REPUBLIC OF THE UNION OF MYANMAR
MYANMA ELECTRIC POWER ENTERPRISE (MEPE)

REPUBLIC OF THE UNION OF MYANMAR

EXPERT FOR ENVIRONMENTAL CONSIDERATION OF ELECTRIC POWER SECTOR

PROJECT COMPLETION REPORT

NOVEMBER 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.

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List of Abbreviations

DEP	Department of Electric Power
DO	Dissolved Oxygen
EC	Electrical conductivity
ECD	Environmental Conservation Department
EHS Guidelines	Environmental, Health, and Safety Guidelines
EIA	Environmental Impact Assessment
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
EQS	Environmental Quality Standard
F/R	Final Report
GoM	Government of Myanmar
IFC	International Finance Corporation
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
JICA Guidelines	JICA Guidelines for Environmental and Social Considerations
JIS	Japanese Industrial Standards
MEPE	Myanma Electric Power Enterprise
MOECF	Ministry of Environmental Conservation and Forestry
MOEP	Ministry of Electric Power
MOI	Ministry of Industry
ORP	Oxidation-Reduction Potential
PCB	Polychlorinated biphenyl
PSD	Power Supply Department
PTPD	Power Transmission Planning Department
TDS	Total Dissolved Solids
TOR	Terms of Reference
TPD	Thermal Power Department
WHO	World Health Organization

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

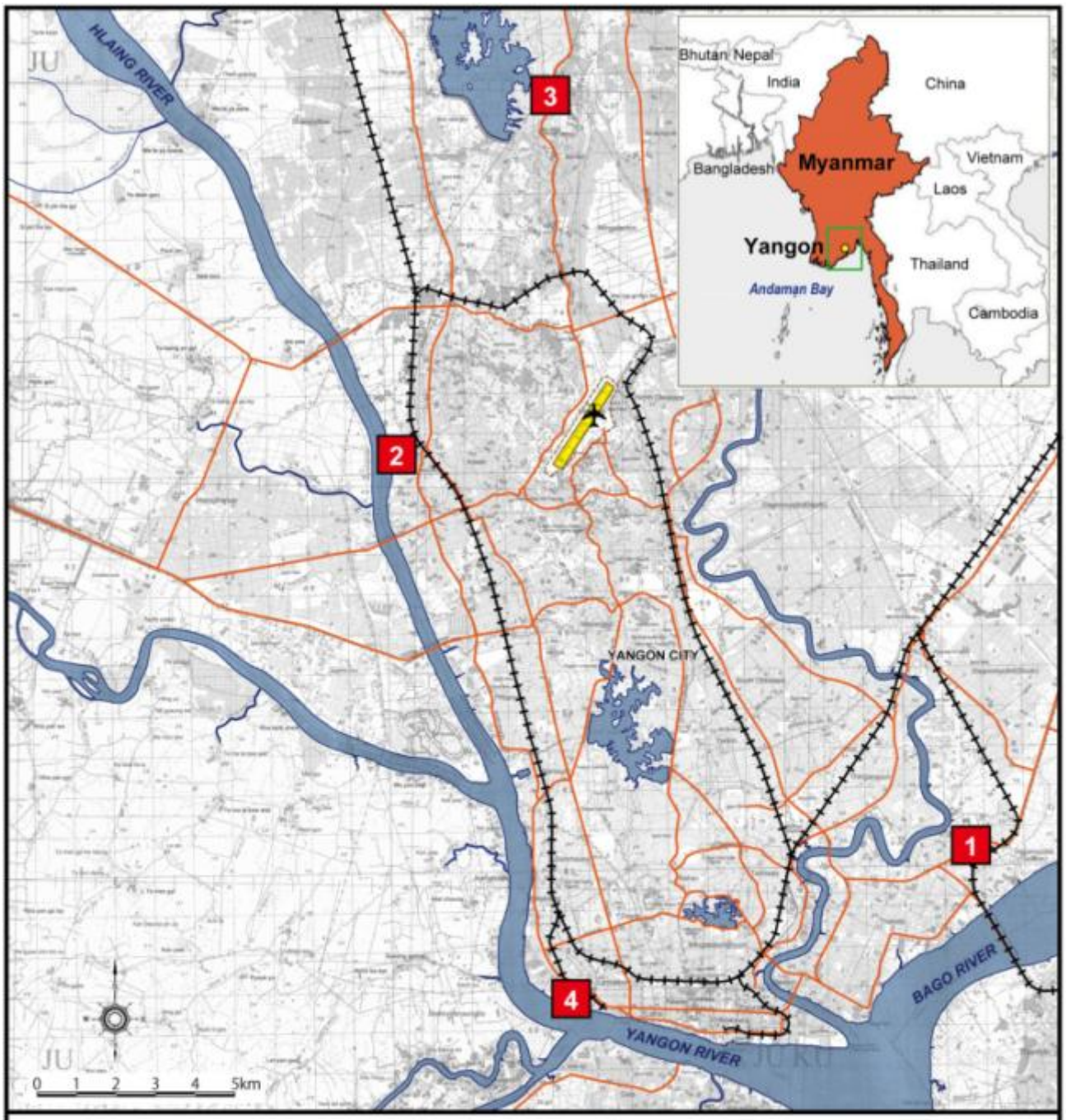
Power shortage has been a significant problem in the Republic of the Union of Myanmar (Myanmar), therefore the Government of Myanmar (GoM) and the Japan International Corporation Agency (JICA) signed a loan agreement for a project titled "Urgent Rehabilitation and Upgrade Project Phase 1" (Urgent Rehabilitation Project) in June 2013. The Phase I Project aims to renovate major power facilities in the central economic zone in the Yangon urban area. The Ministry of Electric Power (MOEP) and its subordinate implementing body, the Myanma Electric Power Enterprise (MEPE), need to be strengthened through capacity building especially in the implementation of appropriate environmental and social considerations. Moreover, the judicial system is under development in Myanmar, hence, it is required to obtain approval for the Phase I Project as well as change the legal system.

1.2 Objective of the Project

The objectives of this project are for MEPE to strengthen its capacity on environmental and social considerations and to be able to manage the environment in a good manner along with related environmental regulations in the country and the JICA Guidelines for Environmental and Social Considerations (April 2010). This will enable MEPE to carry out existing projects and prospective yen loan projects especially for the Phase I Project smoothly.

1.3 Project Area

The project area is relevant areas of the Thaketa Power Plant with its substation, and the other three substations, Ywama substation, Hlawga substation, and Ahlone substation.



Source: JICA Expert Team (JET)

Legend

1	: Thaketa Power Plant/Substation		: River
2	: Ywama Substation		: Road
3	: Hlawga Substation		: Railroad
4	: Ahlone Substation		: Airport

Figure 1.3-1 Location map of Thaketa Power plant and Other Sub-stations

1.4 Relevant Organizations

The organizations related to the project are shown in Table 1.4-1.

Table 1.4-1 Organizations related to the Project

Organization	Relevant Section	Expected Role in this Project
MOEP	DEP	Supervise the activities of MEPE related to the project as necessary
MEPE	TPD	Join the work for preparing Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) for rehabilitation of Thaketa Power Plant.
	PTPD	Join the work for preparing EMP and EMoP for rehabilitation of the substations.
	PSD	Join the work for preparing EMP and EMoP for rehabilitation of the substations.
	Thaketa Power Plant	Join the work for preparing EMP and EMoP for rehabilitation of Thaketa Power Plant.
	Thaketa, Ywama, Hlwaga and Ahlone Substation	Join the work for preparing EMP and EMoP for rehabilitation of the substations.
Ministry of Environmental Conservation and Forestry	ECD	Provide relevant information on ongoing process for development of regulations on environmental impact assessment system in Myanmar

Source: JET

The JET for the Project is composed of three experts as shown in Table 1.4-2.

Table 1.4-2 Members of JICA Expert Team

Name	Position
Kengo NAGANUMA	Team Leader / Social Considerations
Tomoaki TANABE	Environmental Survey 1
Atsushi MINAMI	Environmental Survey 2 / Workshop Planning

Source: JET

CHAPTER 2 IMPLEMENTED ACTIVITIES

2.1 Scoping Result

Based on the founding by field work in May, June and July 2014, JET conducted preliminary scoping for the Urgent Rehabilitation Project. Table 2.1-1 and Table 2.1-2 show the results of preliminary scoping. As a result of the preliminary scoping, it was considered that the environmental and social impact should be examined on the following environmental and social items, and the environmental management and monitoring plan should be considered based on the impact assessment result.

- Renovation of Thaketa Power Plant: air quality, water quality, solid waste, soil contamination, noise/vibration, subsidence, hydrology, indigenous and ethnic group, local economy, water use, infrastructure and social service, social structure, gender, children's right, occupational health and safety, community health and safety, risk of infection disease, accident, risks for fire, and global warming

- Renovation of Thaketa Substation, Ywama Substation, Hlawga Substation, and Ahlone Substation: air quality, water quality, solid waste, soil contamination, noise/vibration, electric and magnetic field, subsidence, indigenous and ethnic group, local economy, infrastructure and social service, social structure, gender, children's right, occupational health and safety, community health and safety, risk of infection disease, accident, risks for fire, and global warming

Table 2.1-1 Preliminary Scoping Results on Renovation of Thaketa Power Plant

Category	Scoping Item	Evaluation		Reasons for Evaluation
		Before/During Construction (BC/DC)	Operation Stage (OS)	
Pollution	Air Quality	B-	B+	DC: Emission from construction equipment, dust arising from construction activities, and air pollution due to traffic congestion are anticipated. OS: Due to rehabilitation of power plant facilities, quality of emission gas is expected to be improved.
	Water Quality	C	B-	DC: Depending on scale of earth work, water pollution impact have to be considered. OS: Amount of wastewater discharge may increase after rehabilitation of Thaketa power plant.
	Solid Waste	B-	B-	DC: Industrial solid waste will be generated by replacing of the existing facilities. OS: Hazardous industrial solid waste such as waste oil will be generated.
	Soil Contamination	C	D	DC: During construction phase, impact due to polluted soil should be checked if surplus soil will be arisen. OS: No activities causing soil pollution are anticipated.
	Noise/Vibration	B-	B-	DC: Noise and vibration from the operation of construction machinery and on-site vehicles are anticipated. OS: Due to operation of power plant facilities, noise impact be arisen.
	Subsidence	D	C	DC: There is no plan to conduct large excavation work raising subsidence. OS: Due to operation of power plant facilities, intake of

Category	Scoping Item	Evaluation		Reasons for Evaluation
		Before/During Construction (BC/DC)	Operation Stage (OS)	
				groundwater has to be conducted, so possibility of subsidence has to be checked.
	Odor	D	D	DC: There are no activities in Thaketa power plant to generate odor. OS: There are no activities in Thaketa power plant to generate odor.
	Sedimentation	D	D	Because the project will not change to riverbed, therefore impacts on sedimentation are not anticipated.
Natural Environment	Natural Preserve	D	D	No natural preserves exist around the project site.
	Flora and Fauna, Ecosystem	D	D	The rehabilitation activities will be carried out within the existing site. Therefore no impact to change regional flora, fauna, and ecosystem.
	Hydrology	D	C	DC: There is no plan to conduct construction work effecting regional hydrology. OS: Due to operation of power plant facilities, intake of groundwater has to be conducted, so magnitude of impact on hydrology should be checked.
	Topography/ Geography	D	D	Because the project does not require massive boring or excavation, therefore no significant impact is anticipated.
Social Environment	Resettlement	D	D	The rehabilitation activities will be carried out within the existing site, so there is no impact on resettlement.
	Poor	D	D	Neither some negative nor positive impacts to the poverty level are expected.
	Indigenous and Ethnic Minority Group	C	C	Existence of indigenous and ethnic minority group has to be confirmed.
	Local Economy such as Employment and Livelihood	B+	B+	DC: There will be job opportunities for locals. OS: The local economy and employment will be boosted, combined with the operation of the improved Thaketa Power Plant.
	Land Use and Local Resources	D	D	The rehabilitation activities will be carried out within the existing site, so there is no impact on land use and land resources.
	Water Use	D	C	DC: There is no plan to conduct construction work effecting regional water use. OS: Due to operation of power plant facilities, intake of groundwater has to be conducted, so magnitude of impact on hydrology should be checked.
	Existing Infrastructures and Services	D	B+	DC: There is no plan to conduct construction work affecting existing infrastructure. OS: Improvement of electricity distribution, infrastructure and services may be affected positively
	Social Structure	D	C	DC: There is no plan to conduct construction work affecting social structure. OS: The local economy will be boosted, so it may affect regional social structure
	Uneven Distribution of Harm and Benefit	D	D	Electric power will be distributed not only around project are but also other area. Thus, it is considered that there will be no uneven distribution of harm and benefit.
	Conflicts of Interest within the Region	D	D	There will be no conflicts of interests within the region by the improvement of Thaketa Power Plant.
	Cultural Heritage	D	D	The rehabilitation activities will be carried out within the existing site, so there is no impact on cultural heritage.
	Landscape	D	D	Impact on landscape is not expected because there are no important landscapes and viewpoints to be considered around the Urgent Rehabilitation Project area.
	Gender	D	B+	DC: Negative impact on gender is not anticipated by the Urgent Rehabilitation Project. OS: Improvement of electricity distribution by the Urgent Rehabilitation Project may contribute to improve women's

Category	Scoping Item	Evaluation		Reasons for Evaluation
		Before/During Construction (BC/DC)	Operation Stage (OS)	
				right.
	Children's Right	C	B+	DC: Children should not be hired as construction workers, and employment condition on construction work should be checked. OS: Improvement of electricity distribution by the Urgent Rehabilitation Project may contribute to improve children's right.
Health and Safety	Occupational Health and Safety	B-	B-	DC: It is necessary to consider operational health and safety during construction such as accident, salinity, and using heavy equipment. OS: Operation of rehabilitated facilities will need new knowledge, and risk of accidents may increase if training on operation of rehabilitated facilities is insufficient.
	Community Health and Safety	B-	C	DC: It is necessary to consider towards community safety by construction noise and traffic accidents. OS: Existing of impacts affecting community health and safety should be checked during operation phase.
	Risks of Infectious Disease	B-	D	DC: There may be risks of infectious disease by increase of workers. OS: In operation phase, there is no factor to increase risk of infection disease by the project.
	Accident	B-	B-	DC: It is necessary to consider the possibility of accidents occurring during construction work. OS: Careful attentions are needed because there would be some dangerous works for operation of gas and steam turbines
Emergency Risk	Emergency risk by flooding	D	D	The renovation work will be carried out within the existing facility site, and the project will not have large scale of earthwork, so the project is considered not to increase risk of flooding.
	Emergency risk by fire	C	D	DC: It is necessary to prepare emergency plan to reduce risk of fire during construction phase. OS: The renovation of Thaketa Power Plant will not have factor to increase risk of fire
Climate Change	Green house gas (GHG) emission	D	C	DC: No Significant impact to climate change by construction work. OS: By improving of power plant facilities, emission of GHG may be decreased.

Evaluation: A-: Significant negative impact A+: Significant positive impact
B-: Some negative impact B+: Some positive impact
C: Impacts are not clear, need further investigation
D: No Impacts or Impacts are negligible, no further study required

Source: JET

Table 2.1-2 Preliminary Scoping Results on Renovation of Substations

Category	Scoping Item	Evaluation		Reasons for Evaluation
		Before/During Construction (BC/DC)	Operation Stage (OS)	
Pollution	Air Quality	B-	D	DC: Emission from construction equipment, dust arising from construction activities, and air pollution due to traffic congestion are anticipated. OS: During operation phase of the improved substation, there is no activity generating air pollution.
	Water Quality	D	D	DC: No large scale of construction work is planned during construction phase. OS: During operation phase of the improved substation, there is no activity generating water pollution.
	Solid Waste	B-	B-	DC: Industrial solid waste will be generated by replacing of the existing facilities.

Category	Scoping Item	Evaluation		Reasons for Evaluation
		Before/During Construction (BC/DC)	Operation Stage (OS)	
				OS: Hazardous industrial solid waste such as transformer oil containing PCB may cause environmental pollution.
	Soil Contamination	C	C	DC: During construction phase, impact due to polluted soil should be checked if surplus soil will be arisen. OS: Hazardous industrial solid waste such as transformer oil containing PCB may cause soil pollution.
	Noise/Vibration	B-	B-	DC: Noise and vibration from the operation of construction machinery and on-site vehicles are anticipated. OS: Due to operation of substation facilities, noise impact be arisen.
	Subsidence	D	D	DC: There is no plan to conduct large excavation work raising subsidence. OS: During operation phase of the improved substation, there is no activity generating subsidence.
	Odor	D	D	DC: There are no activities to generate odor. OS: During operation phase of the improved substation, there is no activity generating odor.
	Sedimentation	D	D	Because the project will not change to riverbed, therefore impacts on sedimentation are not anticipated.
	Electric and Magnetic Field	D	C	After renovation of substations, electric and magnetic filed impact have to be checked.
Natural Environment	Natural Preserve	D	D	No natural preserves exist around the project site.
	Flora and Fauna, Ecosystem	D	D	The rehabilitation activities will be carried out within the existing site. Therefore no impact to change regional flora, fauna, and ecosystem.
	Hydrology	D	D	DC: There is no plan to conduct construction work effecting regional hydrology. OS: During operation phase of the improved substation, there is no activity affecting hydrology.
	Topography/ Geography	D	D	Because the project does not require massive boring or excavation, therefore no significant impact is anticipated.
Social Environment	Resettlement	D	D	The rehabilitation activities will be carried out within the existing site, so there is no impact on resettlement.
	Poor	D	D	There is no activities to improve living condition of poverty level people during construction phase..
	Indigenous and Ethnic Minority Group	C	C	Existence of indigenous and ethnic minority group has to be confirmed.
	Local Economy such as Employment and Livelihood	B+	B+	DC: There will be job opportunities for locals. OS: The local economy and employment will be boosted, combined with the operation of the improved substations.
	Land Use and Local Resources	D	D	The rehabilitation activities will be carried out within the existing site, so there is no impact on land use and land resources.
	Water Use	D	D	Because project will not affected water use such as fisheries and agricultural activities in the surrounding area.
	Existing Infrastructures and Services	D	B+	DC: There is no plan to conduct construction work affecting existing infrastructure. OS: Improvement of electricity distribution, infrastructure and services will be affected positively.
	Social Structure	D	C	DC: There is no plan to conduct construction work affecting social structure. OS: The local economy will be boosted, so it may affect regional social structure
	Uneven Distribution of Harm and Benefit	D	D	Electric power will be distributed not only project site but also other area. Thus, it is considered that there will be no uneven distribution of harm and benefit.
	Conflicts of Interest within the Region	D	D	There will be no conflicts of interests within the region by the improvement of substations.

Category	Scoping Item	Evaluation		Reasons for Evaluation
		Before/During Construction (BC/DC)	Operation Stage (OS)	
	Cultural Heritage	D	D	The rehabilitation activities will be carried out within the existing site, so there is no impact on cultural heritage.
	Landscape	D	D	Impact on landscape is not expected because there are no important landscapes and viewpoints to be considered around the Urgent Rehabilitation Project area.
	Gender	D	B+	DC: Negative impact on gender is not anticipated by the Urgent Rehabilitation Project. OS: Improvement of electricity distribution by the Urgent Rehabilitation Project may contribute to improve women's right.
	Children's Right	C	B+	DC: Children should not be hired as construction workers, and employment condition on construction work should be checked. OS: Improvement of electricity distribution by the Urgent Rehabilitation Project may contribute to improve children's right.
Health and Safety	Occupational Health and Safety	B-	B-	DC: It is necessary to consider operational health and safety during construction such as accident, salinity, and using heavy equipment. OS: Operation of rehabilitated facilities will need new knowledge, and risk of accidents may increase if training on operation of rehabilitated facilities is insufficient.
	Community Health and Safety	B-	C	DC: It is necessary to consider towards community safety and health such as dust, noise and accidents. OS: Existing of impacts affecting community health and safety should be checked during operation phase.
	Risks of Infectious Disease such as AIDS/HIV	B-	D	DC: There may be risks of infectious disease by increase of workers. OS: Because there is no large change in traffic volume from the increasing inflow to the site from different regions, impacts on infectious disease are not anticipated.
	Accident	B-	B-	DC: It is necessary to consider the possibility of accidents occurring during construction work. OS: Careful attentions are needed because there would be some dangerous works with high voltage during operation stage.
Emergency Risk	Emergency risk by flooding	D	D	The renovation work will be carried out within the existing facility site, and the project will not have large scale of earthwork, so the project is considered not to increase risk of flooding.
	Emergency risk by fire	C	D	DC: It is necessary to prepare emergency plan to reduce risk of fire during construction phase. OS: The renovation of Thaketa Power Plant will not have factor to increase risk of fire
Climate Change	Green house gas (GHG) emission	D	C	DC: No significant impact to climate change by construction work. OS: By improving of the existing electricity distribution network, emission of GHG may be decreased.

Evaluation: A-: Significant negative impact A+: Significant positive impact
B-: Some negative impact B+: Some positive impact
C: Impacts are not clear, need further investigation
D: No Impacts or Impacts are negligible, no further study required

Source: JET

2.2 Result of Field Survey

2.2.1 Result of Baseline Survey around Thaketa Power Plant

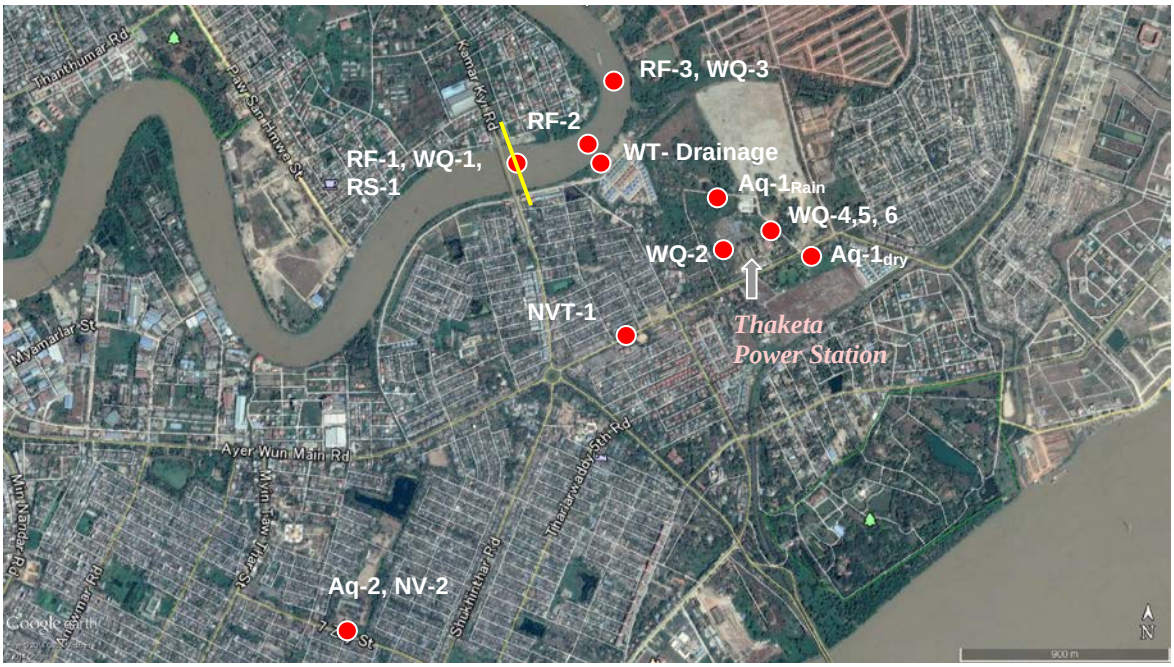
The field survey for collecting the baseline data was conducted around Thaketa Power station during dry season and rainy season. The summary of the field survey is shown in Table 2.2-1.

Table 2.2-1 Summary of Field Survey

No.	Items	Description	
1	Meteorology	Location	1 point (Aq-1)
		Duration	-Seven consecutive days (1 week) -2 seasons (dry and rainy seasons)
		Parameters	1) wind speed, 2) wind direction, and 3) temperature
2	Air quality measurement	Location	2 points (Aq-1, Aq-2)
		Duration	-Seven consecutive days (1 week) -2 seasons (dry and rainy season)
		Parameters	1) Sulfur dioxide (SO_2), 2) Carbon oxide (CO), 3) Nitrogen dioxide(NO_2), 4) PM2.5, and 5) PM10
3	Noise and vibration level measurement	Location	2 points (NVT-1, NV-2)
		Duration	24 hours for one location (1 weekday in dry season)
		Parameters	1) Equivalent continuous A-weighted sound pressure level (LAeq), and 2) Vibration as acceleration (La)
4	Traffic Volume	Location	1 points (1 section) (NVT-1)
		Duration	24 hours for one location (1 weekday)
		Parameters	Number of vehicle by each type (track, normal vehicle motor cycle)
5	River flow and water temperature	Location	3 points (3 layer per 1 point) (RF-1, RF-2, RF-3)
		Duration	-14 consecutive days(5 times measures/day) during dry season -1 day (4 times measures) during rainy season
		Parameters	1) velocity, 2) pH, 3) salinity, temperature (water, and atmosphere), 4) turbidity, 5) electric conductivity, and 6) tidal condition (river flow direction)
6	River Section	Location	10 measurement points in 1 section in at Ngamoeyeik Creek (RS-1)
		Duration	1 time in rainy season
		Parameters	1) depth, 2)distance from shore and 3) stream velocity
7	Water quality	Location	4 points for effluent from boiler (WQ-1, WQ-2, WQ-3, WT-Drainage), and 3 points for effluent from cooling tower(WQ-4, WQ-5, WQ-6)
		Duration	1time x 2 seasons (dry and rainy seasons)
		Parameters	1) temperature (water, and atmosphere), 2) water level, 3) flow rate, 4) odor, 5) color, 6) electrical conductivity, 7) pH, 8) suspended solid (SS), 9) oil and grease, 10)Total chlorine residual, 11) total chromium (T-Cr), 12) copper (Cu), 13) iron (Fe), 14) zinc (Zn), 15) lead (Pb), 16) cadmium (Cd), 17)mercury (Hg), 18) arsenic (As)

Source: JET

Figure 2.2-1 and Table 2.2-1 shows the survey points for meteorology, air quality, noise and vibration, traffic flow, river flow and water quality.



Note: Aq - Air Quality; N - Noise; V - Vibration; T - Traffic; RF - River Flow, RS – River Section, WQ - Water Quality, WT-Water Temperature
Source: JET

Figure 2.2-1 Location Map of Field Survey Sampling Point

Table 2.2-2 Description of Sampling Point Location

No.	Sampling points	GPS Location	Geographic Location
1	Aq-1 dry	16°48'40.77"N 96°13'37.85"E	Within the compound of MEPE staff's housing, Thaketa Township; about 70 m south of Thaketa Power Plant
	Aq-1 rain	16°48'50.40"N 96°13'29.59"E	Within the compound of MEPE staff's housing, Thaketa Township; about 80 m North of Thaketa Power Plant
2	NVT-1	16°48'31.46"N 96°13'15.95"E	In front of No.(3), Basic Education Middle School, Thaketa Township; about 620 m southwest of Thaketa Power Plant
3	Aq-2, NV-2	16°47'49.71"N 96°12'36.40"E	Within the compound of No.(2), Basic Education High School, Thaketa Township: about 2.2 km southwest of Thaketa Power Plant; vibration is monitored closed to car road
4	RF-1, WQ-1, RS-1	16°48'55.14"N 96°12'59.10"E	Pazundaung Creek, about 50 m east of Kamarkyi Bridge
5	RF-2	16°48'58.08"N 96°13'8.82"E	Pazundaung Creek, about 350 m east of Kamarkyi Bridge
6	WQ-2	16°48'42.06"N 96°13'28.98"E	Drainage from the Thaketa power plant, west of the plant
7	RF-3, WQ-3	16°49'5.34"N 96°13'12.60"E	Pazundaung Creek, about 600 m east of Kamarkyi Bridge
8	WQ-4	16°48'44.4"N 96°13'37.7"E	Water tank for cooling tower
9	WQ-5	16°48'45.6"N 96°13'36.6"E	Outlet of cooling tower
10	WQ-6	16°48'46.4"N 96°13'36.1"E	Discharge point of wastewater from cooling tower Stream Outside Thaketa Power Plant
11	WT-Drainage	16°48'55.45"N 96°13'10.58"E	At the entering point of drainage (from the Thaketa Power Plant) into Ngamoeyeik Creek.

Note: Aq - Air Quality; N - Noise; V - Vibration; T - Traffic; RF - River Flow, RS – River Section, WQ - Water Quality, and WT-Water Temperature
Source: JET

(1) Meteorology and Air Quality

1) Objectives

The field survey of meteorology and air quality in dry and rainy season was conducted for collecting the present condition of air quality in the project area.

2) Survey Point

Two survey points were selected at different conditions around the study area. One was selected near Thaketa Power Station for getting the data of nearest point from emission sources. During dry season, the monitoring point named Aq-1_{dry} was set in the south side of Thaketa Power Plant. In rainy season, the monitoring point named Aq-1_{dry} was submerged. Therefore, it had to change to Aq-1_{rain} The other point was selected in the residential area named Aq-2, for obtaining general air quality condition in sub-urban area of Yangon Region.

Measurement of Air Quality (Aq-1_{dry}), May 2014	Measurement of Meteorology and Air Quality (Aq-2), May 2014
Measurement of Air Quality (Aq-1_{rain}), July 2014	Measurement of Meteorology and Air Quality (Aq-2), July 2014

Source: JET

Figure 2.2-2 Meteorological Measurement and Air quality Sampling point

3) Survey Period

The survey period is shown in Table 2.2-3.

Table 2.2-3 Survey Period for Meteorology and Air Quality

Season	Period
Dry Season	Seven Days (10:00A.M. 9th May–10:00 A.M. 16th May, 2014)
Rainy Season	Seven Days (14:00P.M. 30th June–14:00 P.M. 7th July, 2014)

Source: JET

4) Survey Method

The survey method is shown in Table 2.2-4. HAZ-SCANNER Environmental Perimeter Air Monitoring System (Model-EPAS) was used for the meteorology and air quality survey.

Table 2.2-4 Description of Sampling and Analysis Methodology for Meteorology and Air Quality

Items and Parameters	Equipment	Analysis Method
Meteorology (1) wind speed, (2) wind direction, (3) temperature, and (4) relative humidity	HAZ-SCANNER Environmental Perimeter Air Monitoring System (Model-EPAS)	-On site monitoring -The height of sampling is about 1.5 m above ground level and wind speed and direction sensor is about 2.6 m. -Parameters are automatically recorded as one minute interval and then downloaded by computer. -The data of each parameter were averaged as hourly and then as daily in the spread sheet.
Air quality (1) Sulfur dioxide (SO_2), (2) Nitrogen dioxide(NO_2), (3) Carbon oxide (CO), (4) $PM_{2.5}$, and (5) PM_{10}		

Source: JET

5) Setting of Tentative Target for Ambient Air Quality

Currently, there is no ambient air quality standard to receptors in Myanmar. On the other hands, most of the countries in south-east Asia as well as Japan have the ambient air quality standard to receptors. International standard is also available in the IFC EHS Guidelines. Table 2.2-5 shows ambient air quality standards in south-east Asia countries, Japan, and IFC. On the basis of the information in Table 2.2-5, target ambient level is set as shown in Table 2.2-6, tentatively. Averaging period is adapted to 24 hours, which could be measured by the available equipment in Myanmar (Currently impossible to implement continuous measure for one month at project site due to battery/ electrical capacities). Target ambient air quality level is referred to standards in Japan basically because huge amount of air quality monitoring data are available on website. The parameters on PM_{10}, which are not covered with the standard in Japan, are referred to the standard in Thailand because applied unit is same as Japan.

Table 2.2-5 Ambient Air Quality Standard in South-East Countries, Japan, IFC

Item	Averaging period	Japan*1	Thailand*2	Vietnam*3	IFC*4
SO_2	10 min	-	-	-	0.5 mg/m^3
	1 hour	0.1 ppm	0.3 ppm	0.35 mg/m^3	-
	24 hours	0.04 ppm	0.12 ppm	0.125 mg/m^3	0.125 mg/m^3(Interim Target-1) 0.05mg/m^3(Interim Target-2) 0.02mg/m^3(Guideline)
	1 year	-		0.05 mg/m^3	-
NO_2	1 hour	-	0.17 ppm	-	0.2 mg/m^3
	24 hours	0.04-0.06 ppm	-	-	-
	1 year	-	0.03 ppm	-	0.04 mg/m^3
NOx	1 hour	-	-	0.2 mg/m^3	
	24 hours	-	-	0.04 mg/m^3	
CO	1 hour	-	30 ppm	30 mg/m^3	-
	8 hours	20 ppm	-	10 mg/m^3	-
	24 hours	10 ppm	9 ppm	-	-
TSP	1 hour	-	-	0.3 mg/m^3	-
	24 hours	-	0.33 mg/m^3	0.2 mg/m^3	-
	1 year		0.10 mg/m^3	0.14 mg/m^3	-
PM_{10}	24 hours	-	0.12 mg/m^3	0.15 mg/m^3	0.15 mg/m^3(Interim Target-1) 0.10 mg/m^3(Interim Target-2) 0.07 mg/m^3(Interim Target-3) 0.05 mg/m^3(Guideline)
	1 year	-	0.05 mg/m^3	0.05 mg/m^3	0.07 mg/m^3(Interim Target-1) 0.05 mg/m^3(Interim Target-2) 0.03 mg/m^3(Interim Target-3) 0.02 mg/m^3(Guideline)
SPM	1 hour	0.2 mg/m^3	-	-	-
	24 hours	0.1 mg/m^3	-	-	-
$PM_{2.5}$	24 hours	0.035 mg/m^3	0.05 mg/m^3	-	0.075 mg/m^3(Interim Target-1) 0.05 mg/m^3(Interim Target-2) 0.0375 mg/m^3(Interim Target-3) 0.025 mg/m^3(Guideline)
	1 year	0.015 mg/m^3	0.025 mg/m^3	-	0.035 mg/m^3(Interim Target-1) 0.025 mg/m^3(Interim Target-2) 0.015 mg/m^3(Interim Target-3) 0.01 mg/m^3(Guideline)
Ozone	1 hour	-	0.10 ppm	0.3 mg/m^3	-
	8 hour daily maximum	-	0.07 ppm	0.2 mg/m^3	0.16 mg/m^3(Interim Target-1) 0.1 mg/m^3(Guideline)
	1 year	-	0.04 ppm	0.14 mg/m^3	-
Ox	1 hour	0.06 ppm	-	-	-
Pb	24 hours	-	-	0.0015 mg/m^3	
	1 month	-	0.0015 mg/m^3	-	
	1 year	-	-	0.0005 mg/m^3	

Source*1: National Air Quality Standard in Japan (Circular No. 25, 1973, originally), Ministry of Environment, Japan
*2: Notifications of National Environmental Board No.10, 24, 28, 33, and 36, Ministry of Natural Resources and Environment, Thailand
*3: National Ambient Air Quality Standard (TCVN5973:2005), Ministry of Science and Technology in Vietnam
*4: Environmental, Health, and Safety Guidelines, General EHS Guidelines, IFC, 2007

Table 2.2-6 Tentative Target Value on Ambient Air Quality Level

Parameters	Averaging Period	Value
SO_2	24 hours	0.03 ppm
NO_2	24 hours	0.06 ppm
CO	24 hours	10 ppm
$PM_{2.5}$	24 hours	0.05 mg/m^3
PM_{10}	24 hours	0.12 mg/m^3

The tentative target value of SO_2 was set as the converted value of the Interim Target I of IFC from mg/m^3 to ppm under the mean temperature of Yangon, 27.4 ^oC
Source: JET

6) Survey Result

(a) Sulfur dioxide (SO_2)

During dry season, a few measurement results of the daily average of SO_2 concentration were higher than the tentative air quality target based on the environmental standard value (1-day). During rainy season, all measurement results were lower than the tentative air quality target value as shown in Table 2.2-7.

Table 2.2-7 Daily Average Concentration of Sulfur Dioxide (SO_2)

Unit: ppm

Date	Dry Season (9th May– 16th May, 2014)		Rainy Season (30th June– 7th July, 2014)		Target Value
	Aq-1	Aq-2	Aq-1	Aq-2	
1	0.07	0.07	0.02	< 0.01	0.03
2	0.07	0.07	0.02	< 0.01	
3	0.03	0.05	0.03	< 0.01	
4	0.01	0.02	0.03	< 0.01	
5	0.01	0.03	0.03	< 0.01	
6	0.02	0.02	0.01	< 0.01	
7	0.01	0.02	0.02	< 0.01	
Maximum	0.07	0.07	0.03	< 0.01	
Average	0.03	0.04	0.02	< 0.01	
Minimum	0.01	0.02	0.01	< 0.01	

Source: JET

(b) Nitrogen dioxide (NO_2)

During dry and rainy season, the daily average of NO_2 concentration except 14th May at Aq-1 was lower than the tentative air quality target based on the environmental standard (1-day) as shown in Table 2.2-8.

Table 2.2-8 Daily Average Concentration of Nitrogen dioxide (NO_2)

Unit: ppm

Date	Dry Season (9th May– 16th May, 2014)		Rainy Season (30th June– 7th July, 2014)		Target Value
	Aq-1	Aq-2	Aq-1	Aq-2	
1	0.02	0.04	0.02	< 0.01	< 0.06
2	< 0.01	0.02	0.02	< 0.01	
3	0.03	0.02	0.02	0.02	
4	0.05	0.02	0.03	0.01	
5	0.04	0.02	0.02	0.01	
6	0.08	0.02	0.04	0.01	
7	0.05	0.02	0.04	0.02	
Maximum	0.08	0.04	0.04	0.02	
Average	0.04	0.02	0.03	0.01	
Minimum	< 0.01	0.02	0.02	< 0.01	

Source: JET

(c) Carbon monoxide (CO)

During dry and rainy season, the daily average of CO concentration were lower than the tentative air quality target based on the environmental standard (1-day) as shown in Table 2.2-9.

Table 2.2-9 Daily Average Concentration of Carbon monoxide (CO)

Unit: ppm

Date	Dry Season (9th May– 16th May, 2014)		Rainy Season (30th June– 7th July, 2014)		Target Value
	Aq-1	Aq-2	Aq-1	Aq-2	
1	0.43	0.19	0.38	0.20	10
2	0.40	0.11	0.35	0.54	
3	0.43	0.14	0.33	0.18	
4	0.33	0.06	0.51	0.33	
5	0.39	0.06	0.30	0.22	
6	0.37	0.06	0.45	0.23	
7	1.26	0.08	0.36	0.13	
Maximum	1.26	0.19	0.51	0.54	
Average	0.52	0.10	0.38	0.26	
Minimum	0.33	0.19	0.30	0.13	

Source: JET

(d) $PM_{2.5}$

During dry and rainy season, the daily average $PM_{2.5}$ concentration except 1st July at Aq-2 was lower than the tentative air quality target based on the environmental standard (1-day) as shown in Table 2.2-10.

Table 2.2-10 Daily Average Concentration of $PM_{2.5}$

Unit: mg/m^3

Date	Dry Season (9th May– 16th May, 2014)		Rainy Season (30th June– 7th July, 2014)		Target Value
	Aq-1	Aq-2	Aq-1	Aq-2	
1	0.006	0.041	0.004	0.034	< 0.05
2	0.006	0.049	0.003	0.084	
3	0.006	0.040	0.005	0.009	
4	0.005	0.030	0.004	0.026	
5	0.006	0.042	0.004	0.015	
6	0.005	0.033	0.004	0.024	
7	0.018	0.044	0.003	0.009	
Maximum	0.018	0.049	0.005	0.084	
Average	0.007	0.040	0.004	0.029	
Minimum	0.005	0.030	0.003	0.009	

Source: JET

(e) PM_{10}

During dry and rainy season, the daily average PM_{10} level is lower than environmental standard (1-day) as shown in Table 2.2-11.

Table 2.2-11 Daily Average Concentration of PM_{10}

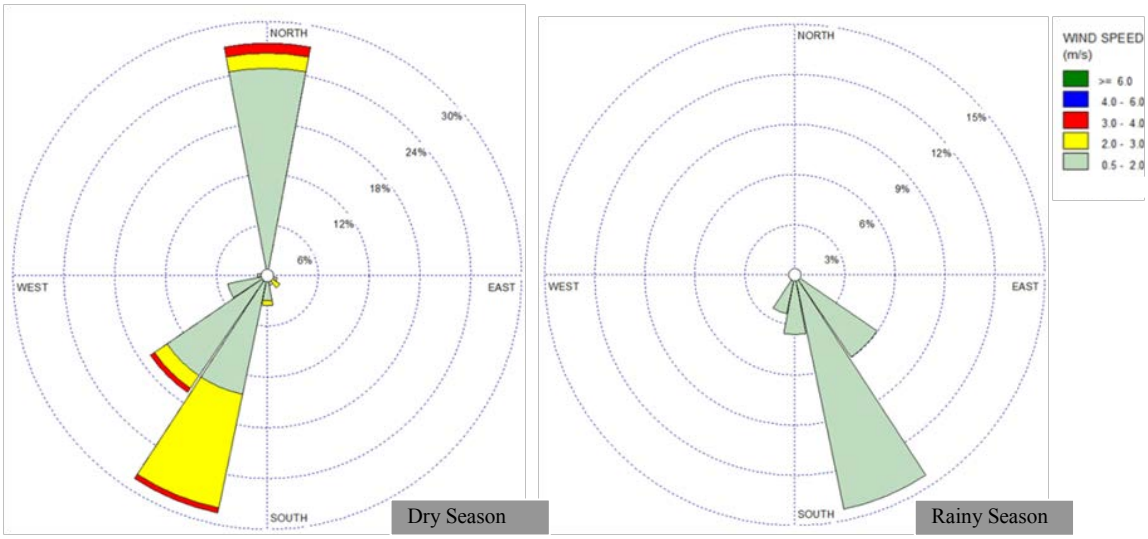
Unit: mg/m^3

Date	Dry Season (9th May– 16th May, 2014)		Rainy Season (30th June– 7th July, 2014)		Target Value
	Aq-1	Aq-2	Aq-1	Aq-2	
1	0.072	0.076	0.04	0.05	< 0.12
2	0.095	0.070	0.04	0.04	
3	0.082	0.054	0.03	0.04	
4	0.048	0.042	0.05	0.05	
5	0.035	0.057	0.02	0.04	
6	0.054	0.067	0.05	0.05	
7	0.062	0.053	0.05	0.04	
Maximum	0.095	0.076	0.05	0.05	
Average	0.064	0.060	0.04	0.05	
Minimum	0.035	0.042	0.02	0.04	

Source: JET

(f) Wind Direction and Speed

Wind direction and wind speed were measured at Aq-1. The measured data were analyzed where calm wind is defined below 0.5 m/s. Dry season survey as 9th May – 16th May suggested that the prevailing wind directions during 9th – 15th May are NNW to NNE and SSW to SW in directions with the average wind speed of 1.40 m/s. The first prominent wind which blew from north and the second prominent one is from SSW. Calm wind was 12.5%. Rainy season survey as 30th June – 7th July suggested that the prevailing wind direction is from SW to S in direction where the prominent wind blew from SSW. The average wind speed encountered for that season is 0.20 m/s. Calm wind was 73.8%.



Source: JET

Figure 2.2-3 Wind speed and Wind direction at Aq-1

(2) Noise and Vibration

1) Objectives

The field survey of noise and vibration in dry season was conducted for collecting the present condition of noise and vibration level in the project area.

2) Survey Point

Two survey points were selected to measure noise and vibration level at different conditions in the project area. The one survey point was set along the road to Thaketa Power Plant named NVT-1 for obtaining the noise and vibration data at roadside area. The other survey point was selected in the residential area named NV-2, for obtaining general condition in sub-urban area of Yangon Region.

Measurement of Noise and Vibration (NVT-1)

Measurement of Noise (NV-2)

Source: JET

Figure 2.2-4 Noise and Vibration Survey Point (May, 2014)

3) Survey Period

Noise and vibration survey was conducted as shown in Table 2.2-12.

Table 2.2-12 Survey Period for Noise and Vibration

Survey Point	Period
NVT-1 (Access road to Thaketa Power Station)	24 hours (14th 10:00A.M. – 15th 10:00A.M. May, 2014)
NV-2 (Living environment area)	

Source: JET

4) Survey Method

The survey method is shown in Table 2.2-13.

Table 2.2-13 Description of Sampling and Analysis Methodology for Noise and Vibration

Items and Parameters	Equipment	Sampling and Analysis Method
Noise (Equivalent continuous A-weighted sound pressure level : L_{Aeq}(dB))	Lutron brand sound level meter (SL-4023SD)	- The microphone is placed about 1.55m above ground level for noise measurement. -Ten minutes interval is set for 24 hours and the data is firstly calculated as hourly average and then as daily equivalent, maximum and minimum sound level.
Vibration (Vibration as acceleration :La(m/s^2))	Lutron brand Vibration level meter (VB-8206SD)	- The pickup sensor is placed on the ground for vibration measurement. - Five seconds intervals of vibration level is recorded for ten minutes in an hour and then calculated as daily average, maximum and minimum vibration level.

Source: JET

5) Setting of Tentative Target for Noise and Vibration

(a) Noise

Currently, there is no ambient noise standard to receptors in Myanmar. On the other hands, most of the countries in south-east Asia as well as in Japan have the ambient noise standard to receptors categorized land use or requirement of quiet as shown in Table 2.2-14. International standard is also available in the EHS Guidelines prepared by IFC. Target ambient noise level is referred to standards in Japan basically. The standard can be selected in accordance with land use, because Japanese standards have several categories including road side noise. On the basis of the information in Table 2.2-14, target ambient level is set as shown in Table 2.2-15.

