		120	80	DERATED DUE TO AGEING OBSOLETE INSTRUMENTATION DEVICES	DITTO	Q3/2012	
	ST03		120	0	UNDERGOING REHABILITATION WRKS BUT ALS HAS OBSOLETE INSTRUMENTATION DEVICES	ONGOING RECOVERY WORKS BUT UNIT REQUIRES INSTRUMENTATION UPGRADE FOR PERFORMANCE ENHANCEMENT	NOV., 2011	

(2) PHCN – TRANSMISSION COMPANY OF NIGERIA (TCN)

PROJECT COMPLETION REPORT (SHORT, MEDIUM AND LONG TERMS)

S/No	Project Name / Contractor	Name of Contractor	Commence-ment Date	Expected Completion Date	Derivable Benefits of Project	Constraints
	SHORT TERM					
1	Gombe-Yla-Jalingo 330kv SC line Gombe–Adamawa-Taraba States/ Chrome Consortium-Dextron Ltd	Chrome Consortium/Dextron	13th Dec, 2001	July, 2010	Improved voltage profile to the North East Zone and enhancement of socio-economic growth of the area. 367.5Km of 330KV Line length to be added to the network to improve TCN wheeling capacity	· Recent vandalisation of the line may delay completion. · Dextron has however promised to complete project by July 2010
2	Gombe-Damaturu-Maiduguri 330kV line Gome-Yobe-Borno States /KEC/News Engineering Ltd	KEC/NEWS Engineering	Apr., 2006	Aug, 2010	Improve voltage profile and enhancement of socio-economic growth of the area.	· Gombe-Damaturu Line competed. · Damaturu-Maiduguri Line – on-going · Damaturu T, S. – terminated and to be re-awarded
3	Akure-Ado Ekiti 132kv SC line Ondo-Ekiti/Dextron Engineering Ltd	Dextron Engineering Ltd	May, 2003	July, 2010	Improve voltage profile and enhancement of socio-economic growth of the area.	· Stringing of the entire line lengh to be completed by 10th of Juy 2010. · Commissioning of the line of the 17th of July, if line bay is made available at Akure T.S. by JKN
4	Afam-PH 132kv DC turning in and out at PH main TS	ABB Powerlines	Oct. 2009	July, 2010	To ensure flexibility of the grid in the evacuation of RVSG power generation.	· Slow Pace of work by ABB Powerlines. · ABB Powerlines Project Manager promised to complete it by the end of July, 2010. · TCN requested the EPC to formalize the promise in writing to TCN & the Minister.
5	Transmission—Yola 2 x 150MV A 330/132kV S/S and 330kV Bay Extension at Gombe Adamawa State/MBH Power Ltd	MBH Power Ltd.	Dec. 2001 Sept. 2008	Aug, 2010	Improvement of serious low boltage profile in Yola and Jalingo Trx station and connection of additional loads in Yola and environs.	· Jalingo T.S. commissioned in Oct. 2009. · Gombe T.S. to be commissioned by 20th July, on the provision that Gombe-Yoka 330kV Line is made available by Dextron/Chrome.
6	Ado-Ekiti 132/33kV substration and Akure 132kV line bay extension. Ekiti-Ondo States	JKN Limited	May, 2001	Aug, 2010	Improvement of quality and quantity of power supply in Ado0Ekiti and enhancement of socio-economic growth of Ekiti State	· Pre-Commissioning of the Substation – 90% completed. · JKN yet to collect relay password for 10% remaining precommissioning works. · Above is due to JKN outstanding debt to ConCos-AS of South Africa. TCN