Table 2.2-14 Ambient Noise Standard at Operation Stage in South-East Countries

Items		Day time (Leq)	Night time (Leq)
Indonesia*1	Noise standard for sensitive areas such as residences, hospitals, schools, places of religious worships	55 dB	
	Noise standard for office and commercial	65 dB	
	Noise standard for commercial and service	70 dB	
Malaysia*2	Sensitive Areas/ Low Density Residential Areas	55 dB (7am – 10pm, 15hrs)	50 dB (10pm – 7am, 9hrs)
	Sub Urban Residential	60 dB (7am – 10pm, 15hrs)	55 dB (10pm – 7am, 9hrs)
	Urban Residential	65 dB (7am – 10pm, 15hrs)	60 dB (10pm – 7am, 9hrs)
	Commercial and Business	70 dB (7am – 10pm, 15hrs)	60 dB (10pm – 7am, 9hrs)
Singapore*3	Sensitive Areas	60 dB (7am – 7pm, 12hrs)	55 dB (7pm – 10pm, 3hr) 50 dB (10pm – 7am, 9hr)
	Residential Areas	65 dB (7am – 7pm, 12hrs)	60 dB (7pm – 10pm, 3hr) 55 dB (10pm – 7am, 9hr)
	Commercial Areas	70 dB (7am – 7pm, 12hrs)	65 dB (7pm – 10pm, 3hr) 60 dB (10pm – 7am, 9hr)
Thailand*4	Noise standard	70 dB (24hrs)	
Japan*5	Sensitive Area (Class AA)	50 dB (6am – 10pm, 16hrs)	40 dB (10pm – 6pm, 8hrs)
	Residential Area (Class A and Class B)	55 dB (6am – 10pm, 16hrs)	45 dB (10pm – 6pm, 8hrs)
	Area A facing roads with two or more lanes	60 dB (6am – 10pm, 16hrs)	55 dB (10pm – 6pm, 8hrs)
	Area B facing roads with two or more lanes,	65 dB (6am – 10pm, 16hrs)	60 dB (10pm – 6pm, 8hrs)
	Commercial and Industrial Area (Class C)	60 dB (6am – 10pm, 16hrs)	50 dB (10pm – 6pm, 8hrs)
	Area C facing a road with one or more lanes	65 dB (6am – 10pm, 16hrs)	60 dB (10pm – 6pm, 8hrs)
	Space adjacent to a road carrying arterial traffic	70 dB (6am – 10pm, 16hrs)	65 dB (10pm – 6pm, 8hrs)
IFC*6	Residential; institutional, educational	55 dB (7am – 10pm, 15hrs)	45 dB (10pm – 7am, 9hrs)
	Industrial; commercial	70 dB (7am – 10pm, 15hrs)	70 dB (10pm – 7am, 9hrs)

*1: Nose Standard in Indonesia (KEP-48/MENLH/11/1996)
*2: Effect of Traffic Noise on Sleep: A Case Study in Serdang Raya, Selangor, Malaysia, Environment Asia, 2010
*3: Environmental Protection and Management Act in Singapore (Chap.94A, Section 77, revised in 2008)
*4: Notification of Environmental Board No. 15 B.E.2540(1997) under the Conservation and Enhancement of National Environmental Quality Act B.E.2535 (1992) dated March 12, B.E.2540 (1997) and Notification of Pollution Control Department ; Subject: Calculation of Noise Level Dated August 11, B.E. 2540 (1997) in Thailand
*5: Environmental Quality Standards for Noise in Japan (Environment Agency Notification No. 64, 1998), Ministry of Environment, Japan
*6: Environmental, Health, and Safety Guidelines, General EHS Guidelines, IFC, 2007

Table 2.2-15 Tentative Target Value on Ambient Noise Level

No.	Category	Day time (6am – 10pm, 16hrs)	Night Time (10pm – 6pm, 8hrs)
1	Sensitive Area	50 dB	40 dB
2-1	Residential Area	55 dB	45 dB
2-2	facing roads with two or more lanes,	65 dB	60 dB
3-1	Commercial and Industrial Area	60 dB	50 dB
3-2	facing a road with one or more lanes	65 dB	60 dB
4	Space adjacent to a road carrying arterial traffic	70 dB	65 dB

Source: JET

(b) Vibration

There is no ambient vibration standard to receptors in Myanmar as well as south-east Asia and International Organizations such as WHO and IFC. Japan has the vibration standards for operating of heavy equipment. The equipment for vibration used commonly in Myanmar can record the vibration as vibration velocity (Lv: mm/s) or vibration acceleration (La: mm/s^2). The measurement data cannot be compared with standard defined as decibel directly. Thus, the target vibration level shall be set based on the standards or guidelines in some foreign countries in consideration of available equipment in Myanmar. The tentative target vibration level is shown in Table 2.2-16.

Table 2.2-16 Tentative Target Value on Ambient Vibration Level

No.	Category	Assessment period	Vibration acceleration for z-axis unit: m/s^2	
			Preferred values	Maximum values
1	Critical areas	Day- or Night time	0.005	0.010
2	Residences	Day time: 7:00-22:00 Night time:22:00-7:00	0.010 0.007	0.020 0.014
3	Offices, schools, educational institutions and places of worship	Day- or Night time	0.020	0.040
4	Workshops	Day- or Night time	0.040	0.080

Source: Vibration Criteria in New South Wales

6) Survey Result

(a) Noise

Noise level survey results are shown in Table 2.2-17. During day time, the noise levels at both survey points were higher than the tentative target value. On the other hand, during night time, the noise levels at both survey points were lower than the tentative target value based on the Japanese ambient noise standard.

Table 2.2-17 Result of Noise level

Unit: dB(A)

Time	NVT-1	NV-2	Target Value (L_{eq})	
			Resident Area facing the road	Resident Area
Day time 6:00-22:00	72	59	65	55
Night Time 22:00-6:00	51	36	60	45

Source: JET

(b) Vibration

Vibration levels survey results are shown in Table 2.2-18. Maximum vibration level for 24 hours encountered is as 0.008 m/s^2 at NVT-1. The result is lower than the tentative target value based on the ambient vibration standard.

Table 2.2-18 Result of Vibration level

Unit: m/s^2

Time	NVT-1		Target Value (La)	
			Preferred values	Maximum values
Day time 7:00-22:00	Maximum Average Minimum	0.0080 0.0009 <0.0010	0.010	0.020
Night Time 22:00-7:00	Maximum Average Minimum	0.0020 0.0002 <0.0010	0.007	0.014

Source: JET

(3) Traffic Volume Survey

1) Objectives

The traffic volume survey was conducted for obtaining traffic volume data to evaluate noise and vibration measurement result at road side.

2) Survey Point

Survey point was set at NVT-1, which is the same survey point for noise and vibration.

Traffic Count (NVT-1)

Source: JET

Figure 2.2-5 Traffic Volume Survey Point (May, 2014)

3) Survey Period

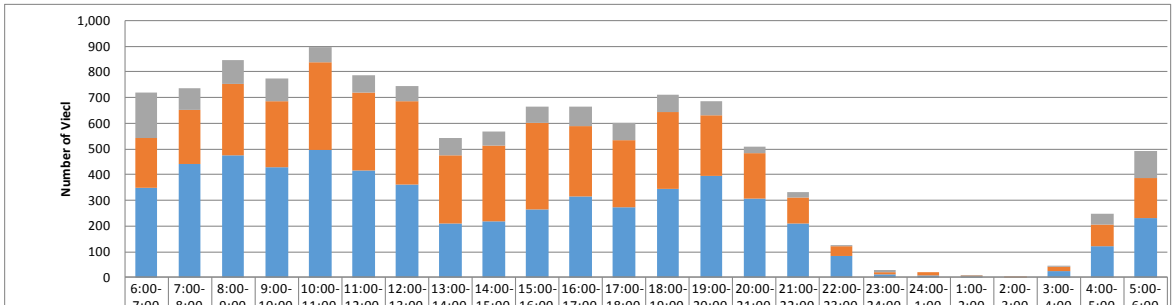
Traffic volume survey was conducted as shown in Table 2.2-12, which was same day of noise and vibration measurement.

4) Survey Method

Traffic volumes of three types of vehicles; i) Motorbike, ii) Light vehicle (private car and small freight transport car) and iii) Heavy vehicle (passenger bus, heavy freight transport car) were measures manually.

5) Survey Result

The total number of 24 hours traffic volume was 11,729 vehicles/day. Hourly traffic trend is shown in Figure 2.2-6. During morning time, the number of vehicles is over 700 vehicles/hour. During night time, the number of vehicles was less than 50 vehicles/hour. Motorbike was observed as main transportation mode during survey.



	6:00-7:00	7:00-8:00	8:00-9:00	9:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-24:00	24:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00	5:00-6:00
Heavy Vehicle	177	87	92	87	60	68	59	66	57	62	75	68	66	58	25	20	5	5	0	1	0	6	42	107
Light vehicle	194	210	279	256	339	302	327	266	293	335	274	261	300	234	180	102	38	9	9	2	1	16	86	158
Motorbike	350	441	474	430	498	416	360	210	218	266	315	271	343	395	305	209	84	13	9	2	0	25	120	229

Source: JET

Figure 2.2-6 Traffic Volume Survey Result (May, 2014)

(4) River Flow, Section and Water Quality Survey

1) Objectives

The river water and water quality survey was conducted for collecting information on the present water condition and quality of the water body that receives effluent from the Thaketa Power Plant.

2) Survey Point

Sampling points for river flow and water quality measurement are shown in Table 2.2-19 and Figure 2.2-7.

(a) River flow and section

Three sampling points as named RF1, RF-2 and RF-3 were set for river flow survey. RF-2 was set at the mixing point of the Ngamoeyeik Creek and small creek. RF-1 was set downstream from RF-2. River section survey was conducted at RS-1. It is same as RF-1. RF-3 was set upstream from RF-2. The additional one point named WT-Drainage was set at inflowing point of small creek receiving effluent from Thaketa Power Plant for monitoring water temperature only.

(b) Water quality

Three sampling points were set for water quality measurement of effluent from the boiler. One survey point was set at the wastewater discharge channel inside Thaketa Power Plant. The other two sampling points were set on the Ngamoeyeik Creek, which locations were same as river water survey.

As for effluent from cooling tower, three sampling points were set. Two of three sampling points were set inside Thaketa Power Plant, and another point was set on the small stream outside Thaketa Power Plant.

Table 2.2-19 River flow and Water Quality Survey Point

Point	Sampling Point	Location
RF-1	Downstream of the mixing point of the Ngamoeyeik Creek and small creek	Ngamoeyeik Creek
RF-2	Mixing point of the Ngamoeyeik Creek and small creak	Ngamoeyeik Creek
RF-3	Upstream of the mixing point of the Ngamoeyeik Creek and small creek	Ngamoeyeik Creek
WT-Drainage	At the entering point of drainage (from the Thaketa Power Plant) into Ngamoeyeik Creek.	Ngamoeyeik Creek
RS-1	Same asRF-1	Ngamoeyeik Creek
WQ-1	Same asRF-1 and WQ-1	Ngamoeyeik Creek
WQ-2	Discharge channel	Inside the Thaketa Power Plant
WQ-3	Same asRF-3	Ngamoeyeik Creek
WQ-4	Water tank for cooling tower	Inside the Thaketa Power Plant
WQ-5	Outlet of cooling tower	Inside the Thaketa Power Plant
WQ-6	Stream outside Thaketa	Outside the Thaketa Power Plant

Source: JET

RF-1,2, 3 and WQ-1,3
Ngamoeyeik Creek

WT-Drainage
At the entering point of drainage

WQ-2
Channel in Thaketa PS

WQ-4
Water Tank for Cooling Tower

WQ-5
Outlet of Cooling Tower

WQ-6
Stream Outside Thaketa

Source: JET

Figure 2.2-7 River Water and Water Quality Survey Point

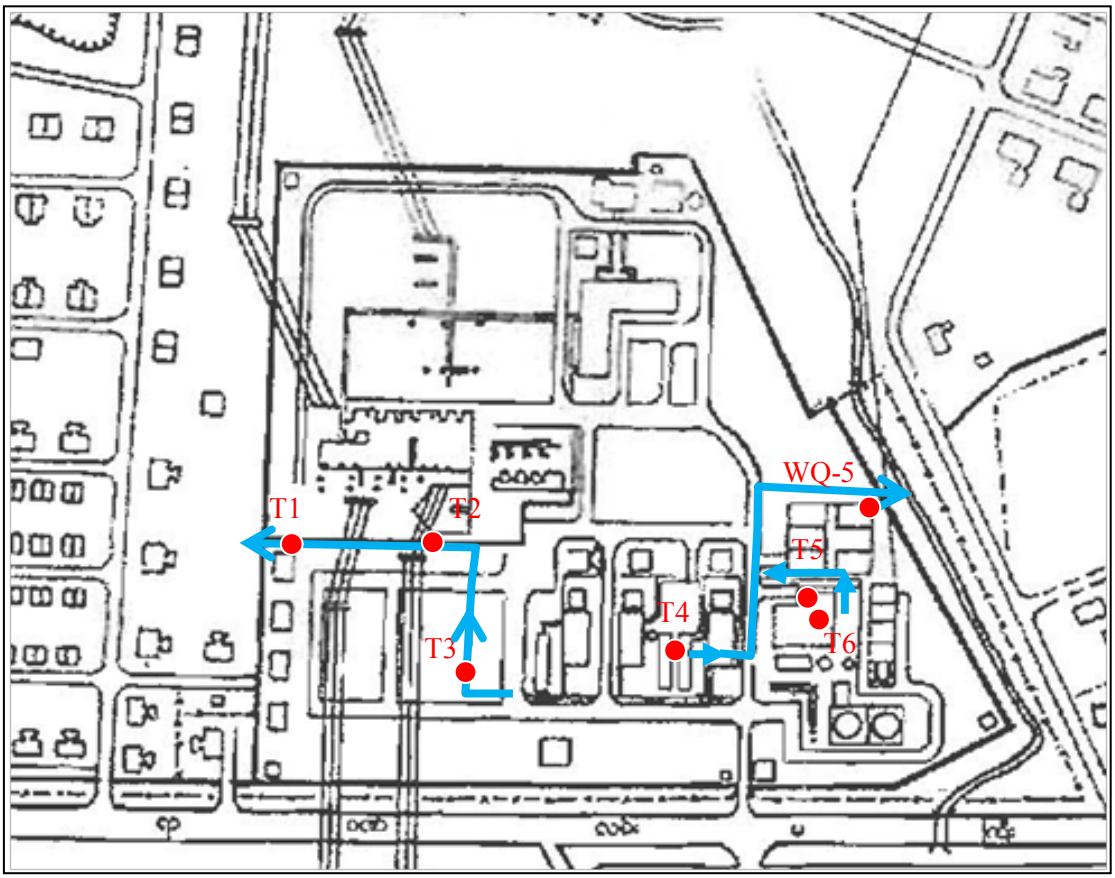
Additionally, water temperatures of three locations (T1, T2 and T3) along the small drain and the other three locations (T4, T5 and T6) of discharging from cooling water facility in Thaketa Power Plant were also recorded. Discharging water from each cooling facilities were put together to WQ-5, and it flow to outside of Thaketa Power Plant.

Survey points for water temperatures along the small drain and discharging from cooling water facilities are shown in Table 2.2-21 and Figure 2.2-8.

Table 2.2-20 Description of Survey Point of Water Temperature

No	Location	GPS Location	Geographic Location
1.	T1(=WQ2)	16°48'42.00"N 96°13'28.90"E	Discharge point
2.	T2	16°48'42.74"N 96°13'30.70"E	Middle point between T1 and T3
3.	T3	16°48'41.43"N 96°13'32.82"E	Near the thermal effluent from boiler
4	T4	16°48'43.14"N 96°13'33.76"E	Cooling water for heat recovery steam generator
5	T5	16°48'44.83"N 96°13'35.95"E	Cooling water for Oil Cooler of steam turbine
6	T6	16°48'43.67"N 96°13'35.59"E	Cooling water for generator cooler of steam turbine
7	WQ-5	16°48'45.6"N 96°13'36.6"E	Outlet of cooling tower (Mixting point of all discharge from cooling water facility)

Source: JET



T1
Discharge point

T2
Middle point between T1 and T3

T3
Near the thermal effluent from boiler

T4
Cooling water for heat recovery steam generator

T5
Cooling water for Oil Cooler of steam turbine

T6
Cooling water for generator cooler of steam turbine

Source: JET

Figure 2.2-8 Measurement Points of Water Temperature along the Drain from the Boiler

River Water Sampling

Thermal Effluent Monitoring

Source: JET

Figure 2.2-9 River Water and Water Quality Survey

3) Survey Period

Survey period for water quality is shown in Table 2.2-21. The timing of water sampling was determined in accordance with the time of discharging hot wastewater from Thaketa Power Plant.

Table 2.2-21 River flow and Water Quality Survey Point

Items	Sampling Point	Period
River flow	RF-1	Dry season :14 days(16th – 29th May, 2014), 5times per day, 3layer Rainy season: 1day (1st July, 2014) , 4 times per day
	RF-2	
	RF-3	
	WT-Drainage	
River section	RS-1	1st July, 2014 , 10 measurement points in one section
Water quality	WQ-1	Dry season:22th May, 2014 Rainy season: 1st July, 2014
	WQ-2	
	WQ-3	
	WQ-4	1st survey:18th June, 2014 2nd survey : 1st July, 2014
	WQ-5	
	WQ-6	

Source: JET

4) Survey Method

River flow monitoring was consecutively carried out 14 days and 5 times at each sample points were measured within day time in dry season. During rainy season, it was carried out on 1st July. These measurements were done in three different layers as surface, middle and bottom at each sampling points.

River section survey was conducted at Ngamoeyeik Creek which is same as RF-1. 10 measurement points was selected in one section. Each points were measured depth, distance from the shore and stream velocity of middle layer.

Analytical methods of water quality are shown in Table 2.2-22. All sampling and analysis method were in accordance with recognized standard procedures applied internationally. Valeport digital water velocity meter and HONDEX digital depth sounder are utilized for river flow rate and water depth measurement. Water samples were taken by Alpha horizontal water sampler and collected in sterilized sample containers. All sampling was in strict accordance with recognized standard procedures. The parameters as pH, temperature,

velocity, salinity, colour, odor, dissolved oxygen (DO), electrical conductivity (EC), and turbidity were measured at each site concurrently with sample collection. Tide conditions were also noted. All samples were kept in iced boxes and were transported to the laboratory and stored at 2-4 °C refrigerators.

Table 2.2-22 Field Equipment for river flow measurement and water quality survey

No.	Equipment	Manufacturer	Originate Country	Model
1	Digital Water Velocity Meter	Valeport	USA	001
2	Digital Water Depth Sounder	HONDEX	USA	PS7
3	Multiparameter (water quality)	HANNA	USA	HI7609829 (with 3 sensors)
4	Hand-held Refractometer (Salinity)	ATAGO	Japan	S/Mill-E
5	Alpha Bottle (Water Sampler)	Wildlife Supply Company®	Indonesia	-

Source: JET

5) Setting of Tentative Target for Water Quality

(a) Water Temperature

Currently, there is a water temperature standard for discharging hot wastewater to water body in Myanmar. It is less than 40 ^{o}C. On the other hands, most of the developed countries, such as Japan, USA, and UK, have the water temperature standards for discharging hot wastewater. In addition, there is water temperature standard at mixing area around 50 to 1,000m downstream from discharge point stipulated in the developed countries such as France, UK, USA as well as international standard by IFC EHS Guidelines. Table 2.2-23 shows water temperature standards for discharging hot wastewater to water body, and water temperature standards at mixing area around 50 to 1,000m downstream from discharge point in the developed countries as well as IFC EHS Guidelines. The tentative target water temperature level discharging to water body was set at median value, of which value is within 12ºC of difference from the temperature of receiving body) among the referred standards as shown in Table 2.2-24 .

Table 2.2-23 Water Temperature Standard in the Developed Countries and IFC GHS Guideline

No	Countries/ International Organization	Water temperature standard discharging to water body	Water temperature standard at mixing area around 50-1,000m from discharging point
1.	Japan*1	<Δ7 ºC (Difference of water temperature between intake and outlet)	- (Check area of water temperature difference around discharge point in EIA)
2.	Some States in USA	<Δ7-15 ºC (Difference of water temperature between intake and outlet)	27-36 ºC (depending on the location) <Δ2.2 ºC
3.	UK	<Δ10-12 ºC (Difference of water temperature between intake and outlet)	<Δ3 ºC
4.	France	<Δ15 ºC (Difference of water temperature between intake and outlet)	30 ºC (at 50m from discharging point)
5.	IFC *2	-	• Site specific requirement to be established by the EA. • Elevated temperature areas due to discharge of once-through cooling water (e.g., 1 Celsius above, 2 Celsius above, 3 Celsius above ambient water temperature) should be minimized by adjusting intake

No	Countries/ International Organization	Water temperature standard discharging to water body	Water temperature standard at mixing area around 50-1,000m from discharging point
			and outfall design through the project specific EA depending on the sensitive aquatic ecosystems around the discharge point.
6.	World Bank*3	-	<Δ3 ºC

*1: Survey Report on Environmental Impact on Warm Water from Power Plant in Japan and other countries, Ministry of Environment Japan, 2011 (Japanese)
*2: Environmental, Health, and Safety Guidelines, Thermal Power Plant EHS Guidelines, IFC, 2009
*3: Pollution Prevention and Abatement Handbook, 1998 World Bank
Source: JET

Table 2.2-24 Tentative Target Value on Water Temperature

Water Temperature Standard Discharging to Water Body
Target Value 1: ±Δ12 ºC (Difference of water temperature between discharged wastewater and receiving body) Target Value 2 : <40 ^{o}C

Source: JET

(b) Water quality

Though effluent standard has not been stipulated by MOECAF, industrial wastewater effluent guideline value is determined by the Ministry of Industry (MOI) as shown in Table 2.2-25. Factories shall comply with the effluent standard for certification on the discharge of sewage and process wastewater from their factories. In this project, tentatively the MOI guidelines values are adopted as the tentative target values.

Table 2.2-25 Industrial Wastewater Effluent Guideline Value

No	Items	Allowable Rate	Unit	Remarks
1.	BOD (5 days at 20 ºC)	Max. 20-60	ppm	Depending on geography of waste discharging point.
2.	Suspended Solids	Max. 30	ppm	-
3.	Dissolved solids	Max 2,000	ppm	-
4.	pH Value	Between 5 and 9	—	-
5.	COD Permanganate value	Max. 60	ppm	-
6.	Sulphide (as HS)	Max. 1	ppm	-
7.	Cyanide (as HCN)	Max. 0.2	ppm	-
8.	Oil and grease	Max. 5	ppm	-
9.	Tar	None	-	-
10.	Formaldehyde	Max. 1	ppm	-
11.	Phenols and cresols	Max. 1	ppm	-
12.	Free chlorine	Max. 1	ppm	-
13.	Zinc	Max. 5	ppm	-
14.	Chromium	Max. 0.5	ppm	-
15.	Arsenic	Max. 0.25	ppm	-
16.	Copper	Max. 1.0	ppm	-
17.	Mercury	Max. 0.005	ppm	-
18.	Cadmium	Max. 0.03	ppm	-
19.	Barium	Max. 1.0	ppm	-
20.	Selenium	Max. 0.02	ppm	-
21.	Lead	Max. 0.2	ppm	-
22.	Nickel	Max. 0.2	ppm	-
23.	Insecticides	None	-	-
24.	Radioactive Materials	None	-	-
25.	Temperature	Max. 40	ºC	-

No	Items	Allowable Rate	Unit	Remarks
26.	Color and Odor	-		Not objectionable when mixed in receiving water

Source: MOI

IFC EHS Guidelines determined the effluent guideline values from thermal power plants as shown in Table 2.2-26.

Table 2.2-26 Effluent Guideline Value from Thermal Power Plant

No	Items	Allowable Rate	Unit
1.	pH	6-9	
2.	TSS	50	mg/l
3.	Oil and grease	10	mg/l
4.	Total residual Chlorine	0.2	mg/l
5.	Chromium-Total	0.5	mg/l
6.	Copper	0.5	mg/l
7.	Iron	1.0	mg/l
8.	Zinc	1.0	mg/l
9	Lead	0.5	mg/l
10	Cadmium	0.1	mg/l
11	Mercury	0.005	mg/l
12	Arsenic	0.5	mg/l

Source: IFC EHS Guidelines Thermal Power Plants

The water quality analytical results are compared with both standards mentioned above in this report.

6) Survey Result

(a) Discharge water temperature

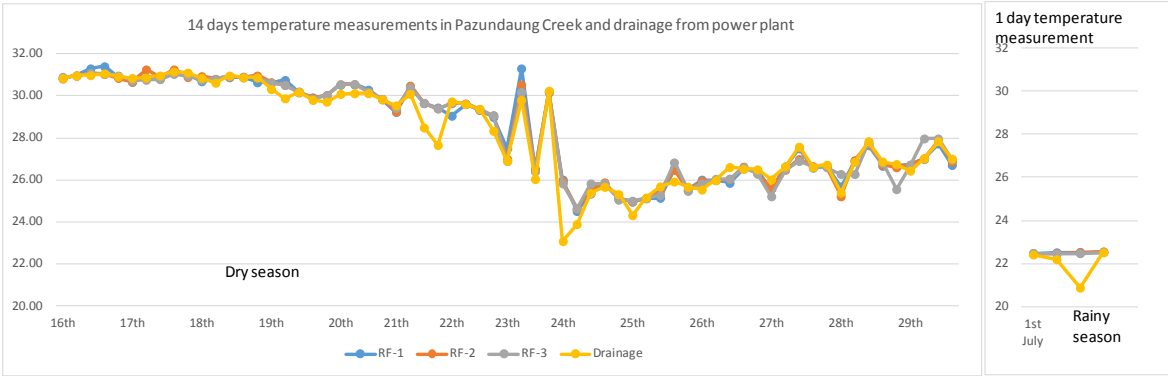
The result of discharge water temperature at three locations (T1, T2 and T3) along the small drain during discharging from boiler and the other three locations (T4, T5 and T6) discharging from cooling water of each facilities in Thaketa Power Plant is shown in Table 2.2-27. According to the result of discharging from boiler, the water temperature is gradually decreased from the power plant to away. Regarding the result of discharging from cooling water facilities, all discharge water was collected and it decreased to 30 ºC before went out to power plant.

Table 2.2-27 Water Temperature at Seven Locations in Thaketa Power Plant

No	Location	description	Water Temperature (ºC)	
			1st Survey (18tn June 2014)	2nd Survey (1st July 2014)
1.	T1(=WQ2)	Discharge point	29	22
2.	T2	Middle point between T1 and T3	48	30
3.	T3	Near the thermal effluent from boiler	> 55	39
4	T4	Cooling water for heat recovery steam generator	-	35
5	T5	Cooling water for Oil Cooler of steam turbine	-	42
6	T6	Cooling water for generator cooler of steam turbine	-	35
7	T7	Same as WQ-5	-	30

Source: JET

Dry season and rainy season river water temperature at monitoring point is shown in Figure 2.2-10. Based on the trend of water temperature, there is no significant difference among four data.



Source: JET

Figure 2.2-10 Water Temperature for Dry Season and Rainy Season

(b) Water quality (W-1,2, and 3: effluent from the boiler)

During dry season, the survey results of effluent from the boiler are shown in Table 2.2-28. A part of parameters cannot be analyzed in Myanmar, so are being analyzed in the Thailand laboratory. According to the results shown below, water temperature does not shown large difference between outlet of hot wastewater channel from Thaketa Power Plant (WQ-2) and Ngamoeyeik Creek, receiving body of thermal effluent.

Table 2.2-28 Water Quality Survey Result (Effluent from the Boiler)

Parameter	Unit	WQ-1		WQ-2		WQ-3		Tentative Target Value*	
		Dry	Rain	Dry	Rain	Dry	Rain	MOI Guideline	IFC Guideline
Date	-	22nd May	1st July	22nd May	1st July	22nd May	1st July		
Time	-	15:20	14:45	14:30	14:15	16:00	14:55		
Weather	-	Cloudy	Rainy	Cloudy	Rainy	Cloudy	Rainy		
Transparency	-	Low	Medium	Low	Medium	High	Medium	-	-
Depth	m	6.9	5.1	0.8	0.2	12.2	10.1	-	-
Flow rate/Velocity	m/s	0.18	0.104	-	-	0.17	0.174	-	-
Temperature (atmosphere)	˚C	27.5	26	29	26	29	25	-	-
Temperature (Water) *	˚C	29.33	22.21	28.92	22.09	29.36	22.29	<40	-
Odor	-	Earthy	Earthy	Normal	Normal	Earthy	Earthy	-	-
Color	-	Light brown	Light brown	Clear	Clear	Light brown	Light brown	-	-
pH	-	7.72	7.30	8.42	7.23	7.91	6.90	5 - 9	6 - 9
ORP	mv	85.30	58.5	75.40	66.3	87.60	58.9	-	-
EC	us/cm	1448	83	2464	284	1300	128	-	-
TDS	ppm	710	26	1231	140	650	66	2000	-
DO	mg/l	1.65	8.40	1.54	7.16	1.80	8.13	-	-
Turbidity	FNU	>1000	334	35	40.7	>1000	342	-	-

Suspended solid	mg/l	258	328	559	151	488	429	30	50
Oil and grease	mg/l	<1.0	To be confirmed	<1.0	To be confirmed	<1.0	To be confirmed	5	10
Chromium (total)	mg/l	0.04	To be confirmed	<0.02	To be confirmed	0.08	To be confirmed	0.5	0.5
Chlorine (residual)	mg/l	0.04	To be confirmed	<0.01	To be confirmed	0.06	To be confirmed	-	-
Copper	mg/l	ND	0.006537	ND	0.003889	ND	ND	1	0.5
Iron	mg/l	0.10	2.20	0.10	0.15	0.20	1.20	-	1
Zinc	mg/l	ND	ND	ND	ND	ND	0.000325	5	1
Lead	mg/l	ND	ND	ND	ND	ND	ND	0.2	0.5
Cadmium	mg/l	ND	ND	ND	ND	ND	ND	0.03	0.1
Mercury	mg/l	ND	ND	ND	0.000106	ND	ND	0.005	0.005
Arsenic	mg/l	0.005877	0.000040	0.005284	0.000045	0.004810	0.000030	0.25	0.5

ND: Not Detected (as per LAB report)
MOI – Ministry of Industry Guideline
IFC – Effluent Guideline for Thermal Power Plant
* Tentative target value of water temperature is set as "<Δ15 ºC (Difference of water temperature between intake and outlet)". (see Table 2.2-24)
** ORP-Oxidation-Reduction Potential; EC- electrical conductivity; TDS: Total Dissolved Solids; DO- Dissolved Oxygen
Source: JET

(c) Water quality (W-4,5, and 6: effluent from the cooling tower)

During dry season, the survey results of effluent from the boiler are shown in Table 2.2-29. The result of pH at WQ-5 was higher than tentative target value, though WQ-5 is inside the Thaketa Power Plant. The result of pH at WQ-4 and WQ-6 were within range of tentative target value.

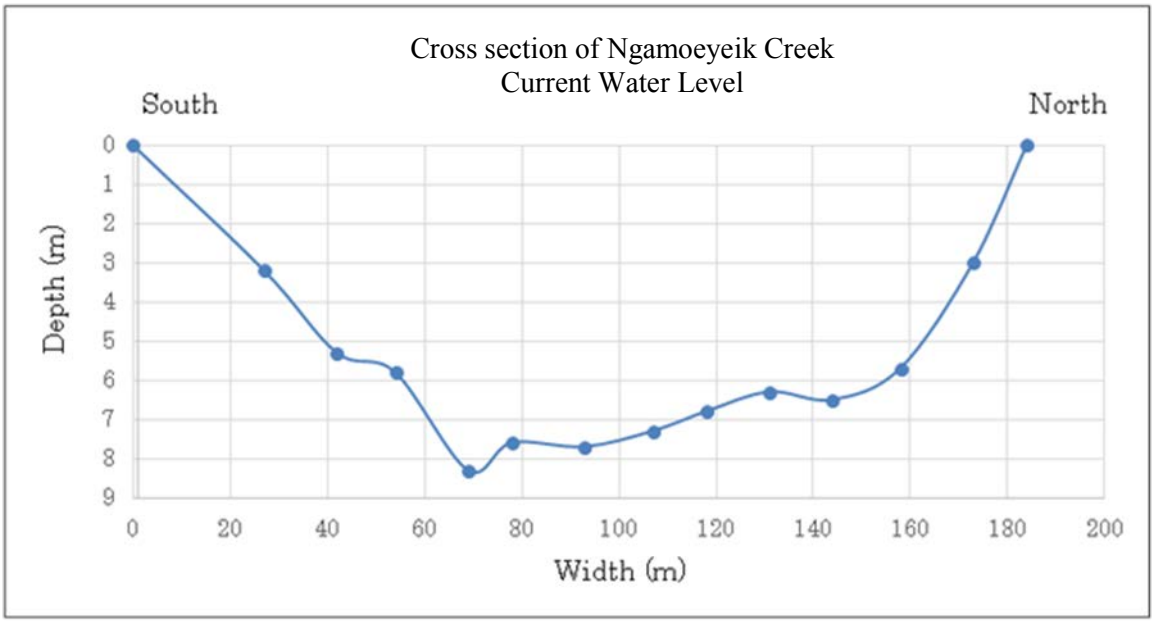
Table 2.2-29 Water Quality Survey Result (Effluent from the Cooling Tower)

Parameter	Unit	WQ-4 (inside)		WQ-5 (inside)		WQ-6 (outside)		Tentative Target Value*	
		1st	2nd	1st	2nd	1st	2nd	MOI Guideline	IFC Guideline
Date	-	18th June	1st July	18th June	1st July	18th June	1st July		
Time	-	11:00	13:05	11:20	13:10	11:45	13:45		
Weather	-	Cloudy	Shower	Cloudy	Shower	Cloudy	Cloudy		
Temperature (Water) *	˚C	23.4	23.12	23.9	25.13	21.9	21.23	<40	-
Odor	-		Normal		Normal		Normal	-	-
Color	-		Clear		Clear		Clear	-	-
pH	-	8.88	7.95	9.39	7.85	7.72	7.54	5 - 9	6 - 9
ORP	mv		17.3		39.6		97.9	-	-
EC	us/cm	80	62	3,256	2240	869	556	-	-
TDS	ppm	40	30	1,628	1124	434	301	2000	-
DO	mg/l		10.84		9.31		7.02	-	-
Turbidity	FNU	8.8	7.7	116	119	28.9	47.5	-	-

* Tentative target value of water temperature is set as "<Δ15 ºC (Difference of water temperature between intake and outlet)". (see Table 2.2-24)
** ORP-Oxidation-Reduction Potential; EC- electrical conductivity; TDS: Total Dissolved Solids; DO- Dissolved Oxygen
Source: JET

(d) River Section

The survey result of river section is shown in Figure 2.2-11. According to this result, the average flow volume is approximately 153 m^3/s.



Source: JET

Figure 2.2-11 River Section Measurement of Ngamoeyeik Creek

2.2.2 Result of Emisson gas, Noise and Vibration Survey at Thaleta Power Plant

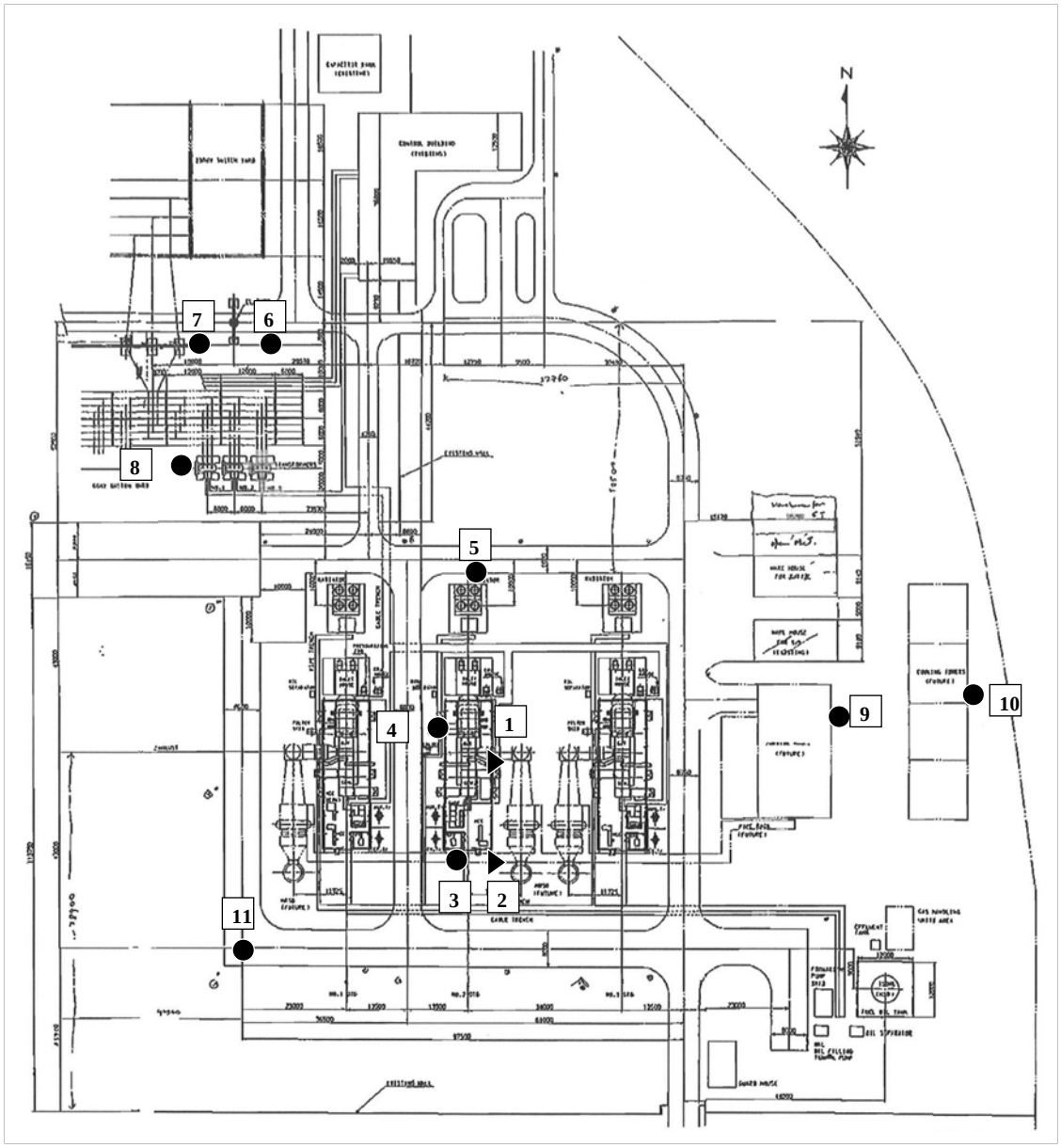
The field survey for collecting the data of the emission gas, noise and vibration in Thaketa Power Plant was conducted as shown in Table 2.2-30.

Table 2.2-30 Summary of Emission gas, Noise and Vibration Survey in Thaleta Power Plan

Type	Item	Point
Emission gas	1) Nitrogen oxide(NOx), 2) Carbon monoxide(CO), 3) Carbon dioxide(CO_2), 4) Oxygen(O_2), 5) Gas flow velocity, 6) Gas temperature,and 7) Water amount	2 points
Noise and Vibration	Noise and Vibration at Boundary of Thaketa Power Plant (24 hours)	1 point
	Emission Noise and Vibration from power plant equipments such as 1)Gas Turbine, 2) Steam Turbine, 3) Cooling Tower, 4) Cooling Fun, 5) Transformer, and 6) Gas engine	9 points

Source: JET

Figure 2.2-12 and Figure 2.2-13 show the survey points for emission gas, noise and vibration in the Thaketa Power Plant.



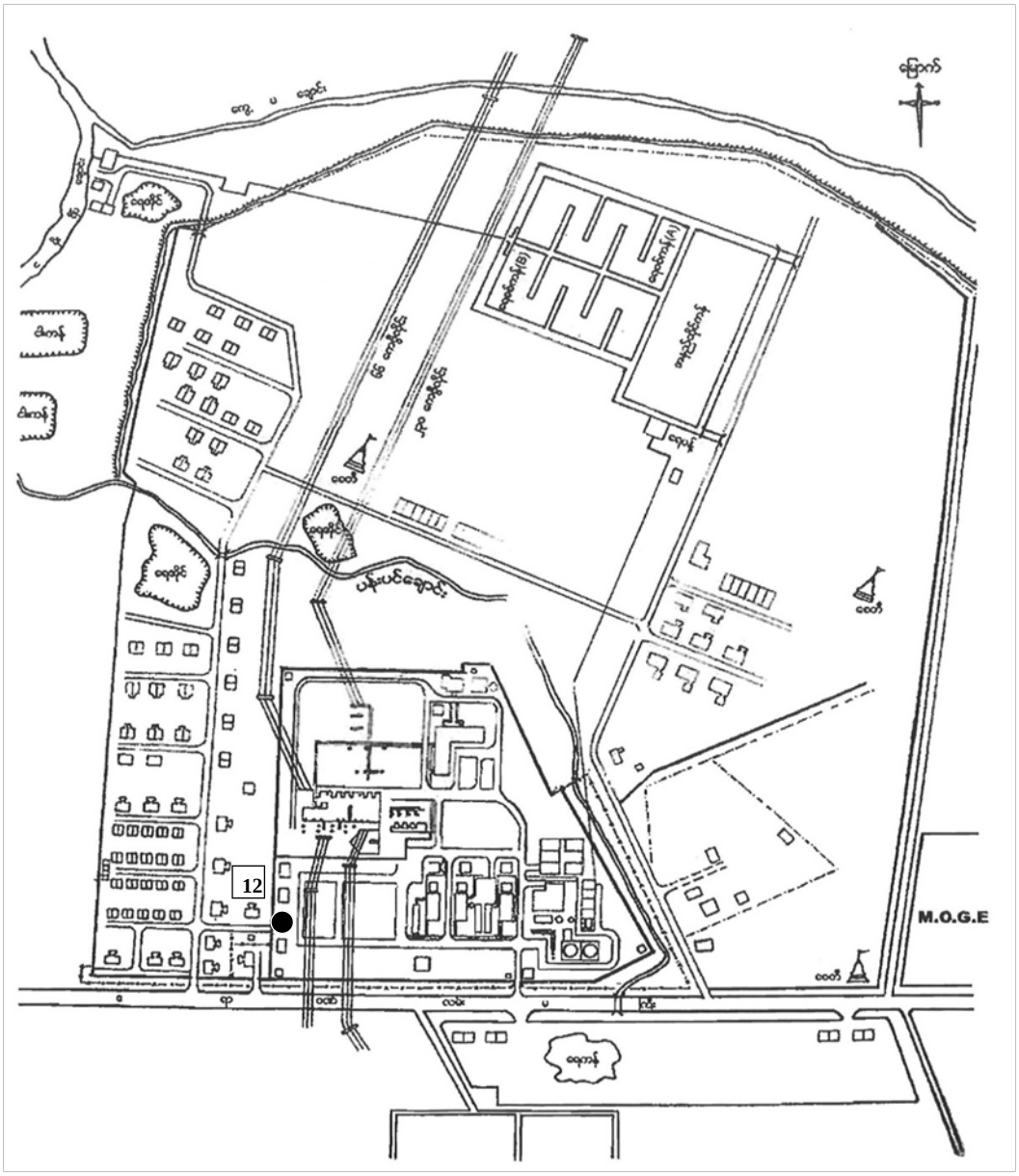
Legend

▲ Emission Gas (1 and 2)

● Noise and Vibration (from 3 to 11)

Source: JET

Figure 2.2-12 Location Map of Field Survey Sampling Point at Thaketa Power Plant



Legend

● Noise and Vibration at Boundary (12)

Source: JET

Figure 2.2-13 Location Map of Field Survey Sampling Point at Thaketa Power Plant

Table 2.2-31 Description of Sampling Point Location

Item	No.	Facilities	Maker/Model/ Specification	Measurement Point or Type
Emission gas	1	Gas Turbine	KAWASAKI, VOGT HRSG, 44.05 ton/hr	Flange1: After the damper
	2			Flange2: Chimney
Noise and Vibration	3	Gas Turbine	HITACHI, PG5361 (P) 19,014kW	South side
	4			West side
	5	Cooling Fun	MEIDENSHA corporation, TISP85-NNR	North side
	6	Transformer	AREVA, DFS-33, 1 phase forced-air cooling	
	7		FUJI Electronic, IEC-76, 1 phase / 50Hz	
	8		Hitachi, IEC-76-1976, 3 phase / 50Hz	
	9	Steam Turbine	FUJI Electronic, Single casing condensing type, 34,900kW	East side
	10	Cooling Tower	Cofimco, 6706-08-36N/G1.5, For steam turbine	East side
	11	Gas Engine	MAXPOWER, Jenbacher gas engines,	
	12	Boundary		

Source: JET

(1) Emission gas

1) Objectives

The field survey of emission gas was conducted for evaluating the current emission gas quality from the existing Thaketa Power Plant.

2) Survey Point

Two survey points equipped with the flange to take a sample were selected to measure emission gas as shown in Figure 2.2-14.

Sampling Point No.1:Flange1	Sampling Point No.2:Flange2

Source: JET

Figure 2.2-14 Emission Gas Sampling Point

3) Survey Period

Sampling and analyzing was conducted on 17th June, 2014.

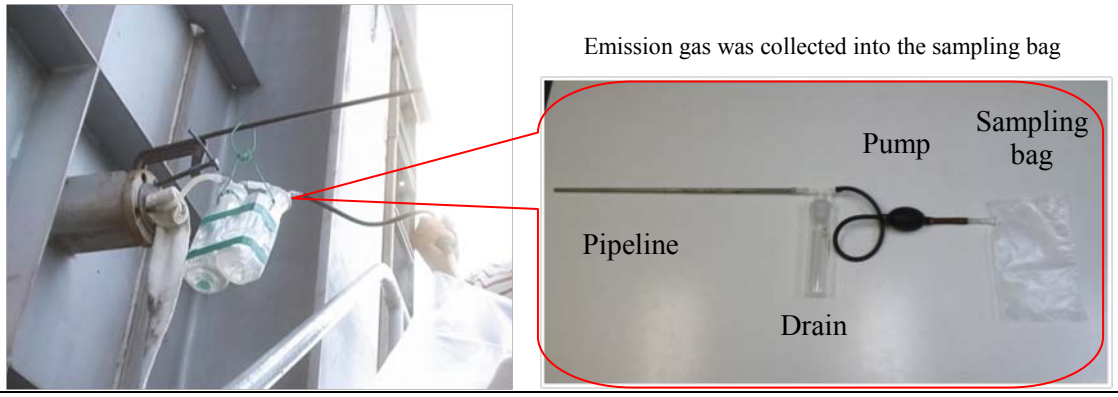
4) Survey Method

Sampling and analysis of emission gas are shown in Figure 2.2-15. The gas sample was collected during 30 to 60 minutes at one sampling point by gas measurement equipment

and other apparatus to measure flow rate, temperature and water contents from the flange. Regarding chemical analysis of emission gas, the collected sample was injected to gas detecting tubes, and concentration of pollutants was identified by changed color of the gas detecting tubes. The outline of procedure of the measurement is as bellows;

Step 1: Emission gas was collected into the sampling bag from the flange in emission process, and;

Step2: Sampled emission gas was analyzed by detector tube.



Sampling Procedures

Analysis Procedure

Source: JET

Figure 2.2-15 Sampling and Analysis Procedure of Emission Gas

The equipments used for analysis of emission gas are shown in Table 2.2-32.

Table 2.2-32 Equipments for Analysis of Emission Gas

Parameters	Equipments
Nitrogen oxide(NOx), Carbon monoxide(CO), Carbon dioxide(CO_2), Oxygen(O_2)	Detector Tube
Gas flow velocity	Hot wire anemometer
Gas temperature	Thermometer
Water volume	JIS Z8808

Source: JET

5) Setting of Tentative Target for Emission gas

Currently, there is no emission gas standard in Myanmar. Japan has standard of nitrogen dioxide for thermal plant, as shown in Table 2.2-33 . International standards on nitrogen oxides are also available in the Environmental, Health, and Safety (EHS) Guidelines prepared by International Fiancé Cooperation (IFC) and Pollution the Prevention and Abatement Handbook (PPAH) prepared by World Bank (WB) group as shown in Table 2.2-34 and Table 2.2-35.

On the basis of the emission standard for thermal power plant as shown from Table 2.2-33 to Table 2.2-35, target value of nitrogen oxides is set as shown in Table 2.2-36 with the following considerations.

- NOx concentration in emission gas is affected by concentration of the nitrogen in the natural gas fuel.
- There is a possibility that MOGE will supply the natural gas which includs high concentration of nitrogen to Thaketa Power Plant in future, depending on demand on natural gas at each power plant in Yangon Region.
- Therefore, the target value of nitrogen oxides in emission gas is set as the broad target, from 25 ppm to 62.5 ppm.

Table 2.2-33 Emission Standards for Gas Turbine Plant in South-East Countries, Japan

Item	Japan*1	Thailand*2	Vietnam*3	Indonesia*4
NO_x	70 ppm	120 ppm	122 ppm (250mg/Nm^3)	195 ppm (400mg/Nm^3)

Source: *1: Air Pollution Control Act in Japan (Act No. 97, 1968, originally), Japan
*2: Notification of the Ministry of Science, Technology and Environment published in the Royal Government Gazette, Vol.113, 1996, Thailand
*3:National Technical Regulation on Emission of Thermal Power industry (QCVN 22: 2009), Ministry of Science and Technology in Vietnam
*4: Regulation No. 21, Ministry of Environment in Indonesia, 2008

Table 2.2-34 IFC Emission Guideline for Combustion Turbine

Combustion Technology/ Fuel Particulate	Particulate Matter		Sulfur Dioxide (SO_2)		Nitrogen Oxides (NOx)	Dry Gas, Excess O_2 Content (%)
Combustion Turbine			NDA/DA		NDA/DA	
Natural Gas (All turbine types of unit >50MWth)	N/A	N/A	N/A	N/A	51mg/Nm^3 (25ppm)	15%
Fuel other than Natural Gas (Unit >50MWth)	50	30	Use of 1% or less S fuel	Use of 0.5% or less S fuel	152mg/Nm^3 (74ppm)	15%

Note: MWth=Megawatt thermal input on HMV basis; N/A=not applicable; NDA: Non-degraded air shed; DA=Degraded air shed (poor air quality)
Comparison of the Guideline limits with standards of selected countries / region (as of August 2008):
- Natural Gas-fired Combustion Turbine – NOx
  Guideline limits: 51 (25 ppm)
  EU: 50 (24 ppm), 75 (37 ppm) (if combined cycle efficiency > 55%), 50*η / 35 (where η = simple cycle efficiency)
  US: 25 ppm (> 50 MMBtu/h (≈ 14.6 MWth) and ≤ 850 MMBtu/h (≈ 249MWth)), 15 ppm (> 850 MMBtu/h (≈ 249 MWth))
  (Note: further reduced NOx ppm in the range of 2 to 9 ppm is typically required through air permit)
- Liquid Fuel-fired Combustion Turbine – NOx

Guideline limits: 152 (74 ppm) – Heavy Duty Frame Turbines & LFO/HFO, 300 (146 ppm) – Aeroderivatives & HFO, 200 (97 ppm) – Aeroderivatives & LFO
EU: 120 (58 ppm), US: 74 ppm (> 50 MMBtu/h (≈ 14.6 MWth) and ≤ 850 MMBtu/h (≈ 249MWth)), 42 ppm (> 850 MMBtu/h (≈ 249 MWth))
- Liquid Fuel-fired Combustion Turbine – SOx
Guideline limits: Use of 1% or less S fuel
EU: S content of light fuel oil used in gas turbines below 0.1% / US: S content of about 0.05% (continental area) and 0.4% (non-continental area)

Source: Emission Standard for Thermal Power Plant, 2009, IFC

Table 2.2-35 PPAH WB Emission Standard for Thermal Power Plant

Combustion Technology/ Fuel Particulate	Nitrogen Oxides (NOx)	Dry Gas, Excess O_2 Content (%)
Combustion turbine units for Gas	125 mg/Nm^3 (62.5 ppm)	15%

Source: Pollution Prevention and Abatement Handbook, 1998 World Bank

Table 2.2-36 Tentative Target Value on Emission Guideline for Combustion Turbine

Combustion Technology/ Fuel Particulate	Nitrogen Oxides (NOx)	Dry Gas, Excess O_2 Content (%)
Natural Gas (All turbine types of unit >50 MWth)	51mg/Nm^3 - 125 mg/Nm^3 (25ppm - 62.5ppm)	15%

Source: JET

6) Result

The result of emission gas is shown in Table 2.2-37. Because O_2 was contained 16 % in emission gas, the concentration of NOx was converted under O_2 condition of 15 % for comparing with the tentative target value as follows;.

$C = (21-O_n) / (21-O_s) \times C_s$
C : Nitrogen oxides (NOx) concentration after conversion (ppm)
On : Oxygen (O_2) concentration of standard condition (15 %)
Os : Oxygen (O_2) concentration in emission gas (%)
Cs : Nitrogen oxides (NOx) concentration in emission gas (ppm)

Table 2.2-37 Result of Emission gas

	Parameter	Unit	Flange 1 (After the damper)		Flange 2 (Chimney)	
			Result*	Average	Result*	Average
1	NO_x	ppm	20.0	20.0	20.0	20.0
			20.0		20.0	
			20.0		20.0	
2	CO	ppm	25.0	25.0	25.0	25.0
			25.0		25.0	
			25.0		25.0	
3	CO_2	%	2.4	2.4	2.2	2.2
			2.4		2.2	
			2.3		2.1	
4	O_2	%	15.9	16.0	16.0	16.0
			16.0		16.0	
			16.0		16.0	
5	Flow velocity	m/s	17.8		9.1	
6	Gas Temperature	^oC	465		225	
7	Water amount	%	7.1		7.6	

*The gas was taken into three bags.
Source: JET

The emission gas (conversed under 15% O_2) was lower than the tentative emission gas target value as shown in Table 2.2-38.

Table 2.2-38 Emission Gas NOx (converted under 15 % O_2)

Sampling Point	Parameter	Result of field survey	After conversion under 15 % O_2	Tentative Target
Flange 1	NOx	20 ppm	24 ppm	25 ppm -62.5 ppm
Flange 2	NOx	20 ppm	24 ppm	

Source: JET

(2) Noise and Vibration

1) Objectives

The field survey of noise and vibration was conducted for evaluating the noise and vibration level from the existing Thaketa Power Plant.

2) Survey Point

(a) Property boundary monitoring

Microphone and vibration pick-up sensor were set at western property boundary as shown in Figure 2.2-16, because there was residential area next to Thaketa Power Plant area.

Microphone setting situation

Vibration pickup setting situation

Source: JET

Figure 2.2-16 Noise and Vibration Survey Point (Property Boundary)

(b) Facility monitoring

9 monitoring points were selected to measure noise and vibration from 6 facilities (gas turbine, steam turbine, cooling tower, cooling fun, transformer, and gas engine).

Survey point No.4:Gas Turbine	Survey point No.9:Steam Turbine
Survey point No.10:Cooling Tower	Survey point No.5:Cooling Fun
Survey point No.6:Transformer	Survey point No.11:Gas engine

Source: JET

Figure 2.2-17 Noise and Vibration Survey Point (Power Plant Facilities)

3) Survey Period

Survey was carried out on 18th and19th June, 2014.

4) Survey Method

Noise and vibration measurement was conducted by specific noise and vibration measurement equipment brought from Japan at the property line of Thaketa Power Plant (24 hours) and major facilities generating noise and vibration (10 to 20 minutes at each facility). The noise/vibration measurement was carried out in reference to Japanese Industrial Standard (JIS) C 1509-1/JIS C 1510, respectively. The noise/vibration level with the instantaneous value per 100ms was stored by the noise/vibration level meter. The preliminary data was analyzed and distinguished in accordance with the fluctuant range.

The equipments and survey condition for noise and vibration is shown in Table 2.2-39.

Table 2.2-39 Equipments and Survey condition for Noise and Vibration

Parameters	Equipments	Setting condition
Noise (L_{Aeq}, L_{max}, and L_{min})	RION-NL-22	Frequency character : A Dynamic trait : Fast Sampling interval : 100ms Height of microphone: about 1.2m
Vibration (Monitoring Vibrating with 80% range level (L_{10}))	RION-VM-53A	Measurement component : Vertical Vibration(Z component) Dynamic trait : VIB LEVEL Sampling interval : 100ms

Source: JET

5) Setting of Tentative Target for Noise and Vibration

(a) Tentative Target for Noise and Vibration at Property Boundary

Currently, there is no noise and vibration standard at property boundary of factory in Myanmar as well as south-east Asia. IFC prepare the ambient noise standard for Industrial area. On the other hand, Japan has the criteria for regulation of noise and vibration generated in a particular factory. The tentative target value of noise and vibration at property boundary is set as shown in Table 2.2-40.

Table 2.2-40 Tentative Target Value on Noise and Vibration at Property Boundary

Items	Land use	Time zone	Time	Tentative Target Value
Noise Level	Residential area	Morning	6:00-8:00	50 dB(A)
		Day	8:00-18:00	50 dB(A)
		Evening	18:00-21:00	50 dB(A)
		Night	21:00-6:00	50 dB(A)
Vibration Level	Residential area	Dayt	8:00-19:00	65dB
		Night	19:00-8:00	60 dB

Source: JIS C 1509-1/JIS C 1510

(b) Tentative Target for Noise and Vibration for Facilities

Currently, there is no noise and vibration standard from thermal power plant facilities in Myanmar as well as south-east Asia. As for noise, international organization standards are prepared for workers. IFC recommend the ambient noise level and remark the attention to working condition. WHO define the daily (8hours) equivalent exposure limits. Japan has also established the Noise regulation act which defines regulatory standards for noise emitted from specified factories, and Industrial Safety and Health Act which recommend the working place noise level and adequate conditions. The tentative target value of noise at working condition is set as shown in Table 2.2-41 in consideration of the international standards target.

Table 2.2-41 Tentative Target Value on Noise at Working Condition

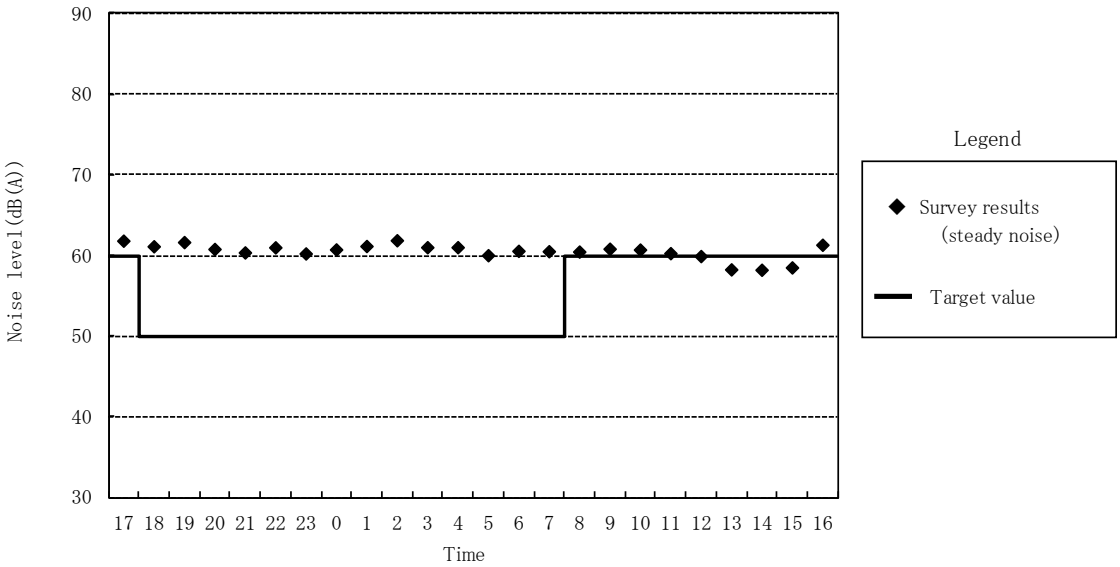
Items	Condition	Time	Tentative Target Value
Noise Level	Working place	8-hours	85dB

Source: JIS C 1509-1/JIS C 1510

6) Result of Noise and Vibration at Property Boundary

(a) Result of Noise and Vibration at Property Boundary

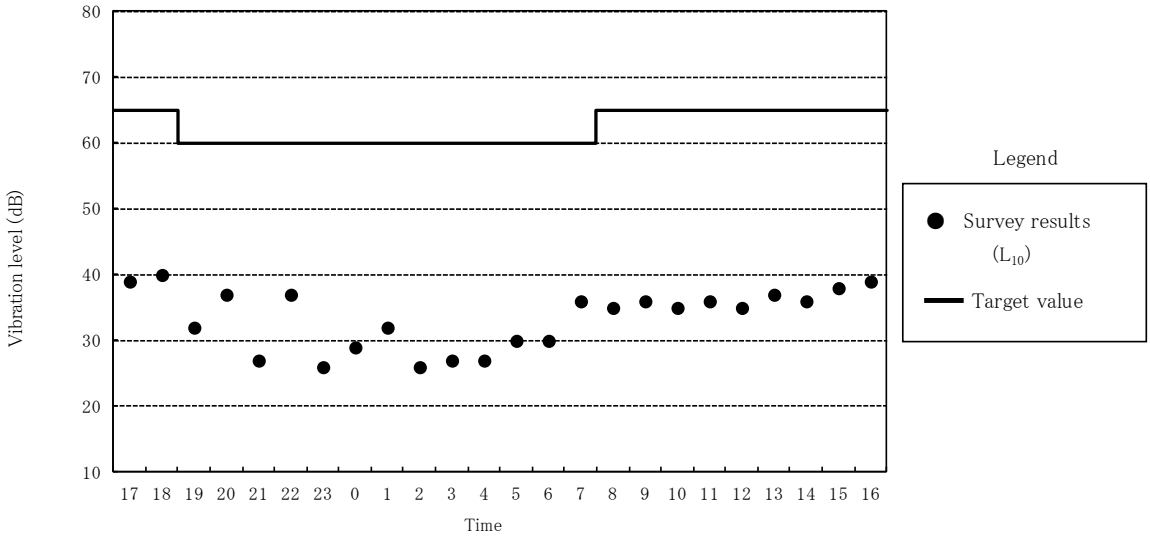
The result of noise at property boundary shows that there is no big change during day and night as shown in Figure 2.2-18. The daily average is 61 dB(A). The result is almost higher than tentative target value, except from 11:00 to 15:00.



Source: JET

Figure 2.2-18 Time-dependent change of Noise (at the boundary line)

The result of vibration at property boundary shows that there is approximately 10dB change during evening time as shown in Figure 2.2-19. The daily average is 33 dB, and the maximum is 40dB. The result is lower than tentative target value.



Source: JET

Figure 2.2-19 Time-dependent change of Vibration (at the boundary line)

(b) Result of Noise and Vibration of Power Plant Facilities

The result of noise and vibration near power plants facilities is as shown in Table 2.2-42.

The maximal noise level is 96dB(A)at west side of the gas turbine (No.4). The result near Gas turbine and cooling fun is higher the tentative target noise level for working place (8hours).

The maximum vibration level is 61dB near the steam turbine (No.9).The result of vibration level near the transformers (No.6, 7 and 8) is nearly equal to ambient vibration level (See Figure 2.2-19)

Table 2.2-42 Noise and Vibration near Power Plants Facilities

Survey Point No.	Facilities (Maker)	Distance from Facility	Result	
			Noise Level dB(A)	Vibration Level dB
3	Gas Turbine - South side	1 m	88	-
4	Gas Turbine -West side	2 m	96	52
5	Cooling Fun (MEIDENSHA)	1 m	88	47
6	Transformer (AREVA)	2 m	70	39
7	Transformer (FUJI Electronic)	1 m	76	41
8	Transformer (Hitachi,)	1 m	72	35
9	Steam Turbine(FUJI Electronic)	1 m	82	61
10	Cooling Tower(Cofimco)	Noise:3 m Vibration:1m	81	56
11	Gas Engine (MAXPOWER)	1 m	82	50

Tentative target noise level for working place : 85dB (8-hours)
Source: JET

2.3 Workshops

2.3.1 1st Mini-workshop

1st mini-workshop was held in 20th June 2014. The outline of 1st mini-workshop is shown in Table 2.3-1.

Table 2.3-1 Outline of 1st Mini-workshop

Date / Time	Venue	Participants
20 June, 2014 / 2:00pm to 4:30pm	Meeting Room, Thaketa Power Plant, Yangon	- Totally 26 persons from PTPD, Thaketa Power Plant & Substation, Ywama Power Plant (Old Plant), Ywama 240MW Power Plant (New Plant), Hlawga Power Plant & Substation, Ahlone Power Plant & Substation -JICA Expert team members (3 expert)

Source: JET

The following points were presented and discussed;

- Scoping results and frameworks of environmental management and monitoring plan for the Urgent Rehabilitation Project
- Key topics on environmental management and monitoring on combined cycle power plants (e.g. emission gas, noise and wastewater)
- Key topics on environmental management and monitoring on substations (e.g. hazardous waste including PCB waste, occupational safety and electric and magnetic field)
- Discussion on obstructive factors against preferable implementation of environmental management and monitoring plan, and required actions and recommendations

Table 2.3-2 shows record of question and answer in 1st mini-workshop.

Table 2.3-2 Record of Question and Answer in 1st Mini-workshop

No.	Question	Answer
1	A participant from Thaketa Power Plant asked how often emission gas monitoring for power plant was conducting/checking in Japan.	JET member answered that it depended on case by case. Generally, annual monitoring is done for power plant. In some facilities, 24hours/day automatic monitoring system is operating for 365 days throughout the whole year. The monitoring equipment is installed in path way to the chimney.
2	A participant from Thaketa Power Plant asked which standard was used for the limitation value for emission gas or generation of noise in our survey and what tentative target value means. In addition, he would like to know that it is in severe impact condition when the survey values are exceeding the limited values.	JET member replied that we referred other international standards including standards in Japan since there is no environmental standard in Myanmar. Thus, they called these values as tentative target value. If the values is just over the target values, it is not in very bad condition. Impact on surrounding area depends on several condition of the climate and it is considered in evaluation of impact. For example. If the survey values is double of target value, it is severe condition to the environment.
3	Thaketa Power Plant manager asked how long it would take for a training course if they want to train their staffs or people for environmental management program (measuring, data analysis, and reporting),	JET member suggested to write their requests in the Questionnaire if they need such training for power plant and substation staffs. JET will inform to MEPE headquarter and then power plants and substations can have such training in future. One week is enough as one training period. First one or two days is theoretical training and next one or two days is field training.
4	A participant from Ahlone Power Plant asked how	JET member answered that in large power plant, control

	automatic 24 hour monitoring system in Japan was controlled.	system from a control room of power is found for automatic monitoring.
5	A participant from Thaketa Power Plant asked that PCB contained in all transformer oil.	JET member replied that some companies used PCB in transformer oil but some did not use PCB for transformer oil. United States and United Kingdom announced the list of companies which use PCB oil. Hence staffs from each power plant/ substation can know whether their transformer contains PCB or not by checking manufacture year and manufacture company of each transformer.
6	A participant from Ahlone Power Plant asked that same type of survey like in Thaketa Power Plant would be carried out in other power plants such as Ywama Power Plant, Ahlone Power Plant.	JET member answered that EMP and EMoP would submit to MEPE headquarter and JICA headquarter. So, recommendations or requests from the participants for conducting environmental baseline survey in other power plants would be include in the EMP and EMoP. Then, MEPE headquarter and JICA would consider those requests.
7	JET member asked to Thaketa Power Plant manager that plant manager level had authority to manage budget for environmental management plan and monitoring plan in power plants. In addition, he asked that current human resource at power plant was possible to conduct same kind of survey or monitoring system if the staffs had been trained.	Thaketa Power Plant manager answered that the plant manager level was not allowed to manage the budget. MEPE headquarter manages/ allocates the budget. He said that it was not sure to answer the second question.
8	A participant from Hlawga power plant asked that in Japan there were any award to power plant/ substation which abide by EMP and EMoP very well.	JET member answered that it depended on case by case. There was not such award to the facilities. But the facilities which share their information to the public on webpage has a greater reliability by the public. In the past, the companies do such activities, local government announced the companies as the environmental friendly companies which do not impact the environment. However, in Myanmar, monitoring activities have to be done under the rules in near future. On the other hand, EMP and EMoP are essential for application of financial supports from international organization such as JICA.
9	A participant from PTPD asked how the concentration of PCB in the oil was checked and it could be done in the field. He would like to know that JET would perform this task or not in the current project.	JET member replied that currently there was no laboratories in Myanmar for analysis of PCB. The rapid check equipment can measure PCB in the oil either less than 50ppm or greater than 50ppm. So, if necessary, the participant can request the MEPE headquarter to have the rapid check equipment.
10	Some participants asked that using oil purification system would accelerate PCB pollution in transformer oil.	JET member answered that it depended on concentration of PCB in the oil. So, he recommend that it was better to record the manufacture year and company and then, to do cross check with the list of companies announced by US and UK before purification to avoid the pollution. It may reduce PCB pollution caused by the usage of oil purification system.

Source: JET

2.3.2 2nd Mini-workshop

2nd mini-workshop was held in 9th July 2014. The outline of 2nd mini-workshop is shown in Table 2.3-3.

Table 2.3-3 Outline of 2nd Mini-workshop

Date / Time	Venue	Participants
9th July, 2014 1:30pm to 3:30pm	Meeting Room, Power System Department, MEPE, Naypyitaw	- Totally 7 persons from Power System Department and Power Transmission Projects Department - JICA Expert Team (JET) members (2 expert)

Source: JET

The following points were presented and discussed;

Topic-l: Interim result of prediction and evaluation of environmental impact by the Phase I Project.

Topic-2: Framework of environmental management and monitoring plan

Discussion on obstructive factors against preferable implementation of environmental management and monitoring plan, providing suggestion on required actions to address the identified obstructive factors.

Table 2.3-4 shows record of question and answer in the final workshop.

Table 2.3-4 Record of Question and Answer in 2nd Mini-workshop

No.	Question	Answer
1	Most of the participants would like to know why other power plants was not included in this project. And why the field study on substations was not conducted.	JET answered that this project background is based on "Urgent rehabilitation project" in which Thaketa Power Plant and other three substations are included. Currently, the impact on substation such as PCB content in transformer oil is considered to be studied. But field study was not done so far.
2	U Myo Min Tun (EE) from PTPD asked how the increase of noise level in power plant can be reduced or prevented.	JET replied that there are many possible ways to reduce noise impact. JET suggested as follows, (i) If someone worked beside the facility which produces high level of noise, the facility should be replaced with new low noise facility which possesses same capacity like previous one. And the noise level of new facility also should be considered at the time of selection of new facilities for the replacement. (ii) One of the another possible ways to reduce noise impact to the individual, is to manage the assignment of working shift to the staffs and engineers who are working near a high noise level facility. It is not good to assign only one person to work for long time shift near such facility. So, it is better to provide short time working shift to the individual by sharing with more than three or four persons. (iii) In Japan, sometimes the noise barrier wall is constructed between workers and facility. This is also one of the ways to prevent high noise level. (iv) In Japan, engineers and staffs in some facilities use anti-noise device such as ear cover to protect themselves against high noise level. Even it is a small device, it can be helpful to reduce noise impact. JET will include these possible ways for prevention of noise level in Environmental Management Plan.
3	U Thein Thura (Dy. CE) from PSD asked that the field noise level measurements at Thaketa power plant (for example, measurements conducted a certain distance from the facility) are conducted by following any rules or regulations.	JET answered that there is no certain rules. The distance for the noise level measurement from each facility is defined as a distance where the maximum noise level of the relative facility is detected. It depends on the height of a noise source from the facility, surrounded area of the facility and body of facility. Then, JET also explained the way how to measure the noise level of a facility.
4	U Kyaw Thu (Dy. CE) from PTPD was curious about the job description for Tokyo Electric Power Company (TEPCO) regarding the Urgent Rehabilitation Project in which EIA is included to conduct for Thaketa Power Plant and three substations. So, he would like to know that current project is a part of Urgent Rehabilitation Project by TEPCO.	JET replied that Environmental experts will conduct EIA during the construction phase after contracting with TEPCO. Based on EMP and EMOP prepared by current project, MEPE can instruct or ask the experts what they should carry out regarding EIA during construction phase. The JICA expert team was hired directly by JICA. The EMP and EMOP reported by this team will contain all phases (before construction, during construction, and during operation). Basically, in construction phase, contractor and subcontractor will conduct EIA including EMP and EMOP. MEPE will prepare TOR for contractor in which the information provided by this project will be helpful (for example, MEPE can ask the contractor to conduct noise level measurement every one or two month based on this

No.	Question	Answer
		study). In addition, after construction phase, these EMP and EMOP will be prepared by MEPE, itself. Thus, JET should propose the feasible actions for MEPE.
5	U Myo Min Tun (EE) from PTPD would like to know what kind of actions should be done by MEPE side after submitting of EMP and EMOP by JET.	JET suggested that for power plants, the NOx gas and discharge waste water temperature should be checked periodically. Moreover, noise level condition should be aware and it should be considered whether serious impacts exist or not. For substation, during the construction phase, the transformers will be checked whether PCB contain or not. If PCB contains in transformer oil, MEPE will be requested to store such transformers and oils safely in the storage facility which will be recommended by JET. Currently, JET collected information about transformers in all three substations and recorded. Then, JET will approximately determine whether the transformers contain PCB or not. This type of action should be conducted and continued throughout the operation phase to report to JICA.
6	U Aung Thura Win (SE) from PTPD would like to suggest that the information of safety clearance (e.g., between power transformer and operation staff) shall be included in the prepared EMP and EMoP by the current project.	JET agreed to describe safety condition clearly in EMP and EMoP which may note the referred guideline as well.
7	JET raised a question to MEPE officers that there are any plan to secure some budget for environmental management activities after "Urgent Rehabilitation Project". Any specific step are necessary for JET to explain to whether finical section of MEPE or M.D of MEPE about the budget and what kind of action by JET need to do.	U Aung Thura Win (SE) from PTPD replied that currently there is a budget for the maintenance of substations in which environmental safety partially is included. . However, there is not budget for environmental management of substation so far. U Myo Min Tun (EE) from PTPD also suggested if JET should suggest the approximate budget amount in EMP and EMoP for the implementation of environmental activities, it would be better. At the moment, there is some amount of budget for construction phase of Urgent rehabilitation project. Also, in fact, M.D is a main responsible person who manages the budget of MEPE. It is important that M.D realizes well why the budget is required for Environmental Impact Assessment/Monitoring during operation phase after implementation of the Urgent Rehabilitation Project.
8	U Aung Thura Win (SE) from PTPD informed that there is no laboratory in MEPE even if it is required to conduct some environmental studies/research analysis (e.g. measurement of PCB content)	JET answered that JET is planning to propose simple kit tester for measuring PCB concentration not exactly but whether the concentration is below or above of the limited amount (500ppb of PCB) can be checked if some transformers in substation has high possibility of PCB content.

Source: JET

2.3.3 Final Workshop

The final workshop was held in 7th August 2014. The outline of the final workshop is shown in Table 2.3-5.

Table 2.3-5 Outline of Final Workshop

Date / Time	Venue	Participants
7th August, 2014 2:00pm to 4:00pm	Meeting Room, MEPE, Naypyitaw	- Totally 26 persons from Thermal Power Department, Power System Department, Power Transmission Project Department, Thaketa Power Plant, Ywama Power Plant, Hlawga Substation, and Ahlone Substation under MEPE, Department of Electric Power (DEP), and Enviromental Conservation Department, MOECF - JICA Expert Team (JET) members (2 expert)

Source: JET

The following points were presented and discussed;

(1) Introduction on the draft EIA of the "Urgent Rehabilitation and Upgrade Project Phase I"
(2) Introduction on the draft EMP and EMoP of the "Urgent Rehabilitation and Upgrade Project Phase I"
(3) Discussion on key factors to be examined for preferable implementation of the EMP and EMoP

Table 2.3-6 shows record of question and answer in the final workshop.

Table 2.3-6 Record of Question and Answer in 2nd Mini-workshop

No.	Comment and Question from participant	Comment and answer from JET
1.	U Kyaw Swar Soe Naing (Senior Engineer from TPD) asked water quality survey was conducted whether only near Thaketa Power Plant or not. If it is in the creek, it is at the river side or not.	- JET explained that water quality survey was done totally seven measured points including inside Thaketa Power Plant and in Nga Moe Yeik Creek. Water temperature and other parameters of the collected water samples were measured. Water temperature near boiler discharge was high and it decreased gradually in a distance from the plant. In the creek, water sample measurement was done in the middle of the river. The survey was performed in both dry and raining season. So, JET suggests that water quality survey should be done two times per year during construction and operation phases.
2.	U Kyaw Swar Soe Naing (Senior Engineer from TPD) also asked why the reduction of Green House Gas (GHG) emission appears after rehabiliation project in the presentation of JET.	- JET answered that this is just examination. In the rehabilitation project, there are plans to improve new equipment/machine to control amount of air to Gas Turbine so that amount of combustion can be controlled and amount of gas usage can be saved. If the gas usage is controlled, the amount of emission gas which contains CO_2 would be reduced. Based on Japanese Company's study, JET expected that combustion efficiency can be improved 20% in the case of promoting equipment's efficiency.
3.	U Aung Myo Win (Executive Engineer from DEP) said that PCB is one of their concerns. Because of the lack of equipment to measure the content of PCB in transformer oil, it is difficult to say current transformer oil has PCB or not. Besides, most of transformer suppliers described no PCB in transformer and transformer oil while DEP was purchasing transformers. He thought that it may not be effective by only checking the name of product companies for transformer before 1980. In addition, he would like to know JET's comment on the control or disposal of old transformers and oil. What kind of plan would be proposed by JET.	- JET answered that one of the possible ways is that ,in future, if Ministry of Environmental Conservation and Forestry has any idea or plan to promote or develop Laboratories and oil samples would be taken and tested in Laboratories. Another way is that, for example, in this project, JET plans to propose purchasing of test kits for the easy measurement of PCB in site. That kit cannot measure PCB concentration in oil exactly, but it can measure that PCB in transformer oil has a potential of risk or not. According to International Guidelines, 500ppm of PCB is a boundary concentration of PCB for the risk. If PCB concentration in transformer oil is over 500ppm, it is recorded that the oil has high risk of PCB. That test kit can easily describe whether transformer oil has a risk of PCB or not. Regarding the treatment of PCB, it is complicated. In Myanmar , it is difficult to develop such treatment plant in each regions because even in Japan, there are just five facilities for the treatment of PCB. Therefore, under this circumstance, it is better to keep in the storage facilities in which identify clearly the dangerous of PCB. U Aung Myo Win commented that it will not be effective, but, in fact, according to international guideline, the companies from developed countries did not use PCB in transformer oil exactly after 2000. If necessary, transformer oil can be checked by test kit.
	Daw Kyi Kyi Myint alos recommend such kind of test kit which would be easily	- JET replied that under this project, if PCB risk was found for the target facilities (Thaketa, Ywama, Ahlone, Hlawga), JET can

No.	Comment and Question from participant	Comment and answer from JET
	measured PCB content in oil. Also, She informed that although they know that storage facilities are one of possible way to dispose PCB transformer oil, they are not constructed yet. One of the reasons is that specific materials are required to build such storage. In this project, she did not know JICA will provide such facilities or not.	propose to JICA for the necessarily of the construction of such facilities.
4.	Daw Kyi Kyi Myint (Director from Pollution Control Division, ECD) said that ambient air quality survey was conducted only one week in each season. In 2012, YCDC performed ambient air quality measurements and found that NOx might be one of the potential pollutants. So, she recommends that it would be better if the survey period is more than one week in each season.	- JET member answered that there are two reasons for conducting measurements for one week. One reason is that current project period is very short and field surveys were selected to carried out at two seasons (dry (May) and raining (July) seasons) for one week in each during project period. Another reason regarding one week measurement is that even in Japan, for Environmental Impact Assessment (EIA), if the project site has no regular monitoring system/equipment which is controlled by Japan Ministry of Environment, according to the guideline of EIA procedure, one week of the measurement in four seasons per year is necessary to be conducted. Based on these reasons, period of the measurement was selected as one week. Of course, the surveys can be done in every month of a year. In future, ECD will set up a guideline for Environmental Impact Assessment. Here, JET would like to explain that it will take cost and be time consuming to implement Environmental Impact Assessment if many samples are collected for analysis in the measurements. Therefore, both aspects that necessarily of a particular survey and feasibility of EIA should be considered while setting up the guidelines. Currently, many companies including both high and middle class are trying to perform EIA works in Myanmar. Thus, JET expected that the guidelines should be fit to many stakeholders.
5.	U Aung Aung Lay (Assistance Director from Resource Conservation and EIA Division, ECD) asked who will be responsible for the budget of preparation of EIA, EMP and EMoP of this rehabilitation project.	- JET member replied that basically the project component is responsible for the budget of preparation of EIA, EMP and EMoP of a project. Regarding the operation phase, Ministry of Electric Power (or) MEPE is expected to conduct it. Anyway, project component need to allocate budget for environmental management and monitoring plans. Actually, there is no particular request in EIA (Draft) notification on how often EMP and EMoP have to be submitted to ECD during operation phase. JET member also suggests ECD that the demand of the budget required for EMP and EMoP mainly rely on national rules and regulations. For example, if country regulation likes EIA procedure is very strict, many organizations would not perform monitoring works due to budget issue or something. So, it is better to take into account on budget issue while setting up a rule or regulation for public and organizations. JET member also suggests that period of submitting EMoP of a project, for instance, should be one time per year, at least, by considering the actual conditions in other developing countries where many companies and organization could not follow the regulation well because of difficulties of allocation budget for Environmental Monitoring Plan.

Source: JET

2.4 Public Consultation Meeting

In consideration of the requirement of the Draft EIA procedure in Myanmar as of August 2014, MEPE held a public consultation meeting. During the explanation of the Project to ECD in May 2014, ECD did not advice MEPE to hold the stakeholder / public consultation meeting at scoping stage. Therefore, MEPE held the public consultation meeting at draft EIA stage in October 2014. The outline of the meeting is shown in Table 2.4-1. For the public consultation meeting, MEPE sent invitation to the concerned stakeholders, organized and facilitated the meeting. The program of the meeting is shown in Table 2.4-2.

Table 2.4-1 Draft Public Consultation Meeting

Timing and Date	Venue	Participants	Purpose
Draft EIA Stage (21st October)	Conference room in Thaketa Power Plant (Yangon)	➢ ECD in Yangon ➢ General Administration Department, Thaketa Township ➢ General Administration Department, No.9 Ward of Thaketa Township ➢ Residents of No.9 Ward of Thaketa Township ➢ DOH of Thatketa Township ➢ YESB of East Dagon Region ➢ Staff housing committee of Thaketa Power Plant ➢ MEPE ➢ EIA study team Total: 37 persons	The objective of the stakeholder meeting is to disseminate evaluation result of environmental and social impacts, and planned environmental and social management plan in accordance with the rule stipulated by the draft Notification of EIA Procedure that will be enforced near future by MOECF.

Source: JET

Table 2.4-2 Program of the Consultation Meeting

Time	Contents	Persons in Charge
13:00 – 13:30	Registration of participants	-
13:30 – 13:35	Opening remark	Mr. Khin Mg Myint, Deputy Chief Engineer, TPD
13:35 – 13:45	- Introduction of rehabilitation work of Thaketa Power Plant	Mr. Than Soe, Manager of Thaketa Power Plant
13:45 – 14:20	- Introduction of evaluation result of environmental and social impacts, and planned environmental and social management plan for rehabilitation of Thaketa Power Plant	Ms. Phyu Phyu Shein, Resource and Environment Myanmar, local consultant
14:20 – 14:30	Coffee break	-
14:30 – 15:20	Question and discussion	All participants
15:20 – 15:30	Closing remark	Mr. Than Soe, Manager of Thaketa Power Plant

Source: JET

Through the consultation meeting, the following discussion was made by participants.

(1) Question: Does the environmental management plan have any particular countermeasures to address noise impacts? (Mr. Khin Mg Myint, TPD)

Answer: Against the noise impact to engineers and staffs in Thaketa Power Plant, the environmental management plan (EMP) plans to provide noise protection

equipment. Regarding the noise impacts around the Thaketa Power Plant, serious impacts will not be predicted. However, to confirm actual noise level, noise monitoring will be planned during construction and operation phase as explained, and conduct required mitigation measures based on the monitoring results, as necessary.

(2) Question: Currently, MEPE and Thaketa Power Plant does not have water quality analytical laboratory. How the water quality analysis will be carried out? (Ms. Myint Myint San, Thaketa Power Plant)

Answer: During construction phase, contractor will conduct water quality analysis with local private laboratory. In operation phase, simple analysis like measurement of water temperature will be conducted by Thaketa Power Plant, and other parameters will be measured by external private laboratory as sub-contract work by MEPE.

(3) Question: Is there any serious impact on global warming or climate change by thermal discharge from Thaketa Power Plant by operation of combined cycle steam turbine (Mr. Khin Mg Te, ECD)?

Answer: The expected main impact by thermal discharge is possibility of changing water temperature of surrounding water bodies by wastewater disposal from steam turbine and cooling tower. Those may be affected to river water ecosystem, but will give impact on global warming issue. By our prediction, impact by discharge of wastewater from steam turbine and cooling tower will not be significant.

(4) Question: Regarding environmental impacts caused by activities in surrounding area, how can you distinguish from the impacts by Thaketa Power Plant?

Answer: By implementation of environmental monitoring at inside and border of Thaketa Power Plant and regional area, we will distinguish the environmental impacts by Thaketa Power Plant itself, and activities in surrounding area.

(5) Question: As you explained in the presentation, it will take 1.5 years for renovation of Thaketa Power Plant and environmental conservation works. How long can we maintain this improvement of Thaketa Power Plant and environment after renovation? For example, within next 5 to 10 years, we may not need any renovation work, is it? (Mr. Wai Yan Tun Kyaw, Thaketa Power Plant)

Answer: In the renovation project, we consider and prepare both environmental management and monitoring plans. Those plans will support to achieve the productive operation of Thaketa Power Plant and to conserve surrounding environment effectively. But it is difficult to predict the warranty period since there are many factors influencing on the operation of a power plant and the environment.

CHAPTER 3 PREPARATION OF ENVIRONMENTAL MANAGEMENT PLAN AND MONITORING PLAN

3.1 Prediction and Evaluation of Environmental and Social Impacts

JET predicted negative impact due to the implementation of each project such as rehabilitation of power plant, substation and electric transmission. For assessment of negative impacts such as exhaust gas, hot waste water, noise and waste material in the substations, existing baseline data and the specification of facilities were collected and confirmed.

According to the interview with ECD in MOECAF, National Environmental Quality Standard (EQS) is under preparing currently. Since there is no national environmental standard in Myanmar, JET set the tentative target value for this project in reference to i) guidelines by international Agencies (e.g. IFC EHS Guidelines), ii) Other south-east Asian countries' standard, and iii) Japanese standards.

In case that it was difficult to conduct the quantitative evaluation on account of the lack of realistic specific content, parameter and/or conditions, the qualitative assessment was adopted in consideration with mitigation measurement. The result of the predicted impacts is shown in Table 3.1-1 for rehabilitation of Thaketa Power Plant, and Table 3.1-2 for rehabilitation of substations.

Table 3.1-1 Summary of Environmental and Social Impacts Evaluation Results for Rehabilitation of Thaketa Power Plant

Category	Scoping Item	Evaluation at Scoping		Evaluation by EIA		Reasons for Evaluation
		BC/ DC	OS	BC/ DC	OS	
Pollution	Air Quality	B-	B+	B-	B+	DC: Air pollution may arise due to emission gas from construction vehicles, and dust from the construction work. OS: Due to rehabilitation of power plant facilities, quality of emission gas from the gas turbine is expected to be improved.
	Water Quality	D	B-	D	D	DC: No large scale earthworks is planned during the construction phase. OS: The amount of discharged wastewater is quite small compared with the amount of water of the receiving body. Therefore, impact of thermal discharge from Thaketa Power Plant can be neglected. After operating phase, it is recommended to implement water quality monitoring to confirm appropriateness of this prediction.
	Solid Waste	B-	C	B-	D	DC: Construction waste will be generated by the replacement of the existing facilities. OS: No new hazardous industrial solid waste will be generated by the Project, and existing management system can be applied.
	Noise/ Vibration	B-	B-	B-	B-	DC: Noise and vibration due to construction work are anticipated. OS: Due to operation of power plant facilities, noise impact will arise.
	Subsidence	D	C	D	D	DC: There is no plan to conduct large scale

Category	Scoping Item	Evaluation at Scoping		Evaluation by EIA		Reasons for Evaluation
		BC/ DC	OS	BC/ DC	OS	
						groundwater usage during construction work. OS: Currently, no subsidence information was obtained by the survey. After the Project, the magnitude of water usage will not be changed significantly, and it is not planned to increase the rate of groundwater usage. Therefore, it is considered that subsidence will not occur.
Natural Environ-ment	Hydrology	D	C	D	D	DC: There is no plan to conduct construction work which may affect regional hydrology. OS: After the Project, the magnitude of water usage will not be changed significantly, and it is not planned to change the rate of water usage between groundwater and supplied water. Therefore, the impact on hydrology is not anticipated.
Social Environment	Local Economy such as Employment and Livelihood	D	B+	D	B+	DC: Construction work for the Project will be carried out within the existing facilities, and scale of construction work is not so large. Therefore, significant impacts on local economy will not be anticipated. OS: Through the Project, the amount of electric power generation by the Thaketa Power Plant will increase to 1.5 times of the amount before the Project at the end of the transmission line. Improvement of power generation and transmission of electricity will contribute to accelerate the economic condition of Yangon Region, and it is expected to provide positive impacts on local economy and livelihood.
	Water Use	D	C	D	D	DC: There is no plan to conduct construction work that will affect regional water use. OS: After the Project, the magnitude of water usage will not be changed significantly, and it is not planned to change the rate of water usage between groundwater and supplied water. Therefore, the impact on hydrology is not anticipated.
	Existing Infrastructures and Services	D	B+	D	B+	DC: Construction work for the Project will be carried out within the existing facilities, and the scale of construction work is not so large. Therefore, significant impacts on local economy will not be anticipated. OS: Through the Project, the amount of electric power generation by the Thaketa Power Plant will increase to 1.5 times of the amount before the Project at the end of the transmission line. Improvement of power generation and transmission of electricity will contribute to providing positive impacts on the existing infrastructures and services..
Health and Safety	Occupational Health and Safety	B-	B-	B-	B-	DC: It is necessary to consider operational health and safety during construction such as accidents, salinity, and use of heavy equipment. OS: Operation of rehabilitated facilities will need some new knowledge, so occupational health and safety system has to be reviewed to confirm necessity of revising.
	Community Health and Safety	B-	D	B-	D	DC: It is necessary to avoid impact of traffic accidents due to transportation during construction work. OS: There is no large residential area around the Thaketa Power Plant, and the operation of the power plant is not significantly different before and after the Project. Therefore, change on

Category	Scoping Item	Evaluation at Scoping		Evaluation by EIA		Reasons for Evaluation
		BC/ DC	OS	BC/ DC	OS	
						community safety before and after the rehabilitation is not anticipated.
	Risks of Infectious Disease	C	D	B-	D	DC: Risks of infectious diseases cannot be neglected. OS: During operation phase, there is no factor that may increase the risk of infectious diseases from the Project.
	Accident	B-	B-	B-	B-	DC: It is necessary to consider the possibility of accidents occurring during construction work. OS: Careful attention is needed because there would be some dangerous works for the operation of gas and steam turbines
Emergency Risk	Emergency Risk of Fire	C	D	B-	D	DC: It is necessary to prepare emergency plan to reduce the risk of fire during construction phase. OS: The renovation of the Thaketa Power Plant will not have factor that may increase the risk of fire.
Climate Change	Greenhouse Gas (GHG) Emission	D	C	D	B+	DC: There is no significant impact on climate change due to the construction work. OS: Reduction of GHG emission is estimated by the Project.