S/No	Project Name / Contractor	Name of Contractor	Commence-ment Date	Expected Completion Date	Derivable Benefits of Project	Constraints
						mediating between ConCoS-AS & JKN for password. · To fastract completion, TCN has loan to JKN equipment previously paid for.
7	Installation of 1No 150MVA Power Transformer in Kano T/S	In house	June	30th July, 2010	Improved and stable Supply of electricity to Kano State.	· Completion date realizable. · Filtration of transformer oil commenced – 5/07/2010. · Pre-commissioning tests to commence-11/07/2010. · Awaiting as built drawing from Areva to enable total pre-commissioning
8	Installation of 1No 150MVA Power Transformer in Akangba T/S	In house	Apr-10	Aug-10	Will release Customers constantly on load shedding and enhance power evacuation capacity.	· Relisable date of commissioning.
9	Installation of 1No 150MVA Power Transformer and Seperation of Bank 75MX Reactor in Ososgbo T/S	In house	Apr-10	30th July, 2010	Improve voltage profile, power evacuation capacity and management of grid operations during high voltage surges.	· Transformer installation to be completed by July, 2010. · 75MX Reactor to be completed by Nov. 2010.
10	Installation of 1No 150MVA Power Transformer in Ayede T/S	Matelec	May-10	30th Aug, 2010	Enhance power evacuation capacity.	· TCN would complete installation and make available the 150MVA Transformer to Matelec by 15th of July 2010. · Delayed pace of contractor works due to outage constraints from NCC. · And need not to compromise grid stability during outage. · NCC directed to facilitate outages. · Matelec is to formalize the promise to complete the project by August 2010.
11	Installation of 1No 60MVA Power transformer in Calabar T/S	In house	Jun-10	Aug, 2010	Improve evacuation capacity from 60MVA to 120MVA.	Delivery of Earthing Transformer.
12	Installation of 1No 60MVA Power transformer in Dakata T/S	In house	Jun-10	30th Sept-2010	Improve evacuation capacity from 60MVA to 120MVA	· Modification of plinth in progress. · Transformer and Accessories on site.
13	Installation of 1No 60MVA Power transformer in Minna T/S	In house	May-10	15th August 2010	Improve evacuation capacity.	Delivery of Earthing transformer 33kV Circuit Breakers.

S/No	Project Name / Contractor	Name of Contractor	Commence-ment Date	Expected Completion Date	Derivable Benefits of Project	Constraints
14	Installation of 1No 30MVA 132/33KV Power transformer in Akure T/S	In house	Feb-10	30th July, 2010	Improvement and flexibility of power evacuation capacity	Erection of CTS
15	Jalingo 2x30/40MVA, 132/33kV Substation. Taraba-State	News Engineering Ltd	Sept 2002	Commissioned	Improvement of serious low voltage profile in Jalingo and environs	Outstanding remedial works: - · Staff Quarters. · Access road to Staff Quarters. · Provision of Bore hole. · Control Room furniture. · Sealing of 1No, Transformer leakage.
MEDIUM TERM						
1	Onitsha 150MVA 330/132/33kV T/F and 330kV bays at Onitsha and Benin. Anambra and Edo States/MBH Power Ltd	Siemens Ltd. MBH Power Ltd	18th May, 2001, Sept. 2008	Oct. 2010	Increaed transformation capacity in the station	Material shortages found, sourcing them may delay completion though progress is being made.
2	Installation of 1No 60MVA Power transformer in Akangba T/S	In house	Jun-10	Oct-10	Improve evacuation capacity from 60MVA to 120MVA	Plinth needs modification and other civil works
3	Installation of 11No 60MVA Power transformer in B/Kebbi T/S	In house	Feb-10	Dec-10	Improve evacuation capacity from 60MVA to 120MVA.	Modification of plinth
4	Installation of 1No 60MVA power transformer in PH Town	In house	Jun-10	Dec-10	Improved power evacuation capacity of TCN and RVSG.	Need for several outages to create safe working space which may not be granted as at when required.
5	Installation of 1No 60MVA Power transformer in Katsina T/S	In house	Jun-10	30th Nov. 2010	Improve evacuation capacity.	Plinth needs modification
6	Installation of 1No 60MVA Power transformer in Abakiliki T/S	Ebony Stack	Jul-10	Jan. 2011	Improve evacuation capacity	
7	Alaoji-Umuahia 132kv DC line Abia State/Pivot Engineering Ltd	Pivot Engineering	Nov. 2001	Sept, 2010	57KM of 132KV line DC line length to be added to improve TCN wheeling capacity	Unresolved compensation issues
8	Owerri-Ahoada-Yenegoa 132kv DC lines and substations Imo-Rivers-Bayelsa States/Pivot Engineering ltd.	Pivot Engr	Oct.2000	Commissioned	Connect Ahoada and Yenagoa to the National grid	Remedial works outstanding