Evaluation: A-: Significant negative impact A+: Significant positive impact
B-: Some negative impact B+: Some positive impact
C: Impacts are not clear; need further investigation
D: No impact or impacts are negligible; no further study required
Evaluation Stage: BC: Before Construction DC: During Construction OS: Operation Stage
Source: JET

Table 3.1-2 Summary of Environmental and Social Impacts Evaluation Results for Rehabilitation of Substations

Category	Scoping Item	Evaluation at Scoping		Evaluation by EIA		Reasons for Evaluation
		BC/ DC	OS	BC/ DC	OS	
Pollution	Air Quality	B-	D	B-	D	DC: Air pollution may arise due to emission gas from construction vehicles, and dust from construction work. OS: During the operation phase of the improved substation there is no activity that will generate air pollution.
	Water Quality	C	D	B-	D	DC: Leakage of transformer oil during construction work should be controlled. Especially, transformers that may have PCB in their transformer oil were found. Therefore, water quality pollution during construction work has to be controlled carefully. OS: During the operation phase of the improved substation there is no activity that will generate water pollution.
	Solid Waste	B-	B-	B-	B-	DC: Construction waste will be generated by the replacement of the existing facilities. If transformer oil containing PCB is found, it should be handled carefully. OS: The transformers that may have PCB in their transformer oil were found. Therefore, PCB waste management plan has to be prepared.
	Noise/Vibration	B-	B-	B-	B-	DC: Noise and vibration due to construction work are anticipated. OS: Due to the operation of substation facilities, noise impact may arise.
	Electric and Magnetic Field	D	C	D	D	In the beginning of the operation phase, it is recommended to check the electric and magnetic field conditions.
Social Environ-	Local Economy	D	B+	D	B+	DC: Construction work for the Project will be carried out within the existing facilities, and the scale of

Category	Scoping Item	Evaluation at Scoping		Evaluation by EIA		Reasons for Evaluation
		BC/ DC	OS	BC/ DC	OS	
ment	such as Employment and Livelihood					construction work is not so large. Therefore, significant impacts on local economy will not be anticipated. OS: Through the Project, the transmitted electric power by the target substations will increase to 3 times of the amount before the Project. Improvement of power generation and transmission of electricity will contribute to accelerate the economic condition of Yangon Region, and it is expected to provide positive impacts on local economy and livelihood.
Social Environ-ment	Existing Infrastructures and Services	D	B+	D	B+	DC: Construction work for the Project will be carried out within the existing facilities, and the scale of the construction work is not so large. Therefore, significant impacts on local economy will not be anticipated. OS: Through the Project, the transmitted electric power by the target substations will increase to 3 times of the amount before the Project. Improvement of power generation and transmission of electricity will contribute to providing positive impacts on the existing infrastructures and services.
Health and Safety	Occupational Health and Safety	B-	B-	B-	B-	DC: It is necessary to consider operational health and safety during construction such as accidents, salinity, and use of heavy equipment. OS: Operation of rehabilitated facilities will need some new knowledge, so occupational health and safety system has to be reviewed to confirm the necessity of revising.
	Community Health and Safety	B-	C	B-	D	DC: It is necessary to avoid impact of traffic accidents due to transportation during construction work. OS: There is no large residential area around the target substations, and the operation of the substation is not significantly different before and after the Project. Therefore, any change in community safety before and after the rehabilitation is not anticipated.
	Risks of Infectious Disease such as AIDS/HIV	C	D	B-	D	DC: Risks of infectious diseases such as AIDS/HIV should be checked before the construction phase. OS: During operation phase, there is no factor that may increase the risk of infectious diseases.
	Accident	B-	C	B-	B-	DC: It is necessary to consider the possibility of accidents occurring during construction work. OS: Careful attention is needed because there would be some dangerous works especially when working near high voltage transformers.
Emergency Risk	Emergency Risk of Fire	C	D	B-	D	DC: It is necessary to prepare emergency plan to reduce the risk of fire during construction phase. OS: The renovation of the target substations will not have factors that will increase the risk of fire before, during, and after the Project.
Climate Change	Greenhouse Gas (GHG) Emission	D	C	D	B-	DC: Scale of construction work is not so large. Therefore, no significant impact on climate change is anticipated by the construction work. OS: Sulfur hexafluoride (SF6) used for gas-insulated switchgear (GIS) is a kind of greenhouse gas. For substation officers, handling of SF6 is a new experience, Therefore, it should be controlled carefully to avoid impact on global warming.

Evaluation: A-: Significant negative impact A+: Significant positive impact
B-: Some negative impact B+: Some positive impact
C: Impacts are not clear; need further investigation
D: No impact or impacts are negligible; no further study required
Evaluation Stage: BC: Before Construction DC: During Construction OS: Operation Stage
Source: JET

3.2 Preparation of Environmental Management Plan and Environmental Monitoring Plan

JET prepared EMP and EMoP, based on the results of environmental and social impact evaluation results, and resources, facilities, organizational structure of MEPE.

3.2.1 EMP and EMoP for Thateka Power Plant

(1) EMP for Thaketa Power Plant

The proposed EMPs for the rehabilitation of the Thaketa Power Plant are shown from Table 3.2-1 to 3.2-3.

Table 3.2-1 EMP for the Rehabilitation of the Thaketa Power Plant during Pre-construction Phase

Category	Scoping Item	Impact Evaluation	Environmental Management Activities to be Taken	Actor	Supervisor	Duration of Implementation
Pollution	Air Quality	Air pollution may arise due to emission gas from construction vehicles and dust from construction work.	➢ Specification will be designed on rehabilitated equipment considering the tentative target set by this report. ➢ Environmental management plans and monitoring plans have to be planned by candidate contractors, and the plans have to be reviewed and the appropriate plan has to be identified during the tender evaluation process.	Contractor	PMU Deputy Project Directors	Design and tender phase
	Solid Waste	Construction waste will be generated by replacing the existing facilities.				
	Noise/ Vibration	Noise and vibration due to construction work are anticipated.				
Health and Safety	Occupational Health and Safety	It is necessary to consider operational health and safety during construction such as accidents, salinity, and use of heavy equipment.				
	Community Health and Safety	It is necessary to avoid impact of traffic accidents due to transportation during construction work.				
	Risks of Infectious Disease	Risks of infectious diseases cannot be neglected.				
	Accident	It is necessary to consider the possibility of accidents occurring during construction work.				
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare emergency plan to reduce the risk of fire during construction phase.	➢ Emergency response plan on fire cases will be prepared, and the plans have to be reviewed and the appropriate plan has to be identified during the tender evaluation process.	Contractor	PMU Deputy Project Directors	Design and tender phase

Source: JET

Table 3.2-2 EMP for the Rehabilitation of the Thaketa Power Plant during Construction Phase

Category	Scoping Item	Impact Evaluation	Environmental Management Activities to be Taken	Actor	Supervisor	Duration of Implementation
Pollution	Air Quality	Air pollution may arise due to emission gas from construction vehicles and dust from construction work.	➢ Measures to avoid dust generation will be taken. ➢ Construction vehicles will be operated efficiently to minimize amount of discharged air pollutants. ➢ Transportation of construction equipment will be implemented efficiently to minimize amount of discharged air pollutants.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
	Solid Waste	Construction waste will be generated by replacing the existing facilities.	➢ Generated construction waste will be handled in cooperation with YCDC.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
	Noise/ Vibration	Noise and vibration due to construction work are anticipated.	➢ Construction work will be carried out only during daytime. ➢ Construction vehicles will be operated efficiently to minimize generated noise level. ➢ Transportation of construction equipment will be implemented efficiently to minimize generated noise level.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
Health and Safety	Occupational Health and Safety	It is necessary to consider operational health and safety during construction such as accidents, salinity, and use of heavy equipment.	➢ The planned construction workers' health and safety plan will be implemented. ➢ The planned training program will be conducted to avoid accidents during construction phase. ➢ The planned construction workers' health and safety plan will be reviewed and modified as necessary at the	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)

Category	Scoping Item	Impact Evaluation	Environmental Management Activities to be Taken	Actor	Supervisor	Duration of Implementation
			middle of construction phase.			
	Community Health and Safety	It is necessary to avoid impact of traffic accidents due to transportation during construction work.	➢ The planned community health and safety program will be conducted. ➢ Complaints on construction work from local residents will be collected and required actions will be taken, in cooperation with local township and ward administrations.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
	Risks of Infectious Disease	Risks of infectious diseases cannot be neglected.	➢ The planned training program will be conducted to reduce risks of infectious diseases in the beginning of the construction phase.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
	Accident	It is necessary to consider the possibility of accidents occurring during construction work.	➢ The planned accident avoidance plan will be implemented. ➢ The planned training program will be conducted to avoid accidents during the construction phase. ➢ The planned accident avoidance plan will be reviewed and modified as necessary in the middle of the construction phase.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare emergency plan to reduce the risk of fire during the construction phase.	➢ The simulator trainings will be conducted on the prepared emergency response plan in the beginning and middle of the construction phase. ➢ The planned emergency response plan will be reviewed and modified as necessary in the middle of the construction phase.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)

Source: JET

Table 3.2-3 EMP for the Rehabilitation of the Thaketa Power Plant during Operation Phase

Category	Scoping Item	Impact Evaluation	Environmental Management Activities to be Taken	Actor	Supervisor	Duration of Implementation
Pollution	Air Quality	Due to rehabilitation of power plant facilities, the quality of emission gas from the gas turbine is expected to be improved.	➢ Gas turbine system will be operated properly, and regular maintenance shall be provided.	Manager of Thaketa Power Plant	Chief Engineer of TPD	During operation of Thaketa Power Plant
	Water Quality	Impact of wastewater discharge from the Thaketa Power Plant should be checked.	➢ Amount of wastewater discharged from each process will be determined. ➢ Cooling water system will be operated appropriately.	Manager of Thaketa Power Plant	Chief Engineer of TPD	During operation of Thaketa Power Plant
	Noise/ Vibration	Due to the operation of power plant facilities, noise impact will arise.	➢ The facilities for power generation will be operated appropriately and provided with proper maintenance.	Manager of Thaketa Power Plant	Chief Engineer of TPD	During operation of Thaketa Power Plant
Health and Safety	Occupational Health and Safety	Operation of rehabilitated facilities will need some new knowledge, so occupational health and safety system has to be reviewed to confirm the necessity of revising.	➢ The planned occupational health and safety plan will be implemented. ➢ The planned training program will be conducted to avoid accidents during the construction phase. ➢ The planned occupational health and safety plan will be reviewed and modified as necessary every year.	Manager of Thaketa Power Plant	Chief Engineer of TPD	During operation of Thaketa Power Plant
	Accident	Careful attention is needed because there would be some dangerous works for the operation of gas and steam turbines	➢ The planned accident avoidance plan will be implemented. ➢ The planned training program will be conducted to avoid accidents during the construction phase. ➢ The planned accident avoidance plan will be reviewed and modified as necessary every year.	Manager of Thaketa Power Plant	Chief Engineer of TPD	During operation of Thaketa Power Plant

Source: JET

(2) EMoP for Thaketa Power Plant

The proposed EMoPs for the rehabilitation of the Thaketa Power Plant are shown from Table 3.2-4 to 3.2-5.

Table 3.2-4 EMoP for the Rehabilitation of the Thaketa Power Plant during Construction Phase

Category	Scoping Item	Impact Evaluation	Items to be Monitored	Frequency of Monitoring	Actor	Supervisor	Duration of Monitoring
Pollution	Air Quality	- Air pollution may arise due to emission gas from construction vehicles and dust from construction work.	Condition of construction work and air quality management	Every week during construction work	Contractor	PMU Deputy Project Directors and Project Managers	During construction work (1.5 year) Reporting to JICA, has to be carried out quarterly. Reporting to MOECF, has to be carried out every year after enforcing the EIA procedure notification.
			- SO_2 - NO_2 - PM10 - PM2.5	Every 6 month			
			NO_2 in emission gas	1 time			
	Water Quality	No large-scale earthwork is planned during the construction phase. To confirm that the construction work will not affect water quality, monitoring activities will be conducted.	Condition of construction work and water quality management	Every week during construction work			
			- pH - Turbidity	As necessary			
			- Water temperature of wastewater from steam turbine and cooling tower	Every month			
	Solid Waste	Construction waste will be generated by the replacement of the existing facilities.	Condition of solid waste management	Every month			
	Noise/ Vibration	Noise and vibration due to construction work are anticipated.	Condition of construction work	Every week during construction work			
			- Noise level at the property border of the Thaketa Power Plant	As necessary			
Health and Safety	Occupational Health and Safety	It is necessary to consider operational health and safety during construction such as accidents, salinity, and use of heavy equipment.	Condition of construction workers' health and safety	Every week during construction work			
			Training record	Every training implemented			
	Community Health and Safety	It is necessary to avoid impact of traffic accidents due to transportation during construction work.	Existence of complaints on construction work from local residents	Every month			
	Risks of Infectious Disease	Risks of infectious diseases cannot be neglected.	Existence of patients with infectious disease	Every month			
			Training record	Every training implemented			
	Accident	It is necessary to consider the possibility of accidents occurring during construction work.	Condition of equipment to be prepared based on the accident	Every month			

Category	Scoping Item	Impact Evaluation	Items to be Monitored	Frequency of Monitoring	Actor	Supervisor	Duration of Monitoring
			avoidance plan				
			Record of accident	Every accident			
			Training record	Every training implemented			
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare emergency plan to reduce the risk of fire during the construction phase.	Condition of equipment to be prepared based on the emergency response plan	Every month			
			Record of emergency case	Every emergency case			
			Training record	Every training implemented			

Source: JET

Table 3.2-5 EMoP for the Rehabilitation of the Thaketa Power Plant during Operation Phase

Category	Scoping Item	Reasons for Evaluation	Items to be Monitored	Frequency of Monitoring	Actor	Supervisor	Duration of Monitoring
Pollution	Air Quality	Due to rehabilitation of power plant facilities, the quality of emission gas from gas turbine is expected to be improved.	Operation condition of gas turbine	Every month	Engineers of Thaketa Power Plant	TPD Chief Engineer and Thaketa Power Plant Manager	Reporting twice in a year during initial 2 years to JICA (For MOECF, once a year during operation period after enforcing EIA notification procedure)
			NO_2 in emission gas	Every year (as necessary depending on complaints from local residence and request of JICA)			
	Water Quality	Impact of wastewater discharge from the Thaketa Power Plant should be checked.	- Water temperature - Amount of wastewater discharged	Every month (during initial 2 years, as necessary based on request of JICA)	Engineers of Thaketa Power Plant	TPD Chief Engineer and Thaketa Power Plant Manager	
			pH, EC, turbidity, SS, oil and grease, Cu, Fe, Zn	Once a year (during initial 2 years, as necessary based on request of JICA)			
	Noise/ Vibration	Due to operation of power plant facilities, noise impact will arise.	Operation and maintenance condition of equipment	Every month	Engineers of Thaketa Power Plant	TPD Chief Engineer and Thaketa Power Plant Manager	
			Noise level at the property border of Thaketa Power Plant	Once a year (as necessary depending on complaints from local residence and request of JICA)			
Social Environmen	Local Economy	Through the Project, the amount of electric power	Distribution of electric power	End of initial 2 years	Engineers of Thaketa	TPD Chief Engineer	

Category	Scoping Item	Reasons for Evaluation	Items to be Monitored	Frequency of Monitoring	Actor	Supervisor	Duration of Monitoring
t	such as Employment and Livelihood	generation by the Thaketa Power Plant will increase to 1.5 times of the amount before the Project at the end of the transmission line. Improvement of power generation and transmission of electricity will contribute to accelerate the economic condition of Yangon Region, and it is expected to provide positive impacts on local economy and livelihood.			Power Plant	and Thaketa Power Plant Manager	
	Existing Infrastructures and Services	Through the Project, the amount of electric power generation by the Thaketa Power Plant will increase to 1.5 times of the amount before the Project at the end of the transmission line. Improvement of power generation and transmission of electricity will contribute to accelerate the economic condition of Yangon Region, and it is expected to provide positive impacts on local economy and livelihood.	Distribution of electric power	At the end of initial 2 years	Engineers of Thaketa Power Plant	TPD Chief Engineer and Thaketa Power Plant Manager	
Health and Safety	Occupational Health and Safety	Operation of rehabilitated facilities will need some new knowledge, so occupational health and safety system has to be reviewed to confirm the necessity of revising.	Condition of construction workers' health and safety	Every month	Engineers of Thaketa Power Plant	TPD Chief Engineer and Thaketa Power Plant Manager	
			Training record	Every training implemented			
	Accident	Careful attention is needed because there would be some dangerous work in the operation of gas and steam turbines	Condition of equipment to be prepared based on the accident avoidance plan	Every month	Engineers of Thaketa Power Plant	TPD Chief Engineer and Thaketa Power Plant Manager	
			Record of accident	Every accident			
			Training record	Every training implemented			
Climate Change	Greenhouse gas (GHG) emission	Reduction of GHG emission is estimated by the Project.	Expected CO_2 reduction amount	At the end of initial 2 years	Engineers of Thaketa Power Plant	TPD Chief Engineer and Thaketa Power Plant Manager	

Source: JET

3.2.2 EMP and EMoP for Substations

(1) EMP for Substations

The proposed EMPs for the rehabilitation of the substations are shown from Table 3.2-6 to 3.2-8.

Table 3.2-6 EMP for the Rehabilitation of the Substations during Pre-construction Phase

Category	Scoping Item	Impact Evaluation	Environmental Management Activities to be Taken	Actor	Supervisor	Duration of Implementation
Pollution	Air Quality	Air pollution may arise due to emission gas from construction vehicles and dust from construction work.	➢ Specification will be designed on rehabilitated equipment considering the tentative target set by this report. ➢ Environmental management plans and monitoring plans have to be planned by candidate contractors, and the plans have to be reviewed and the appropriate plan has to be identified during the tender evaluation process.	Contractor	PMU Deputy Project Directors	Design and tender phase
	Water quality	Leakage of transformer oil during construction work should be controlled. Especially if transformers that may have PCB in their transformer oil are found. Therefore, water quality pollution during construction work has to be controlled carefully.				
	Solid Waste	Construction waste will be generated by the replacement of the existing facilities.				
	Noise/ Vibration	Noise and vibration due to construction work are anticipated.				
Health and Safety	Occupational Health and Safety	It is necessary to consider operational health and safety during construction such as accidents, salinity, and use of heavy equipment.				
	Community Health and Safety	It is necessary to avoid impact of traffic accidents due to transportation during construction work.				
	Risks of Infectious Disease	Risks of infectious diseases cannot be neglected.				
	Accident	It is necessary to consider the possibility of accidents occurring during construction work.				
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare emergency plan to reduce the risk of fire during the construction phase.	➢ An emergency response plan on fire cases will be prepared, and the plans have to be reviewed and the appropriate plan has to be identified during the tender evaluation process.	Contractor	PMU Deputy Project Directors	Design and tender phase

Source: JET

Table 3.2-7 EMP for the Rehabilitation of the Substations during Construction Phase

Category	Scoping Item	Impact Evaluation	Environmental Management Activities to be Taken	Actor	Supervisor	Duration of Implementation
Pollution	Air Quality	Air pollution may arise due to emission gas from construction vehicles and dust from construction work.	➢ Measures to avoid dust generation will be taken. ➢ Construction vehicles will be operated efficiently to minimize the amount of discharged air pollutants. ➢ Transportation of construction equipment will be implemented efficiently to minimize the amount of discharged air pollutants.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
	Water Quality	Leakage of transformer oil during construction work should be controlled. Especially if transformers that may have PCB in their transformer oil are found. Therefore, water quality pollution during construction work has to be controlled carefully.	➢ Checking leakage of oils from replaced transformers.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
	Solid Waste	Construction waste will be generated by the replacement of the existing facilities.	➢ Generated construction waste will be handled in cooperation with YCDC. ➢ For the transformers manufactured by Minel Transformer Factory in Yugoslavia, it is better to check PCB concentration by field test kit. ➢ For other transformers, the contractor should contact manufacturers to confirm whether they used PCB or not in the past through providing information of serial numbers and year manufactured. If manufacturer cannot provide information on the usage of PCB, it is better to check PCB concentration by field test kit. ➢ In case that transformers having PCB are found,	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)

Category	Scoping Item	Impact Evaluation	Environmental Management Activities to be Taken	Actor	Supervisor	Duration of Implementation
			specfic storage yard will be secured and proper storage codition has to be developed.			
	Noise/ Vibration	Noise and vibration due to construction work are anticipated.	➢ Construction work will be carried out only during daytime. ➢ Construction vehicles will be operated efficiently to minimize generated noise level. ➢ Transportation of construction equipment will be implemented efficiently to minimize generated noise level.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
Health and Safety	Occupational Health and Safety	It is necessary to consider operational health and safety during construction such as accidents, salinity, and use of heavy equipment.	➢ The planned construction workers' health and safety plan will be implemented. ➢ The planned training program will be conducted to avoid accidents during construction phase. ➢ The planned construction workers' health and safety plan will be reviewed and modified as necessary in the middle of the construction phase.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
	Community Health and Safety	It is necessary to avoid impact of traffic accidents due to transportation during construction work.	➢ The planned community health and safety program will be conducted. ➢ Complaints on construction work from local residents will be collected and required actions will be taken, in cooperation with local township and ward administrations.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
	Risks of Infectious Disease	Risks of infectious diseases cannot be neglected.	➢ The planned training program will be conducted to reduce risks of infectious diseases in the beginning of the construction phase.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
	Accident	It is necessary to consider the possibility of accidents occurring during construction work.	➢ The planned accident avoidance plan will be implemented. ➢ The planned training	Contractor	PMU Deputy Project Directors	Construction period (1.5 years)

Category	Scoping Item	Impact Evaluation	Environmental Management Activities to be Taken	Actor	Supervisor	Duration of Implementation
			program will be conducted to avoid accidents during construction phase. ➢ The planned accident avoidance plan will be reviewed and modified as necessary in the middle of the construction phase.		and Project Managers	
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare emergency plan to reduce the risk of fire during the construction phase.	➢ The simulator trainings will be conducted on the prepared emergency response plan in the beginning and middle of the construction phase. ➢ The planned emergency response plan will be reviewed and modified as necessary in the middle of the construction phase.	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)

Source: JET

Table 3.2-8 EMP for the Rehabilitation of the Substations during Operation Phase

Category	Scoping Item	Impact Evaluation	Environmental Management Activities to be Taken	Actor	Supervisor	Duration of Implementation
	Solid Waste	The transformers that may have PCB in their transformer oils were found. Therefore, PCB waste management plan has to be prepared.	In case that transformers having PCB are found and replaced, the replaced old transformer has to be stored in specific storage areas under the following condition: **Base** Storage areas should be on a firm, impermeable base, such as concrete, coated with a suitable sealant having continuous curbing. The storage area must be able to contain two (2) times the volume of the largest PCB container, or 25% of the total internal volume of the stored items, whichever is greater. **Contaminant** Storage areas for drums, equipment such as transformers and other goods should be kerbed,	Manager of each substation	Chief Engineer of PSD	During operation of each substation

Category	Scoping Item	Impact Evaluation	Environmental Management Activities to be Taken	Actor	Supervisor	Duration of Implementation
			and positively drained to a sealed collecting sump. No drains, joint lines, sewer lines, or other openings that would allow fluids to flow **Labeling / Signing** All packages, drums and other PCB material must be labeled, marked, and identified.			
	Noise/ Vibration	Due to the operation of the power plant facilities, noise impact will arise.	➢ The replaced facilities such as transformers will be operated appropriately and provided with proper maintenance.	Manager of each substation	Chief Engineer of PSD	During operation of each substation
Health and Safety	Occupational Health and Safety	Operation of rehabilitated facilities will need some new knowledge, so occupational health and safety system has to be reviewed to confirm the necessity of revising.	➢ The planned occupational health and safety plan will be implemented. ➢ The planned training program will be conducted to avoid accidents during the construction phase. ➢ The planned occupational health and safety plan will be reviewed and modified as necessary every year.	Manager of each substation	Chief Engineer of PSD	During operation of each substation
	Accident	Careful attention is needed because there would be some dangerous work in the operation of gas and steam turbines	➢ The planned accident avoidance plan will be implemented. ➢ The planned training program will be conducted to avoid accidents during construction phase. ➢ The planned accident avoidance plan will be reviewed and modified as necessary every year.	Manager of each substation	Chief Engineer of PSD	During operation of each substation

Source: JET

(2) EMoP for Substations

The proposed EMoPs for the rehabilitation of the substations are shown from Table 3.2-9 to 3.2-10.

Table 3.2-9 EMoP for the Rehabilitation of the Substations during Construction Phase

Category	Scoping Item	Impact Evaluation	Items to be Monitored	Frequency of Monitoring	Actor	Supervisor	Duration of Monitoring
Pollution	Solid Waste	Construction waste will be generated by the replacement of the existing facilities.	Condition of solid waste management including PCB waste if it is found.	Every month	Contractor	PMU Deputy Project Directors and Project Managers	Construction period (1.5 years)
	Noise/ Vibration	Noise and vibration due to construction work are anticipated.	Condition of construction work	Every week during construction work			
			- Noise level at the property border of each substation	As necessary			
	Electric and Magnetic Field	In the beginning of the operation phase, it is recommended to check the electric and magnetic field condition.	Magnetic field at each substation	End of construction phase			
Health and Safety	Occupational Health and Safety	It is necessary to consider operational health and safety during construction such as accidents, salinity, and use of heavy equipment.	Condition of construction workers' health and safety	Every week during construction work			
			Training record	Every training implemented			
	Community Health and Safety	It is necessary to avoid impact of traffic accidents due to transportation during construction work.	Existence of complaints on construction work from local residents	Every month			
	Risks of Infectious Disease	Risks of infectious diseases cannot be neglected.	Existence of patients with infectious disease	Every month			
			Training record	Every training implemented			
	Accident	It is necessary to consider the possibility of accidents occurring during construction work.	Condition of equipment to be prepared based on the accident avoidance plan	Every month			
			Record of accident	Every accident			
			Training record	Every training implemented			
Emergency Risk	Emergency Risk of Fire	It is necessary to prepare emergency plan to reduce the risk of fire during the construction phase.	Condition of equipment to be prepared based on the emergency response plan	Every month			
			Record of emergency case	Every emergency case			
			Training record	Every training implemented			

Source: JET

Table 3.2-10 EMoP for the Rehabilitation of Substations during Operation Phase

Category	Scoping Item	Impact Evaluation	Items to be Monitored	Frequency of Monitoring	Actor	Supervisor	Duration of Monitoring
Pollution	Solid Waste	If PCB waste is found, it should be stored under safe condition.	Condition of PCB waste storage	Every month	Engineers of each substation	PSD Chief Engineer and each substation manager	Reporting twice in a year during initial 2 years to JICA (For MOECF, once a year during operation period after enforcing EIA notification procedure)
	Noise/ Vibration	Due to the operation of power plant facilities, noise impact will arise.	Operation and maintenance condition of equipment	Every month	Engineers of each substation	PSD Chief Engineer and each substation manager	
			Noise level at the property border of the Thaketa Power Plant	Once a year (as necessary depending on complaints from local residents and request of JICA)			
Social Environment	Local Economy such as Employment and Livelihood	Through the Project, the amount of electric power generation by the Thaketa Power Plant will increase to 1.5 times of the amount before the Project at the end of the transmission line. Improvement of power generation and transmission of electricity will contribute to accelerate the economic condition of Yangon Region, and it is expected to provide positive impacts on local economy and livelihood.	Distribution condition of electric power	End of initial 2 years	Engineers of each substation	PSD Chief Engineer and each substation managers	
	Existing Infrastructures and Services	Through the Project, the amount of electric power generation by the Thaketa Power Plant will increase to 1.5 times of the amount before the Project at the end of the transmission line. Improvement of power generation and transmission of electricity will contribute to accelerate the economic condition of Yangon Region, and it is expected to provide positive impacts on the local economy and livelihood.	Distribution of electric power	At the end of the initial 2 years	Engineers of each substation	PSD Chief Engineer and each substation manager	
Health and Safety	Occupational Health and Safety	Operation of rehabilitated facilities will need some new knowledge, so occupational health and safety system has to be reviewed to confirm the necessity of revising.	Condition of construction workers' health and safety	Every month	Engineers of each substation	PSD Chief Engineer and each substation manager	
			Training record	Every training implemented			
	Accident	Careful attention is needed because there would be some dangerous work in the operation of gas and steam turbines	Condition of equipment to be prepared based on the accident avoidance plan	Every month	Engineers of each substation	PSD Chief Engineer and each substation manager	

Category	Scoping Item	Impact Evaluation	Items to be Monitored	Frequency of Monitoring	Actor	Supervisor	Duration of Monitoring
			Record of accident	Every accident			
			Training record	Every training implemented			
Climate Change	Greenhouse gas (GHG) Emission	Reduction of GHG emission is estimated by the Project.	Expected CO_2 reduction amount	At the end of the initial 2 years	Engineers of each substation	PSD Chief Engineer and each substation manager	

Source: JET

CHAPTER 4 RECOMMENDATION

Through the Project, the engineers of TPD and PSD of MEPE, Thaketa Power Plant and relevant substations worked with JET, and were expected to obtain experiences and skills for implementing EIA and planning an environmental management plan and monitoring plan based on the Rules of EIA Procedure in Myanmar. To use the experience and skills more effectively in future for environmental management related to the electric sector, it is recommended the followings;

- At Thaketa Power Plant, JET worked with engineers of the plant for analyzing emission gas from gas turbine. The adopted method for analyzing the emission gas was relatively simple one, and some of engineers was able to take emission gas from chimney and analyze pollutants by himself during the Project. Therefore, JET recommended MEPE to share the experiences of the emission gas measurement among the concerned engineers, and would implement emission gas monitoring in future.

- In the Project, the engineers of Thaketa, Iwama, Hlawga and Ahlone substations conducted inventory survey of transformers which may have PCBs. JET recommended to share the experiences among the relevant officers in MEPE, and examine to conduct inventory survey of transformers in nationwide. Currently, ECD worked with UNIDO for capacity development of such inventory survey and PCBs waste management. It is also recommended that MEPE would share experiences and skills that ECD obtained to enhance PCBs waste management capacity.

- The proposed environmental monitoring plan by the Project proposed to purchase some environmental monitoring equipment by the contractor in construction phase of the Project. JET recommended that the equipment would be handover from the contractor to MEPE after finishing construction work. MEPE would use the equipment to conduct environmental monitoring during operation phase of the Project, or other facilities in MEPE in future.

- In the Project, MEPE and Thaketa Power Plant obtained the experiences on preparation and holding of public consultation for a project requiring EIA after enforcing of the rule of EIA procedure. JET recommended to share the experience with relevant officers in MEPE when MEPE has any project requiring EIA in future.

Appendix

Appendix-1 Result of Baseline Survey
Appendix-2 Result of Baseline Survey in Thaketa Power Plant
Appendix-3 Materials for 1st Mini-workshop (20th June, 2014)
Appendix-4 Materials for 2st Mini-workshop (9th July, 2014)
Appendix-5 Materials for Final Workshop (7th August, 2014)
Appendix-6 Minuts of Discussion with ECD (23rd May, 2014)
Appendix-7 Minuts of Discussion of Public Consultation Meeting (21st October, 2014)
Appendix-8 Draft EIA Procedure in Myanmar (as of August, 2014)
Appendix-9 Summary of the Project in Myanmar

Appendix-1: Result of Baseline Survey

1) Hourly Raw Data of Meteorology and Air Quality Monitoring at Aq-1 (Dry Season)

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
9.5.2014	10:00-11:00	1.5	16.6	0.0	20.8	67.5	25.0	9.0	32.0	225	6.8
9.5.2014	11:00-12:00	0.6	14.2	0.1	9.1	34.3	20.0	17.3	33.7	217	9.2
9.5.2014	12:00-13:00	0.3	17.0	0.2	1.8	12.2	34.8	10.1	29.8	176	10.6
9.5.2014	13:00-14:00	0.0	227.7	0.0	0.0	32.4	83.2	0.0	24.5	241	5.2
9.5.2014	14:00-15:00	0.0	48.8	0.0	0.0	34.3	91.9	3.7	25.3	142	6.0
9.5.2014	15:00-16:00	0.0	1.5	0.0	0.0	26.5	85.3	6.1	24.7	191	3.0
9.5.2014	16:00-17:00	0.8	5.8	0.0	16.0	19.7	46.2	0.0	28.2	277	1.4
9.5.2014	17:00-18:00	0.0	4.5	0.0	1.9	89.9	94.2	0.2	26.2	285	0.6
9.5.2014	18:00-19:00	0.1	11.5	0.0	0.4	106.2	101.6	1.4	22.5	291	1.0
9.5.2014	19:00-20:00	0.2	7.6	0.0	1.4	82.3	88.1	15.1	22.3	291	0.9
9.5.2014	20:00-21:00	0.4	0.0	0.0	2.2	87.2	87.0	76.9	22.0	291	0.8
9.5.2014	21:00-22:00	0.9	0.0	0.0	3.0	118.5	90.1	139.4	22.0	291	0.0
9.5.2014	22:00-23:00	0.5	0.0	0.0	3.3	143.2	95.5	131.3	22.2	291	0.6
9.5.2014	23:00-00:00	0.2	0.0	0.0	1.2	132.7	98.7	140.2	22.0	291	0.4
10.5.2014	00:00-01:00	0.1	0.0	0.0	0.6	56.9	106.5	164.1	22.0	291	0.1
10.5.2014	01:00-02:00	0.1	0.0	0.0	1.9	59.7	109.2	167.1	21.9	291	0.0
10.5.2014	02:00-03:00	0.1	0.0	0.0	1.2	66.5	110.8	173.9	21.8	291	0.0
10.5.2014	03:00-04:00	0.1	0.0	0.0	1.1	96.5	106.8	170.8	21.4	291	0.2
10.5.2014	04:00-05:00	0.4	0.0	0.0	1.4	136.4	109.0	178.7	21.4	291	0.1
10.5.2014	05:00-06:00	0.3	0.0	0.0	7.9	102.3	73.1	143.4	22.4	275	1.7
10.5.2014	06:00-07:00	0.4	0.3	0.0	15.2	47.3	56.9	0.2	23.5	213	6.5
10.5.2014	07:00-08:00	1.0	4.7	0.2	14.1	40.8	53.2	9.5	25.6	203	7.6
10.5.2014	08:00-09:00	1.2	5.3	0.2	16.3	55.3	45.9	52.8	27.8	207	8.3
10.5.2014	09:00-10:00	1.1	0.5	0.1	16.0	86.3	40.7	100.0	29.5	213	8.8

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
10.5.2014	10:00-11:00	0.4	4.2	0.1	4.5	54.3	37.4	110.8	30.6	203	9.2
10.5.2014	11:00-12:00	0.7	1.4	0.0	8.3	85.0	32.8	95.4	32.0	209	7.7
10.5.2014	12:00-13:00	0.6	2.4	0.0	19.7	27.2	60.6	128.2	26.1	212	6.8
10.5.2014	13:00-14:00	1.0	0.0	0.0	13.2	30.4	50.2	271.5	26.7	218	7.5
10.5.2014	14:00-15:00	0.3	0.0	0.0	2.1	50.4	57.7	248.2	25.9	207	6.3
10.5.2014	15:00-16:00	0.0	0.0	0.0	0.1	174.8	60.7	207.9	24.5	205	5.2
10.5.2014	16:00-17:00	0.0	0.0	0.0	0.0	361.9	60.0	167.2	24.4	195	2.9
10.5.2014	17:00-18:00	0.6	0.0	0.0	0.8	111.5	55.4	82.9	24.5	204	4.1
10.5.2014	18:00-19:00	0.0	0.0	0.0	0.6	41.5	57.7	106.2	24.1	218	6.5
10.5.2014	19:00-20:00	0.1	0.0	0.0	1.6	33.2	56.0	57.0	23.9	227	6.0
10.5.2014	20:00-21:00	0.2	0.7	0.0	1.4	50.9	54.4	53.0	23.5	249	3.0
10.5.2014	21:00-22:00	0.2	0.5	0.0	1.3	75.8	56.5	38.4	23.4	318	2.4
10.5.2014	22:00-23:00	0.2	2.9	0.0	2.7	65.1	57.3	23.9	23.4	282	3.8
10.5.2014	23:00-00:00	0.1	15.4	0.0	1.3	76.7	63.2	0.4	23.1	222	6.4
11.5.2014	00:00-01:00	0.0	17.7	0.0	1.3	90.6	64.2	0.0	23.0	233	4.4
11.5.2014	01:00-02:00	0.1	22.9	0.0	0.9	107.9	66.0	0.0	22.9	257	4.0
11.5.2014	02:00-03:00	0.1	23.2	0.0	1.1	122.8	74.6	0.2	22.2	357	1.7
11.5.2014	03:00-04:00	0.4	10.1	0.0	2.7	160.4	85.4	0.2	22.1	357	0.5
11.5.2014	04:00-05:00	0.4	41.2	0.0	3.7	184.4	88.0	0.4	22.4	357	0.3
11.5.2014	05:00-06:00	0.6	17.5	0.0	10.2	118.9	66.1	2.7	23.0	264	4.8
11.5.2014	06:00-07:00	0.5	8.5	0.0	14.3	56.4	55.3	5.6	24.1	209	7.0
11.5.2014	07:00-08:00	1.1	3.5	0.3	15.0	42.4	52.6	14.4	25.8	204	7.8
11.5.2014	08:00-09:00	1.3	5.3	0.2	17.1	59.7	45.1	56.0	28.1	208	8.6
10.5.2014	09:00-10:00	1.1	0.5	0.1	16.0	86.3	40.7	100.0	29.5	213	8.8

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
11.5.2014	10:00-11:00	0.2	4.2	0.1	4.0	52.5	37.0	107.4	30.7	205	8.7
11.5.2014	11:00-12:00	0.8	2.2	0.0	8.2	87.6	32.4	87.5	32.1	205	7.5
11.5.2014	12:00-13:00	0.7	4.1	0.1	13.9	55.2	29.9	82.6	33.9	200	6.7
11.5.2014	13:00-14:00	0.1	6.2	0.0	0.8	159.5	61.7	77.8	23.6	242	4.7
11.5.2014	14:00-15:00	0.1	22.1	0.0	3.1	105.3	54.5	60.5	24.6	229	6.6
11.5.2014	15:00-16:00	0.2	1.2	0.0	0.7	518.0	52.8	24.6	24.5	229	7.0
11.5.2014	16:00-17:00	0.4	17.5	0.0	7.4	91.6	57.2	0.5	23.7	203	4.2
11.5.2014	17:00-18:00	0.2	50.3	0.0	2.5	29.0	62.1	0.0	23.2	224	3.9
11.5.2014	18:00-19:00	0.1	55.5	0.0	1.4	35.2	62.9	0.0	23.0	243	3.6
11.5.2014	19:00-20:00	0.2	58.7	0.0	4.3	43.7	62.9	0.0	22.7	106	2.8
11.5.2014	20:00-21:00	0.3	48.4	0.0	3.4	50.5	66.9	0.0	23.0	0	4.1
11.5.2014	21:00-22:00	0.1	61.4	0.0	1.3	49.3	69.3	0.0	22.9	0	4.3
11.5.2014	22:00-23:00	0.2	62.4	0.0	2.1	50.5	70.8	0.0	23.0	0	5.3
11.5.2014	23:00-00:00	0.1	54.4	0.0	2.4	48.5	72.5	0.0	23.0	0	5.9
12.5.2014	00:00-01:00	0.1	64.5	0.0	1.6	46.4	74.6	0.0	23.0	0	6.2
12.5.2014	01:00-02:00	0.1	54.9	0.0	3.2	37.6	70.9	0.0	23.0	0	7.1
12.5.2014	02:00-03:00	0.2	45.7	0.0	2.2	32.8	68.9	0.0	23.0	0	6.3
12.5.2014	03:00-04:00	0.2	56.3	0.0	3.6	43.0	67.8	0.0	23.4	0	2.6
12.5.2014	04:00-05:00	0.9	41.6	0.0	4.4	95.9	67.7	52.0	22.7	162	1.1
12.5.2014	05:00-06:00	1.2	14.8	0.0	16.6	135.2	60.7	0.0	24.4	226	1.5
12.5.2014	06:00-07:00	1.2	3.5	0.0	17.1	40.8	53.7	18.3	26.4	255	2.8
12.5.2014	07:00-08:00	1.2	5.6	0.0	16.9	70.6	48.9	65.5	28.5	200	2.9
12.5.2014	08:00-09:00	0.9	4.3	0.1	12.6	66.2	44.3	97.9	30.3	181	3.2
12.5.2014	09:00-10:00	0.5	4.0	0.1	3.7	30.6	43.8	75.8	30.2	202	6.3

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
12.5.2014	10:00-11:00	0.9	7.1	0.0	12.4	92.6	38.1	60.5	31.7	209	6.8
12.5.2014	11:00-12:00	0.8	16.8	0.0	15.4	39.7	31.9	82.1	33.7	204	7.1
12.5.2014	12:00-13:00	0.9	3.8	0.1	8.0	11.6	34.8	63.5	33.7	206	9.7
12.5.2014	13:00-14:00	0.0	16.1	0.1	0.0	0.1	47.7	35.1	29.6	216	12.4
12.5.2014	14:00-15:00	0.0	146.9	0.0	0.0	134.1	81.9	0.0	23.0	214	5.9
12.5.2014	15:00-16:00	0.0	126.7	0.0	1.3	56.7	61.6	0.0	23.1	218	5.1
12.5.2014	16:00-17:00	0.1	86.0	0.0	1.2	104.4	63.9	0.0	22.8	213	2.5
12.5.2014	17:00-18:00	0.1	56.3	0.0	1.1	51.8	62.4	0.0	23.0	233	4.8
12.5.2014	18:00-19:00	0.1	55.5	0.0	1.4	35.2	62.9	0.0	23.0	243	3.6
12.5.2014	19:00-20:00	0.2	62.5	0.0	3.8	39.2	62.2	0.0	22.6	148	2.7
12.5.2014	20:00-21:00	0.3	44.8	0.0	4.2	53.8	65.8	0.0	23.0	0	3.9
12.5.2014	21:00-22:00	0.1	62.0	0.0	1.2	48.4	69.2	0.0	23.0	0	3.9
12.5.2014	22:00-23:00	0.2	61.8	0.0	2.4	50.2	70.2	0.0	23.0	0	4.9
12.5.2014	23:00-00:00	0.1	56.3	0.0	2.7	49.6	71.7	0.0	23.0	0	6.3
13.5.2014	00:00-01:00	0.1	63.0	0.0	2.0	46.1	74.5	0.0	23.0	0	5.7
13.5.2014	01:00-02:00	0.1	55.8	0.0	2.8	43.8	72.4	0.0	23.0	0	6.7
13.5.2014	02:00-03:00	0.1	49.4	0.0	2.5	28.5	68.7	0.0	23.0	0	7.6
13.5.2014	03:00-04:00	0.2	49.4	0.0	2.8	45.7	68.5	0.0	23.1	0	2.9
13.5.2014	04:00-05:00	0.3	48.6	0.0	5.1	35.0	66.9	0.0	23.4	0	1.8
13.5.2014	05:00-06:00	0.7	13.4	0.0	9.6	45.3	61.9	0.2	23.8	0	5.2
13.5.2014	06:00-07:00	0.6	6.9	0.1	10.3	43.2	56.2	8.7	25.3	0	5.5
13.5.2014	07:00-08:00	0.9	5.7	0.2	7.5	36.7	55.5	4.4	25.7	174	6.2
13.5.2014	08:00-09:00	0.4	5.1	0.1	7.9	28.4	54.5	9.2	26.3	200	7.3
13.5.2014	09:00-10:00	0.7	4.8	0.3	2.9	34.4	55.2	5.8	26.1	195	12.4

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
13.5.2014	10:00-11:00	0.1	7.8	0.0	6.2	25.3	47.9	33.5	26.2	0	12.6
13.5.2014	11:00-12:00	0.4	2.7	0.0	8.3	28.1	45.1	20.5	27.0	0	11.4
13.5.2014	12:00-13:00	0.6	27.4	0.0	7.6	17.2	43.9	24.2	27.7	0	10.2
13.5.2014	13:00-14:00	0.4	9.6	0.0	2.4	38.5	40.9	18.2	28.0	0	4.8
13.5.2014	14:00-15:00	0.0	11.3	0.0	0.0	15.3	46.5	17.6	26.9	0	6.5
13.5.2014	15:00-16:00	0.0	79.4	0.0	0.1	34.7	53.5	0.0	24.9	0	6.8
13.5.2014	16:00-17:00	0.0	89.9	0.0	0.3	13.8	59.4	0.0	23.9	0	5.5
13.5.2014	17:00-18:00	0.0	69.4	0.0	0.5	13.1	61.1	0.0	23.7	0	5.8
13.5.2014	18:00-19:00	0.0	73.1	0.0	1.0	18.2	64.0	0.0	23.5	0	4.1
13.5.2014	19:00-20:00	0.0	80.4	0.0	1.8	23.9	65.5	0.0	23.2	0	5.5
13.5.2014	20:00-21:00	0.1	75.7	0.0	1.6	34.7	67.3	0.0	23.2	0	5.8
13.5.2014	21:00-22:00	0.0	60.2	0.0	1.4	28.0	68.8	0.0	22.9	0	5.6
13.5.2014	22:00-23:00	0.1	70.8	0.0	2.1	26.5	69.1	0.0	22.9	0	5.8
13.5.2014	23:00-00:00	0.1	79.0	0.0	2.1	29.7	70.6	0.0	22.7	0	5.9
14.5.2014	00:00-01:00	0.1	67.7	0.0	1.7	47.5	74.9	0.0	22.8	0	4.5
14.5.2014	01:00-02:00	0.1	55.4	0.0	2.0	55.1	79.9	0.0	22.5	0	3.4
14.5.2014	02:00-03:00	0.1	49.3	0.0	2.8	46.1	80.3	0.0	22.9	0	4.3
14.5.2014	03:00-04:00	0.2	57.5	0.0	5.0	60.4	72.4	0.0	23.1	0	5.3
14.5.2014	04:00-05:00	1.5	9.2	0.0	25.6	11.5	60.7	0.0	23.4	201	4.9
14.5.2014	05:00-06:00	1.6	7.0	0.0	23.0	57.8	55.7	0.0	24.6	197	4.6
14.5.2014	06:00-07:00	1.0	4.7	0.0	14.3	50.0	51.7	26.6	27.1	215	5.8
14.5.2014	07:00-08:00	1.4	3.6	0.0	19.7	57.8	44.9	57.1	29.9	253	3.5
14.5.2014	08:00-09:00	0.7	5.8	0.1	7.6	61.2	42.5	88.3	31.1	199	5.0
14.5.2014	09:00-10:00	0.8	12.4	0.0	12.0	51.8	38.0	73.3	32.4	211	4.3

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
14.5.2014	10:00-11:00	0.3	65.2	0.0	0.1	17.5	43.0	57.1	31.5	205	5.7
14.5.2014	11:00-12:00	0.1	219.2	0.4	0.0	23.2	68.5	27.4	26.9	192	6.7
14.5.2014	12:00-13:00	0.0	141.0	0.2	0.0	10.5	54.7	23.2	24.8	135	7.2
14.5.2014	13:00-14:00	0.0	192.2	0.0	0.1	134.9	59.8	0.0	22.3	199	2.1
14.5.2014	14:00-15:00	0.1	175.5	0.0	0.9	93.7	59.6	0.0	22.0	3	1.4
14.5.2014	15:00-16:00	0.9	215.3	0.0	11.4	92.4	61.0	0.0	21.2	161	5.8
14.5.2014	16:00-17:00	0.8	210.5	0.0	10.6	38.5	62.7	0.0	21.6	215	7.3
14.5.2014	17:00-18:00	0.6	155.5	0.0	6.6	58.2	63.0	0.0	21.8	216	5.8
14.5.2014	18:00-19:00	0.3	127.4	0.0	5.3	45.3	62.2	0.0	22.0	217	5.1
14.5.2014	19:00-20:00	0.1	65.8	0.0	2.3	56.4	63.2	0.0	22.3	215	5.4
14.5.2014	20:00-21:00	0.1	62.8	0.0	1.4	41.9	64.4	0.0	22.3	220	4.7
14.5.2014	21:00-22:00	0.1	58.0	0.0	1.6	34.5	65.4	0.0	22.1	216	4.2
14.5.2014	22:00-23:00	0.1	34.5	0.0	1.7	41.4	64.4	0.0	22.0	218	4.5
14.5.2014	23:00-00:00	0.1	47.2	0.0	1.6	59.2	65.9	0.0	22.0	215	4.8
15.5.2014	00:00-01:00	0.1	53.0	0.0	1.5	37.3	65.5	0.0	22.0	214	4.6
15.5.2014	01:00-02:00	0.1	47.4	0.0	1.7	47.3	65.9	0.0	22.0	217	4.8
15.5.2014	02:00-03:00	0.2	40.7	0.0	2.7	68.0	68.1	0.0	22.0	220	4.2
15.5.2014	03:00-04:00	0.2	49.1	0.0	3.6	46.5	65.7	0.0	22.0	217	5.6
15.5.2014	04:00-05:00	0.3	28.1	0.0	11.2	46.2	59.0	0.0	23.1	217	5.9
15.5.2014	05:00-06:00	1.0	3.1	0.2	16.9	42.2	53.7	5.6	25.1	202	7.6
15.5.2014	06:00-07:00	1.1	4.4	0.2	14.9	49.9	47.9	44.8	27.3	211	8.5
15.5.2014	07:00-08:00	1.1	3.4	0.1	14.9	74.9	41.4	85.8	29.3	208	8.1
15.5.2014	08:00-09:00	0.6	2.4	0.1	7.4	65.4	38.3	116.2	30.3	213	9.9
15.5.2014	09:00-10:00	0.4	2.2	0.0	7.5	77.5	33.3	99.9	31.7	200	7.6

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
15.5.2014	10:00-11:00	0.9	5.5	0.0	12.5	71.1	30.6	75.3	33.3	199	6.7
15.5.2014	11:00-12:00	0.5	4.4	0.5	3.5	28.4	36.1	65.4	32.1	198	8.2
15.5.2014	12:00-13:00	0.0	141.0	0.2	0.0	10.5	54.7	23.2	24.8	135	7.2
15.5.2014	13:00-14:00	0.0	204.6	0.0	0.1	53.7	60.9	0.0	22.2	220	1.6
15.5.2014	14:00-15:00	0.0	165.4	0.0	0.0	259.2	57.0	0.0	22.2	116	3.0
15.5.2014	15:00-16:00	0.5	91.6	0.0	9.0	124.3	60.9	0.0	22.1	0	0.4
15.5.2014	16:00-17:00	0.4	66.0	0.0	4.7	61.6	59.0	0.0	22.5	0	1.5
15.5.2014	17:00-18:00	0.3	65.1	0.0	4.8	58.3	58.8	0.0	22.8	0	3.4
15.5.2014	18:00-19:00	0.3	38.5	0.0	4.7	59.0	53.9	0.0	22.8	172	5.1
15.5.2014	19:00-20:00	0.3	27.3	0.0	2.8	62.1	54.9	0.0	23.0	212	5.7
15.5.2014	20:00-21:00	0.1	52.7	0.0	3.4	43.0	53.1	0.0	23.0	0	3.7
15.5.2014	21:00-22:00	0.1	34.7	0.0	2.2	47.0	53.3	0.0	23.1	0	5.3
15.5.2014	22:00-23:00	0.2	26.7	0.0	3.6	53.7	56.7	0.0	22.2	0	5.8
15.5.2014	23:00-00:00	0.5	64.3	0.5	7.5	80.4	58.8	18.5	22.6	0	4.4
16.5.2014	00:00-01:00	0.1	66.2	0.0	2.2	62.5	60.4	0.0	22.6	0	4.4
16.5.2014	01:00-02:00	0.1	68.0	0.0	1.4	92.6	61.5	0.0	22.7	0	4.1
16.5.2014	02:00-03:00	0.1	63.5	0.0	1.9	127.4	62.6	0.0	22.4	0	4.1
16.5.2014	03:00-04:00	1.3	11.1	0.0	23.6	12.2	58.8	0.0	22.8	204	4.4
16.5.2014	04:00-05:00	3.4	0.0	0.0	50.8	1.4	59.1	0.0	24.4	199	6.3
16.5.2014	05:00-06:00	5.0	0.0	0.0	69.9	5.2	57.1	0.0	25.5	194	7.8
16.5.2014	06:00-07:00	6.3	0.0	0.0	90.4	21.5	51.7	0.0	27.2	199	8.5
16.5.2014	07:00-08:00	8.4	0.0	0.0	119.1	62.7	44.8	0.0	29.1	202	7.6
16.5.2014	08:00-09:00	0.9	4.3	0.1	12.6	66.2	44.3	97.9	30.3	181	3.2
16.5.2014	09:00-10:00	0.5	4.0	0.1	3.7	30.6	43.8	75.8	30.2	202	6.3

2) Hourly Raw Data of Meteorology and Air Quality Monitoring at Aq-1 (Rainy Season)

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
30.6.2014	14:00-15:00	1.1	57.9	0.0	0.0	92.9	90.3	0.0	26.3	148	2.50
30.6.2014	15:00-16:00	0.3	5.8	0.0	0.0	52.3	92.4	3.7	22.7	144	3.56
30.6.2014	16:00-17:00	0.3	57.6	0.0	7.1	20.7	97.5	4.9	21.7	163	3.04
30.6.2014	17:00-18:00	0.2	90.9	0.0	2.4	37.3	99.9	11.2	21.6	184	2.98
30.6.2014	18:00-19:00	0.0	128.6	0.0	5.4	7.3	105.9	0.0	20.5	199	3.36
30.6.2014	19:00-20:00	0.1	69.1	0.0	4.9	43.2	105.0	0.0	20.1	201	1.98
30.6.2014	20:00-21:00	0.2	36.9	0.0	7.0	62.5	104.5	0.0	20.2	224	0.35
30.6.2014	21:00-22:00	0.3	35.4	0.0	9.8	40.2	103.9	0.0	20.5	209	1.65
30.6.2014	22:00-23:00	0.2	28.4	0.0	3.1	41.4	103.5	0.0	20.7	199	0.45
30.6.2014	23:00-00:00	0.2	7.1	0.0	1.1	47.8	104.4	0.0	20.4	188	0.00
1.7.2014	00:00-01:00	0.1	0.7	0.0	1.8	42.3	103.0	0.0	20.6	183	0.00
1.7.2014	01:00-02:00	0.1	11.9	0.0	4.2	43.6	100.7	0.0	21.1	176	0.08
1.7.2014	02:00-03:00	0.2	15.0	0.0	4.8	31.8	101.7	0.0	21.0	199	0.00
1.7.2014	03:00-04:00	0.0	7.0	0.0	0.0	39.5	100.3	0.0	22.0	199	0.00
1.7.2014	04:00-05:00	0.0	5.5	0.0	1.2	25.6	95.5	6.5	21.7	189	0.08
1.7.2014	05:00-06:00	0.0	11.3	0.1	0.2	36.8	103.5	1.5	21.5	190	0.34
1.7.2014	06:00-07:00	0.0	0.3	0.1	2.0	31.4	100.2	0.0	21.4	188	0.00
1.7.2014	07:00-08:00	1.0	0.6	0.1	0.1	41.2	95.8	0.8	22.3	134	0.56
1.7.2014	08:00-09:00	0.2	0.0	0.0	0.5	20.5	96.6	1.1	22.9	165	1.59
1.7.2014	09:00-10:00	0.3	0.0	0.0	1.4	23.5	95.2	25.4	22.0	138	0.87
1.7.2014	10:00-11:00	1.0	0.0	0.0	8.4	24.8	82.6	100.3	24.0	142	1.88
1.7.2014	11:00-12:00	1.1	0.0	0.0	11.2	46.3	86.2	104.2	22.7	144	2.01
1.7.2014	12:00-13:00	1.0	0.5	0.1	12.5	39.4	80.6	100.5	24.5	152	3.02
1.7.2014	13:00-14:00	1.3	5.7	0.0	0.0	145.2	90.3	0.0	24.4	133	2.54

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
1.7.2014	14:00-15:00	0.4	0.0	0.0	0.0	125.6	93.3	0.0	24.0	160	2.50
1.7.2014	15:00-16:00	0.3	11.1	0.0	2.2	13.8	102.8	14.1	22.2	148	2.25
1.7.2014	16:00-17:00	0.0	25.0	0.0	5.2	5.0	102.1	0.0	22.5	152	0.00
1.7.2014	17:00-18:00	0.2	2.0	0.0	0.2	42.3	100.6	1.4	23.0	256	0.00
1.7.2014	18:00-19:00	0.0	57.1	0.0	0.0	13.9	99.7	0.0	23.0	235	0.58
1.7.2014	19:00-20:00	0.0	14.3	0.0	3.5	9.6	103.0	1.0	21.8	181	1.50
1.7.2014	20:00-21:00	0.3	40.3	0.0	4.1	69.2	101.7	0.0	21.6	170	0.08
1.7.2014	21:00-22:00	0.4	37.8	0.0	1.8	54.3	100.6	0.0	22.1	201	0.25
1.7.2014	22:00-23:00	0.2	38.3	0.0	0.7	33.3	97.5	0.0	22.1	219	0.00
1.7.2014	23:00-00:00	0.2	22.0	0.0	1.4	29.3	98.2	0.0	22.5	170	0.33
2.7.2014	00:00-01:00	0.2	20.4	0.0	0.9	34.2	98.9	0.1	22.0	169	0.00
2.7.2014	01:00-02:00	0.2	15.9	0.0	1.3	28.6	98.3	0.1	22.0	183	0.08
2.7.2014	02:00-03:00	0.2	21.2	0.0	2.3	21.0	98.2	0.0	22.0	179	0.00
2.7.2014	03:00-04:00	0.3	7.2	0.0	4.3	16.2	101.9	0.9	22.0	176	0.25
2.7.2014	04:00-05:00	0.0	6.1	0.0	1.5	27.3	100.9	7.3	21.7	197	0.08
2.7.2014	05:00-06:00	0.3	14.5	0.1	1.2	39.3	101.4	1.2	21.5	190	0.00
2.7.2014	06:00-07:00	0.1	0.3	0.0	2.8	31.4	101.0	0.0	21.4	190	0.00
2.7.2014	07:00-08:00	0.8	0.7	0.0	0.1	41.5	98.6	0.6	22.3	210	0.42
2.7.2014	08:00-09:00	0.2	0.0	0.0	0.5	19.5	96.6	1.1	22.9	129	0.58
2.7.2014	09:00-10:00	0.3	0.0	0.0	1.6	25.8	94.1	25.4	23.1	179	0.33
2.7.2014	10:00-11:00	0.8	0.0	0.0	10.5	31.7	90.5	143.5	23.7	148	2.17
2.7.2014	11:00-12:00	0.9	0.0	0.2	12.6	25.6	84.4	216.8	24.8	156	3.83
2.7.2014	12:00-13:00	1.2	5.7	0.0	8.3	145.2	90.3	72.3	24.4	142	3.33
2.7.2014	13:00-14:00	1.1	55.6	0.0	0.0	90.5	91.2	23.4	26.3	160	4.25

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
2.7.2014	14:00-15:00	1.2	54.2	0.0	0.0	87.9	89.3	0.0	26.3	154	3.58
2.7.2014	15:00-16:00	0.3	53.8	0.0	6.5	50.8	94.3	3.8	22.7	149	2.25
2.7.2014	16:00-17:00	0.2	52.1	0.0	7.1	22.1	97.5	4.5	21.7	165	2.67
2.7.2014	17:00-18:00	0.5	0.0	0.0	9.0	104.7	93.3	77.7	23.0	175	3.50
2.7.2014	18:00-19:00	0.3	0.0	0.0	7.1	61.2	91.8	55.8	23.0	142	3.25
2.7.2014	19:00-20:00	0.1	0.2	0.0	1.1	13.9	92.8	54.5	23.0	151	2.17
2.7.2014	20:00-21:00	0.1	1.1	0.0	1.0	11.6	97.7	49.9	22.9	163	1.83
2.7.2014	21:00-22:00	0.0	8.1	0.0	1.9	5.2	103.7	21.7	21.3	168	2.92
2.7.2014	22:00-23:00	0.0	19.8	0.0	11.2	10.5	102.5	1.4	21.8	209	0.08
2.7.2014	23:00-00:00	0.4	30.2	0.0	5.5	31.0	101.6	0.0	22.0	183	0.00
3.7.2014	00:00-01:00	0.2	29.8	0.0	2.3	32.8	101.3	0.0	22.3	177	0.00
3.7.2014	01:00-02:00	0.0	16.8	0.0	2.4	32.4	101.4	0.0	22.2	185	0.00
3.7.2014	02:00-03:00	0.0	24.2	0.0	4.9	25.5	101.9	0.2	22.0	158	0.08
3.7.2014	03:00-04:00	0.0	14.4	0.0	2.3	25.2	102.0	0.2	21.9	183	0.00
3.7.2014	04:00-05:00	0.0	13.9	0.0	1.6	26.5	101.8	0.0	22.0	167	0.33
3.7.2014	05:00-06:00	0.0	20.2	0.0	1.7	19.1	101.6	0.0	22.0	172	0.50
3.7.2014	06:00-07:00	0.1	29.5	0.0	4.7	28.0	103.0	0.0	21.0	177	2.50
3.7.2014	07:00-08:00	0.0	19.0	0.0	6.8	18.2	102.4	0.0	20.6	176	0.33
3.7.2014	08:00-09:00	0.3	12.0	0.0	1.1	17.5	99.6	0.0	21.4	172	0.75
3.7.2014	09:00-10:00	0.8	5.9	0.0	4.2	31.1	94.7	0.0	22.6	168	0.50
3.7.2014	10:00-11:00	1.3	84.5	0.0	18.6	36.8	89.0	0.0	24.2	145	2.25
3.7.2014	11:00-12:00	0.8	93.1	0.4	11.6	25.2	86.2	6.9	25.4	140	0.75
3.7.2014	12:00-13:00	0.9	0.0	0.1	12.6	18.1	83.5	155.1	26.4	158	3.08
3.7.2014	13:00-14:00	0.2	0.3	0.1	1.3	8.3	86.4	197.8	26.1	151	3.25

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
3.7.2014	14:00-15:00	0.7	0.0	0.1	4.4	13.9	86.2	177.0	25.6	153	3.58
3.7.2014	15:00-16:00	0.1	10.3	0.1	0.0	18.4	97.5	85.9	22.9	155	3.08
3.7.2014	16:00-17:00	0.0	20.5	0.0	4.0	24.4	126.4	8.5	20.9	192	2.75
3.7.2014	17:00-18:00	0.0	54.6	0.0	7.7	16.3	102.9	0.7	20.5	175	2.17
3.7.2014	18:00-19:00	0.1	96.0	0.0	6.2	26.5	106.6	0.0	20.6	176	0.25
3.7.2014	19:00-20:00	0.4	93.1	0.0	5.7	49.7	107.0	0.0	20.6	191	0.00
3.7.2014	20:00-21:00	0.6	95.5	0.0	4.2	59.7	106.7	0.0	20.8	188	0.00
3.7.2014	21:00-22:00	0.4	77.9	0.0	2.2	58.5	104.9	0.0	21.0	193	0.00
3.7.2014	22:00-23:00	0.2	39.0	0.0	2.3	43.0	103.3	0.0	21.0	179	0.00
3.7.2014	23:00-00:00	0.3	38.8	0.0	3.1	46.8	105.1	0.0	21.0	198	0.00
4.7.2014	00:00-01:00	0.0	51.9	0.0	3.0	31.4	103.3	0.0	21.1	166	0.08
4.7.2014	01:00-02:00	0.2	35.0	0.0	3.6	29.6	104.4	0.0	21.1	181	0.00
4.7.2014	02:00-03:00	0.3	24.5	0.0	1.2	36.4	104.6	0.0	21.3	149	0.00
4.7.2014	03:00-04:00	0.2	9.0	0.0	0.0	41.0	104.3	0.0	22.0	50	0.02
4.7.2014	04:00-05:00	0.0	6.2	0.0	1.5	27.3	98.3	7.7	21.7	99	0.33
4.7.2014	05:00-06:00	4.0	12.4	0.1	0.2	36.8	103.5	1.5	21.5	90	0.33
4.7.2014	06:00-07:00	0.0	0.3	0.1	3.0	31.4	101.0	0.0	21.4	239	1.17
4.7.2014	07:00-08:00	1.0	0.6	0.1	0.1	440.5	95.8	0.8	22.3	70	0.50
4.7.2014	08:00-09:00	0.2	0.0	0.0	0.5	20.5	96.6	1.1	22.9	136	0.17
4.7.2014	09:00-10:00	0.3	0.0	0.0	1.4	23.5	95.2	25.4	23.1	152	2.58
4.7.2014	10:00-11:00	0.9	0.0	0.0	10.1	24.8	88.5	117.0	24.0	160	2.67
4.7.2014	11:00-12:00	1.1	0.0	0.0	13.2	46.3	86.2	104.2	25.0	178	3.67
4.7.2014	12:00-13:00	1.0	0.5	0.1	13.1	39.4	80.6	127.6	26.6	134	1.58
4.7.2014	13:00-14:00	0.4	0.0	0.1	6.5	23.2	77.4	153.2	27.5	146	2.92

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
4.7.2014	14:00-15:00	0.7	0.0	0.1	1.4	22.4	80.0	143.2	26.6	156	1.00
4.7.2014	15:00-16:00	0.0	0.7	0.0	1.6	1.5	76.4	135.0	26.7	165	2.08
4.7.2014	16:00-17:00	0.0	0.0	0.0	1.2	0.6	76.9	102.4	26.5	157	2.83
4.7.2014	17:00-18:00	0.1	0.0	0.0	0.0	6.2	78.8	65.5	25.5	179	1.33
4.7.2014	18:00-19:00	0.4	5.9	0.0	9.2	23.9	80.5	16.5	22.4	167	0.58
4.7.2014	19:00-20:00	0.5	18.7	0.0	5.2	36.0	89.5	3.9	23.1	149	0.25
4.7.2014	20:00-21:00	0.1	22.1	0.0	0.2	22.6	96.7	0.0	22.4	169	0.00
4.7.2014	21:00-22:00	0.0	56.2	0.0	0.2	12.9	101.6	0.0	21.8	199	0.00
4.7.2014	22:00-23:00	0.1	45.4	0.0	0.5	28.3	104.1	0.0	21.3	199	0.00
4.7.2014	23:00-00:00	0.1	61.2	0.0	2.2	15.6	103.3	0.0	21.4	199	0.00
5.7.2014	00:00-01:00	0.2	49.6	0.0	3.7	21.8	99.3	0.0	21.9	186	0.00
5.7.2014	01:00-02:00	0.0	14.3	0.0	2.4	33.1	100.2	0.0	22.2	189	0.08
5.7.2014	02:00-03:00	1.0	25.4	0.0	5.2	25.5	101.9	0.2	22.0	185	0.42
5.7.2014	03:00-04:00	0.1	14.4	0.0	2.3	25.2	102.0	0.2	21.9	180	0.08
5.7.2014	04:00-05:00	0.0	13.9	0.0	1.6	26.5	101.8	0.0	22.0	189	0.08
5.7.2014	05:00-06:00	0.0	19.6	0.0	1.5	19.1	101.6	0.0	22.0	184	0.00
5.7.2014	06:00-07:00	0.1	29.5	1.0	4.7	28.0	98.2	0.0	21.0	188	0.00
5.7.2014	07:00-08:00	0.0	19.0	0.0	6.8	18.2	100.4	0.0	20.6	260	0.00
5.7.2014	08:00-09:00	0.3	12.0	0.0	1.0	17.5	99.6	0.0	21.4	198	0.00
5.7.2014	09:00-10:00	0.8	5.9	0.0	4.2	31.1	94.7	0.0	22.6	166	0.50
5.7.2014	10:00-11:00	1.3	84.5	0.0	16.4	35.8	89.0	0.0	24.2	187	0.17
5.7.2014	11:00-12:00	0.1	90.3	0.4	11.6	24.9	86.2	5.9	25.4	149	0.92
5.7.2014	12:00-13:00	0.8	0.0	0.1	12.6	19.2	84.5	150.5	26.4	143	2.83
5.7.2014	13:00-14:00	0.2	0.3	0.1	1.3	8.3	86.4	196.2	26.1	142	2.67

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
5.7.2014	14:00-15:00	0.0	85.2	0.0	2.2	22.5	100.2	2.9	21.2	148	2.50
5.7.2014	15:00-16:00	0.0	100.5	0.0	7.6	16.6	102.5	0.0	21.4	154	1.50
5.7.2014	16:00-17:00	0.2	95.7	0.0	0.4	67.5	90.0	0.0	21.9	155	0.50
5.7.2014	17:00-18:00	0.4	107.5	0.0	0.6	37.9	97.0	0.0	22.0	157	0.67
5.7.2014	18:00-19:00	0.4	60.7	0.0	5.1	29.8	98.4	0.3	22.0	187	0.42
5.7.2014	19:00-20:00	0.1	54.1	0.0	2.9	24.9	100.8	0.0	21.9	195	0.83
5.7.2014	20:00-21:00	0.3	22.4	0.0	3.4	45.3	104.3	0.0	21.9	225	0.33
5.7.2014	21:00-22:00	0.3	40.2	0.0	3.5	40.3	101.3	0.0	21.7	163	0.00
5.7.2014	22:00-23:00	0.2	24.0	0.0	3.4	41.2	102.4	0.0	21.3	184	0.00
5.7.2014	23:00-00:00	0.1	28.0	0.0	2.9	43.8	103.0	0.0	21.5	199	0.00
6.7.2014	00:00-01:00	0.1	25.9	0.0	2.3	41.4	102.7	0.0	21.3	199	0.00
6.7.2014	01:00-02:00	0.2	23.4	0.0	1.3	49.8	104.0	0.0	21.4	199	0.00
6.7.2014	02:00-03:00	0.0	41.5	0.0	1.7	48.7	100.6	0.0	21.1	199	0.00
6.7.2014	03:00-04:00	0.1	51.2	0.0	4.2	46.2	104.9	0.0	21.3	199	0.00
6.7.2014	04:00-05:00	0.3	34.2	0.0	4.6	70.4	105.4	0.0	21.1	199	0.00
6.7.2014	05:00-06:00	0.4	37.4	0.0	3.2	108.5	105.7	0.0	21.1	199	0.00
6.7.2014	06:00-07:00	0.5	30.5	0.0	4.7	123.0	105.2	0.0	21.3	201	0.00
6.7.2014	07:00-08:00	0.8	20.5	0.0	0.6	77.4	101.3	0.0	22.3	209	0.00
6.7.2014	08:00-09:00	1.0	5.7	0.0	15.5	72.4	90.8	40.6	24.6	180	0.00
6.7.2014	09:00-10:00	1.4	0.2	0.1	18.7	64.4	81.1	90.2	26.8	161	0.25
6.7.2014	10:00-11:00	1.5	1.6	0.0	0.0	84.4	85.5	28.9	25.8	153	1.83
6.7.2014	11:00-12:00	1.1	3.1	0.0	0.0	59.0	82.3	68.5	26.6	202	0.17
6.7.2014	12:00-13:00	1.0	1.4	0.1	1.1	53.4	80.5	86.5	27.2	189	1.17
6.7.2014	13:00-14:00	0.5	21.0	0.0	0.0	50.9	93.7	36.8	24.4	187	0.42

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp	WDir	WSpd
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C	Deg.	kph
6.7.2014	14:00-15:00	0.0	89.9	0.0	2.2	22.5	103.5	2.9	21.2	201	0.25
6.7.2014	15:00-16:00	0.0	108.2	0.0	7.6	16.6	101.3	0.0	21.4	203	0.17
6.7.2014	16:00-17:00	0.2	109.2	0.0	0.4	67.5	99.2	0.0	21.9	191	1.50
6.7.2014	17:00-18:00	0.4	107.5	0.0	0.6	37.9	97.0	0.0	22.0	190	1.25
6.7.2014	18:00-19:00	0.4	60.7	0.0	5.1	29.8	98.4	0.3	22.0	185	1.75
6.7.2014	19:00-20:00	0.1	54.1	0.0	2.9	24.9	101.0	0.0	21.9	189	0.17
6.7.2014	20:00-21:00	0.3	22.4	0.0	3.4	45.3	100.8	0.0	21.9	184	0.17
6.7.2014	21:00-22:00	0.3	39.8	0.0	3.5	40.3	101.3	0.0	21.7	199	0.00
6.7.2014	22:00-23:00	0.2	24.0	0.0	3.4	41.2	102.4	0.0	21.3	191	0.00
6.7.2014	23:00-00:00	0.1	28.0	0.0	2.9	43.8	103.0	0.0	21.5	181	0.08
7.7.2014	00:00-01:00	0.1	25.9	0.0	2.3	41.4	102.7	0.0	21.3	194	0.08
7.7.2014	01:00-02:00	0.2	28.2	0.0	1.3	49.8	104.0	0.0	21.4	199	0.00
7.7.2014	02:00-03:00	0.0	40.3	0.0	1.7	48.7	104.0	0.0	21.1	200	0.08
7.7.2014	03:00-04:00	0.1	52.7	0.0	4.2	46.2	104.9	0.0	21.3	192	0.00
7.7.2014	04:00-05:00	0.3	36.4	0.0	4.6	70.4	105.4	0.0	21.1	184	0.00
7.7.2014	05:00-06:00	0.4	37.4	0.0	3.2	108.5	105.7	0.0	21.1	194	0.00
7.7.2014	06:00-07:00	0.5	39.0	0.0	4.7	123.0	105.2	0.0	21.3	190	0.00
7.7.2014	07:00-08:00	0.8	20.5	0.0	0.6	77.4	101.3	0.0	22.3	180	0.00
7.7.2014	08:00-09:00	1.0	5.7	0.0	15.5	72.4	90.8	40.6	24.6	194	0.33
7.7.2014	09:00-10:00	1.4	0.2	0.1	18.7	64.4	81.1	96.6	26.8	187	0.75
7.7.2014	10:00-11:00	1.0	3.5	0.5	3.6	27.6	80.7	120.0	27.6	166	0.33
7.7.2014	11:00-12:00	0.3	12.2	0.2	3.0	21.5	79.7	121.2	27.7	191	0.75
7.7.2014	12:00-13:00	0.1	1.9	0.0	4.1	21.8	76.9	103.7	28.3	187	1.00
7.7.2014	13:00-14:00	0.7	0.3	0.1	12.6	18.0	72.4	108.9	30.4	196	0.67

3) Hourly Raw Data of Air Quality Monitoring at AqNV-1 (Dry Season)

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
9.5.2014	11:00-12:00	0.0	167.8	0.0	20.3	14.6	50.2	43.8	35.9
9.5.2014	12:00-13:00	0.0	23.4	0.0	47.6	63.9	76.8	412.5	26.9
9.5.2014	13:00-14:00	366.5	2.0	0.0	46.1	77.1	86.7	1.0	25.9
9.5.2014	14:00-15:00	252.6	28.2	0.0	35.8	89.7	94.2	1.0	26.5
9.5.2014	15:00-16:00	617.4	35.5	0.0	69.6	46.8	93.9	1.0	24.0
9.5.2014	16:00-17:00	704.2	31.7	0.0	83.6	68.4	95.9	1.0	24.0
9.5.2014	17:00-18:00	335.4	29.1	0.0	48.0	66.6	77.5	1.0	23.7
9.5.2014	18:00-19:00	593.6	28.5	0.0	98.4	179.9	21.2	27.9	24.0
9.5.2014	19:00-20:00	150.1	20.4	0.0	50.2	66.8	91.7	1.7	25.4
9.5.2014	20:00-21:00	62.3	23.4	0.0	37.9	49.9	82.7	1.7	27.4
9.5.2014	21:00-22:00	218.9	33.2	0.0	79.8	230.8	96.1	75.8	23.0
9.5.2014	22:00-23:00	418.4	19.8	0.0	82.4	252.2	96.5	14.6	23.0
9.5.2014	23:00-00:00	183.7	38.1	0.0	28.9	82.0	71.0	206.5	30.3
10.5.2014	00:00-01:00	0.0	43.8	0.0	9.2	34.3	60.5	81.2	34.2
10.5.2014	01:00-02:00	0.0	159.7	0.0	2.3	3.8	68.6	2.2	31.6
10.5.2014	02:00-03:00	0.0	72.0	0.0	33.5	16.1	62.9	53.7	32.5
10.5.2014	03:00-04:00	0.0	26.3	0.0	2.7	2.8	65.2	541.3	33.0
10.5.2014	04:00-05:00	50.9	14.1	0.0	13.9	205.6	86.3	57.3	26.4
10.5.2014	05:00-06:00	266.2	19.9	0.0	4.4	22.5	76.3	1.0	28.6
10.5.2014	06:00-07:00	140.5	32.2	0.0	24.3	46.9	82.4	156.9	27.1
10.5.2014	07:00-08:00	0.2	23.4	0.0	38.4	42.1	85.2	85.4	26.0
10.5.2014	08:00-09:00	28.6	24.7	0.0	49.4	46.8	82.7	1.0	26.0
10.5.2014	09:00-10:00	47.3	19.8	0.0	57.6	65.0	81.6	6.7	26.0
10.5.2014	10:00-11:00	8.3	12.2	0.0	30.6	53.3	84.1	4.9	25.3

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
10.5.2014	11:00-12:00	89.1	19.5	0.0	28.2	67.9	82.3	1.0	25.5
10.5.2014	12:00-13:00	49.8	22.8	0.0	36.6	53.2	86.0	28.7	25.0
10.5.2014	13:00-14:00	0.0	2.0	0.0	121.1	102.6	91.6	1.0	24.1
10.5.2014	14:00-15:00	62.8	10.7	0.0	89.3	115.1	93.5	1.0	24.0
10.5.2014	15:00-16:00	84.3	15.5	0.0	100.0	154.0	94.4	14.0	24.0
10.5.2014	16:00-17:00	180.9	10.7	0.0	118.5	206.9	96.7	62.6	23.3
10.5.2014	17:00-18:00	450.0	11.4	0.0	155.1	271.5	96.0	47.3	24.0
10.5.2014	18:00-19:00	565.7	12.2	0.0	134.9	206.8	94.8	28.9	24.3
10.5.2014	19:00-20:00	197.8	9.4	0.0	65.1	78.0	93.2	1.2	25.5
10.5.2014	20:00-21:00	128.6	17.7	0.0	26.6	21.2	87.7	1.0	26.9
10.5.2014	21:00-22:00	35.1	26.9	0.0	7.1	13.4	71.5	4.3	30.2
10.5.2014	22:00-23:00	0.0	79.8	0.0	1.1	2.0	63.2	138.7	32.4
10.5.2014	23:00-00:00	0.0	64.7	0.0	1.2	2.2	59.4	350.1	33.5
11.5.2014	00:00-01:00	0.0	41.0	0.0	9.7	9.5	56.9	472.6	34.4
11.5.2014	01:00-02:00	0.0	26.4	0.0	14.5	10.7	54.3	408.3	35.4
11.5.2014	02:00-03:00	0.0	34.9	0.0	36.5	42.5	70.0	120.0	31.1
11.5.2014	03:00-04:00	0.0	7.2	0.0	19.3	28.1	76.2	4.4	27.1
11.5.2014	04:00-05:00	21.7	3.1	0.0	4.3	10.5	76.8	1.0	27.3
11.5.2014	05:00-06:00	47.9	16.3	0.0	32.7	42.1	78.7	1.0	26.7
11.5.2014	06:00-07:00	253.1	19.5	0.0	28.9	42.2	80.3	1.0	26.7
11.5.2014	07:00-08:00	158.0	15.3	0.0	30.7	45.9	85.0	1.0	26.2
11.5.2014	08:00-09:00	72.6	20.1	0.0	33.3	48.1	84.8	1.2	26.3
11.5.2014	09:00-10:00	117.2	26.2	0.0	45.9	63.6	83.3	1.3	26.0
11.5.2014	10:00-11:00	126.2	20.7	0.0	32.0	42.6	84.5	1.6	26.0

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
11.5.2014	11:00-12:00	6.3	18.2	0.0	44.2	61.0	85.5	1.2	25.2
11.5.2014	12:00-13:00	0.0	10.1	0.0	3.6	28.8	86.2	1.4	25.8
11.5.2014	13:00-14:00	34.1	21.4	0.0	34.5	49.7	87.4	1.3	25.4
11.5.2014	14:00-15:00	4.0	19.4	0.6	47.0	63.8	88.7	11.0	25.0
11.5.2014	15:00-16:00	48.7	16.9	0.2	49.8	72.1	91.4	3.7	24.2
11.5.2014	16:00-17:00	320.9	10.5	0.0	67.8	97.4	93.8	29.5	24.0
11.5.2014	17:00-18:00	197.0	12.0	0.0	82.6	123.1	94.4	8.6	24.0
11.5.2014	18:00-19:00	609.2	11.6	0.0	121.9	177.8	94.6	28.9	24.3
11.5.2014	19:00-20:00	380.0	22.7	0.0	76.8	94.3	84.4	1.0	27.1
11.5.2014	20:00-21:00	22.3	23.0	0.0	28.3	35.5	80.1	1.8	28.1
11.5.2014	21:00-22:00	50.1	27.3	0.0	7.4	16.0	72.1	4.3	30.1
11.5.2014	22:00-23:00	2.8	35.0	0.0	22.8	26.1	65.3	28.4	32.3
11.5.2014	23:00-00:00	1.4	36.4	0.0	35.9	36.7	65.3	176.3	32.2
12.5.2014	00:00-01:00	0.0	45.8	0.0	8.9	9.7	54.5	29.3	35.6
12.5.2014	01:00-02:00	0.0	50.4	0.0	3.7	4.7	49.5	326.6	37.0
12.5.2014	02:00-03:00	0.0	24.5	0.0	7.1	9.3	52.4	372.5	37.0
12.5.2014	03:00-04:00	0.0	16.6	0.0	33.9	42.0	67.8	96.5	32.3
12.5.2014	04:00-05:00	20.2	5.7	0.0	41.6	64.8	84.6	1.0	26.2
12.5.2014	05:00-06:00	394.7	8.0	0.0	39.8	60.8	93.3	1.0	25.0
12.5.2014	06:00-07:00	636.0	18.0	0.0	41.6	54.1	88.5	1.4	24.5
12.5.2014	07:00-08:00	264.9	18.5	0.0	44.6	45.9	86.6	1.0	25.0
12.5.2014	08:00-09:00	59.2	20.2	0.0	34.2	40.5	87.8	1.0	24.8
12.5.2014	09:00-10:00	288.6	17.8	0.0	40.3	46.7	89.4	3.1	25.0
12.5.2014	10:00-11:00	91.3	18.9	0.0	35.1	45.8	90.8	1.1	25.0

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
12.5.2014	11:00-12:00	99.1	16.3	0.0	41.3	59.5	92.2	1.1	24.8
12.5.2014	12:00-13:00	3.4	11.8	0.0	42.1	71.7	93.6	1.0	24.8
12.5.2014	13:00-14:00	43.8	12.6	0.0	49.1	83.8	95.2	1.0	24.8
12.5.2014	14:00-15:00	38.1	15.8	0.0	42.5	64.6	94.9	1.0	25.0
12.5.2014	15:00-16:00	6.1	15.3	0.0	42.4	62.2	94.4	1.3	25.0
12.5.2014	16:00-17:00	57.6	16.8	0.0	33.3	55.1	93.8	1.0	25.0
12.5.2014	17:00-18:00	84.4	13.9	0.0	42.4	62.1	94.1	2.9	25.0
12.5.2014	18:00-19:00	159.6	12.4	0.0	49.0	79.8	93.1	7.1	25.0
12.5.2014	19:00-20:00	265.2	15.2	0.0	42.3	55.7	90.5	2.5	26.1
12.5.2014	20:00-21:00	72.2	32.5	0.0	20.8	31.3	82.1	1.0	28.0
12.5.2014	21:00-22:00	82.5	26.7	0.0	23.6	35.4	82.2	23.9	27.6
12.5.2014	22:00-23:00	143.6	15.7	0.0	26.0	33.8	82.0	55.7	28.3
12.5.2014	23:00-00:00	7.5	21.5	0.0	17.2	13.5	81.2	24.1	28.6
13.5.2014	00:00-01:00	1.3	15.6	0.0	13.8	3.4	77.8	83.5	27.6
13.5.2014	01:00-02:00	0.0	19.4	0.0	2.3	6.3	72.4	1.1	29.0
13.5.2014	02:00-03:00	0.0	27.5	0.0	1.9	6.5	69.1	19.1	29.9
13.5.2014	03:00-04:00	0.0	25.6	0.0	12.8	21.9	69.7	86.0	29.7
13.5.2014	04:00-05:00	0.0	26.8	0.0	30.1	34.6	65.2	76.3	30.0
13.5.2014	05:00-06:00	3.8	24.0	0.0	34.8	44.4	68.6	16.4	29.0
13.5.2014	06:00-07:00	12.3	21.1	0.0	38.5	51.8	74.3	60.0	27.4
13.5.2014	07:00-08:00	73.0	8.4	0.0	29.2	37.6	81.5	2.3	26.0
13.5.2014	08:00-09:00	47.8	8.1	0.0	27.5	37.8	83.4	1.0	26.0
13.5.2014	09:00-10:00	102.0	13.1	0.0	24.7	24.5	85.7	1.0	25.7
13.5.2014	10:00-11:00	68.0	15.2	0.0	24.7	36.5	88.3	1.1	25.0

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
13.5.2014	11:00-12:00	0.0	15.3	0.0	28.7	39.0	90.4	1.0	25.0
13.5.2014	12:00-13:00	0.0	11.2	0.0	27.3	39.5	92.3	1.0	25.0
13.5.2014	13:00-14:00	0.0	14.6	0.0	23.3	40.4	92.6	1.3	25.0
13.5.2014	14:00-15:00	1.1	18.8	0.0	21.1	41.7	93.5	1.0	24.5
13.5.2014	15:00-16:00	3.5	16.2	0.0	26.7	52.1	94.8	1.3	24.3
13.5.2014	16:00-17:00	44.1	12.5	0.0	45.0	73.7	95.9	7.1	24.0
13.5.2014	17:00-18:00	195.6	10.6	0.0	51.3	87.1	96.0	13.4	24.4
13.5.2014	18:00-19:00	74.0	10.9	0.0	51.6	76.1	95.3	1.2	25.0
13.5.2014	19:00-20:00	191.0	11.9	0.0	42.4	46.3	92.3	1.8	25.4
13.5.2014	20:00-21:00	128.6	17.7	0.0	26.6	21.2	87.7	1.0	26.9
13.5.2014	21:00-22:00	37.4	22.2	0.0	21.6	83.1	79.5	1.0	29.3
13.5.2014	22:00-23:00	0.0	32.3	0.0	17.1	25.3	69.3	17.0	31.4
13.5.2014	23:00-00:00	4.8	46.2	0.0	28.8	35.7	65.9	318.6	32.6
14.5.2014	00:00-01:00	0.0	54.9	0.0	17.8	23.0	51.3	33.4	37.8
14.5.2014	01:00-02:00	0.0	54.5	0.0	23.2	29.1	54.6	149.4	36.5
14.5.2014	02:00-03:00	0.0	26.8	0.0	65.8	97.8	78.6	43.6	28.6
14.5.2014	03:00-04:00	92.0	11.1	0.0	80.2	127.0	92.0	1.3	24.8
14.5.2014	04:00-05:00	200.4	14.4	0.0	78.9	40.8	82.5	1.0	24.3
14.5.2014	05:00-06:00	221.2	26.7	0.0	30.0	57.4	89.4	1.0	25.0
14.5.2014	06:00-07:00	85.3	37.8	0.0	46.8	64.5	93.1	11.5	22.7
14.5.2014	07:00-08:00	5.1	39.8	0.0	95.8	94.9	90.4	1.0	23.2
14.5.2014	08:00-09:00	137.5	30.2	0.0	67.0	74.6	91.2	1.0	24.0
14.5.2014	09:00-10:00	93.2	25.4	0.0	48.8	37.0	90.6	1.3	24.0
14.5.2014	10:00-11:00	34.2	24.1	0.0	37.0	65.2	90.5	1.1	24.0

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
14.5.2014	11:00-12:00	0.0	19.1	0.0	31.7	140.1	92.1	1.0	24.0
14.5.2014	12:00-13:00	0.6	16.1	0.0	17.3	88.4	93.1	1.6	24.0
14.5.2014	13:00-14:00	0.0	13.0	0.0	5.0	27.1	92.5	1.4	24.0
14.5.2014	14:00-15:00	3.0	14.6	0.0	1.0	47.8	93.2	1.4	24.0
14.5.2014	15:00-16:00	0.0	16.3	0.0	10.2	46.0	93.2	1.4	24.0
14.5.2014	16:00-17:00	0.0	17.3	0.0	32.3	54.1	93.6	1.1	24.0
14.5.2014	17:00-18:00	14.7	19.2	0.0	45.4	62.8	95.0	5.6	24.0
14.5.2014	18:00-19:00	2.5	17.0	0.0	52.7	68.3	94.7	8.0	24.0
14.5.2014	19:00-20:00	50.1	16.3	0.0	36.7	54.1	91.1	5.0	24.4
14.5.2014	20:00-21:00	9.5	18.9	0.0	11.7	35.3	82.8	1.0	27.9
14.5.2014	21:00-22:00	36.3	29.9	0.0	15.0	27.4	78.7	1.2	29.5
14.5.2014	22:00-23:00	0.0	36.4	0.0	11.1	77.0	69.6	1.4	32.0
14.5.2014	23:00-00:00	0.0	42.4	0.0	47.3	38.8	65.4	236.0	32.8
15.5.2014	00:00-01:00	0.0	32.9	0.0	9.3	37.1	59.2	94.7	34.7
15.5.2014	01:00-02:00	0.0	35.7	0.0	16.5	14.7	54.2	47.0	36.4
15.5.2014	02:00-03:00	0.0	43.4	0.0	33.8	42.1	56.1	93.9	35.9
15.5.2014	03:00-04:00	0.0	32.0	0.0	50.6	53.8	72.1	60.6	29.6
15.5.2014	04:00-05:00	12.7	16.8	0.0	26.7	21.1	75.3	1.0	26.1
15.5.2014	05:00-06:00	168.3	14.2	0.0	46.5	23.2	77.1	1.0	25.9
15.5.2014	06:00-07:00	367.3	22.1	0.0	54.6	40.5	79.0	2.1	26.0
15.5.2014	07:00-08:00	396.7	23.9	0.0	66.6	143.2	82.4	1.0	25.2
15.5.2014	08:00-09:00	166.3	16.6	0.0	61.1	356.9	84.9	1.0	25.7
15.5.2014	09:00-10:00	123.8	21.4	0.0	56.3	59.2	86.4	1.0	25.3
15.5.2014	10:00-11:00	4.9	21.3	0.0	52.9	54.3	85.0	1.9	25.0

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
15.5.2014	11:00-12:00	2.1	18.1	0.0	46.2	64.3	85.5	1.4	25.0
15.5.2014	12:00-13:00	33.1	19.4	0.0	49.5	40.4	86.6	1.0	25.0
15.5.2014	13:00-14:00	0.7	13.1	0.0	47.1	54.3	88.1	1.0	25.0
15.5.2014	14:00-15:00	9.7	15.7	0.0	45.5	20.0	89.2	1.1	25.0
15.5.2014	15:00-16:00	0.3	15.4	0.0	57.3	73.3	92.5	9.2	24.9
15.5.2014	16:00-17:00	11.8	12.5	0.0	56.7	82.4	93.5	5.7	24.8
15.5.2014	17:00-18:00	200.1	16.2	0.0	63.3	96.8	95.0	8.3	24.0
15.5.2014	18:00-19:00	381.4	15.1	0.0	85.3	107.3	95.6	22.4	24.4
15.5.2014	19:00-20:00	197.8	9.4	0.0	65.1	78.0	93.2	1.2	25.5
15.5.2014	20:00-21:00	326.8	15.4	0.0	59.5	117.5	89.3	4.9	26.8
15.5.2014	21:00-22:00	126.4	14.6	0.0	36.2	17.8	86.9	1.2	27.9
15.5.2014	22:00-23:00	43.2	20.0	0.0	17.3	32.4	80.8	1.5	29.7
15.5.2014	23:00-00:00	18.9	28.5	0.0	13.2	30.4	73.6	1.0	31.4
16.5.2014	00:00-01:00	0.0	35.1	0.0	19.7	25.2	68.0	23.8	32.2
16.5.2014	01:00-02:00	0.0	54.5	0.0	23.2	29.1	54.6	149.4	36.5
16.5.2014	02:00-03:00	0.0	26.8	0.0	65.8	97.8	78.6	43.6	28.6
16.5.2014	03:00-04:00	0.0	16.6	0.0	33.9	42.0	67.8	96.5	32.3
16.5.2014	04:00-05:00	0.0	26.8	0.0	30.1	34.6	65.2	76.3	30.0
16.5.2014	05:00-06:00	47.9	16.3	0.0	32.7	42.1	78.7	1.0	26.7
16.5.2014	06:00-07:00	367.3	22.1	0.0	54.6	40.5	79.0	2.1	26.0
16.5.2014	07:00-08:00	0.2	23.4	0.0	38.4	42.1	85.2	85.4	26.0
16.5.2014	08:00-09:00	59.2	20.2	0.0	34.2	40.5	87.8	1.0	24.8
16.5.2014	09:00-10:00	93.2	25.4	0.0	48.8	37.0	90.6	1.3	24.0
16.5.2014	10:00-11:00	68.0	15.2	0.0	24.7	36.5	88.3	1.1	25.0