S/No	Project Name / Contractor	Name of Contractor	Commence-ment Date	Expected Completion Date	Derivable Benefits of Project	Constraints
9	Umuahia 2x30/40MVA 132/33kV Substation Abia/Valenz Holdings (NIG) Ltd.	Valenz Holdings (Nig) Ltd.	Sept. 2001	Sept, 2010	Improve power quality in te south East	EPC request for eacalation n prices
10	Calabar 2x150MVA, 330/132/33kV Substations and line bay at Alaoji Substations. Cross River States/ MBH Power Ltd	MBH ower Ltd.	16th Aug. 2008	Dec. 2010	Improve power supply situation I Calabar and greater part of Cross River State and enhance socio-economic life.	Stealing of power cable, replacement may delay Dec, 2010 completion.
11	Rochukwu 2x30/40MVA 132/33kV substation Abia/Omen Int'l Ltd.	Omen Lnt'l Ltd.	Aug. 2001	Sept, 2010	Addition of 80MVA Transformer capacity at 132KV level to the network.	
12	Mbalano-Okigwe 132kv SC line Abia /Atlantic Engineering & Construction Ltd	Atlantic Engineering & Construction	Nov. 2001	Dec. 2010	22KM of 132KV line length to be added to the network.	
LONG TERM						
1	Okigwe 2x30/40MVA 132/33kV Substation Abia /Union Allied Engr'g Ltd.	Union Allied Engr'g Ltd.	Sept. 2001	March, 2011	Addition of 80MVA Transformer capacity at 122KV level to the network	Inability to clear goods from the Ports
2	Umuahia-Ohafia 132kv SC line Abia /Harlesden Engineering Ltd	Harlesden Engineering Ltd	Oct. 2007	Jun. 2011	Addition of 46.9KM of 132KV line length to improve TCN wheeling capacity.	
3	Ohafia 2x30/40MVA 132/33kV substation. Abia/ Union Allied Engr'g Ltd.	Union Allied Engr'g Ltd.	Sept. 2001	March, 2011	Addition of 80MVA Transformer capacity at 132KV level	Inability to clear goods from the Ports
4	Mbalano 2x30/40MVA 132/33kV substation. Abia /Union Allied Engr'g Ltd.	Union Allied Engr'g Ltd.	May, 2001	July, 2010	Addition of 80MVA Transformer capacity at 132KV level	Inability to clear goods from the Ports
5	Talata Mafara 2x30/40MVA 132/33kV substation Zamfara State /Continental Engr'g Nig. Ltd.	Continental Engr'g Nig. Ltd.	Dec., 2004		Addition of 80MVA Transformer capacity at 132KV level	Commissioned. Remedial works/ Staff Housing outstanding.
6	Katampe-National Stadium 132kv DC line FCT – Abuja /ABB Powerlines	ABB Powerlines	Dec., 2004	Jun. 2012	Addition of 19KM of 132KV line length	Terminated. Scope of work to change and now to be partly underground.
7	Damaturu 1/150MVA, 330/132kV Substation Yobe State /Parsian Hihg Voltage Div.	Parsian High Voltage Div./ Cartlark Int'l Ltd	Nov. 2008	Dec, 2010	Addition of 1x150MVA, at 330kV to the network and improve power supply to Yobe State	Slow Pace of work by the EPC contractor.

S/No	Project Name / Contractor	Name of Contractor	Commence-ment Date	Expected Completion Date	Derivable Benefits of Project	Constraints
	and Cartlark Int'l Ltd					
8	Maiduguri 330/132kV Substation Borno State /Charnel Engr. Co. Ltd and AY - KAY	Charnel Engr. Co. Ltd. AY - KAY	Dec., 2004	Jun. 2011	Improvement of power supply to Maiduguri and the environs	Terminated Procurement on-going.
9	Onitsha-Nnewi-Ihiala 132kV DC line Anambra State /CCC Intl. Ltd and Elements Commns Ltd.	CCC Intl. Ltd / Elements Commns.	Sept, 2009	Jun. 2011	To provide additional 41KM of 32KV line length.	Slow pace of work by the EPC
10	2nd Benin-Onitsha 330kv SC line Edo-Delta-Anambra States /Dextron Engineering ltd	Dextron Engineering Ltd	17th Sept. 2008	Aug, 2011	Relieve heavily loaded Benin-Onitsha 330kV line for improved grid security	Wayleave / Community problems
11	Nnewi 2x60MVA 132kV substation Anambra State /Valenz Holdings (Nig) Ltd	Valenz Holdings (Nig) Ltd.	Apr., 2006	Nov, 2010	Addition of 120MVA transformer capacity at 132KV level	132kV line to supply the substation not ready.
12	Kaduna – Jos 330KV SC LinePlateau – Jos States					BPP approval obtained, FEC approval being awaited.
13	2x330KV Line bay extension at Kaduna, Jos and Onitsha Kaduna-Plateau-Anambra States /Valenz Holding Ltd	Valenz Holding Ltd	Apr., 2010	Sept. 2011	To provide take off print for the 2nd Benin – Onitsha 330kV S/C line.	
14	Nsukka – Ayangba 132KV DC Line Enugu-Kogi States /Valenz Holding Ltd	Valenz Holding Ltd	Apr., 2010	Sept. 2011	To provide take off point for the 2nd Benin – Onitsha 330kV S/C line.	
15	132/33KV S/S at Ayangba Kogi State / Omen Int ltd	Omen Int ltd	Aug.2008	April, 2011	To provide 120MVA transformer capacity at 132KV level and improve power supply to Kogi state.	
16	Jos – Kafanchan 132KV D/C Line Plateau – Kaduna States /Energo Nig Limited	Energo Nig Limited	Dec., 2007	March, 2011	To provide additional 80KM of 32KV line length to wheel power to Kafanchan and environs	
17	Kafanchsan 132kv 2x60MVA Substation Kaduna State /Valenz Holding Ltd	Valenz Holding Ltd	Sep., 2007	March, 2011	To provide 120MVA transformer capacity at 132KV level to Kafanchan and its environs.	
18	Makere – Pankshin 132KV DC Line Plateau State /Mogas Nig. Ltd	Mogabs Nig. Ltd	Dec., 2007	Dec, 2010	To rehabilitate the 132kV line and wheel power to Makere – Pankshin and other partsof Plateau state	
19	2x30/40MVA 132/33KV S/S at Pankshin and Makeri /North China and EESE Ltd	North China /EESE	Dec., 2007	Dec, 2010	To provide 80MVA transformer capacity at 132KV level to Makere – Pankshin and other parts of plateau state	

S/No	Project Name / Contractor	Name of Contractor	Commence-ment Date	Expected Completion Date	Derivable Benefits of Project	Constraints
20	Ganmo-Ogbomosho 132kV DC line Kwara – Oyo State	Being re-procured		Dec. 2011		
21						
22	2x60MVA 132/33kV S/S at Ogbomosho 1no. 132kV Bay Extension at Ganmo Oyo-Ilorin States /Payma Bargh and Cartlark Ltd	Payma Bargh/ Cartlark	Dec., 2007	March, 2011	To provide 120MVA transformer capacity and improve power supply in Ogbomosho and other parts of Oyo state.	
23	Kano-Walalanbe 132KV Line (Turn in and out of Dan agundi-Dakata 132KV single Cct Line) and 2x30/40MVA S/S at Walalambe Kano State /GIT Ltd	GIT	Dec., 2007	March, 2011	To provide 80MVA transformer capacity and to improve power supply to Kano state	
24	Yelwa-Yauri 2x30/40MVA S/S and 100KM of 33KV Line Kebbi State /Vlaenz and Electromontaz Ltd	Valenz/ Electromontaz	Dec., 2007	March, 2011	To provide 80MVA transformer capacity and improvement of power supply to Kebbi State	
25	3rd Benin – Onitsha 330KV DC Line Edo – Anambra States /KEC International Ltd	KEC International	Dec., 2007	March, 2011	Relieve heavily loaded Benin-Onitsha 330kV line for improved grid security	
26	Darura 2/30/40MVA S/S and 2x132kv line bay ext. at Katsina Katsina State /NCEP	NCEP	Dec., 2007			Terminated. Re-procurement on-going
27	Katsina Daura 132kv DC line Katsina State /Income Electric Ltd	Income Electric Ltd	Dec., 2007			Terminated. To be reprocured.
28	Obudu – Ogoja 132KV DC Line Cross River State /Jilon Elect Engr; Sinotec and Elements; Income electric Ltd	Jihon Elect Engr; Sinotec /Elements; Income electric	Dec., 2007	Nov, 2011	To provide additional 80KM of 32KV line length to wheel power to Cross River state	
29	2x30/40MVA 132/33kV S/S at Ogoja – Cross River State /Income Electrix Ltd	Income Electrix Ltd	Dec., 2007	Oct, 2010	To provide 80MVA transformer capacity and to improve power supply to Cross River state	
30	Rehabilitation of Sokoto – Talatmafara 132KV DC line /Dextron Ltd	Dextron	Oct, 2009	Sept, 2011	To rehabilitate the 132kV line and wheel power to Sokoto and Zanfara states	
31	1x60MVA Substation at Ughelli	Continental Engr'g	Oct, 2009	Dec, 2010	To provide 60MVA transformer capacity and to	