4) Hourly Raw Data of Air Quality Monitoring at AqNV-1 (Rainy Season)

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
30.6.2014	14:00-15:00	0.1	0.0	0.0	6.8	38.2	86.9	1.0	25.2
30.6.2014	15:00-16:00	0.1	0.0	0.0	57.9	40.1	86.5	0.0	26.1
30.6.2014	16:00-17:00	0.1	0.0	0.0	15.7	34.8	85.0	0.0	26.0
30.6.2014	17:00-18:00	0.0	0.0	0.0	22.2	43.9	73.2	9.5	23.3
30.6.2014	18:00-19:00	0.0	0.0	0.0	11.4	48.8	94.0	23.4	23.0
30.6.2014	19:00-20:00	0.1	0.0	0.0	25.6	64.3	90.1	0.0	22.5
30.6.2014	20:00-21:00	0.0	0.0	0.0	15.0	70.6	74.4	0.5	21.6
30.6.2014	21:00-22:00	0.1	0.0	0.0	61.4	114.2	89.0	0.0	21.4
30.6.2014	22:00-23:00	0.1	0.0	0.0	27.3	98.2	79.9	0.0	22.0
30.6.2014	23:00-00:00	0.4	0.0	0.0	85.0	59.9	83.8	0.0	21.7
1.7.2014	00:00-01:00	0.2	0.0	0.0	53.0	77.2	90.0	0.0	22.0
1.7.2014	01:00-02:00	0.1	0.0	0.0	18.8	74.9	93.2	0.0	22.4
1.7.2014	02:00-03:00	0.0	0.0	0.0	106.4	53.3	93.1	0.0	22.1
1.7.2014	03:00-04:00	0.0	0.0	0.0	74.0	57.1	82.2	0.0	22.4
1.7.2014	04:00-05:00	0.1	0.0	0.0	58.1	50.0	100.0	0.0	22.3
1.7.2014	05:00-06:00	0.0	0.0	0.0	51.7	45.5	100.0	0.0	22.5
1.7.2014	06:00-07:00	0.0	0.0	0.0	33.9	42.9	100.0	0.0	21.7
1.7.2014	07:00-08:00	0.0	0.0	0.0	20.3	44.1	100.0	0.0	21.4
1.7.2014	08:00-09:00	0.1	0.0	0.0	14.6	48.1	100.0	0.0	21.5
1.7.2014	09:00-10:00	0.6	0.0	0.0	21.0	40.7	100.0	0.0	22.4
1.7.2014	10:00-11:00	0.9	0.0	0.0	2.1	32.1	100.0	0.0	23.6
1.7.2014	11:00-12:00	0.8	0.0	0.0	8.2	34.2	94.1	0.0	24.7
1.7.2014	12:00-13:00	0.3	0.0	0.0	14.1	58.0	95.8	0.0	24.8
1.7.2014	13:00-14:00	0.8	34.9	0.0	5.0	22.3	93.2	0.0	26.4

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
1.7.2014	14:00-15:00	0.4	34.5	0.0	9.5	56.1	100.0	0.0	26.7
1.7.2014	15:00-16:00	0.9	0.0	0.0	3.8	35.5	79.1	0.0	27.6
1.7.2014	16:00-17:00	0.6	34.5	0.0	60.4	50.3	99.0	0.0	26.8
1.7.2014	17:00-18:00	1.0	0.0	0.0	1.3	38.5	96.0	0.0	26.8
1.7.2014	18:00-19:00	0.9	34.9	0.0	6.5	31.9	60.2	0.0	28.3
1.7.2014	19:00-20:00	1.2	0.0	0.0	17.3	73.4	83.9	0.0	22.9
1.7.2014	20:00-21:00	0.9	0.0	0.0	1.0	66.5	100.0	0.0	22.5
1.7.2014	21:00-22:00	0.4	0.0	0.0	702.6	57.6	87.7	0.0	23.3
1.7.2014	22:00-23:00	1.1	0.0	0.0	9.4	70.1	91.7	0.0	22.7
1.7.2014	23:00-00:00	0.6	0.0	0.0	574.7	63.0	83.8	0.0	23.2
2.7.2014	00:00-01:00	0.3	0.0	0.0	447.3	45.8	89.9	0.0	23.2
2.7.2015	01:00-02:00	0.1	34.7	0.0	56.8	30.8	81.5	0.0	23.7
2.7.2016	02:00-03:00	0.0	0.0	0.0	11.4	28.1	82.1	0.0	23.3
2.7.2017	03:00-04:00	0.0	34.9	0.0	1.1	24.2	73.6	0.0	23.4
2.7.2018	04:00-05:00	0.1	34.6	0.0	2.6	29.0	80.6	0.0	23.5
2.7.2019	05:00-06:00	0.0	0.0	0.0	2.3	29.6	73.7	0.0	23.4
2.7.2020	06:00-07:00	0.0	0.0	0.0	12.0	39.6	73.7	0.0	23.0
2.7.2021	07:00-08:00	0.1	0.0	0.0	38.4	54.5	96.5	0.0	23.1
2.7.2022	08:00-09:00	0.3	0.0	0.0	31.1	54.6	92.3	0.0	23.7
2.7.2023	09:00-10:00	0.7	0.0	0.0	14.6	41.3	93.3	0.0	24.5
2.7.2024	10:00-11:00	0.6	0.0	0.0	5.8	32.4	92.4	0.0	25.0
2.7.2025	11:00-12:00	0.6	0.0	0.0	4.1	21.1	85.6	0.0	26.0
2.7.2026	12:00-13:00	0.9	0.0	0.0	4.4	8.1	92.2	0.0	27.3
2.7.2027	13:00-14:00	1.2	0.0	0.2	2.2	6.6	73.1	0.1	29.6

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
2.7.2014	14:00-15:00	0.4	34.5	0.0	9.5	56.1	100.0	0.0	26.7
2.7.2015	15:00-16:00	0.9	0.0	0.0	3.8	35.5	79.1	0.0	27.6
2.7.2016	16:00-17:00	0.2	34.5	0.0	14.6	25.6	63.9	0.0	30.1
2.7.2017	17:00-18:00	0.1	34.8	0.0	18.2	27.8	72.1	0.0	30.0
2.7.2018	18:00-19:00	0.0	34.7	0.0	34.4	51.9	62.5	0.4	27.7
2.7.2019	19:00-20:00	0.0	0.0	0.0	23.0	34.8	73.2	7.2	25.9
2.7.2020	20:00-21:00	0.0	0.0	0.0	6.4	31.8	94.1	2.9	25.7
2.7.2021	21:00-22:00	0.0	0.0	0.0	13.0	33.4	93.3	0.1	25.1
2.7.2022	22:00-23:00	0.0	0.0	0.0	3.2	32.3	90.2	0.7	24.2
2.7.2023	23:00-00:00	0.0	0.0	0.0	2.1	38.6	97.6	2.7	23.0
3.7.2014	00:00-01:00	0.2	0.0	0.0	6.2	46.9	98.3	0.0	23.7
3.7.2015	01:00-02:00	0.2	34.7	0.0	14.3	43.8	98.2	0.0	23.9
3.7.2016	02:00-03:00	0.2	34.8	0.0	2.7	44.7	96.6	0.0	24.2
3.7.2017	03:00-04:00	0.0	34.8	0.0	8.2	40.3	97.8	0.0	24.1
3.7.2018	04:00-05:00	0.0	34.4	0.0	2.2	38.4	99.9	0.0	23.8
3.7.2019	05:00-06:00	0.0	0.0	0.0	3.3	36.0	100.0	0.0	23.9
3.7.2020	06:00-07:00	0.1	34.7	0.0	22.8	51.9	97.8	0.0	23.8
3.7.2021	07:00-08:00	0.1	34.8	0.0	13.0	39.4	97.9	0.0	23.6
3.7.2022	08:00-09:00	0.0	0.0	0.0	2.8	47.7	93.3	1.0	22.7
3.7.2023	09:00-10:00	0.3	0.0	0.0	1.0	29.3	88.4	0.0	23.2
3.7.2024	10:00-11:00	0.3	0.0	0.0	1.0	34.2	75.4	0.0	23.0
3.7.2025	11:00-12:00	0.0	0.0	0.0	1.0	50.6	86.6	0.0	22.7
3.7.2026	12:00-13:00	0.0	0.0	0.0	9.6	33.0	98.6	0.0	23.5
3.7.2027	13:00-14:00	1.2	34.9	0.3	3.4	10.4	55.8	0.2	30.3

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
3.7.2014	14:00-15:00	0.0	0.0	0.0	9.6	34.4	84.6	1.0	25.9
3.7.2015	15:00-16:00	0.2	0.0	0.0	48.0	35.5	85.3	0.0	26.0
3.7.2016	16:00-17:00	0.9	34.9	0.0	6.5	31.7	58.2	0.0	28.3
3.7.2017	17:00-18:00	0.1	34.8	0.0	18.2	27.8	72.1	0.0	30.0
3.7.2018	18:00-19:00	0.1	34.7	0.0	18.4	31.1	79.1	0.0	29.8
3.7.2019	19:00-20:00	0.8	34.3	0.0	192.4	88.6	100.0	0.0	21.7
3.7.2020	20:00-21:00	0.7	34.4	0.0	146.4	89.6	100.0	0.0	21.8
3.7.2021	21:00-22:00	0.3	34.9	0.0	25.3	81.4	95.0	0.0	22.2
3.7.2022	22:00-23:00	0.1	0.0	0.0	7.0	84.7	93.6	0.0	22.4
3.7.2023	23:00-00:00	0.0	0.0	0.0	22.3	93.3	96.0	0.0	22.3
4.7.2014	00:00-01:00	0.0	0.0	0.0	23.3	74.9	100.0	0.0	22.6
4.7.2015	01:00-02:00	0.0	0.0	0.0	26.8	78.7	98.3	0.0	22.4
4.7.2016	02:00-03:00	0.1	0.0	0.0	3.2	49.5	96.7	0.0	22.8
4.7.2017	03:00-04:00	0.2	0.0	0.0	4.2	60.9	100.0	0.0	22.7
4.7.2018	04:00-05:00	0.0	0.0	0.0	9.3	59.5	100.0	0.0	22.7
4.7.2019	05:00-06:00	0.0	0.0	0.0	7.5	47.8	96.7	0.0	22.9
4.7.2020	06:00-07:00	0.0	0.0	0.0	3.0	52.7	100.0	0.0	22.8
4.7.2021	07:00-08:00	0.1	0.0	0.0	14.2	55.3	100.0	0.0	23.0
4.7.2022	08:00-09:00	0.3	0.0	0.0	12.7	56.4	98.3	0.0	23.0
4.7.2023	09:00-10:00	0.6	0.0	0.0	7.6	37.9	91.5	0.0	23.9
4.7.2024	10:00-11:00	0.4	0.0	0.0	5.7	28.1	88.7	0.0	24.7
4.7.2025	11:00-12:00	1.0	0.0	0.1	1.7	20.4	89.9	0.0	26.9
4.7.2026	12:00-13:00	0.9	0.0	0.0	4.9	10.6	92.7	0.0	27.0
4.7.2027	13:00-14:00	1.2	34.9	0.3	3.4	10.4	55.8	0.2	30.3

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
4.7.2014	14:00-15:00	0.0	0.0	0.0	9.6	34.4	84.6	1.0	25.9
4.7.2015	15:00-16:00	1.0	0.0	0.0	1.3	38.8	96.8	0.0	26.9
4.7.2016	16:00-17:00	0.2	0.0	0.0	3.7	30.7	81.0	0.0	26.0
4.7.2017	17:00-18:00	0.0	0.0	0.0	14.8	41.7	55.0	18.2	22.9
4.7.2018	18:00-19:00	0.0	0.0	0.0	1.0	42.2	92.5	32.0	22.7
4.7.2019	19:00-20:00	0.0	0.0	0.0	25.9	55.9	95.6	13.8	23.4
4.7.2020	20:00-21:00	0.4	34.8	0.0	17.1	54.1	84.4	0.0	25.5
4.7.2021	21:00-22:00	0.0	34.8	0.0	17.5	51.1	89.9	0.0	24.9
4.7.2022	22:00-23:00	0.5	34.4	0.0	37.6	79.3	55.4	0.0	23.6
4.7.2023	23:00-00:00	0.2	33.9	0.0	37.1	67.3	30.2	0.0	22.4
5.7.2014	00:00-01:00	0.0	34.2	0.0	46.1	68.5	95.3	0.0	22.6
5.7.2015	01:00-02:00	0.0	34.7	0.0	29.5	53.7	97.1	0.0	23.1
5.7.2016	02:00-03:00	0.0	0.0	0.0	3.5	14.1	76.6	0.0	23.8
5.7.2017	03:00-04:00	0.1	0.0	0.0	2.3	16.2	91.6	0.0	24.0
5.7.2018	04:00-05:00	0.2	0.0	0.0	1.3	16.5	94.1	0.0	24.0
5.7.2019	05:00-06:00	0.0	0.0	0.0	7.5	19.6	92.8	0.0	23.9
5.7.2020	06:00-07:00	0.1	0.0	0.0	11.6	31.1	88.5	0.0	23.8
5.7.2021	07:00-08:00	0.1	34.9	0.0	25.2	48.9	98.3	0.0	23.5
5.7.2022	08:00-09:00	0.1	0.0	0.0	43.8	55.4	97.8	0.1	23.3
5.7.2023	09:00-10:00	0.0	0.0	0.0	6.8	50.3	100.0	13.2	22.2
5.7.2024	10:00-11:00	0.0	0.0	0.0	9.9	52.4	100.0	9.4	22.3
5.7.2025	11:00-12:00	0.9	0.0	0.0	3.1	33.8	100.0	0.0	23.9
5.7.2026	12:00-13:00	0.6	0.0	0.0	10.3	38.7	99.5	0.0	24.4
5.7.2027	13:00-14:00	0.8	0.0	0.0	2.7	20.1	87.9	0.0	25.9

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
5.7.2014	14:00-15:00	0.0	0.0	0.3	9.6	34.4	84.6	1.0	25.9
5.7.2015	15:00-16:00	0.2	0.0	0.0	45.2	35.5	85.3	0.0	26.0
5.7.2016	16:00-17:00	0.5	34.9	0.0	6.5	31.7	58.2	0.0	28.3
5.7.2017	17:00-18:00	0.1	34.8	0.2	18.2	27.8	72.1	0.0	27.6
5.7.2018	18:00-19:00	0.1	34.7	0.0	18.4	31.1	79.1	0.0	25.2
5.7.2019	19:00-20:00	0.4	34.3	0.0	150.3	85.3	92.5	0.1	21.7
5.7.2020	20:00-21:00	0.7	34.4	0.1	140.3	80.3	100.0	0.0	21.8
5.7.2021	21:00-22:00	0.3	35.3	0.0	25.3	78.2	95.0	0.0	22.2
5.7.2022	22:00-23:00	0.1	0.0	0.0	7.0	80.3	93.6	0.0	22.4
5.7.2023	23:00-00:00	0.0	0.0	0.1	22.3	90.2	96.0	0.0	22.3
6.7.2014	00:00-01:00	0.1	0.0	0.0	23.3	74.9	100.0	0.1	22.6
6.7.2015	01:00-02:00	0.0	0.0	0.1	26.8	78.7	98.3	0.0	22.4
6.7.2016	02:00-03:00	0.1	0.0	0.0	3.2	49.5	96.7	0.2	22.8
6.7.2017	03:00-04:00	0.2	34.1	0.1	4.2	60.9	96.3	0.0	22.7
6.7.2018	04:00-05:00	0.0	0.0	0.0	9.3	59.5	100.0	0.0	22.7
6.7.2019	05:00-06:00	0.0	0.0	0.0	7.5	47.8	96.7	0.1	22.9
6.7.2020	06:00-07:00	0.0	33.7	0.0	3.0	52.7	100.0	0.0	22.8
6.7.2021	07:00-08:00	0.1	0.0	0.0	14.2	55.3	95.3	0.0	22.3
6.7.2022	08:00-09:00	0.3	0.0	0.0	12.7	56.4	98.3	0.0	23.0
6.7.2023	09:00-10:00	0.6	0.0	0.0	7.6	37.9	90.5	0.0	23.9
6.7.2024	10:00-11:00	0.4	0.0	0.0	5.7	28.1	83.2	0.1	24.7
6.7.2025	11:00-12:00	0.6	0.0	0.1	1.7	20.4	85.4	0.0	26.9
6.7.2026	12:00-13:00	0.6	0.0	0.0	4.9	10.6	90.7	0.0	25.4
6.7.2027	13:00-14:00	0.3	32.7	0.3	3.4	10.4	55.8	0.2	25.8

Date	Time	CO	NO2	NO	PM2.5	PM10	RH	SO2	Temp
D.M.Y	H.M.S	ppm	ppb	ppm	µg/m3	µg/m3	%	ppb	Deg. C
6.7.2014	14:00-15:00	0.1	34.5	0.0	9.5	50.2	100.0	0.0	26.7
6.7.2015	15:00-16:00	0.5	0.0	0.1	3.8	35.5	79.1	0.0	27.6
6.7.2016	16:00-17:00	0.2	34.5	0.0	14.6	25.6	63.9	0.0	30.1
6.7.2017	17:00-18:00	0.1	34.8	0.1	18.2	27.8	72.1	0.0	30.0
6.7.2018	18:00-19:00	0.0	32.5	0.0	30.5	50.2	62.5	0.4	27.7
6.7.2019	19:00-20:00	0.0	0.0	0.1	23.0	34.8	73.2	5.2	22.4
6.7.2020	20:00-21:00	0.0	0.0	0.0	6.4	31.8	94.1	2.9	22.7
6.7.2021	21:00-22:00	0.0	0.0	0.1	10.5	33.4	93.3	0.1	25.1
6.7.2022	22:00-23:00	0.0	0.0	0.1	3.2	32.3	90.2	0.7	24.2
6.7.2023	23:00-00:00	1.0	0.0	0.0	2.1	38.6	97.6	2.0	23.0
7.7.2014	00:00-01:00	0.2	0.0	0.0	6.2	46.9	98.3	0.0	23.7
7.7.2015	01:00-02:00	0.1	34.7	0.2	14.3	43.8	98.2	0.0	23.9
7.7.2016	02:00-03:00	0.2	34.8	0.0	2.7	46.1	96.6	0.0	24.2
7.7.2017	03:00-04:00	0.0	30.6	0.0	8.2	40.3	97.8	0.1	24.1
7.7.2018	04:00-05:00	0.0	34.4	0.0	2.2	38.4	99.9	0.0	23.8
7.7.2019	05:00-06:00	0.0	0.0	0.0	3.3	36.0	103.2	0.0	23.9
7.7.2020	06:00-07:00	0.1	34.7	0.1	25.6	51.9	97.8	0.0	23.8
7.7.2021	07:00-08:00	0.0	31.5	0.0	13.0	39.4	97.9	0.0	23.6
7.7.2022	08:00-09:00	0.0	0.0	0.0	2.8	40.7	93.3	1.0	22.7
7.7.2023	09:00-10:00	0.3	0.0	0.0	1.0	29.3	88.4	0.0	23.2
7.7.2024	10:00-11:00	0.3	0.0	0.0	1.0	34.2	75.4	0.0	23.0
7.7.2025	11:00-12:00	0.0	0.0	0.0	1.0	45.6	80.4	0.1	22.7
7.7.2026	12:00-13:00	0.0	0.0	0.0	9.6	33.0	90.1	0.0	23.5
7.7.2027	13:00-14:00	0.0	34.9	0.4	3.4	10.4	55.8	0.2	25.2

5) Raw Data of Noise Level Monitoring at NVT-1 and AqNV-2

NVT-1		
Date	**Time**	**Value (dB)**
14/5/2014	10:07:50	71
14/5/2014	10:17:50	64.2
14/5/2014	10:27:50	54.4
14/5/2014	10:37:50	64.2
14/5/2014	10:47:50	66.5
14/5/2014	10:57:50	52.6
14/5/2014	11:07:50	58.3
14/5/2014	11:17:50	62.1
14/5/2014	11:27:50	55.5
14/5/2014	11:37:50	63.8
14/5/2014	11:47:50	75.8
14/5/2014	11:57:50	66.6
14/5/2014	12:07:50	57.5
14/5/2014	12:17:50	62.5
14/5/2014	12:27:50	73.5
14/5/2014	12:37:50	65.4
14/5/2014	12:47:50	73.1
14/5/2014	12:57:50	66.1
14/5/2014	13:07:50	68.2
14/5/2014	13:17:50	55.5
14/5/2014	13:27:50	61.7
14/5/2014	13:37:50	82.9
14/5/2014	13:47:50	81.1
14/5/2014	13:57:50	83.8
14/5/2014	14:07:50	65.6
14/5/2014	14:17:50	72.6
14/5/2014	14:27:50	65.4
14/5/2014	14:37:50	67.6
14/5/2014	14:47:50	80.2
14/5/2014	14:57:50	75.1
14/5/2014	15:07:50	77.8
14/5/2014	15:17:50	73.2
14/5/2014	15:27:50	75.7
14/5/2014	15:37:50	66.7
14/5/2014	15:47:50	70.4
14/5/2014	15:57:50	70.8
14/5/2014	16:07:50	68.6
14/5/2014	16:17:50	67.5
14/5/2014	16:27:50	65.1
14/5/2014	16:37:50	63.6
14/5/2014	16:47:50	64.3
14/5/2014	16:57:50	67.3
14/5/2014	17:07:50	61.3
14/5/2014	17:17:50	61.2
14/5/2014	17:27:50	68.1
14/5/2014	17:37:50	66
14/5/2014	17:47:50	69.1
14/5/2014	17:57:50	63.8
14/5/2014	18:07:50	64.7
14/5/2014	18:17:50	61.8
14/5/2014	18:27:50	78.4
14/5/2014	18:37:50	61.5
14/5/2014	18:47:50	71.9
14/5/2014	18:57:50	59.8
14/5/2014	19:07:50	66.6

AqNV-2		
Date	**Time**	**Value (dB)**
14/5/2014	9:04:54	51.8
14/5/2014	9:14:54	53.5
14/5/2014	9:24:54	51
14/5/2014	9:34:54	54.2
14/5/2014	9:44:54	54.4
14/5/2014	9:54:54	48.3
14/5/2014	10:04:54	62.3
14/5/2014	10:14:54	53.6
14/5/2014	10:24:54	47.1
14/5/2014	10:34:54	47.9
14/5/2014	10:44:54	52.5
14/5/2014	10:54:54	57.4
14/5/2014	11:04:54	49.4
14/5/2014	11:14:54	52.8
14/5/2014	11:24:54	52.9
14/5/2014	11:34:54	53.4
14/5/2014	11:44:54	51.3
14/5/2014	11:54:54	41
14/5/2014	12:04:54	45.5
14/5/2014	12:14:54	48.7
14/5/2014	12:24:54	53.9
14/5/2014	12:34:54	51.3
14/5/2014	12:44:54	48.1
14/5/2014	12:54:54	57.4
14/5/2014	13:04:54	46
14/5/2014	13:14:54	45.9
14/5/2014	13:24:54	49.7
14/5/2014	13:34:54	67.5
14/5/2014	13:44:54	66.8
14/5/2014	13:54:54	59.1
14/5/2014	14:04:54	56.1
14/5/2014	14:14:54	56.1
14/5/2014	14:24:54	
14/5/2014	14:34:54	53.4
14/5/2014	14:44:54	
14/5/2014	14:54:54	68.5
14/5/2014	15:04:54	
14/5/2014	15:14:54	63.2
14/5/2014	15:24:54	51.6
14/5/2014	15:34:54	54.2
14/5/2014	15:44:54	42.8
14/5/2014	15:54:54	45.1
14/5/2014	16:04:54	49.4
14/5/2014	16:14:54	43.5
14/5/2014	16:24:54	53.5
14/5/2014	16:34:54	66.8
14/5/2014	16:44:54	44.3
14/5/2014	16:54:54	41.7
14/5/2014	17:04:54	51.3
14/5/2014	17:14:54	75.7
14/5/2014	17:24:54	48.1
14/5/2014	17:34:54	41
14/5/2014	17:44:54	39.9
14/5/2014	17:54:54	43.7
14/5/2014	18:04:54	43.5

14/5/2014	19:17:50	66
14/5/2014	19:27:50	56.6
14/5/2014	19:37:50	72.4
14/5/2014	19:47:50	64.5
14/5/2014	19:57:50	69.1
14/5/2014	20:07:50	56.6
14/5/2014	20:17:50	57
14/5/2014	20:27:50	56.2
14/5/2014	20:37:50	57.2
14/5/2014	20:47:50	54.2
14/5/2014	20:57:50	59.8
14/5/2014	21:07:50	55.8
14/5/2014	21:17:50	60.2
14/5/2014	21:27:50	51.9
14/5/2014	21:37:50	47.3
14/5/2014	21:47:50	59.4
14/5/2014	21:57:50	50.8
14/5/2014	22:07:50	49.4
14/5/2014	22:17:50	47.6
14/5/2014	22:27:50	50
14/5/2014	22:37:50	50.2
14/5/2014	22:47:50	58.5
14/5/2014	22:57:50	49
14/5/2014	23:07:50	46.8
14/5/2014	23:17:50	56.8
14/5/2014	23:27:50	42.7
14/5/2014	23:37:50	46.6
14/5/2014	23:47:50	45.6
14/5/2014	23:57:50	48.1
15/5/2014	0:07:50	52.4
15/5/2014	0:17:50	45.3
15/5/2014	0:27:50	58.1
15/5/2014	0:37:50	53
15/5/2014	0:47:50	43.3
15/5/2014	0:57:50	44.7
15/5/2014	1:07:50	52.1
15/5/2014	1:17:50	45.7
15/5/2014	1:27:50	52.2
15/5/2014	1:37:50	46
15/5/2014	1:47:50	45
15/5/2014	1:57:50	49.5
15/5/2014	2:07:50	40.5
15/5/2014	2:17:50	42.2
15/5/2014	2:27:50	-
15/5/2014	2:37:50	-
15/5/2014	2:47:50	-
15/5/2014	2:57:50	44
15/5/2014	3:07:50	52
15/5/2014	3:17:50	-
15/5/2014	3:27:50	-
15/5/2014	3:37:50	-
15/5/2014	3:47:50	-
15/5/2014	3:57:50	-
15/5/2014	4:07:50	-
15/5/2014	4:17:50	-
15/5/2014	4:27:50	-
15/5/2014	4:37:50	-
15/5/2014	4:47:50	-
15/5/2014	4:57:50	-
15/5/2014	5:07:50	-

14/5/2014	18:14:54	46.3
14/5/2014	18:24:54	43.2
14/5/2014	18:34:54	42.9
14/5/2014	18:44:54	44.4
14/5/2014	18:54:54	38.5
14/5/2014	19:04:54	41.5
14/5/2014	19:14:54	43.2
14/5/2014	19:24:54	39.1
14/5/2014	19:34:54	39.3
14/5/2014	19:44:54	36.4
14/5/2014	19:54:54	42.5
14/5/2014	20:04:54	38.4
14/5/2014	20:14:54	41.3
14/5/2014	20:24:54	38.6
14/5/2014	20:34:54	39
14/5/2014	20:44:54	49.9
14/5/2014	20:54:54	36
14/5/2014	21:04:54	31.4
14/5/2014	21:14:54	36.3
14/5/2014	21:24:54	34.2
14/5/2014	21:34:54	31.9
14/5/2014	21:44:54	35.9
14/5/2014	21:54:54	35.3
14/5/2014	22:04:54	35.1
14/5/2014	22:14:54	36.6
14/5/2014	22:24:54	32
14/5/2014	22:34:54	33.3
14/5/2014	22:44:54	39.8
14/5/2014	22:54:54	37.6
14/5/2014	23:04:54	37.5
14/5/2014	23:14:54	36.3
14/5/2014	23:24:54	32.4
14/5/2014	23:34:54	32.1
14/5/2014	23:44:54	32.5
14/5/2014	23:54:54	31.7
15/5/2014	0:04:54	32
15/5/2014	0:14:54	32.6
15/5/2014	0:24:54	31.6
15/5/2014	0:34:54	32.6
15/5/2014	0:44:54	31.9
15/5/2014	0:54:54	31.6
15/5/2014	1:04:54	31.3
15/5/2014	1:14:54	30.4
15/5/2014	1:24:54	32.1
15/5/2014	1:34:54	32.5
15/5/2014	1:44:54	37.3
15/5/2014	1:54:54	31.5
15/5/2014	2:04:54	31.6
15/5/2014	2:14:54	31.4
15/5/2014	2:24:54	30.3
15/5/2014	2:34:54	30.2
15/5/2014	2:44:54	29.7
15/5/2014	2:54:54	30
15/5/2014	3:04:54	31.5
15/5/2014	3:14:54	31.3
15/5/2014	3:24:54	31.5
15/5/2014	3:34:54	33.4
15/5/2014	3:44:54	29
15/5/2014	3:54:54	36.2
15/5/2014	4:04:54	41.9

15/5/2014	5:17:50	-
15/5/2014	5:27:50	-
15/5/2014	5:37:50	56.5
15/5/2014	5:47:50	57.8
15/5/2014	5:57:50	55
15/5/2014	6:07:50	55.1
15/5/2014	6:17:50	68.1
15/5/2014	6:27:50	73.7
15/5/2014	6:37:50	75
15/5/2014	6:47:50	58.8
15/5/2014	6:57:50	60.3
15/5/2014	7:07:50	76.6
15/5/2014	7:17:50	65.4
15/5/2014	7:27:50	68
15/5/2014	7:37:50	71
15/5/2014	7:47:50	62.9
15/5/2014	7:57:50	58.1
15/5/2014	8:07:50	70.7
15/5/2014	8:17:50	71.7
15/5/2014	8:27:50	65.6
15/5/2014	8:37:50	67.2
15/5/2014	8:47:50	65.7
15/5/2014	8:57:50	65.4
15/5/2014	9:07:50	65.2
15/5/2014	9:17:50	67
15/5/2014	9:27:50	68.5
15/5/2014	9:37:50	64.5
15/5/2014	9:47:50	55.3
15/5/2014	9:57:50	50.6

15/5/2014	4:14:54	36.7
15/5/2014	4:24:54	31.3
15/5/2014	4:34:54	34.8
15/5/2014	4:44:54	36.8
15/5/2014	4:54:54	41.1
15/5/2014	5:04:54	35.6
15/5/2014	5:14:54	35.4
15/5/2014	5:24:54	32.5
15/5/2014	5:34:54	39.2
15/5/2014	5:44:54	43.2
15/5/2014	5:54:54	38
15/5/2014	6:04:54	38.1
15/5/2014	6:14:54	31.8
15/5/2014	6:24:54	40.2
15/5/2014	6:34:54	32.6
15/5/2014	6:44:54	30.2
15/5/2014	6:54:54	30.4
15/5/2014	7:04:54	30.7
15/5/2014	7:14:54	37.1
15/5/2014	7:24:54	30.2
15/5/2014	7:34:54	61.2
15/5/2014	7:44:54	57.2
15/5/2014	7:54:54	52
15/5/2014	8:04:54	57.9
15/5/2014	8:14:54	56.4
15/5/2014	8:24:54	56.1
15/5/2014	8:34:54	53.7
15/5/2014	8:44:54	48.9
15/5/2014	8:54:54	54.4

6) Hourly Raw Data of Vibration Level Monitoring at NVT-1 And AqNV-2

NVT-1		
Date	**Time**	**Acce. (m/s^2)**
14/5/2014	10:00-11:00	0
14/5/2014	11:00-12:00	0
14/5/2014	12:00-13:00	0
14/5/2014	13:00-14:00	0
14/5/2014	14:00-15:00	0.0083
14/5/2014	15:00-16:00	0
14/5/2014	16:00-17:00	0
14/5/2014	17:00-18:00	0.0054
14/5/2014	18:00-19:00	0
14/5/2014	19:00-20:00	0
14/5/2014	20:00-21:00	0
14/5/2014	21:00-22:00	0
14/5/2014	22:00-23:00	0
14/5/2014	23:00-24:00	0
15/5/2014	24:00-1:00	0
15/5/2014	1:00-2:00	0.0015
15/5/2014	2:00-3:00	0
15/5/2014	3:00-4:00	0
15/5/2014	4:00-5:00	0
15/5/2014	5:00-6:00	0
15/5/2014	6:00-7:00	0
15/5/2014	7:00-8:00	0
15/5/2014	8:00:9:00	0
15/5/2014	9:00-10:00	0

AqNV-2		
Date	**Time**	**Acce. (m/s^2)**
15/5/2014	11:00-12:00	0
15/5/2014	12:00-13:00	0
15/5/2014	13:00-14:00	0
15/5/2014	14:00-15:00	0
15/5/2014	15:00-16:00	0
15/5/2014	16:00-17:00	0
15/5/2014	17:00-18:00	0
15/5/2014	18:00-19:00	0
15/5/2014	19:00-20:00	0
15/5/2014	20:00-21:00	0
15/5/2014	21:00-22:00	0
15/5/2014	22:00-23:00	0
15/5/2014	23:00-24:00	0
16/5/2014	24:00-1:00	0
16/5/2014	1:00-2:00	0
16/5/2014	2:00-3:00	0
16/5/2014	3:00-4:00	0
16/5/2014	4:00-5:00	0
16/5/2014	5:00-6:00	0
16/5/2014	6:00-7:00	0
16/5/2014	7:00-8:00	0
16/5/2014	8:00:9:00	0
16/5/2014	9:00-10:00	0
16/5/2014	10:00-11:00	0

7) Record sheet for traffic count (NVT-1) 14th-15th May, 2014

No.	Start	End	Direction 1 (Power Plant to Thaketa Circle)				Direction 2(Thaketa Circle to Power Plant)			
			Motorbike	Light vehicle	Heavy Vehicle	Total	Motorbike	Light vehicle	Heavy Vehicle	Total
1	9:00:00 AM	9:10:00 AM	31	22	3	56	15	12	1	28
2	9:10:00 AM	9:20:00 AM	42	27	8	77	36	17	2	55
3	9:20:00 AM	9:30:00 AM	40	34	9	83	55	25	1	81
4	9:30:00 AM	9:40:00 AM	37	20	9	66	37	22	2	61
5	9:40:00 AM	9:50:00 AM	34	26	11	71	43	22	5	70
6	9:50:00 AM	10:00:00 AM	38	34	8	80	22	21	7	50
7	10:00:00 AM	10:10:00 AM	30	38	10	78	47	26	4	77
8	10:10:00 AM	10:20:00 AM	34	31	7	72	57	29	5	91
9	10:20:00 AM	10:30:00 AM	33	21	4	58	49	26	3	78
10	10:30:00 AM	10:40:00 AM	34	21	4	59	41	29	5	75
11	10:40:00 AM	10:50:00 AM	40	30	6	76	28	30	4	62
12	10:50:00 AM	11:00:00 AM	32	22	7	61	73	36	1	110
13	11:00:00 AM	11:10:00 AM	38	20	7	65	51	26	2	79
14	11:10:00 AM	11:20:00 AM	29	26	10	65	44	30	1	75
15	11:20:00 AM	11:30:00 AM	24	25	5	54	31	27	4	62
16	11:30:00 AM	11:40:00 AM	23	18	13	54	36	36	4	76
17	11:40:00 AM	11:50:00 AM	32	24	8	64	43	24	4	71
18	11:50:00 AM	12:00:00 PM	26	25	7	58	39	21	3	63
19	12:00:00 PM	12:10:00 PM	19	19	5	43	56	25	3	84
20	12:10:00 PM	12:20:00 PM	24	30	4	58	37	30	1	68
21	12:20:00 PM	12:30:00 PM	20	27	10	57	21	19	-	40
22	12:30:00 PM	12:40:00 PM	26	28	6	60	34	39	3	76
23	12:40:00 PM	12:50:00 PM	24	25	6	55	27	29	2	58
24	12:50:00 PM	1:00:00 PM	30	21	11	62	42	35	8	85
25	1:00:00 PM	1:10:00 PM	29	25	9	63	24	17	2	43
26	1:10:00 PM	1:20:00 PM	11	17	4	32	26	23	5	54
27	1:20:00 PM	1:30:00 PM	21	33	10	64	23	23	3	49
28	1:30:00 PM	1:40:00 PM	6	24	9	39	17	27	5	49
29	1:40:00 PM	1:50:00 PM	9	18	8	35	12	15	3	30
30	1:50:00 PM	2:00:00 PM	12	19	5	36	20	25	3	48
31	2:00:00 PM	2:10:00 PM	12	30	7	49	34	18	1	53
32	2:10:00 PM	2:20:00 PM	15	17	5	37	17	14	2	33
33	2:20:00 PM	2:30:00 PM	12	43	6	61	12	20	3	35
34	2:30:00 PM	2:40:00 PM	21	38	9	68	25	31	3	59
35	2:40:00 PM	2:50:00 PM	19	18	6	43	25	25	5	55
36	2:50:00 PM	3:00:00 PM	7	14	4	25	19	25	6	50
37	3:00:00 PM	3:10:00 PM	16	27	8	51	30	42	-	72
38	3:10:00 PM	3:20:00 PM	11	28	11	50	35	30	5	70
39	3:20:00 PM	3:30:00 PM	8	17	7	32	25	16	3	44
40	3:30:00 PM	3:40:00 PM	21	39	7	67	22	16	1	39
41	3:40:00 PM	3:50:00 PM	12	25	4	41	35	27	4	66
42	3:50:00 PM	4:00:00 PM	24	26	7	57	27	42	5	74
43	4:00:00 PM	4:10:00 PM	34	34	7	75	34	12	5	51
44	4:10:00 PM	4:20:00 PM	24	19	12	55	23	24	5	52
45	4:20:00 PM	4:30:00 PM	33	28	8	69	22	29	3	54
46	4:30:00 PM	4:40:00 PM	27	25	6	58	25	21	12	58
47	4:40:00 PM	4:50:00 PM	19	18	3	40	19	19	8	46
48	4:50:00 PM	5:00:00 PM	28	27	3	58	27	18	3	48
49	5:00:00 PM	5:10:00 PM	33	26	6	65	15	22	2	39
50	5:10:00 PM	5:20:00 PM	18	17	3	38	20	20	5	45
51	5:20:00 PM	5:30:00 PM	30	30	5	65	33	29	13	75

No.	Start	End	Direction 1 (Power Plant to Thaketa Circle)				Direction 2(Thaketa Circle to Power Plant)			
			Motorbike	Light vehicle	Heavy Vehicle	Total	Motorbike	Light vehicle	Heavy Vehicle	Total
52	5:30:00 PM	5:40:00 PM	26	27	6	59	9	12	8	29
53	5:40:00 PM	5:50:00 PM	19	26	2	47	17	10	7	34
54	5:50:00 PM	6:00:00 PM	24	24	2	50	27	18	9	54
55	6:00:00 PM	6:10:00 PM	36	28	4	68	19	22	9	50
56	6:10:00 PM	6:20:00 PM	20	29	4	53	22	18	6	46
57	6:20:00 PM	6:30:00 PM	38	25	2	65	20	30	11	61
58	6:30:00 PM	6:40:00 PM	30	29	5	64	32	24	6	62
59	6:40:00 PM	6:50:00 PM	29	22	4	55	25	22	5	52
60	6:50:00 PM	7:00:00 PM	39	20	1	60	33	31	9	73
61	7:00:00 PM	7:10:00 PM	24	17	1	42	50	34	17	101
62	7:10:00 PM	7:20:00 PM	35	14	5	54	40	15	12	67
63	7:20:00 PM	7:30:00 PM	32	27	-	59	25	15	10	50
64	7:30:00 PM	7:40:00 PM	30	17	1	48	19	14	5	38
65	7:40:00 PM	7:50:00 PM	42	20	3	65	30	21	3	54
66	7:50:00 PM	8:00:00 PM	24	18	1	43	44	22	-	66
67	8:00:00 PM	8:10:00 PM	23	9	3	35	31	14	1	46
68	8:10:00 PM	8:20:00 PM	31	19	4	54	32	19	5	56
69	8:20:00 PM	8:30:00 PM	24	16	2	42	21	22	1	44
70	8:30:00 PM	8:40:00 PM	31	17	-	48	28	12	2	42
71	8:40:00 PM	8:50:00 PM	18	17	-	35	22	10	2	34
72	8:50:00 PM	9:00:00 PM	20	9	2	31	24	16	3	43
73	9:00:00 PM	9:10:00 PM	22	11	1	34	20	17	2	39
74	9:10:00 PM	9:20:00 PM	16	10	3	29	23	13	4	40
75	9:20:00 PM	9:30:00 PM	12	7	1	20	25	12	1	38
76	9:30:00 PM	9:40:00 PM	15	5	-	20	22	9	3	34
77	9:40:00 PM	9:50:00 PM	17	3	3	23	18	10	-	28
78	9:50:00 PM	10:00:00 PM	9	2	-	11	10	3	2	15
79	10:00:00 PM	10:10:00 PM	11	1	-	12	13	7	1	21
80	10:10:00 PM	10:20:00 PM	5	4	-	9	9	3	-	12
81	10:20:00 PM	10:30:00 PM	2	6	1	9	15	8	2	25
82	10:30:00 PM	10:40:00 PM	4	2	-	6	8	2	-	10
83	10:40:00 PM	10:50:00 PM	7	-	-	7	3	4	1	8
84	10:50:00 PM	11:00:00 PM	3	1	-	4	4	-	-	4
85	11:00:00 PM	11:10:00 PM	2	1	1	4	3	2	-	5
86	11:10:00 PM	11:20:00 PM	1	-	-	1	1	-	1	2
87	11:20:00 PM	11:30:00 PM	2	1	-	3	-	1	-	1
88	11:30:00 PM	11:40:00 PM	-	2	-	2	2	1	2	5
89	11:40:00 PM	11:50:00 PM	-	-	1	1	-	-	-	-
90	11:50:00 PM	12:00:00 AM	1	1	-	2	1	-	-	1
91	12:00:00 AM	12:10:00 AM	-	1	-	1	2	-	-	-
92	12:10:00 AM	12:20:00 AM	-	2	-	2	3	1	-	4
93	12:20:00 AM	12:30:00 AM	1	1	-	2	-	1	-	1
94	12:30:00 AM	12:40:00 AM	-	-	-	-	-	1	-	1
95	12:40:00 AM	12:50:00 AM	1	-	-	1	1	2	-	3
96	12:50:00 AM	1:00:00 AM	-	-	-	-	1	-	-	1
97	1:00:00 AM	1:10:00 AM	-	-	-	-	-	1	-	1
98	1:10:00 AM	1:20:00 AM	2	-	-	2	-	-	1	1
99	1:20:00 AM	1:30:00 AM	-	-	-	-	-	-	-	-
100	1:30:00 AM	1:40:00 AM	-	-	-	-	-	1	-	1
101	1:40:00 AM	1:50:00 AM	-	-	-	-	-	-	-	-
102	1:50:00 AM	2:00:00 AM	-	-	-	-	-	-	-	-
103	2:00:00 AM	2:10:00 AM	-	-	-	-	-	-	-	-
104	2:10:00 AM	2:20:00 AM	-	1	-	1	-	-	-	-
105	2:20:00 AM	2:30:00 AM	-	-	-	-	-	-	-	-

No.	Start	End	Direction 1 (Power Plant to Thaketa Circle)				Direction 2(Thaketa Circle to Power Plant)			
			Motorbike	Light vehicle	Heavy Vehicle	Total	Motorbike	Light vehicle	Heavy Vehicle	Total
106	2:30:00 AM	2:40:00 AM	-	-	-	-	-	-	-	-
107	2:40:00 AM	2:50:00 AM	-	-	-	-	-	-	-	-
108	2:50:00 AM	3:00:00 AM	-	-	-	-	-	-	-	-
109	3:00:00 AM	3:10:00 AM	-	-	-	-	-	-	-	-
110	3:10:00 AM	3:20:00 AM	-	-	-	-	-	-	-	-
111	3:20:00 AM	3:30:00 AM	-	-	-	-	-	-	-	-
112	3:30:00 AM	3:40:00 AM	2	1	-	3	1	-	2	3
113	3:40:00 AM	3:50:00 AM	5	2	1	8	3	3	-	6
114	3:50:00 AM	4:00:00 AM	9	4	2	15	5	6	1	12
115	4:00:00 AM	4:10:00 AM	6	3	2	11	7	4	1	12
116	4:10:00 AM	4:20:00 AM	8	5	3	16	7	6	2	15
117	4:20:00 AM	4:30:00 AM	7	6	4	17	8	5	2	15
118	4:30:00 AM	4:40:00 AM	10	8	2	20	12	9	3	24
119	4:40:00 AM	4:50:00 AM	13	9	5	27	14	10	5	29
120	4:50:00 AM	5:00:00 AM	15	13	7	35	13	8	6	27
121	5:00:00 AM	5:10:00 AM	16	10	5	31	17	9	4	30
122	5:10:00 AM	5:20:00 AM	18	13	7	38	16	13	8	37
123	5:20:00 AM	5:30:00 AM	20	15	16	41	18	15	11	44
124	5:30:00 AM	5:40:00 AM	15	10	9	34	20	16	10	46
125	5:40:00 AM	5:50:00 AM	16	8	7	31	25	14	8	47
126	5:50:00 AM	6:00:00 AM	18	15	13	46	30	20	9	59
127	6:00:00 AM	6:10:00 AM	27	18	16	56	25	18	6	50
128	6:10:00 AM	6:20:00 AM	25	21	18	64	28	20	11	59
129	6:20:00 AM	6:30:00 AM	32	25	20	77	25	13	14	52
130	6:30:00 AM	6:40:00 AM	28	17	25	70	26	10	12	48
131	6:40:00 AM	6:50:00 AM	40	27	27	94	29	9	10	48
132	6:50:00 AM	7:00:00 AM	43	9	9	61	22	7	9	38
133	7:00:00 AM	7:10:00 AM	35	20	6	61	24	8	6	38
134	7:10:00 AM	7:20:00 AM	52	26	7	85	31	22	5	58
135	7:20:00 AM	7:30:00 AM	41	16	7	64	25	17	6	48
136	7:30:00 AM	7:40:00 AM	49	17	8	74	33	15	6	54
137	7:40:00 AM	7:50:00 AM	26	13	7	46	30	16	7	53
138	7:50:00 AM	8:00:00 AM	61	25	13	99	34	15	9	58
139	8:00:00 AM	8:10:00 AM	41	25	11	77	25	10	5	40
140	8:10:00 AM	8:20:00 AM	51	29	5	85	45	19	9	73
141	8:20:00 AM	8:30:00 AM	50	28	11	89	50	25	7	82
142	8:30:00 AM	8:40:00 AM	33	17	6	56	35	16	10	61
143	8:40:00 AM	8:50:00 AM	42	32	5	79	29	30	9	68
144	8:50:00 AM	9:00:00 AM	38	28	6	72	35	20	8	63
145	9:00:00 AM	9:10:00 AM	42	27	6	73	27	20	7	54
146	9:10:00 AM	9:20:00 AM	41	29	6	76	48	21	8	77
147	9:20:00 AM	9:30:00 AM	36	16	11	63	26	16	8	50
148	9:30:00 AM	9:40:00 AM	35	23	6	64	42	19	6	67
149	9:40:00 AM	9:50:00 AM	46	20	4	70	20	20	6	46
150	9:50:00 AM	10:00:00 AM	44	23	4	71	23	22	15	60