S/No	Project Name / Contractor	Name of Contractor	Commence-ment Date	Expected Completion Date	Derivable Benefits of Project	Constraints
	Power Plant	Nig. Ltd			improve power supply Delta state	
32	2x60MVA, 132/33KV AT Aboh-Mbaise S/S	Ashtavinayka/Bran Engineering Nov., 2009 April, 2011	Nov., 2009	April, 2011	120MVA Transformer capacity at 132KV level, to improve power supply to Imo state	
33	Transmission & Supply of Substation at Tamburawa Water Facility, 2x30/40MVA, 132/33kV S/S at Tamburawa	NESPAKI	Oct., 2009	Sept, 2011	To supply power to the Tamburawa water projects and environs.	
34	2x60MVA, 132/33kV substation at Oba and 2x132KV Line Bays at Nnewi	Xian/GIT Engineering	Dec., 2009	Dec, 2011	120MVA Transformer capacity at 132KV level, to improve power supply to Anambra state	Site recently handed over, Enumeration on-going
35	2x60MVA, 132/33 kV substation at Ideato and 2/132KV Line Bays at Okigwe	Ashtavinayaka/ Bran Engineering	Nov., 2009	Dec, 2011	120MVA Transformer capacity at 132KV level, to improve power supply to Imo state	New Project
36	Onisha – Oba-Nnewi-Ideato-Okigwe 132KV DC Line				To supply power to Oba, Nnewi, Ideator, and Okigwe 132/33kV S/S	Being reprocured, Project stepped down in year 2009
37	Owerri – Aboh Mbaise 132KV DC Line					Being reprocured
38	1x30MVA 132/33KV SS at Kwanar Dangora	MATALEC	Oct., 2009	Jun 2011	30MVA Transformer capacity at 132KV level, to improve power supply to Kano state	
39	2x60MVA, 132/33KV Substation at Kubwa /Shreem/Jyoti/MBH Ltd	Shreem/Jyoti/MBH Ltd			Proposed date of commissioning: 26-31 July 2010	

Appendix-14

Environmental Checklist

Environmental Checklist: 19. Other Infrastructure Projects

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process?	(a) N	(a) There is no need of preparation of EIA due to the fact that the scope of this project is the replacement of the existing deteriorated generation facilities, which have been in use since 1983, with the new ones with improved performance, hence no environmental degradation will be expected.
		(b) Have EIA reports been approved by authorities of the host country's government?	(b) N	(b) Not applicable because of the reason stated above.
		(c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?	(c) N	(c) Not applicable because of the reason stated above.
		(d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(d) N	(d) There is no environmental permit required.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders?	(a) N	(a) There is no impact to the Local stakeholders because of the reason stated above and the project site is isolated and remote from the residential area.
		(b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(b) N	(b) Not applicable because of the reason stated above.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) N	(a) There is no possible alternative plans exist since the project is the replacement of the existing generation facilities.
2 Pollution Control	(1) Air Quality	(a) Do air pollutants, (such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust) emitted from the proposed infrastructure facilities and ancillary facilities comply with the country's emission standards and ambient air quality standards? Are any mitigating measures taken?	(a) N	(a) There is no possibility of emission of air pollutants from the rehabilitated facilities in the existing hydro electric power station.
		(b) Are electric and heat source at accommodation used fuel which emission factor is low?	(b) N	(b) There is no fuel used for electric and heat source at accommodation because the source is the electric power produced in the hydro electric power station in an environmentally friendly manner.
	(2) Water Quality	(a) Do effluents or leachates from various facilities, such as infrastructure facilities and the ancillary facilities comply with the country's effluent standards and ambient water quality standards?	(a) N	(a) There is no possibility of effluents or leachate from the rehabilitated facilities.
	(3) Wastes	(a) Are wastes from the infrastructure facilities and ancillary facilities properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) Some of the parts subject for rehabilitation contain asbestos. In accordance with National Environmental (Construction Sector) Regulation, 2011 published in FNG Offical Gazzette No.46 Lagos-17th May 2011 Vol.98, the proponent will appoint a local professional treatment company which holds a person certified by the National Enviromental Stadards and Regulations Enforcement Agency (NESREA) to be in charge of inspection and evaluation for the presence of asbestos at the site as well as disposal of such waste. The above local professional treatment company shall be appointed from companies registered by the Federal Ministry of Environment.

Environmental Checklist: 19. Other Infrastructure Projects

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
2 Pollution Control	(4) Soil Contamination	(a) Are adequate measures taken to prevent contamination of soil and groundwater by the effluents or leachates from the infrastructure facilities and the ancillary facilities?	(a) N	(a) There is no possibility of soil and groundwater contamination from the rehabilitated facilities since the project is implemented inside of the exsiting powerhouse.
	(5) Noise and Vibration	(a) Do noise and vibrations comply with the country's standards?	(a) N	(a) Noise anf vibrations from the rehabilitated facilities are less than those from the existing ones and comply with Nigerian standards.
	(6) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N	(a) There is no possibility of groundwater extraction from the rehabillitated facilities.
	(7) Odor	(a) Are there any odor sources? Are adequate odor control measures taken?	(a) N	(a) There is no possibility of odor from the rehabillitated facilities.
3 Natural Environment	(1) Protected Areas	(a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) There is no possibility that the project will adversely affect the protected areas since the project is implemented inside of the exsiting powerhouse.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) Is there a possibility that changes in localized micro-meteorological conditions, such as solar radiation, temperature, and humidity due to a large-scale timber harvesting will affect the surrounding vegetation? (d) Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) N (b) N (c) N (d) N	(a) There is no possibility of impact to the existing ecosystem since the project is implemented inside of the exsiting powerhouse. (b) Same as above. (c) There is no possibility of such changes. (d) There is no possibility of usage of huge volume of water other than the same volume of water presently used for power generation.
	(3) Hydrology	(a) Is there a possibility that hydrologic changes due to the project will adversely affect surface water and groundwater flows?	(a) N	(a) There is no possibility of hydraulic changes due to the project.
	(4) Topography and Geology	(a) Is there a possibility the project will cause large-scale alteration of the topographic features and geologic structures in the project site and surrounding areas?	(a) N	(a) There is no possibility of large-scale alteration of the topographic features and geologic structures in the project site and surrounding areas.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance (c) Is the resettlement plan, including compensation with full replacement (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups (g) Are agreements with the affected people obtained prior to resettlement?	(a) N (b) N (c) N (d) N (e) N (f) N (g) N	(a) There is no possibility of involuntary resettlement by project implementation since the project is done in the enclosed environment inside of the exisitng powerhouse. (b) Not applicable due to the above reason. (c) Not applicable due to the above reason. (d) Not applicable due to the above reason. (e) Not applicable due to the above reason. (f) Not applicable due to the above reason. (g) Not applicable due to the above reason.

Environmental Checklist: 19. Other Infrastructure Projects

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?	(h) N	(h) Not applicable due to the above reason.
		(i) Are any plans developed to monitor the impacts of resettlement?	(i) N	(i) Not applicable due to the above reason.
		(j) Is the grievance redress mechanism established?	(j) N	(j) Not applicable due to the above reason.
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?	(a) N	(a) There is no possibility of impacts to the living conditions of inhabitants since the project site is remote from the residential area.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There is no possibility of adverse impact to the local archeological, historical, cultural, and religious heritage since the project is implemented inside of the exsiting powerhouse.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) There is no possibility of damage to the local landscape since the project is implemented inside of the exsiting powerhouse.
		(b) Is there a possibility that landscape is spoiled by construction of high-rise buildings such as huge hotels?	(b) N	(b) There is no possibility of spoil to the local landscape since the project is implemented inside of the exsiting powerhouse.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples?	(a) N	(a) There is no possibility of impacts on the culture and lifestyle of ethnic minorities and indigenous peoples since the project is implemented inside of the exsiting powerhouse.
		(b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(b) N	(b) Not applicable due to the above reason.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project?	(a)N	(a) The project proponet is a licensed power producer and is not violating any laws and ordinances associated with the working conditions of Nigeria.
		(b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials?	(b) Y	(b) The project proponent will require to the international contractor for rehabilitation works to install safety equipment and protective means which prevents industrial accidents, and management of asbestos-containing parts. The project proponent will also entrust the treatment and disposal of such waste to the local professional treatment company registered by the Ministry of Environment.
		(c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.?	(c) Y	(c) The project proponent will require to the international contractor for rehabilitation works to provide execution programme including safety management of asbestos to establish, implement and maintain safety and health of workers against risks from asbestos throughout the period of removal of asbestos-containing parts.
		(d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(d) Y	(d) The project proponent will require to the international contractor for rehabilitation works to provide execution programme including safety management of asbestos to make sure that the safety and security be strictly observed and maintained in all aspects and occasions during removal work of asbestos-containing parts.