8) Result of Depth at RF-1, RF-2 and RF-3

Unit: m

Time	No.	Dry-1	Dry-2	Dry-3	Dry-4	Dry-5	Dry-6	Dry-7	Dry-8	Dry-9	Dry-10	Dry-11	Dry-12	Dry-13	Dry-14	Rainy	Avg.
		16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	1-Jul	
1st (6:00 AM)	RF-1	7.2	8.8	9.2	9.4	10.3	5.3	-	5.5	7	5.2	7.1	6.9	6.1	7.1	8.8	7.4
	RF-2	12	11.8	11.5	12.7	13.4	9.6	-	7.6	10.6	8.0	10.5	8.4	9.3	9.9	12	10.5
	RF-3	12	10.3	12.1	13.9	10.9	10.9	-	10.6	10.3	10.4	10.01	10.2	8.2	8.1	11.4	10.7
2st (9:00 AM)	RF-1	6.3	6.7	7.7	8.1	9.9	8.7	8.3	9.4	5.3	4.7	5.5	5.6	5.7	6.6	8	7.1
	RF-2	10.5	12.4	10.0	11.9	13.0	12.8	13.2	12.6	11.5	7.8	8.9	7.5	8.7	8.2	8.08	10.5
	RF-3	10.3	9.1	11.0	13.4	8.8	13.5	12.9	13.5	10.7	8.1	8.2	8.6	7.1	9.9	9	10.3
3st (12:00 PM)	RF-1	4.7	5.9	5.4	6.3	7.8	7.5	7.2	8.6	8.8	8.4	7.2	5.2	3.7	4.1	6.2	6.5
	RF-2	8.6	8.4	7.1	9.9	10.9	10.4	10.9	10.6	11.1	11.4	8.8	7.4	7.0	5.6	7.5	9.0
	RF-3	8.2	7.9	9.2	7.7	9.4	11.8	11.2	12.9	12.5	12.2	7.8	10.6	7.7	7.8	9.9	9.8
4st (3:00 PM)	RF-1	7.5	6.8	5.5	5.6	5.6	6.5	6.9	6.5	8.2	9.0	9.4	9.6	9.6	8.6	-	7.5
	RF-2	12.2	12.4	10.7	9.8	8.4	8.4	10.1	9.7	11.6	10.1	13.0	12.9	12.6	12.1	-	11.0
	RF-3	11.6	10.8	9.2	9.0	10.3	10.8	12.2	7.9	9.3	13.4	12.4	11.9	12.9	9.4	-	10.8
5st (6:00 PM)	RF-1	8.9	8.5	7.6	6.4	-	-	5.4	-	7	6.9	8.2	9	9.1	-	9.3	7.8
	RF-2	12.3	12.9	12.2	10.4	-	-	8.7	-	7.9	8.4	8.8	10.0	12.4	-	12.2	10.6
	RF-3	13.7	11.9	12.7	12.0	-	-	9.6	-	10.0	9.7	11.3	9.8	10.7	-	12.1	11.2
Average		9.7	9.6	9.4	9.8	9.9	9.7	9.7	9.6	9.5	8.9	9.1	8.9	8.7	8.1	9.5	9.4

9) Result of Air Temperature at RF-1, RF-2 and RF-3

Unit: ^{o}C

Time	No.	Dry-1	Dry-2	Dry-3	Dry-4	Dry-5	Dry-6	Dry-7	Dry-8	Dry-9	Dry-10	Dry-11	Dry-12	Dry-13	Dry-14	Rainy	Avg.
		16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	1-Jul	
1st (6:00 AM)	RF-1	30	28	28	27	26	27	-	29	29	35	32	35	33	29	24	29.4
	RF-2	29	28.5	28	29	26	28	-	30	30	37	30	35	33	28	23	29.6
	RF-3	29	30	28	29	27	28	-	30	30	30.5	30	34	33	28	23	29.3
2st (9:00 AM)	RF-1	31	31	29	29	26	29	26.5	32	31	40	33	38	35	29	25	31.0
	RF-2	31.7	31	29	32.5	28	30	28	32.5	32	36.5	33	35	33	30	26	31.2
	RF-3	32	31	29	34	28	29	29	32.5	32	32	31	35	33	33	27	31.2
3st (12:00 PM)	RF-1	32	31	30	33	25.2	29	28	35	35	34	35	34	35	35	32	32.2
	RF-2	32.5	33	32	33	26.4	29	29	35.5	34	33	35	35	36	34	33	32.7
	RF-3	33	35	33.5	32	27.5	28	28	32	34.5	37	33	35	37	33	32	32.7
4st (3:00 PM)	RF-1	29	35.2	27	29.5	26.2	26.5	27.5	33	37	40	40	40	37	27	-	32.5
	RF-2	29.5	35	27.3	29	26	26	28.2	33	35	37	36	37	36	29	-	31.7
	RF-3	29	35	27.3	28	27	27	29	32	33	32	34	35	34	29	-	30.8
5st (6:00 PM)	RF-1	28	35	26	27	-	-	28	-	30	30	32	31	30	-	25	29.3
	RF-2	28	34	26	28	-	-	28	-	30	30	34	32	30	-	25	29.5
	RF-3	28	33.5	26	28	-	-	27.2	-	30	30	35	32	30	-	25	29.5
Average		30.1	32.4	28.4	29.9	26.6	28.0	28.0	32.2	32.2	34.3	33.5	34.9	33.7	30.3	26.7	30.8

10) Result of Water Temperature at RF-1, RF-2 and RF-3

Unit: : °C

Time	No.	Dry-1	Dry-2	Dry-3	Dry-4	Dry-5	Dry-6	Dry-7	Dry-8	Dry-9	Dry-10	Dry-11	Dry-12	Dry-13	Dry-14	Rainy	Avg.
		16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	1-Jul	
1st Time (6:00 AM)	RF-1T	30.85	30.66	30.69	30.60	30.53	29.23	-	27.50	26.01	24.97	26.01	25.58	25.69	26.72	22.46	27.7
	RF-1M	30.87	30.67	30.68	30.62	30.53	29.22	-	26.85	25.97	24.96	25.97	25.52	25.56	26.72	22.47	27.6
	RF-1B	30.87	30.67	30.68	30.62	30.53	29.22	-	26.76	25.95	24.97	25.95	25.49	25.42	26.77	22.47	27.6
	RF-2T	30.82	30.67	30.93	30.64	30.54	29.25	-	26.99	25.95	24.97	25.95	25.59	25.22	26.72	22.45	27.6
	RF-2M	30.86	30.69	30.93	30.63	30.54	29.23	-	26.84	25.51	24.96	25.51	25.48	26.01	26.73	22.48	27.6
	RF-2B	30.87	30.69	30.94	30.62	30.55	29.23	-	26.82	25.49	24.95	25.49	25.47	25.57	26.72	22.45	27.6
	RF-3T	30.90	30.71	30.76	30.63	30.54	29.42	-	26.90	25.83	25.01	25.83	25.22	26.28	26.71	22.47	27.7
	RF-3M	30.87	30.71	30.75	30.63	30.55	29.41	-	26.90	25.51	24.98	25.51	25.18	25.93	26.74	22.47	27.6
	RF-3B	30.89	30.71	30.75	30.62	30.56	29.41	-	26.90	25.48	24.97	25.48	25.04	25.90	26.73	22.47	27.6
2nd Time (9:00 AM)	RF-1T	30.96	30.86	30.80	30.75	30.54	30.37	29.05	31.3	24.52	25.13	26.00	26.64	26.92	26.99	22.5	28.2
	RF-1M	30.92	30.83	30.80	30.62	30.54	30.37	29.08	30.96	24.51	25.11	25.90	26.46	26.83	26.98	22.49	28.2
	RF-1B	30.94	30.82	30.80	30.62	30.55	30.39	29.08	30.92	24.50	25.10	25.99	26.39	26.81	26.98	22.48	28.2
	RF-2T	30.97	31.25	30.80	30.52	30.55	30.48	29.66	30.52	24.63	25.13	26.01	26.48	26.93	27.03	22.47	28.2
	RF-2M	30.94	31.14	30.80	30.56	30.55	30.46	29.65	30.56	24.56	25.11	25.93	26.43	26.79	27.03	22.47	28.2
	RF-2B	30.92	31.10	30.80	30.45	30.56	30.45	29.68	30.45	24.57	25.06	25.93	26.38	26.81	26.94	22.42	28.2
	RF-3T	30.95	30.76	30.80	30.51	30.55	30.40	29.64	30.18	24.65	25.13	26.05	26.49	26.86	27.97	22.45	28.2
	RF-3M	31	30.79	30.80	30.54	30.56	30.42	29.62	30.12	24.56	25.12	25.94	26.46	26.80	27.04	22.44	28.1
	RF-3B	30.95	30.83	30.81	30.61	30.56	30.40	29.57	30.11	24.49	25.11	25.93	26.39	26.80	27.12	22.42	28.1
3rd Time (12:00 PM)	RF-1T	31.3	30.81	30.88	30.20	30.29	29.65	29.61	26.45	25.35	25.15	25.86	27.50	27.65	27.73	22.52	28.1
	RF-1M	30.96	30.83	30.84	30.16	30.30	29.65	29.61	26.47	25.37	25.40	25.86	26.85	27.49	27.78	22.46	28.0
	RF-1B	30.92	30.82	30.83	30.12	30.29	29.66	29.62	26.33	25.39	25.41	25.87	26.76	27.29	27.43	22.46	27.9
	RF-2T	31.01	30.86	30.91	30.16	30.17	29.65	29.63	26.53	25.53	25.51	26.05	26.99	27.69	27.86	22.5	28.1
	RF-2M	30.93	30.83	30.84	30.17	30.13	29.65	29.63	26.38	25.25	25.53	25.97	26.84	27.36	27.82	22.48	28.0
	RF-2B	30.92	30.84	30.88	30.12	30.12	29.70	29.67	26.32	25.26	25.38	25.98	26.82	27.33	27.50	22.46	28.0
	RF-3T	31.08	30.79	30.93	30.18	30.19	29.66	29.62	26.41	25.39	25.28	26.06	26.90	27.78	27.97	22.46	28.0
	RF-3M	30.96	30.8	30.82	30.12	30.16	29.65	29.61	26.33	25.31	25.27	26.06	26.90	27.70	27.64	22.45	28.0
	RF-3B	30.94	30.85	30.84	30.11	30.19	29.66	29.62	26.23	25.36	25.25	26.05	26.90	27.52	27.55	22.47	28.0
4th Time (3:00 PM)	RF-1T	31.4	31.18	30.90	29.91	29.83	29.44	29.33	30.20	25.82	26.55	26.55	26.58	26.67	26.71	-	28.6
	RF-1M	31.5	31.07	30.91	29.90	29.86	29.43	29.33	30.16	25.96	26.50	26.57	26.57	26.62	26.70	-	28.6
	RF-1B	31.5	31.06	30.91	29.9	29.85	29.44	29.34	30.12	25.82	26.50	26.48	26.55	26.60	26.69	-	28.6
	RF-2T	31.04	31.25	30.90	29.92	29.85	29.40	29.34	30.16	25.88	26.48	26.63	26.65	26.72	26.87	-	28.6
	RF-2M	31.04	31.14	30.92	29.86	29.86	29.41	29.35	30.17	25.40	26.49	26.51	26.58	26.70	26.87	-	28.6
	RF-2B	31.04	31.10	30.92	29.86	29.86	29.40	29.36	30.12	25.9	26.52	26.47	26.51	26.65	26.87	-	28.6
	RF-3T	31.03	31.04	30.87	29.86	29.85	29.34	29.36	30.18	25.83	26.83	26.60	26.61	26.81	26.97	-	28.7
	RF-3M	31.03	31.06	30.91	29.84	29.87	29.34	29.35	30.12	25.91	26.34	26.48	26.54	26.75	26.95	-	28.6
	RF-3B	31.03	31.10	30.91	29.81	29.87	29.36	29.37	30.11	25.89	26.24	26.47	26.50	26.75	26.96	-	28.6
5th Time (6:00 PM)	RF-1T	30.88	31.04	30.64	30.02	-	-	28.99	-	25.13	25.53	26.45	26.68	26.69	-	22.52	27.7
	RF-1M	30.92	31.02	30.63	30.02	-	-	29.09	-	25.18	25.54	26.39	26.61	26.68	-	22.52	27.7
	RF-1B	30.92	31.01	30.63	30.03	-	-	29.11	-	25.17	25.55	26.36	26.61	26.68	-	22.52	27.7
	RF-2T	30.85	30.89	30.96	30.03	-	-	29.07	-	25.13	25.51	26.30	26.64	26.60	-	22.54	27.7
	RF-2M	30.90	30.90	30.95	30.06	-	-	29.11	-	25.15	25.55	26.30	26.59	26.65	-	22.52	27.7
	RF-2B	30.90	30.90	30.95	30.06	-	-	29.11	-	25.16	25.54	26.28	26.61	26.65	-	22.52	27.7
	RF-3T	30.96	30.95	30.86	30.01	-	-	29.07	-	25.06	25.48	26.30	26.60	26.56	-	22.53	27.7
	RF-3M	30.90	30.98	30.88	30.01	-	-	29.09	-	25.09	25.52	26.28	26.58	26.61	-	22.52	27.7
	RF-3B	30.90	30.98	30.88	30.00	-	-	29.12	-	23.12	25.53	26.24	26.60	26.60	-	22.52	27.5
Average		31.0	30.9	30.8	30.2	30.3	29.7	29.4	28.5	25.3	25.5	26.1	26.4	26.7	27.1	22.5	28.0

11) Result of Depth at RF-1, RF-2 and RF-3

Unit: m

Time	No.	Dry-1	Dry-2	Dry-3	Dry-4	Dry-5	Dry-6	Dry-7	Dry-8	Dry-9	Dry-10	Dry-11	Dry-12	Dry-13	Dry-14	Rainy
		16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	1-Jul
1st Time (6:00 AM)	RF-1T	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1
	RF-1M	3.5	4	4.5	4.5	5	2.5	-	2.5	3.5	2.5	3.5	3	3	3.5	4
	RF-1B	6	7.5	9	8	10	4	-	5	7	5	7	6	5.5	7	8
	RF-2T	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1
	RF-2M	6	6	5.5	6	6.5	5.3	-	3.5	5	4	5	4	4.5	4.5	6
	RF-2B	11	10.5	11	12	13	8	-	7	10	8	10	8	9	9	11.5
	RF-3T	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1
	RF-3M	6	5	6	6.5	5	5.5	-	5	5	5	5	5	4	4	5.5
	RF-3B	11	9	12	13	10	10	-	10	10	10	10	10	8	8	11
2nd Time (9:00 AM)	RF-1T	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	RF-1M	3	3	3.5	4	4.5	4	4	4.5	2.5	2	2.5	2.5	2.5	3	4
	RF-1B	5	5	7	8	9	7	8	9	5	4	5	5	5	6	7.5
	RF-2T	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	RF-2M	5	6	5	5.5	6.5	6	6	6	5	3.5	4	3.5	4	4	4
	RF-2B	9.5	11	10	11	13	12	12	12	10	7	8	7	8	8	7.5
	RF-3T	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	RF-3M	5.3	4.5	6.5	6.5	4	6.5	6	3.5	5	4	4	4	3.5	4.5	4
	RF-3B	9.5	8	11	13	8	13	11.5	7	10	8	8	8	7	9	8.5
3rd Time (12:00 PM)	RF-1T	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	RF-1M	2	3	2.5	3	3.5	3	3	4	4	4	3.5	2.5	5	2	3
	RF-1B	4	5	5	6	7	6.5	6	8	8	8	7	5	8	4	5.5
	RF-2T	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	RF-2M	4	4	3.5	4.5	5	5	5	5	5	5	4	3.5	3.5	8	3.5
	RF-2B	7.5	7	7	9	10	10	10	10	10	10	8	7	6.5	11	7
	RF-3T	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	RF-3M	4	4	4.5	3.5	4.5	5.5	5.5	6	6	6	3.5	5	3.5	3.5	4.5
	RF-3B	7	7	9	7	9	11	10	12	12	12	7	10	7	7	9
4th Time (3:00 PM)	RF-1T	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
	RF-1M	4	3.5	2.5	2.5	2.5	3	3	3	4	4.5	4.5	4.5	4	6	-
	RF-1B	6.5	5.5	5	5	5	6	6	6	8	9	9	9	11	12	-
	RF-2T	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
	RF-2M	6	6	5	4.5	4	4	5	4.5	5.5	5	7.5	6	6	4	-
	RF-2B	11	11	10	9	8	8	10	9	11	10	12.5	12	12	8	-
	RF-3T	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
	RF-3M	6	5	4.5	4.5	5	5	6	3.5	4.5	6.5	6	5.5	6	3	-
	RF-3B	10.5	10	9	9	10	10	12	7	9	13	12	11	12	7	-
5th Time (6:00 PM)	RF-1T	1	1	1	1	-	-	1	-	1	1	1	1	1	-	1
	RF-1M	4.5	4	3.5	3	-	-	2.5	-	3	3	4	5	4.5	-	4.5
	RF-1B	8	7.5	7	6	-	-	5	-	6.5	6	8	11	9	-	9
	RF-2T	1	1	1	1	-	-	1	-	1	1	1	1	1	-	1
	RF-2M	6	6	6	5	-	-	4	-	3.5	4	4	5	6	-	6
	RF-2B	11	12	12	10	-	-	8	-	7	8	8	9.5	12	-	11.5
	RF-3T	1	1	1	1	-	-	1	-	1	1	1	1	1	-	1
	RF-3M	7	6	6	6	-	-	4.5	-	5	4.5	5.5	4.5	5	-	6
	RF-3B	12.5	11	12	12	-	-	9	-	9.5	9	11	9	10	-	11.5

12) Result of Water Temperature at WT-Drainage

Unit: °C

Time	Dry-1	Dry-2	Dry-3	Dry-4	Dry-5	Dry-6	Dry-7	Dry-8	Dry-9	Dry-10	Dry-11	Dry-12	Dry-13	Dry-14	Rainy	Avg.
	16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	1-Jul	
1st Time (6:00 AM)	30.84	30.48	30.85	30.32	30.09	29.54	-	26.9	23.09	24.32	25.54	26.02	25.39	26.44	22.4	27.3
2nd Time (9:00 AM)	30.96	30.86	30.62	29.88	30.12	30.09	29.73	29.8	23.9	25.16	25.98	26.64	26.86	27.02	22.18	28.0
3rd Time (12:00 PM)	30.98	30.96	30.96	30.18	30.12	28.49	29.6	26.04	25.38	25.69	26.16	27.58	27.84	27.84	20.86	27.9
4th Time (3:00 PM)	31.06	31.15	30.87	29.8	29.83	27.66	29.38	30.24	25.67	25.92	26.52	26.61	26.87	27.01	-	28.5
5th Time (6:00 PM)	30.91	31.1	30.87	29.72	-	-	28.33	-	25.32	25.67	26.5	26.72	26.75	-	22.5	27.7
Average	30.95	30.91	30.83	29.98	30.04	28.95	29.26	28.25	24.67	25.35	26.14	26.71	26.74	27.08	21.99	27.86

13) Result of Water Velocity at RF-1, RF-2 and RF-3

Unit: m/s

Time	No.	Dry-1	Dry-2	Dry-3	Dry-4	Dry-5	Dry-6	Dry-7	Dry-8	Dry-9	Dry-10	Dry-11	Dry-12	Dry-13	Dry-14	Rainy	Avg.
		16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	1-Jul	
1st Time (6:00 AM)	RF-1T	0.152	0.204	0.195	0.059	0.063	0.211	-	0.218	0.165	0.134	0.162	0.210	0.212	0.203	0.162	0.168
	RF-1M	0.193	0.169	0.163	0.038	0.054	0.223	-	0.197	0.098	0.091	0.097	0.114	0.151	0.141	0.114	0.132
	RF-1B	0.06	0.163	0.098	0.028	0.032	0.162	-	0.129	0.104	0.066	0.102	0.108	0.098	0.054	0.086	0.092
	RF-2T	0.198	0.211	0.187	0.064	0.063	0.231	-	0.232	0.183	0.112	0.182	0.201	0.121	0.227	0.139	0.168
	RF-2M	0.108	0.179	0.176	0.036	0.042	0.145	-	0.175	0.194	0.101	0.191	0.152	0.101	0.126	0.155	0.134
	RF-2B	0.132	0.149	0.124	0.026	0.061	0.136	-	0.144	0.095	0.049	0.096	0.174	0.087	0.059	0.102	0.102
	RF-3T	0.093	0.268	0.169	0.035	0.053	0.186	-	0.235	0.226	0.211	0.224	0.191	0.168	0.265	0.106	0.174
	RF-3M	0.068	0.187	0.095	0.028	0.049	0.192	-	0.160	0.163	0.158	0.160	0.150	0.133	0.153	0.087	0.127
	RF-3B	0.066	0.166	0.086	0.054	0.038	0.162	-	0.134	0.097	0.057	0.091	0.143	0.115	0.101	0.088	0.100
2nd Time (9:00 AM)	RF-1T	0.143	0.195	0.270	0.231	0.081	0.159	0.165	0.208	0.238	0.097	0.156	0.222	0.206	0.218	0.169	0.184
	RF-1M	0.182	0.15	0.197	0.179	0.057	0.189	0.142	0.142	0.230	0.050	0.069	0.121	0.135	0.165	0.159	0.144
	RF-1B	0.052	0.117	0.159	0.087	0.036	0.15	0.129	0.097	0.224	0.047	0.086	0.085	0.064	0.101	0.158	0.106
	RF-2T	0.181	0.201	0.207	0.172	0.074	0.220	0.197	0.187	0.220	0.093	0.136	0.148	0.128	0.198	0.186	0.170
	RF-2M	0.096	0.211	0.159	0.189	0.057	0.163	0.155	0.163	0.017	0.091	0.197	0.112	0.078	0.101	0.136	0.128
	RF-2B	0.105	0.189	0.128	0.176	0.078	0.160	0.118	0.142	0.169	0.042	0.070	0.032	0.045	0.071	0.128	0.110
	RF-3T	0.086	0.162	0.187	0.262	0.040	0.179	0.197	0.193	0.196	0.088	0.182	0.165	0.177	0.122	0.208	0.163
	RF-3M	0.051	0.134	0.153	0.222	0.042	0.091	0.128	0.084	0.141	0.067	0.117	0.152	0.117	0.132	0.177	0.121
	RF-3B	0.051	0.089	0.150	0.121	0.035	0.150	0.138	0.066	0.056	0.051	0.183	0.146	0.057	0.149	0.053	0.100
3rd Time (12:00 PM)	RF-1T	0.087	0.184	0.225	0.191	0.213	0.189	0.182	0.078	0.158	0.200	0.193	0.214	0.086	0.179	0.122	0.167
	RF-1M	0.149	0.150	0.136	0.073	0.187	0.156	0.151	0.136	0.136	0.173	0.134	0.198	0.084	0.087	0.128	0.139
	RF-1B	0.04	0.117	0.124	0.039	0.201	0.091	0.086	0.097	0.112	0.122	0.115	0.129	0.030	0.052	0.128	0.099
	RF-2T	0.125	0.156	0.138	0.222	0.159	0.108	0.105	0.156	0.150	0.201	0.228	0.230	0.095	0.191	0.152	0.161
	RF-2M	0.026	0.069	0.108	0.142	0.083	0.155	0.15	0.104	0.067	0.167	0.203	0.172	0.073	0.086	0.11	0.114
	RF-2B	0.093	0.083	0.126	0.098	0.124	0.073	0.069	0.057	0.066	0.131	0.142	0.142	0.042	0.04	0.063	0.090
	RF-3T	0.045	0.074	0.110	0.169	0.213	0.208	0.206	0.138	0.180	0.180	0.159	0.235	0.160	0.122	0.155	0.157
	RF-3M	0.025	0.083	0.112	0.148	0.187	0.126	0.123	0.118	0.097	0.163	0.115	0.158	0.112	0.023	0.105	0.113
	RF-3B	0.025	0.086	0.110	0.174	0.169	0.135	0.131	0.043	0.067	0.049	0.091	0.132	0.090	0.053	0.121	0.098
4th Time (3:00 PM)	RF-1T	0.156	0.204	0.203	0.283	0.102	0.196	0.187	0.193	0.162	0.131	0.128	0.138	0.172	0.201	-	0.175
	RF-1M	0.104	0.177	0.218	0.224	0.146	0.152	0.182	0.075	0.149	0.095	0.047	0.114	0.167	0.167	-	0.144
	RF-1B	0.126	0.182	0.232	0.248	0.135	0.071	0.124	0.037	0.112	0.145	0.023	0.080	0.125	0.139	-	0.127
	RF-2T	0.152	0.201	0.268	0.163	0.136	0.162	0.149	0.222	0.198	0.126	0.159	0.218	0.221	0.21	-	0.185
	RF-2M	0.196	0.211	0.204	0.139	0.035	0.172	0.118	0.143	0.165	0.077	0.126	0.162	0.173	0.254	-	0.155
	RF-2B	0.119	0.189	0.232	0.135	0.081	0.70	0.053	0.097	0.029	0.067	0.080	0.091	0.142	0.152	-	0.155
	RF-3T	0.198	0.117	0.160	0.043	0.062	0.198	0.201	0.167	0.210	0.148	0.163	0.193	0.204	0.222	-	0.163
	RF-3M	0.173	0.143	0.186	0.039	0.059	0.129	0.170	0.145	0.167	0.138	0.119	0.141	0.146	0.100	-	0.133
	RF-3B	0.057	0.135	0.158	0.074	0.059	0.066	0.152	0.175	0.163	0.101	0.078	0.045	0.108	0.144	-	0.108
5th Time (6:00 PM)	RF-1T	0.235	0.254	0.256	0.280	-	-	0.193	-	0.166	0.213	0.227	0.142	0.120	-	0.197	0.208
	RF-1M	0.211	0.187	0.196	0.196	-	-	0.100	-	0.197	0.110	0.116	0.084	0.100	-	0.105	0.146
	RF-1B	0.2	0.184	0.176	0.232	-	-	0.029	-	0.115	0.110	0.083	0.067	0.100	-	0.15	0.131
	RF-2T	0.176	0.231	0.279	0.213	-	-	0	-	0.179	0.206	0.203	0.112	0.119	-	0.159	0.171
	RF-2M	0.173	0.215	0.258	0.173	-	-	0	-	0.128	0.148	0.174	0.078	0.100	-	0.135	0.144
	RF-2B	0.097	0.200	0.262	0.171	-	-	0	-	0.053	0.206	0.132	0.102	0.112	-	0.094	0.130
	RF-3T	0.167	0.152	0.236	0.167	-	-	0.197	-	0.187	0.153	0.193	0.173	0.173	-	0.148	0.177
	RF-3M	0.142	0.135	0.245	0.179	-	-	0.163	-	0.150	0.060	0.166	0.088	0.122	-	0.098	0.141
	RF-3B	0.156	0.142	0.212	0.182	-	-	0.105	-	0.087	0.038	0.122	0.074	0.029	-	0.081	0.112
Average		0.122	0.165	0.179	0.142	0.092	0.172	0.130	0.141	0.144	0.117	0.138	0.141	0.120	0.139	0.130	0.139

14) Result of pH at RF-1, RF-2 and RF-3

Time	No.	Dry-1	Dry-2	Dry-3	Dry-4	Dry-5	Dry-6	Dry-7	Dry-8	Dry-9	Dry-10	Dry-11	Dry-12	Dry-13	Dry-14	Rainy	Avg.
		16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	1-Jul	
1st Time (6:00 AM)	RF-1T	7.22	7.39	7.21	8.30	7.14	7.14	-	7.56	7.69	7.31	7.69	7.70	8.05	7.68	7.62	7.6
	RF-1M	7.2	7.37	7.18	8.31	7.13	7.15	-	7.50	7.52	7.27	7.52	7.39	7.86	7.65	7.51	7.5
	RF-1B	7.18	7.36	7.15	8.28	7.13	7.16	-	7.44	7.48	7.19	7.48	7.32	7.72	7.54	7.42	7.4
	RF-2T	7.28	7.18	7.15	8.37	7.68	7.12	-	7.32	7.10	7.47	7.10	7.56	8.09	7.62	7.65	7.5
	RF-2M	7.23	7.17	7.14	8.36	7.68	7.13	-	7.34	7.06	7.4	7.06	7.49	7.95	7.60	7.87	7.5
	RF-2B	7.2	7.16	7.14	8.33	7.67	7.13	-	7.32	7.04	7.11	7.04	7.41	7.67	7.46	7.75	7.4
	RF-3T	7.1	7.12	7.23	8.45	7.66	7.25	-	7.35	7.72	7.74	7.72	7.52	8.02	7.67	7.58	7.6
	RF-3M	7.1	7.1	7.20	8.44	7.65	7.26	-	7.28	7.59	7.60	7.59	7.48	7.97	7.65	7.55	7.5
	RF-3B	7.07	7.06	7.20	8.39	7.63	7.27	-	7.24	7.57	7.50	7.57	7.42	7.62	7.56	7.50	7.5
2nd Time (9:00 AM)	RF-1T	7.2	7.21	7.13	9.28	7.64	8.40	8.18	7.88	7.88	7.32	7.40	7.30	8.03	7.84	7.85	7.8
	RF-1M	7.14	7.1	7.06	9.27	7.67	8.37	8.08	7.73	7.73	7.25	7.34	7.26	7.99	7.78	7.62	7.7
	RF-1B	7.12	7.06	7.04	9.23	7.65	8.34	8.04	7.73	7.73	7.02	7.23	7.25	7.93	7.75	7.53	7.6
	RF-2T	7.1	7.25	7.08	9.52	7.66	8.31	8.01	7.71	7.71	7.37	7.29	7.30	8.03	7.76	8.02	7.7
	RF-2M	7.06	7.18	7.07	9.60	7.66	8.26	7.97	7.69	7.69	7.13	7.27	7.22	7.98	7.52	7.84	7.7
	RF-2B	7	7.15	7.05	9.69	7.60	8.26	7.95	7.63	7.63	6.96	7.04	7.14	7.73	7.27	7.71	7.6
	RF-3T	7.06	7.08	7.18	9.77	7.65	8.31	7.95	7.62	7.62	7.50	7.52	7.31	8.13	7.85	8.21	7.8
	RF-3M	7.04	7.05	7.09	9.76	7.6	8.27	7.93	7.58	7.58	7.37	7.42	7.27	8.07	7.70	8.07	7.7
	RF-3B	7.04	7.01	7.05	9.69	7.58	8.23	7.80	7.51	7.51	7.07	7.25	7.06	7.98	7.50	7.91	7.6
3rd Time (12:00 PM)	RF-1T	7.23	7.18	7.12	9.40	7.59	7.86	7.86	8.08	7.97	7.67	7.57	7.56	8.42	8.13	7.92	7.8
	RF-1M	7.1	7.10	7.05	9.38	7.57	7.85	7.85	8.05	7.79	7.67	7.48	7.50	8.27	8.08	7.83	7.8
	RF-1B	7.04	7.06	7.04	9.39	7.54	7.85	7.85	8.03	7.76	7.62	7.36	7.44	8.30	7.99	7.23	7.7
	RF-2T	6.93	7.03	7.00	8.65	7.52	7.83	7.83	8.07	7.73	7.61	7.54	7.32	8.25	7.97	8.02	7.7
	RF-2M	6.8	6.99	6.98	8.71	7.50	7.82	7.82	8.04	7.65	7.60	7.45	7.34	8.02	7.88	7.89	7.6
	RF-2B	6.76	6.97	6.98	8.81	7.48	7.77	7.77	7.97	7.50	7.52	7.42	7.32	7.85	7.63	7.56	7.6
	RF-3T	7.18	7.02	6.99	11.57	7.55	7.92	7.92	8.17	7.72	7.74	7.70	7.35	8.34	7.85	7.83	7.9
	RF-3M	7.09	6.97	6.93	11.58	7.49	7.82	7.82	8.14	7.66	7.70	7.52	7.28	8.23	7.84	7.64	7.8
	RF-3B	6.97	6.93	6.81	11.63	7.46	7.75	7.75	8.09	7.60	7.65	7.43	7.24	8.01	7.40	7.58	7.8
4th Time (3:00 PM)	RF-1T	7.23	7.5	7.15	10.46	7.56	7.94	7.72	8.14	7.75	7.91	8.00	7.88	7.92	7.99	-	7.9
	RF-1M	7.19	7.15	6.99	10.51	7.47	7.85	7.68	7.89	7.70	7.83	7.58	7.75	7.81	7.65	-	7.8
	RF-1B	7.17	7.12	6.96	10.61	7.42	7.84	7.67	7.75	7.56	7.65	7.45	7.49	7.62	7.52	-	7.7
	RF-2T	7.13	7.25	6.96	10.32	7.48	7.87	7.86	8.15	7.78	7.85	7.96	7.86	8.01	7.60	-	7.9
	RF-2M	7.1	7.18	6.94	10.38	7.45	7.80	7.79	7.71	7.75	7.63	7.54	7.84	7.76	7.59	-	7.7
	RF-2B	7.08	7.15	6.93	10.39	7.27	7.78	7.76	7.81	7.73	7.39	7.46	7.41	7.54	7.55	-	7.7
	RF-3T	7.2	7.17	6.95	10.83	7.55	7.76	7.91	8.59	7.95	8.13	8.09	8.02	-	7.80	-	8.0
	RF-3M	7.12	7.15	6.93	10.80	7.56	7.74	7.87	8.24	7.88	8.00	8.02	7.92	7.76	7.72	-	7.9
	RF-3B	7.06	7.11	6.89	10.78	7.41	7.72	7.87	8.07	7.83	7.74	7.92	7.80	7.56	7.68	-	7.8
5th Time (6:00 PM)	RF-1T	7.4	7.38	7.14	10.54	-	-	7.38	-	7.93	7.74	7.85	8.14	7.92	-	8.01	7.9
	RF-1M	7.39	7.35	7.12	10.61	-	-	7.39	-	7.80	7.70	7.76	7.95	7.85	-	7.92	7.9
	RF-1B	7.37	7.28	7.12	10.63	-	-	7.38	-	7.75	7.67	7.72	7.65	7.65	-	7.84	7.8
	RF-2T	7.41	7.47	7.21	10.49	-	-	7.56	-	7.70	7.67	7.67	7.84	8.22	-	7.84	7.9
	RF-2M	7.4	7.45	7.19	10.74	-	-	7.52	-	7.63	7.60	7.60	7.52	7.91	-	7.78	7.8
	RF-2B	7.4	7.44	7.19	10.49	-	-	7.43	-	7.52	7.56	7.56	7.48	7.77	-	7.68	7.8
	RF-3T	7.41	7.32	7.12	10.45	-	-	7.71	-	7.55	7.65	7.59	7.84	8.23	-	7.44	7.8
	RF-3M	7.4	7.29	7.11	10.4	-	-	7.64	-	7.50	7.56	7.55	7.55	7.99	-	7.35	7.8
	RF-3B	7.36	7.24	7.10	10.41	-	-	7.64	-	7.47	7.31	7.41	7.46	7.89	-	7.28	7.7
	Average	7.2	7.2	7.1	9.8	7.5	7.8	7.8	7.8	7.6	7.5	7.5	7.5	8.0	7.7	7.7	7.7

15) Result of Salinity at RF-1, RF-2 and RF-3

Unit: %

Time	No.	Dry-1	Dry-2	Dry-3	Dry-4	Dry-5	Dry-6	Dry-7	Dry-8	Dry-9	Dry-10	Dry-11	Dry-12	Dry-13	Dry-14	Rainy	Avg.
		16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	1-Jul	
1st Time (6:00 AM)	RF-1T	0	8	5	8	8	3	-	1	2	1	2	2	2	2	0	3.1
	RF-1M	0	8	5	8	8	3	-	1	2	1	2	2	2	2	0	3.1
	RF-1B	0	6	5	8	8	3	-	1	2	1	2	2	2	2	0	3.0
	RF-2T	0	4	5	8	6	3	-	1	2	1	2	2	2	2	0	2.7
	RF-2M	0	4	5	8	6	3	-	1	2	1	2	2	2	2	0	2.7
	RF-2B	0	3	5	8	6	3	-	1	2	1	2	2	2	2	0	2.6
	RF-3T	0	4	3	6	6	2	-	1	2	1	2	2	2	2	0	2.4
	RF-3M	0	4	3	6	6	2	-	1	2	1	2	2	2	2	0	2.4
	RF-3B	0	3	3	6	6	2	-	1	2	1	2	2	2	2	0	2.3
2nd Time (9:00 AM)	RF-1T	0	0	5	5	6	5	2	3	3	1	2	2	2	2	0	2.5
	RF-1M	0	0	5	5	6	5	2	3	3	1	2	2	2	2	0	2.5
	RF-1B	0	0	5	5	6	5	2	3	3	1	2	2	2	2	0	2.5
	RF-2T	0	2	5	5	5	4	2	3	3	1	2	2	2	2	0	2.5
	RF-2M	0	2	5	5	5	4	2	3	3	1	2	2	2	2	0	2.5
	RF-2B	0	2	5	5	5	4	2	3	3	1	2	2	2	2	0	2.5
	RF-3T	0	0	5	5	5	5	2	3	3	1	2	3	2	2	0	2.5
	RF-3M	0	0	5	5	5	5	2	3	3	1	2	3	2	2	0	2.5
	RF-3B	0	0	5	5	5	5	2	3	3	1	2	3	2	2	0	2.5
3rd Time (12:00 PM)	RF-1T	0	0	1	3	5	1	1	1	0	2	1	1	2	1	0	1.3
	RF-1M	0	0	1	3	5	1	1	1	0	2	1	1	2	1	0	1.3
	RF-1B	0	0	1	3	5	1	1	1	0	2	1	1	2	1	0	1.3
	RF-2T	0	0	1	3	3	1	1	1	0	2	1	1	2	1	0	1.1
	RF-2M	0	0	1	3	3	1	1	1	0	2	1	1	2	1	0	1.1
	RF-2B	0	0	1	3	3	1	1	1	0	2	1	1	2	1	0	1.1
	RF-3T	0	0	1	3	2	3	3	3	0	2	1	1	2	2	0	1.5
	RF-3M	0	0	1	3	2	3	3	3	0	2	1	1	2	2	0	1.5
	RF-3B	0	0	1	3	2	3	3	3	0	2	1	1	2	2	0	1.5
4th Time (3:00 PM)	RF-1T	3	4	2	0	1	1	1	3	1	1	1	1	1	1	-	1.5
	RF-1M	3	4	2	0	1	1	1	3	1	1	1	1	1	1	-	1.5
	RF-1B	3	4	2	0	1	1	1	3	1	1	1	1	1	1	-	1.5
	RF-2T	2	2	5	0	1	1	1	3	1	1	1	1	1	1	-	1.5
	RF-2M	2	2	5	0	1	1	1	3	1	1	1	1	1	1	-	1.5
	RF-2B	2	2	5	0	1	1	1	3	1	1	1	1	1	1	-	1.5
	RF-3T	2	4	4	0	1	1	1	3	2	1	1	1	1	1	-	1.6
	RF-3M	2	4	4	0	1	1	1	3	2	1	1	1	1	1	-	1.6
	RF-3B	2	4	4	0	1	1	1	3	2	1	1	1	1	1	-	1.6
5th Time (6:00 PM)	RF-1T	3	6	5	2	-	-	1	-	1	2	1	1	2	-	0	2.2
	RF-1M	3	6	5	2	-	-	1	-	1	2	1	1	2	-	0	2.2
	RF-1B	3	6	5	2	-	-	1	-	1	2	1	1	2	-	0	2.2
	RF-2T	2	4	5	3	-	-	1	-	1	2	1	1	2	-	0	2.0
	RF-2M	2	4	5	3	-	-	1	-	1	2	1	1	2	-	0	2.0
	RF-2B	2	4	5	3	-	-	1	-	1	2	1	1	2	-	0	2.0
	RF-3T	2	4	5	2	-	-	1	-	1	2	1	1	2	-	0	1.9
	RF-3M	2	4	5	2	-	-	1	-	1	2	1	1	2	-	0	1.9
	RF-3B	2	4	5	2	-	-	1	-	1	2	1	1	2	-	0	1.9
Average		0.9	2.7	3.8	3.5	4.1	2.5	1.4	2.2	1.5	1.4	1.4	1.5	1.8	1.6	0.0	2.0

16) Result of Electric Conductivity at RF-1, RF-2 and RF-3

Unit: us/cm

Time	No.	Dry-1	Dry-2	Dry-3	Dry-4	Dry-5	Dry-6	Dry-7	Dry-8	Dry-9	Dry-10	Dry-11	Dry-12	Dry-13	Dry-14	Rainy	Avg.
		16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	1-Jul	
1st Time (6:00 AM)	RF-1T	12330	13930	12030	13640	13032	3012	-	372	530	446	528	627	612	627	105	5130.1
	RF-1M	11820	13970	11989	13660	12831	3112	-	285	515	458	513	618	593	559	89	5072.3
	RF-1B	11830	13935	11791	13690	12653	3254	-	294	499	455	498	594	581	538	96	5050.6
	RF-2T	12260	11880	11302	13640	12968	3169	-	379	529	473	529	662	512	645	107	4932.5
	RF-2M	11870	12000	11030	13530	12863	3186	-	290	486	445	484	605	494	535	104	4851.6
	RF-2B	12160	12090	10798	13380	12789	3205	-	294	484	475	482	597	421	538	108	4844.4
	RF-3T	10850	10310	9654	13530	12098	2984	-	384	467	453	461	702	452	666	117	4509.1
	RF-3M	8715	9435	9432	13520	12031	2995	-	312	431	428	429	688	380	517	113	4244.7
	RF-3B	8911	9646	9310	13020	11984	3014	-	299	435	434	433	619	373	533	130	4224.4
2nd Time (9:00 AM)	RF-1T	5551	5632	10200	12240	11550	6768	3283	1364	625	419	412	418	433	519	133	3969.8
	RF-1M	5464	2713	10450	12230	11490	6829	3315	1366	625	371	380	328	347	431	137	3765.1
	RF-1B	5440	2672	10100	12350	11380	6877	3380	1369	631	377	324	324	336	410	122	3739.5
	RF-2T	4842	4950	8448	8809	11390	6983	3586	1364	627	389	421	423	436	491	133	3552.8
	RF-2M	5025	5342	8375	9022	11320	6996	3590	1353	633	371	316	314	342	411	126	3569.1
	RF-2B	4860	5514	8555	9611	11200	6940	3598	1338	635	381	317	308	330	423	128	3609.2
	RF-3T	4336	4891	7419	8521	11140	6876	3586	1353	633	417	404	422	441	359	141	3395.9
	RF-3M	4416	4632	7809	8319	10860	6929	3601	1352	642	379	289	305	310	447	134	3361.6
	RF-3B	4300	4589	7630	8378	10840	6955	3635	1302	640	380	304	305	314	413	147	3342.1
3rd Time (12:00 PM)	RF-1T	1996	2708	3373	2915	7861	2413	2410	2015	1511	867	524	369	286	380	126	1983.6
	RF-1M	1971	2713	3265	2905	7803	2681	2679	1989	1514	802	447	283	267	302	122	1982.9
	RF-1B	2112	2672	3242	2925	7788	2665	2663	2051	1507	816	456	292	266	315	117	1992.5
	RF-2T	1628	2351	2838	2933	5965	2615	2611	1975	1507	789	487	378	310	369	143	1793.3
	RF-2M	1871	2355	2789	2891	5814	2574	2570	1999	1506	725	396	289	249	303	126	1763.8
	RF-2B	1966	2329	2833	2910	5756	3101	3126	2003	1508	735	402	291	255	308	142	1844.3
	RF-3T	1514	2386	2829	3171	6808	3047	3036	1987	1471	738	459	380	372	359	143	1913.3
	RF-3M	1596	2345	2644	3163	6658	2591	2593	2022	1462	654	361	310	279	303	133	1807.6
	RF-3B	1692	2271	2665	3134	6445	2891	2890	2066	1551	660	369	299	276	307	130	1843.1
4th Time (3:00 PM)	RF-1T	5527	3581	1724	961	875	1346	1448	2916	1379	613	452	538	739	901	-	1642.9
	RF-1M	5599	3618	1729	948	906	1331	1427	2904	1405	554	365	458	657	858	-	1625.6
	RF-1B	5616	3654	1748	950	864	1340	1412	2923	1370	560	354	454	649	830	-	1623.1
	RF-2T	6414	4950	1824	724	859	1303	1421	2934	1403	560	439	586	771	659	-	1774.8
	RF-2M	6759	5342	1859	719	856	1290	1460	2895	1428	564	370	499	684	611	-	1809.7
	RF-2B	6889	5514	1908	708	945	1184	1477	2912	1415	563	343	485	677	609	-	1830.6
	RF-3T	7465	5571	1863	668	882	912	1300	3170	1352	576	459	632	741	614	-	1871.8
	RF-3M	7582	5623	1983	693	917	920	1390	3167	1373	536	380	524	640	537	-	1876.1
	RF-3B	7603	5671	2001	729	924	961	1488	3134	1369	595	384	515	623	535	-	1895.1
5th Time (6:00 PM)	RF-1T	13500	8664	4529	1542	-	-	641	-	880	682	629	584	1174	-	105	2993.6
	RF-1M	13520	8865	4586	1554	-	-	640	-	891	618	564	525	1061	-	118	2994.7
	RF-1B	13500	8910	4651	1564	-	-	653	-	907	626	563	505	1060	-	127	3006.0
	RF-2T	13800	12850	5987	1784	-	-	637	-	844	660	650	586	940	-	130	3533.5
	RF-2M	13800	12855	5992	1846	-	-	633	-	785	593	585	496	959	-	136	3516.4
	RF-2B	13800	12859	6030	1789	-	-	640	-	822	591	587	490	904	-	142	3514.0
	RF-3T	13780	1098	6982	1421	-	-	592	-	727	643	659	556	925	-	151	2503.1
	RF-3M	13810	1179	7536	1439	-	-	616	-	698	557	590	486	856	-	150	2537.9
	RF-3B	13770	1342	7618	1442	-	-	640	-	744	558	589	457	829	-	145	2557.6
Average		7645.8	6275.7	6074.4	5767.1	7870.7	3479.1	2074.1	1670.3	964.4	555.2	453.0	469.5	559.0	504.5	126.6	3004.3