Environmental Checklist: 19. Other Infrastructure Projects

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?	(a) N	(a) There is no impact of noise, vibrations, turbid water, dust and exhaust gases during construction. However, some of the parts subject for rehabilitation contain asbestos. In accordance with National Environmental (Construction Sector) Regulation, 2011 published in FNG Offical Gazzwtte No.46 Lagos-17th May 2011 Vol.98, a local professional treatment company which holds a person certified by NESREA will carry out inspection and assessment for the presence of asbestos at the site. The project proponent will engage the qualified international contractor for disassembly of such waste under the scope of contractual works and entrust the treatment and disposal of such waste to the above local professional treatment company registered by the Federal Ministry of Environment.
		(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?	(b) N	(b) There is no possibility of adverse impact to the natural environment during rehabilitation work since the project is implemented inside of the exsiting powerhouse.
		(c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(c) N	(c) There is no possibility of impact to the social environment during rehabilitation work since the project site is remofe from the residential area.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?	(a) Y	(a) There is no need of monitoring of asbestos required by the law in Nigeria. However, the proponent will require to the international contractor for rehabilitation works to develop and implement an execution programme for treatment of and protection from the asbestos-containing wastes during disassembly, internal transportation and temporary storage at the designated place outside of the powerhouse. The proponent with assistance from the consultant will monitor and supervise these contractors works.
		(b) What are the items, methods and frequencies of the monitoring program?	(b) Y	(b) As shown in the monitorig form.
		(c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?	(c) N	(c) The emvironmental officer from the proponent together with the environmental specialist from the consultant will monitor and supervise the contractors performance of the related works in accordance with the approved execution programme. Budget for such supervision will be provided as a part of counterpart fund.
		(d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(d) N	(d) There is no regulatory requirement pertaining to the monitoring report system. However, the local professional treatment company shall be appointed from companies registerd by the Federal Ministry of Environment.

Environmental Checklist: 19. Other Infrastructure Projects

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Roads, Railways and Bridges checklist should also be checked (e.g., projects including access roads to the infrastructure facilities).	(a) N	(a) It is not necessary to refer to checklist pergaining to other sectors since the project is implemented in the enclosed environment inside of the exisitng powerhouse.
		(b) For projects, such as installation of telecommunication cables, power line towers, and submarine cables, where necessary, pertinent items described in the Power Transmission and Distribution Lines checklists should also be checked.	(b) N	(b) It is not necessary to refer to checklist pergaining to the projects with long distance sites since the project is implemented in the enclosed environment inside of the exisitng powerhouse.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	(a) It is not necessary to confirm transboundary or global issues since the project is implemented in the enclosed environment inside of the exisitng powerhouse.

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which the project is located.

Appendix-15

Monitoring Form

Appendix-15

MONITORING FORM

-If environmental reviews indicate the need of monitoring by JICA, JICA undertakes monitoring for necessary items that are decided by environmental reviews. JICA undertakes monitoring based on regular reports including measured data submitted by the project proponent. When necessary, the project proponent should refer to the following monitoring form for submitting reports.

-When monitoring plans including monitoring items, frequencies and methods are decided, project phase or project life cycle (such as construction phase and operation phase) should be considered.

１． Responses/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Monitoring Results during Report Period
N/A	

２． Mitigation Measures

- Air Quality（Emission Gas / Ambient Air Quality）
Not applicable.

Item	Unit	Measured Value（Mean）	Measured Value（Max.）	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
SO_2	N/A					
NO_2	N/A					
CO	N/A					
O_3	N/A					
Soot and dust	N/A					
SPM	N/A					
Dust	N/A					

Note:
There is no regulation in terms of air quality in relation to treatment and/or disposal of asbestos.
Treatment of asbestos during dismantle and removal shall be done as stated under "Waste" in accordance with National Environmental (Construction Sector) Regulation, 2011 published in FGN Official Gazette No.46 Lagos-17th May, 2011 Vol. 98 as per attached.

- Water Quality（Effluent/Wastewater/Ambient Water Quality）
Not applicable.

Item	Unit	Measured Value（Mean）	Measured Value（Max.）	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH	mg/l					
SS（Suspended Solid）	mg/l					
BOD/COD	mg/l					
DO	mg/l					

Total Nitrogen NO_3	mg/l					
Total Phosphorus$_3$ PO_4	mg/l					
Heavy Metals	mg/l					
Hydrocarbons / Mineral Oils	mg/l					
Phenols	-					
Cyanide	-					
Temperature	^0C					

- Waste

Monitoring Item	Monitoring Results during Report Period
Waste contained asbestos	Refer to Note hereunder.
(1) Appointment of international contractor for rehabilitation works by Jebba Hydro Power Station (JHEP)	Date of contract Name of company: Person in charge: Contact number
(2) Establishment of execution programme including safety management of asbestos for treatment of and protection from the asbestos-containing wastes during disassembly, internal transportation and temporary storage at site, by the contractor	Execution date:
(3) Appointment of local professional treatment company, which owns a person certified by NESREA, by JHPS	Date of contract Name of company: Person in charge: Contact number
(4) A notification from the contractor to the local professional treatment company	Execution date:
(5) Inspection and assessment of asbestos-containing parts by a person certified by NESREA who belongs to the local professional treatment company prior to the renovation work	Execution date: Name of a certified person in charge: Contact number of the person
(6) Determination of quantity and type of asbestos-containing materials, and recommendation by the above person in (6)	Execution date: Quantity of asbestos: Type of asbestos: Contents of recommendation:
(7) Execution of removal and internal transportation of asbestos-containing wastes to the designated temporary storage at site by the contractor	Duration: From …. to ….
(8) Receipt, transportation, treatment if necessary and disposal of asbestos-containing wastes by the local company	Execution date:
(9) Report of work by the international contractor regarding asbestos- containing wastes by the contractor to JHPS	Execution date:
(10) Report of work by the local company to JHPS by the local company	Execution date:
(11) Report of work by the certified person from the local company to NESREA	Execution date:
(12) Submission of the Monitoring Form to JICA as a part of periodical report prepared by JHPS to	Issue date of report:

Note

1) Country’s Standard:
Treatment of asbestos during dismantle and removal shall be done in accordance with National Environmental (Construction Sector) Regulation, 2011 published in FGN Official Gazette No.46 Lagos-17th May, 2011 Vol. 98.

2) Referred International Standards:
Treatment and disposal of asbestos will be carried out in accordance with the relevant regulations in a country where a selected international contractor belongs to.
In case of Japan, there is no legal duty to measure concentrations of asbestos during work of treatment and removal of asbestos in the Ordinance on Prevention of Health Impairment due to Asbestos.

3) Procedure of treatment of asbestos containing parts:
The process of disassembly of the asbestos-containing parts shall comply with the following procedure:

i) Prior to the commencement of any demolition or renovation, JHPS will appoint the local professional treatment company (hereinafter referred to as “the local company”) who has a person certified by the National Environmental Standards and Regulations Enforcement Agency (NESREA) for assessment, treatment and disposal of asbestos-containing wastes (hereinafter referred to as “the inspector”).
ii) Prior to all demolition activities, including those where no asbestos material is present, a notification by the demolishing contractor (hereinafter referred to as “the contractor”) must be sent to the inspector.
iii) The affected structure/equipment or part of the structure/equipment where the work is to take place must be thoroughly inspected and assessed for the presence of asbestos by the inspector at a work implementation site.
iv) The types and quantities of asbestos-containing materials shall be determined by the inspector who shall make recommendations for the need to remove and dispose appropriately, asbestos-containing materials.
v) The contractor will set up a temporary ‘clean room’, generally made of plastic sheet with sufficient dimensions to be able to cater for treatment of asbestos containing parts inside of the room, at the site. The entrance/exit will be twofold closures with plastic sheet. Also, negative-pressure dust prevention filters (HEPA filter) will be provided on the wall of this room to keep the room under negative pressure as well as to remove floating asbestos fibers. The room will also be kept in high moisture content by humidifier to prevent from scattering of asbestos fibers.
vi) As workers enter into the room, they wear dust prevention gears against asbestos fibers such as masks, glasses and clothes. Also workers will take all gears off before leaving the room. All used gears will be packed into plastic bags in twofold for disposal.
vii) During a work, water mist is sprayed on asbestos containing parts to prevent asbestos from scattering. At the same time, the room is kept under negative-pressure by the above mentioned filter so that no air will leak out of the room.
viii) When the removal work of such parts finishes, asbestos containing waste are packed into plastic bags in twofold for disposal.
ix) Prior to dismantling the clean room, the inner space will be made free from asbestos by HEPA filtered vacuum cleaner under negative pressure created by the HEPA filter.
x) Removed wastes which contain asbestos shall be kept at the designated place outside of the powerhouse until the local company will come to receive such waste for final treatment and disposal under responsibility of the local company.
xi) The inspector will make report to NESREA upon completion of the disposal of asbestos-containing wastes.
xii) No further monitoring will be required once the above exercises are completed.

- Noise / Vibration
Not applicable

Item	Unit	Measured Value（Mean）	Measured Value（Max.）	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Noise level						
Vibration level						

- Odor

Monitoring Item	Monitoring Results during Report Period
N/A	

３． Natural Environment

- Ecosystem

Monitoring Item	Monitoring Results during Report Period
N/A	

４． Social Environment

- Resettlement

Monitoring Item	Monitoring Results during Report Period
N/A	

- Living / Livelihood

Monitoring Item	Monitoring Results during Report Period
N/A	

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