17) Result of Turbidity at RF-1, RF-2 and RF-3

Unit: FNU

Time	No.	Dry-1	Dry-2	Dry-3	Dry-4	Dry-5	Dry-6	Dry-7	Dry-8	Dry-9	Dry-10	Dry-11	Dry-12	Dry-13	Dry-14	Rainy	Avg.
		16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	1-Jul	
1st Time (6:00 AM)	RF-1T	1000	514	1000	1000	1000	1000	-	1000	1000	1000	1000	1000	1000	1000	614	937.7
	RF-1M	1000	1000	1000	1000	767	1000	-	1000	1000	1000	1000	1000	1000	1000	627	956.7
	RF-1B	1000	1000	1000	1000	531	1000	-	1000	1000	1000	1000	1000	1000	1000	629	940.0
	RF-2T	1000	1000	1000	1000	1000	1000	-	1000	1000	1000	1000	1000	1000	1000	618	972.7
	RF-2M	1000	1000	1000	1000	1000	1000	-	1000	1000	1000	1000	1000	1000	1000	635	973.9
	RF-2B	1000	1000	1000	1000	1000	1000	-	1000	1000	683	1000	1000	1000	1000	637	951.4
	RF-3T	1000	1000	1000	1000	1000	1000	-	1000	1000	1000	1000	1000	1000	1000	677	976.9
	RF-3M	1000	1000	1000	1000	1000	1000	-	1000	1000	1000	1000	1000	779	1000	715	963.9
	RF-3B	1000	1000	794	928	1000	1000	-	1000	1000	1000	1000	1000	776	1000	807	950.4
2nd Time (9:00 AM)	RF-1T	300	1000	1000	343	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	418	870.7
	RF-1M	293	667	1000	479	1000	1000	1000	1000	1000	1000	1000	1000	1000	996	450	859.0
	RF-1B	191	314	1000	1000	1000	1000	1000	1000	1000	1000	1000	846	744	773	511	825.3
	RF-2T	499	950	895	163	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	450	863.8
	RF-2M	270	270	716	225	1000	1000	1000	1000	1000	1000	1000	978	456	677	447	735.9
	RF-2B	127	200	540	1000	1000	1000	1000	1000	1000	1000	1000	541	729	1000	690	788.5
	RF-3T	475	1000	970	274	1000	989	1000	1000	1000	1000	1000	1000	1000	1000	508	881.1
	RF-3M	391	1000	1000	333	1000	511	645	1000	1000	1000	965	1000	585	512	471	760.9
	RF-3B	299	1000	160	311	1000	450	1000	928	1000	1000	1000	1000	427	953	494	734.8
3rd Time (12:00 PM)	RF-1T	1000	1000	681	1000	1000	1000	1000	636	1000	1000	736	1000	1000	1000	429	898.8
	RF-1M	350	667	321	1000	1000	1000	1000	616	1000	1000	660	1000	904	1000	468	799.1
	RF-1B	108	314	311	443	1000	841	1000	1000	1000	1000	854	1000	319	1000	426	707.7
	RF-2T	320	511	538	1000	1000	1000	1000	662	1000	1000	1000	1000	1000	1000	411	829.5
	RF-2M	142	387	491	1000	1000	1000	1000	824	1000	1000	1000	1000	942	584	688	803.9
	RF-2B	152	354	399	674	1000	256	1000	820	1000	1000	1000	1000	183	118	949	660.3
	RF-3T	381	271	218	329	1000	1000	1000	812	1000	1000	1000	1000	1000	1000	637	776.5
	RF-3M	244	225	218	328	505	1000	1000	890	1000	1000	974	1000	1000	149	667	680.0
	RF-3B	160	293	228	264	780	1000	1000	1000	1000	1000	832	1000	1000	27.2	435	667.9
4th Time (3:00 PM)	RF-1T	132	196	323	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	-	832.2
	RF-1M	127	168	506	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	-	842.9
	RF-1B	125	159	750	1000	1000	1000	1000	458	1000	1000	1000	1000	1000	1000	-	820.9
	RF-2T	546	950	782	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	-	948.4
	RF-2M	153	270	669	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	-	863.7
	RF-2B	161	200	491	1000	732	1000	1000	677	1000	1000	1000	1000	1000	1000	-	804.4
	RF-3T	137	213	447	1000	1000	1000	1000	334	696	1000	1000	1000	1000	1000	-	773.4
	RF-3M	176	137	280	1000	1000	1000	1000	329	702	1000	1000	1000	1000	712	-	738.3
	RF-3B	145	137	194	1000	1000	1000	1000	269	730	1000	1000	1000	1000	56.0	-	680.8
5th Time (6:00 PM)	RF-1T	943	1000	1000	644	-	-	1000	-	1000	1000	1000	968	702	-	489	886.0
	RF-1M	968	1000	1000	607	-	-	1000	-	1000	1000	1000	1000	895	-	536	909.6
	RF-1B	955	1000	1000	741	-	-	1000	-	1000	1000	1000	1000	969	-	549	928.5
	RF-2T	1000	1000	1000	761	-	-	1000	-	1000	1000	1000	1000	709	-	483	904.8
	RF-2M	1000	1000	1000	664	-	-	1000	-	1000	1000	1000	1000	665	-	558	898.8
	RF-2B	1000	1000	1000	700	-	-	1000	-	1000	1000	1000	1000	937	-	590	929.7
	RF-3T	1000	1000	1000	1000	-	-	1000	-	1000	1000	1000	1000	652	-	600	932.0
	RF-3M	1000	1000	1000	769	-	-	1000	-	1000	1000	1000	1000	642	-	685	917.8
	RF-3B	1000	1000	1000	609	-	-	1000	-	1000	1000	1000	1000	869	-	670	922.5
Average		561.6	674.8	731.6	768.6	953.2	945.8	990.1	868.2	980.6	993.0	978.2	985.2	864.1	848.8	574.1	851.2

18) Result of Tide Condition at Pazundaung Creek

Time	Dry-1	Dry-2	Dry-3	Dry-4	Dry-5	Dry-6	Dry-7	Dry-8	Dry-9	Dry-10	Dry-11	Dry-12	Dry-13	Dry-14	Rainy	Avg.
	16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	1-Jul	
1st Time (6:00 AM)	Ebb Tide	Flood Tide	Flood Tide	Flood Tide	Flood Tide	Ebb Tide	-	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Flood Tide	Ebb Tide
2nd Time (9:00 AM)	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Flood Tide	Ebb Tide	Flood Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide
3rd Time (12:00 PM)	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Flood Tide	Flood Tide	Flood Tide	Flood Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide
4th Time (3:00 PM)	Flood Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Flood Tide	Flood Tide	Flood Tide	Ebb Tide	-	Flood Tide
5th Time (6:00 PM)	Flood Tide	Flood Tide	Flood Tide	Flood Tide	-	-	Ebb Tide	-	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	Ebb Tide	-	Flood Tide	Flood Tide

19) Cross-section Measurement Survey Record (Ngameoyeik Creek)

Date:1st July, 2014

No.	Location/ Station	Distance (from bank) (m)	Depth (m)	Flow Rate (m/s)	Remark
1	CS-S	0	0	-	South bank
2	CS-01	27	3.2	0.108	P-8
3	CS-02	42	5.3	0.117	P-7
4	CS-03	54	5.8	0.157	
5	CS-04	69	8.3	0.087	P-6
6	CS-05	78	7.6	0.207	
7	CS-06	93	7.7	0.063	P-5
8	CS-07	107	7.3	0.201	
9	CS-08	118	6.8	0.112	P-4
10	CS-09	131	6.3	0.21	
11	CS-10	144	6.5	0.128	P-3
12	CS-11	158	5.7	0.214	
13	CS-12	173	3	0.16	P-2
14	CS-E	184	0	-	North bank

20) Lab Results

Government of the Republic of the Union of Myanmar
Ministry of Agriculture and Irrigation
Irrigation Department
Survey and Investigation Branch
Soil Survey Section
Soil and Water Analytical Laboratory

ANALYTICAL DATA FOR WATER SAMPLE

PROJECT NAME:Electric Power Sector Project(Thaketa Power Plant)

SAMPLE DESIGNATED AS:Water Quality

SAMPLING LOCATION:Yangon, Myanmar

SAMPLING DATE:22.5.201
ISSUED DATE :9.6.2014
SAMPLING BY :Client

Sr No	Station	Results (mg/l)			
		Arsenic (As)	Cadmium (Cd)	Lead (Pb)	Mercury (Hg)
1	WQ-1	0.005877	0.000000	0.000000	0.000000
Drinking Water Standard (WHO)	Highest desirable level	0.05 mg/l	-	-	-
	Maximum permissible level	0.05 mg/l	0.01 mg/l	0.1 mg/l	0.001 mg/l

Remark: Analytical mentions are ppb unit by AAS. But this unit is changed as mg/L according to the standard of WHO unit.

(May Aye Lwin)
Staff Officer (Laboratory)
Soil and Water Laboratory
Survey and Investigation Branch
Irrigation Department

Government of the Republic of the Union of Myanmar
Ministry of Agriculture and Irrigation
Irrigation Department
Survey and Investigation Branch
Soil Survey Section
Soil and Water Analytical Laboratory

ANALYTICAL DATA FOR WATER SAMPLE

PROJECT NAME:Electric Power Sector Project(Thaketa Power Plant)

SAMPLE DESIGNATED AS:Water Quality

SAMPLING LOCATION:Yangon, Myanmar

SAMPLING DATE:22.5.201
ISSUED DATE :9.6.2014
SAMPLING BY :Client

Sr No	Station	Results (mg/l)			
		Arsenic (As)	Cadmium (Cd)	Lead (Pb)	Mercury (Hg)
1	WQ-2	0.005284	0.000000	0.000000	0.000590
Drinking Water Standard (WHO)	Highest desirable level	0.05 mg/l	-	-	-
	Maximum permissible level	0.05 mg/l	0.01 mg/l	0.1 mg/l	0.001 mg/l

Remark: Analytical mentions are ppb unit by AAS. But this unit is changed as mg/L according to the standard of WHO unit.

(May Aye Lwin)
Staff Officer (Laboratory)
Soil and Water Laboratory
Survey and Investigation Branch
Irrigation Department

MINISTRY OF LIVESTOCK , FISHERIES AND RURAL DEVELOPMENT
DEPARTMENT OF FISHERIES
AQUACULTURE DIVISION
FRESHWATER AQUACULTURE RESEARCH
WATER AND SOIL EXAMINATION LABORATORY

RESULT ON CHEMICAL EXAMINATION OF WATER

Sender's reference : Resource & Environment Collection Date : 22-5-.2014

Myanmar Co.Ltd

Location : Pazuntaung Township Arrival Date & Time :28.5.2014 &12:30

Project name : **Electric Power Sector Project (Thaketa Power Plant)**

Parameter	Unit	WQ-1	WQ-2	WQ-3
Iron	mg/l	0.10	0.10	0.20
Suspended Solids	mg/l	258	559	488
Copper	mg/l	ND	ND	ND
Zinc	mg/l	ND	ND	ND

Analyzed by - San San Soe
- Khaing Khaing Oo
- Thin Thin Aye

Approved by

Aye Aye Thein
Head of Freshwater Aquaculture Research

The Government of the Republic of the Union of Myanmar
Ministry of Agriculture and Irrigation
Irrigation Department
Survey and Investigation Branch
Soil Survey Section
Soil and Water Analytical Laboratory

ANALYTICAL DATA FOR WATER SAMPLE

PROJECT NAME;Electric Power Sector Project(Thaketa Power Plant)
SAMPLE DESIGNATED AS;Water Quality
SAMPLING LOCATION;Yangon, Myanmar

SAMPLING DATE;22.5.201
ISSUED DATE ;9.6.2014
SAMPLING BY ;Client

Sr No	Station	Results (mg/l)			
		Arsenic (As)	Cadminium (Cd)	Lead (Pb)	Mercury (Hg)
1	WQ-3	0.00481	0.000000	0.000000	0.000000
Drinking Water Standard (WHO)	Highest desirable level	0.05 mg/l	-	-	-
	Maximum permissible level	0.05 mg/l	0.01 mg/l	0.1 mg/l	0.001 mg/l

Remark: Analytical mentions are ppb unit by AAS. But this unit is changed as mg/L according to the standard of WHO unit.

(May Aye Lwin)
Staff Officer (Laboratory)
Soil and Water Laboratory
Survey and Investigation Branch
Irrigation Department

The Government of the Republic of the Union of Myanmar
Ministry of Agriculture and Irrigation
Irrigation Department
Survey and Investigation Branch
Soil Survey Section
Soil and Water Analytical Laboratory

ANALYTICAL DATA FOR WATER SAMPLE

PROJECT NAME;Electric Power Sector Project (Thaketa Power Plant)

SAMPLING LOCATION;Thaketa

SAMPLING DATE 1.7.2014
ISSUED DATE ; 8.7.2014
SAMPLING BY ; Client

Sr No	Station	Results (mg/l)						
		Lead (pb)	Cadmium (Cd)	Mercury (Hg)	Copper (Cu)	Zinc (Zn)	Arsenic (As)	Iron (Fe)
1	WQ-1	0.000000	0.000000	0.000000	0.006537	0.000000	0.000040	2.20
2	WQ-2	0.000000	0.000000	0.000106	0.003889	0.000000	0.000045	0.15
3	WQ-3	0.000000	0.000000	0.000000	0.000000	0.000325	0.000030	1.20
4	WQ-5	0.000000	0.000000	0.000000	0.00407	0.000000	0.000045	1.80
Drinking Water Standard	Highest desirable level	_	_	_	0.05 mg/l	5.0 mg/l	_	0.1 mg/l
	Maximum permissible level	0.05 mg/l	0.01 mg/l	0.001mg/l	1.0 mg/l	15.0 mg/l	0.05 mg/l	1.0 mg/l

Remark: Analytical mentions are ppb unit by AAS. But this unit is changed as mg/L according to the standard of WHO unit.

(May Aye Lwin)
Staff Officer (Lab)
Soil Survey Section
Survey and Investigation Branch
Irrigation Department
Yangon

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Report No. : 2014-00595 / 001-1 (Page 1 of 1) Issued date : June 13, 2014

CLIENT : RESOURCE AND ENVIRONMENT MYANMAR CO., LTD.
CONTACT : Ms. Pwint Pwint
ADDRESS : B702 Delta Plaza, Shwegondaing Rd., Bahan, Yangon, Myanmar
Tel. +959-73013448 Fax. +951-552901
E-mail : pwint@enviromyanmar.net

Analysis Report

PROJECT NAME : Electric Power Sector Project (Thaketa)
SAMPLE DESIGNATED AS : Water Quality
SAMPLING DATE : May 22, 2014
SAMPLING LOCATION : Thaketa, Myanmar
SAMPLING BY : Client

Stations	Results		
	Oil and Grease (mg/l)	Residual Chlorine (mg/l)	Total Chromium (mg/l)
1. WQ-1	< 1.0	0.04	0.04
2. WQ-2	< 1.0	< 0.01	< 0.02
3. WQ-3	< 1.0	0.08	0.08
Detection Limit	1.0	0.01	0.02

Remark : - Analysis Methods followed to Standard Methods for the Examination of Water and Wastewater, recommended by APHA-AWWA-WEF.

(Siripom Imwilaiwan)
License ID : ว-010-ค-1793

(Thepson Yommana)
License ID : ว-010-ค-333

SGS (THAILAND) LIMITED

TY/Client/VV/Ws

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SGS (Thailand) Limited Environmental Services 100 Nangkhaeo Road Chongnonsee Yannawa Bangkok 10120
t +66 (0)2 678 18 13 f +66 (0)2 678 06 22 www.sgs.com

Member of the SGS Group

Report No. : 2014-00824 / 001-1 (Page 1 of 1) **Issued date :** August 14, 2014

CLIENT : **RESOURCE AND ENVIRONMENT MYANMAR CO., LTD.**
CONTACT : Ms. Pwint Pwint
ADDRESS : B702 Delta Plaza, Shwegondaing Rd., Bahan, Yangon, Myanmar
Tel. +959-73013448 Fax. +951-552901
E-mail : pwint@enviromyanmar.net

Analysis Report

PROJECT NAME : Electric Power Sector Project (Thaketa)
SAMPLE DESIGNATED AS : Water Quality **SAMPLING DATE** : July 2 , 2014
SAMPLING LOCATION : Thaketa, Myanmar **SAMPLING BY** : Client

Parameters	Units	LOQ*	Stations			
			WQ-1	WQ-2	WQ-3	WQ-5
Total Chromium	mg/L	0.02	< 0.02	< 0.02	< 0.02	< 0.02
Oil & Grease	mg/L	2.0	3.0	3.0	< 2.0	< 2.0
Total Chlorine (residual)	mg/L	0.01	0.11	0.09	0.09	0.10

Remark :
- Analysis Methods followed *to the Standard Methods for the Examination of Water and Wastewater* endorsed by American Public Health Association (APHA), American Water Works Association (AWWA)and Water Environment Federation (WEF).
- LOQ = Limit of Quantitation

(Siriporn Imwilaiwan)
License ID : ว-010-ค-1793

(Thepson Yommana)
License ID : ว-010-ค-333

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ANALYSIS REPORT

ORIGINAL

Job Ref: 4933/2014
Date : 08.07.2014
Page 1 of 1

Client Name : **RESOURCE AND ENVIRONMENT CO., LTD**
B-702 Delta Plaza, Shwegondaing Rd, Bahan Township,
Yangon, Myanmar
Project Name : ELECTRIC POWER SECTOR PROJECT (THAKETA POWER PLANT)
Sample Brought By : Client
Sample Received Date : 04.07.2014
Analysed Date : 07.07.2014
Commodity Name : **SURFACE WATER**
Test Method : APHA 2540 D

Stations	Lab Code	Results (mg/l)
		Total Suspended Solid
1. WQ – 1	121/14	327.7
2. WQ – 2	122/14	150.7
3. WQ - 3	123/14	428.7
4. WQ – 5	124/14	137.3
Detection Limit		2

End Of Report

SGS (Myanmar) Limited

(Nu Nu Yi)
Manager

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SGS Myanmar Limited | Agricultural Services 79/80, Bahosi Housing Complex, Warden Street, Lanmadaw Tsp, Yangon, Myanmar
t +95(1)211562, 211537, 211538, 211541 f +95(1)211549 e sgs.myanmar@sgs.com

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Appendix-2: Result of Baseline Survey in Thaketa Power Plant

Appendix-2: Result of Baseline Survey in Thaketa Power Plant

1) Emission Gas Data

【Emission gas flow velocity measurement record】

Measurement location			Flange1 (After the damper)		Flange2 (Chimney)		
Measurement point number			1-1	1-2	2-1	2-2	2-3
Flow velocity	V	m/s	8.5	27	9.2	10.4	7.7
Flow velocity (Average)	Va	m/s	17.8		9.1		
Exhaust gas temperature	θs	℃	465		225		
Static pressure	Ps	kPa	0.78		0.029		

【Amount of emission gas measurement record 】

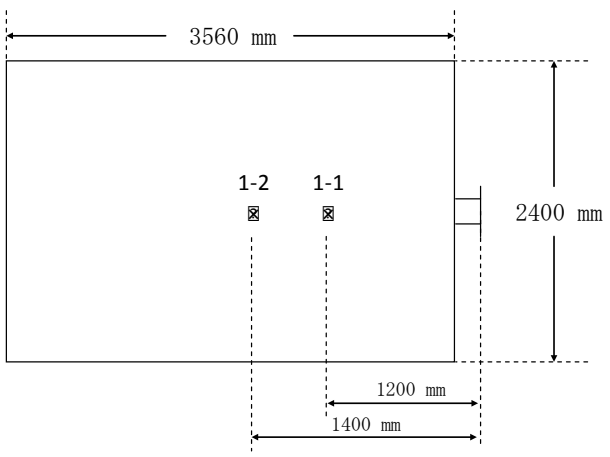
Measurement location			Flange1 (After the damper)	Flange2 (Chimney)
Cross-sectional area	A	m^2	8.54	8.04
Exhaust gas flow rate (wet)	QN	m^3N/h	204,000	144,000
Exhaust gas flow rate (Dry)	Q'N	m^3N/h	189,000	133,000

【Amount of emission gas formula】

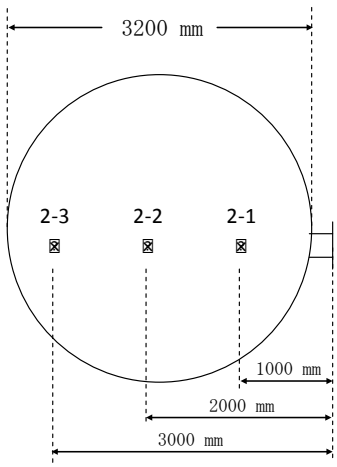
$$QN = A \times Va \times \frac{273}{273 + \theta s} \times \frac{101.3 + Ps}{101.3} \times 60 \times 60$$

$$Q'N = Q\ N \times \left(\frac{100 - Xw}{100} \right)$$

【Sectional view】



Flange 1 (after the damper)



Flange 2 (chimney)

【Water amount measurement record】

Measurement location		Flange 1 (after the dumper)		
Day		2014,6,17		
Method		JIS Z8808		
Time		11:20 ～ 11:45		
Number of measurements			1st	2nd
Suction rate		L/min	2.0	2.0
Gas collection volume	V	L	10.1	10.1
Gas mater temperature	θa	℃	36	36
Gas mater pressure	Pm	kPa	0.01	0.01
Moisture absorption tube weight (before)	m1	g	121.38	121.93
Moisture absorption tube weight (after)	m2	g	121.93	122.44
Moisture absorption water content	ma	g	0.55	0.54
Water amount	Xw	%	7.1	7.0
Water amount (Average)	Xw	%	7.1	

Measurement location		Flange 2 (Chimney)		
Day		2014,6,17		
Method		JIS Z8808		
Time		9:36 ～ 10:05		
Number of measurements			1st	2nd
Suction rate		L/min	2.0	2.0
Gas collection volume	V	L	10.0	10.0
Gas mater temperature	θa	℃	32	34
Gas mater pressure	Pm	kPa	0.01	0.01
Moisture absorption tube weight (before)	m1	g	120.20	120.80
Moisture absorption tube weight (after)	m2	g	120.80	121.38
Moisture absorption water content	ma	g	0.60	0.58
Water amount	Xw	%	7.7	7.5
Water amount (Average)	Xw	%	7.6	

【Amount of water formula】

$$Xw = \frac{\frac{22.4}{18} \times mt}{Vm \times \frac{273}{273 + \theta m} \times \frac{101.3 + Pm}{101.3} + \frac{22.4}{18} \times mt} \times 100$$

【Detector tube measurement record 1】

Measurement place name	:	Thaketa PowerStation		
Facility name	:	Gas Turbine No.2 Flange 1 (After the damper)		
Day and tome	:	2014, 6, 17	1st: 12:05	2nd: 12:10	3rd: 12:15
Gas temperature	:	465℃		

Item	Detector tube type	Number of stroke	Suction time for one	Measuring range	Detection limit	Unit	Discoloration	Temperature and humidity correction	Result			
									1st	2nd	3rd	Average
CO	1L	1(Criteria)	1min	25 ～ 1000	1(n=10)	ppm	Yellow → Dark brown	none	50/2＝25	50/2＝25	50/2＝25	25
		1/2、2～10		2.5 (n=10) ～ 2000 (n=1/2)								
	1M	1(Criteria)	1min	0.1 ～ 2.0	0.01 (n=2)	%	White → Light brown	none				
		1/2、2		0.05 (n=2) ～ 4 (n=1/2)								
CO_2	2H	1(Criteria)	45sec	1 ～ 10	0.1 (n=2)	%	White → Purple	none	2.4	2.4	2.3	2.4
		1/2、2		0.5 (n=2) ～ 20 (n=1/2)								
	2L	1(Criteria)	1.5min	0.25 ～ 3	0.025 (n=2)	%	White → Purple	none				
		1/2、2		0.13 (n=2) ～ 6 (n=1/2)								
O_2	31B	1/2(Criteria)	1min	6 ～ 24	2(n=1)	%	Black → White	none	15.9	16.0	16.0	16.0
		1		3(n=1) ～ 24(n=1/2)								
NOx	11S	1(Criteria)	45sec	10 ～ 250	2(n=2)	ppm	White → Light green	none	20	20	20	20
		1/2、2		5 (n=2) ～ 625 (n=1/2)								
	11HA	1(Criteria)	1min	50 ～ 2500	10(n=1)	ppm	White → Green	none				

【Detector tube measurement record 2】

Measurement place name	:	Thaketa PowerStation			
Facility name	:	Gas Turbine No.2 Flange 2 (Chimney)			
Day and tome	:	2014, 6, 17	1st: 10:32	2nd: 10:35	3rd: 10:40
Gas temperature	:	225℃			

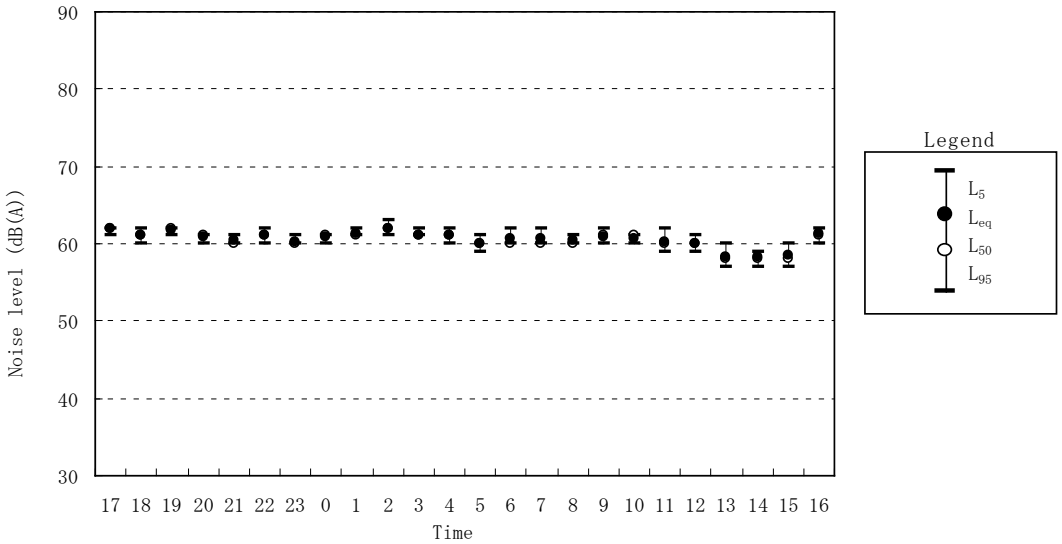
Item	Detector tube type	Number of stroke	Suction time for one	Measuring range	Detection limit	Unit	Discoloration	Temperature and humidity correction	Result			
									1st	2nd	3rd	Average
CO	1L	1(Criteria)	1min	25 ～ 1000	1(n=10)	ppm	Yellow → Dark brown	none	50/2=25	50/2=25	50/2=25	25
		1/2、2～10		2.5 (n=10) ～ 2000 (n=1/2)								
	1M	1(Criteria)	1min	0.1 ～ 2.0	0.01 (n=2)	%	White → Light brown	none				
		1/2、2		0.05 (n=2) ～ 4 (n=1/2)								
CO_2	2H	1(Criteria)	45sec	1 ～ 10	0.1 (n=2)	%	White → Purple	none	2.2	2.2	2.1	2.2
		1/2、2		0.5 (n=2) ～ 20 (n=1/2)								
	2L	1(Criteria)	1.5min	0.25 ～ 3	0.025 (n=2)	%	White → Purple	none				
		1/2、2		0.13 (n=2) ～ 6 (n=1/2)								
O_2	31B	1/2(Criteria)	1min	6 ～ 24	2(n=1)	%	Black → White	none	16.0	16.0	16.0	16.0
		1		3(n=1) ～ 24(n=1/2)								
NOx	11S	1(Criteria)	45sec	10 ～ 250	2(n=2)	ppm	White → Light green	none	18	20	20	19.3
		1/2、2		5 (n=2) ～ 625 (n=1/2)								
	11HA	1(Criteria)	1min	50 ～ 2500	10(n=1)	ppm	White → Green	none				

2) Noise and Vibration data at Property boundary

【Noise measurement results (at boundary line)】

(Unit : dB(A))

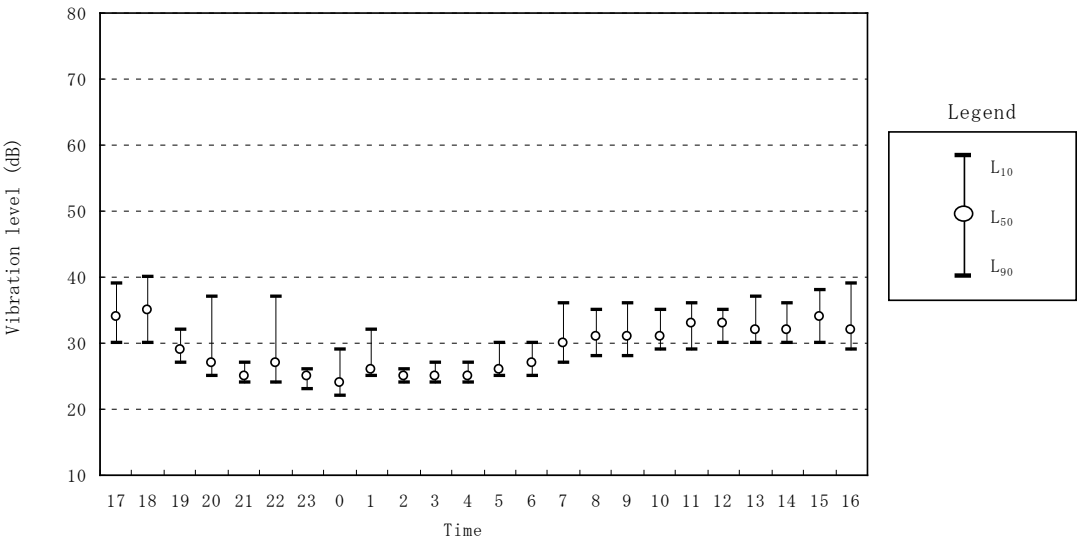
Date and time \ Item		L_5	L_{50}	L_{95}	L_{eq}
16,JUN	17	62	62	61	61.9
	18	62	61	60	61.2
	19	62	62	61	61.7
	20	61	61	60	60.8
	21	61	60	60	60.4
	22	62	61	60	61.0
	23	61	60	60	60.3
17,JUN	0	61	61	60	60.8
	1	62	61	61	61.2
	2	63	62	61	61.9
	3	62	61	61	61.1
	4	62	61	60	61.1
	5	61	60	59	60.1
	6	62	60	60	60.6
	7	62	60	60	60.6
	8	61	60	60	60.5
	9	62	61	60	60.9
	10	61	61	60	60.8
	11	62	60	59	60.3
	12	61	60	59	60.0
	13	60	58	57	58.3
	14	59	58	57	58.3
	15	60	58	57	58.5
	16	62	61	60	61.4



【Vibration measurements (at boundary line)】

(Unit:dB)

Date and time \ Item		L_{10}	L_{50}	L_{90}
16,JUN	17	39	34	30
	18	40	35	30
	19	32	29	27
	20	37	27	25
	21	27	25	24
	22	37	27	24
	23	26	25	23
17,JUN	0	29	24	22
	1	32	26	25
	2	26	25	24
	3	27	25	24
	4	27	25	24
	5	30	26	25
	6	30	27	25
	7	36	30	27
	8	35	31	28
	9	36	31	28
	10	35	31	29
	11	36	33	29
	12	35	33	30
	13	37	32	30
	14	36	32	30
	15	38	34	30
	16	39	32	29



Appendix-3: Materials for 1st Mini-workshop (20th June,2014)

Table 3-1 Participant List (20th June,2014)

No.	Name of Power Plant/Substation	Name of Person	Position
1	Power Transmission Project Dept.	U Thet Paing Myo	Project Manager
2	Thaketa Power Plant/Substation	U Aye Lwin	Senior Engineer/ Plant Manager
3		Daw Sandar Zaw	Assistant Engineer
4		Daw San San Htwe	Assistant Engineer
5		U Nay Myo Myint	Assistant Engineer
6		Daw Mya Kaythi Tun	Sub-Assistant Engineer
7		U Nyunt Win Htun	Sub-Assistant Engineer
8		U Thant Zin Soe Win	Sub-Assistant Engineer
9		U Zaw Win Htay	Sub-Assistant Engineer
10	Ywama Power Plant/Substation	U Min Thin Mg Aye	Assistant Engineer
11		Daw Waing Ei Win	Sub-Assistant Engineer
12		U Phyo Htike Ko	Sub-Assistant Engineer
13	Ywama 240MW Power Plant	U Kyi Hlaing	Sub-Assistant Engineer
14		U Hein Htet Arkar Zaw	Sub-Assistant Engineer
15	Hlawga Power Plant	U Thein Zaw Min Soe	Assistant Engineer
16		U Thet Tin Aung	Assistant Engineer
17		U Naing Ye Win	Sub-Assistant Engineer
18	Hlawga Substation	U Aung Kyi Oo	Assistant Engineer
19		Daw Yin Mar Nwai	Sub-Assistant Engineer
20		Daw Aye Aye Soe	Sub-Assistant Engineer
21	Ahlone Power Plant	Daw Su Mar Lwin	Assistant Engineer
22		U Hlaing Myo Kyaw	Sub-Assistant Engineer
23		U Ye Arkar Min	Sub-Assistant Engineer
24	Ahlone Substation	Daw Myo Thiri Khaing	Sub-Assistant Engineer
25		Daw Hnin Zin Aung Min	Sub-Assistant Engineer
26		U Thura Aung	Sub-Assistant Engineer

Table 3-2 Workshop Program (20th June,2014)

Time	Contents	Persons in Charge
14:00 – 14:05	Opening remark	MEPE
14:05 – 14:50	Topic-1: Scoping results and frameworks of environmental management and monitoring plan for the Urgent Rehabilitation Project - Q&A and short discussion -	JICA Expert Team All participants
14:50 – 15:05	Coffee break	-
15:05 – 15:25	Topic-2: Key topics on environmental management and monitoring on combined cycle power plants, emission gas, noise and wastewater - Q&A and short discussion -	JICA Expert Team All participants
15:25 – 15:45	Topic-3: Key topics on environmental management and monitoring on substations, hazardous waste including PCB waste, occupational safety and electric and magnetic field - Q&A and short discussion -	JICA Expert Team All participants
15:45 – 16:20	Topic-4: Discussion on obstructive factors against preferable implementation of environmental management and monitoring plan, and required actions and recommendations	All participants
16:20 – 16:30	Closing remark	MEPE

Table 3-3 Comment by the Participants (20th June,2014)

Question	Comment
If you attend same kind of workshop, what kind of topic do you want to have related to environmental management plan and environmental monitoring plan?	(1) Topic related to Electric and Magnetic Field monitoring plan and equipment used in the field. (2) Topic related to the ways of protection and reducing of the impacts which occupy the values beyond the targeted values of IFC Standard. (3) Topic related to the explanation of the application of new technology, equipment, and ways which will minimize environmental impacts and to reduce risks by three steps if the plans are carried out under strict condition. (4) Topic which will provide suggestions and comments for implementation of proper and feasible EMP and EMoP which can be conducted under current working condition and budget in Myanmar. (5) It is required to get JICA training for the application of testing equipment in the practical working condition. (6) natural environmental conservation, usage of water resources, air and water pollution control, noise pollution control, energy production from the waste, PCB presentation (7) Necessary equipments for substation and requirement training for engineers and staffs. (8) Water treatment, PCB oil (9) If I attend same kind of workshop, listening to regulation of Japan, noise regulation act, and industrial safety and health act for Myanmar. (10) Electrical related topic (11) If I attend same kind of workshop, necessary training to obtain required knowledge and skills. (12) If I attend same kind of workshop, the topics describe any case caused by electric and magnetic field. (13) Air Pollution, Noise Pollution, Water Pollution (14) The information related to Substation is requested. Hydro and Coal Power Plants, information of PCB. (15) In later workshop, I want to know the important of Environmental Safety advantage and disadvantage of environmental pollution. (16) Pollution on surrounding air and water (17) Benefits (Money/Environment/Climate) (18) I would like to attend not only workshop related to environmental management plan and environmental monitoring plan but also training for how to control the emissiong gas control, thermal discharge & noise for thermal power plant in Japan. (19) 1. Air pollution control, 2. water pollution control, 3. climate change (GHG), 4. Emergency Risk (Fire, flooding ,earthquake)
If you think that any equipment for environmental management or occupational safety should be procured, please kindly describe.	(1) Thermal image detector, temperature sensor, noise detector, vibration sensor (2) People Protection Equipment (PPE) (3) PCB detector or Equipment for measuring PCB concentration to enable to use PCB under control. (4) People Protective Equipment, the buildings and places which will store the waste properly. (5) PPE equipment for occupational staffs and equipment required for the measurement of environmental impacts are requested to be purchased. The distribution of information related to environmental affairs required for CCPP is requested. (6) Equipment for measuring NOx, equipment for measuring and controlling noise pollution, safety devices, environmental monitoring equipment, vibration detector equipment, PCB measuring equipment (7) Equipment for emission gas analysis, vibration detector, Noise detector (8) Any necessary equipments for safety (9) Protective and Measurements device (10) Safety Shoes, Safety Belt, PCB tester, EMF Tester

Question	Comment
	(11) Noise protection and safety equipment are required (12) Testing equipment and laboratories
Please write down any comment/opinion on this mini-workshop.	(1) Nice presentation. Thank you for giving chance to join this workshop. I received a lot of environmental knowledge from this mini-workshop. I wish to join such workshop in future to share knowledge. (2) The survey values from Thaketa Power Plant is requested to describe as a comparison with IFC standard values. Since I do not know well about IFC standards, it is difficult to distinguish whether it is still good or bad. (3) Very nice workshop with well discussion for us. Knowledge about environmental conservation and safety risks was broadened. (4) If possible, training related to control industry and factory, and for Combined Cycle Power Plant are requested to hold in future. (5) Knowledge about EMP and EMoP and disadvantage of PCB are gained. We would like to know in detail next time. (6) Good manner for our Ministry and Country. Because our country did not care environmental impacts from power plants such as waste water, natural gas leakage, air pollution, noise. Workshop for Environmental consideration for Power Plant and Substation is very good and the occupational safety should be implemented. (7) Very good. There should be a coordinator for environmental conservation at each targeted power plant and substation. (8) This mini-workshop is good but period is too short. We need more training and more knowledge.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MYANMA ELECTRIC POWER ENTERPRISE (MEPE)

Environmental Consideration of Electric Power Sector

Scoping Results and Frameworks of Environmental Management and Monitoring Plan for the Urgent Rehabilitation Project

June 2014

NIPPON KOEI CO., LTD.

NIPPON KOEI 1

Background of the Project

- The Government of Myanmar (GoM) and the Japan International Corporation Agency (JICA) signed a loan agreement for a project titled "Urgent Rehabilitation and Upgrade Project Phase 1" (Phase I Project) in June 2013, which aims to renovate major power facilities in the central economic zone in the Yangon urban area. Currently, EIA approval system is under development in Myanmar, hence, it is required to prepare the document which will be requested by the system.
- Under the JICA Environmental and Social Consideration Guideline, appropriate measures to mitigate and monitor environmental and social impact have to be planned and implemented.

NIPPON KOEI 2

Project Area

The project area is relevant areas of the Thaketa Power Plant with its sub-station, and the other three sub-stations, Ywama Substation, Hlawga Substation, and Ahlone Substation.

NIPPON KOEI 3

Objectives and Duration of the Project

The objectives of this project are;

- To enhance MEPE's capacity on environmental and social considerations along with related environmental regulations in Myanmar and the JICA Guidelines for Environmental and Social Considerations (April 2010), and
- To provide assistance for carrying out existing projects and prospective yen loan projects especially for the Phase I Project smoothly from environmental and social consideration viewpoints.

⇨ To achieve above objectives, under this project, JICA Expert Team (JET) will provide assistance to prepare an environmental management plan (EMP) and an environmental monitoring plan (EMoP).

Project period is from May to August 2014 (Preparatory work has been started from April 2014).

NIPPON KOEI 4

Why environmental management plan and monitoring plan is necessary for power plant and substation? – general requirement

1. To avoid serious pollution on surrounding air, water and soil environment
2. To avoid serious impacts to residents and society around power plants and substations
3. To secure safe working condition for engineers and staffs
4. To conserve surrounding natural environment and use natural resource wisely

For urgent rehabilitation project, from the item 1 to item 4 are mainly concerned.

NIPPON KOEI 5

Why environmental management plan and monitoring plan are necessary for power plant and substation? – legal and institutional requirement

1. According to the notification of EIA procedure that is being prepared by MOECF, a certain scale of existing power plant and substation should submit the environmental management plan and environmental monitoring plan.
2. The Urgent Rehabilitation Project is implementing by JICA support. According to the JICA Environmental and Social Consideration Guideline, proper environmental management have to be carried out, and periodical reporting (once in a quarter) is necessary.

NIPPON KOEI 6

Function of EMP and EMoP for Power Plant and Substation

Power Plant / Substation Operation Plan

Provide suggestion from environmental viewpoint

Environmental Management Plan (EMP)

Secure safety and reduce risk on health and environmental pollution

Review effectiveness of EMP

Environmental Monitoring Plan (EMoP)

Report environmental compliance to relevant stakeholders

Managers, engineers and staffs of power plants and substations

MOEP and MEPE headquarter

Relevant ministries such as MOECF

Local residents surrounding power plants and substations

International donors such as JICA

Draft Framework of Environmental Management Plan

Chapter 1: Objectives of EMP
Chapter 2: Project Description
Chapter 3: Relevant Policy and Legal Requirement
Chapter 4: Summary of Predicted Impacts and Mitigation Measures
Chapter 5: Planned Environmental Management Activities
(1) Power Plant
1) During Pre-construction Phase
2) During Construction Phase
3) During Operation Phase
(2) Substations
1) During Pre-construction Phase
2) During Construction Phase
3) During Operation Phase
Chapter 7: Emergency Response Plan ???
Chapter 8: Organization Structure
Chapter 7: Implementation Schedule
Chapter 8: Cost for Implementation

Draft Framework of Environmental Monitoring Plan

Chapter 1: Objectives of EMoP
Chapter 2: Project Description
Chapter 3: Relevant Policy and Legal Requirement
Chapter 4: Summary of Environmental Management Plan
Chapter 5: Planned Environmental Monitoring Activities
(1) Power Plant
1) During Pre-construction Phase
2) During Construction Phase
3) During Operation Phase
(2) Substations
1) During Pre-construction Phase
2) During Construction Phase
3) During Operation Phase
Chapter 6: Reporting
Chapter 7: Organization Structure
Chapter 8: Implementation Schedule
Chapter 9: Cost for Implementation
Attachment: Reporting Form

Items to be discussed for preparation of feasible environmental management plan and monitoring plan

1. How can power plant and substation allocate persons in charge of EMP and EMoP?
2. How will required budget be allocated?
3. What kinds of equipment have to be procured?
4. What kind of training is necessary to obtain required knowledge and skills?

Process for Preparation of Environmental Management Plan and Environmental Monitoring Plan

Phase I: Predict and evaluate impacts

Scoping → Baseline survey

Prediction of Impacts

Evaluation of Impacts

Technical information on methodology for predicting and evaluating impacts, will be provided by JICA Expert Team (JET).

Phase II: Prepare EMP and EMoP

JET will co-work with MEPE for preparation of EMP and EMoP. The MEPE will be expected for finalizing EMP and EMoP reflecting the local actual situation with identification of available and needed resources in order to implement these plans in the future.

Environmental and Social Items to be Examined for

Pollution	air quality, water quality, solid waste, soil contamination, noise/vibration, subsidence, odor, sedimentation
Natural Environment	natural reserve, flora and fauna, ecosystem, hydrology, topography and geography
Social Environment	resettlement, poor, indigenous and ethnic minority group, local economy, land use and local resource, water use, existing infrastructure and service, social structure, uneven distribution of harm and benefit, conflicts of interest within the region, cultural heritage, landscape, gender, children's right
Health and Safety	Occupational health and safety, risks of infection disease, traffic accident
Emergency Risk	Emergency risk by flooding and fire
Climate Change	green house gas (GHG) emission reduction

Draft Scoping Results of Urgent Rehabilitation Project – Power Plant

	Construction Phase	Operation Phase
Some positive impact (Environmental benefit)	Increase of job opportunity	improvement of emission gas quality, local economy, infrastructure and service, woman and children's light, GHG emission reduction
Some negative impact	air pollution, solid waste, soil contamination, noise/vibration, occupational health and safety, occupational health and safety, community health and safety, risks of infection disease, accident	impact by thermal discharge, solid waste, noise/vibration, occupational health and safety, accident
Impacts are not clear, need further investigation		hydrology and water use, emergency risk on flooding and fire

Draft Scoping Results of Urgent Rehabilitation Project - Substation

	Construction Phase	Operation Phase
Some positive impact (Environmental benefit)	Increase of job opportunity	local economy, infrastructure and service, woman and children's light, climate change
Some negative impact	solid waste and hazardous chemicals (including PCB), noise/vibration, occupational health and safety, accident	solid waste and hazardous chemicals (including PCB), soil contamination, noise/vibration, occupational health and safety, occupational health and safety, community health and safety, risks of infection disease, accident
Impacts are not clear, need further investigation		Electric and magnetic field

Thank you very much for your kind attention.

Topic 2

Key Topics on EMP and EMoP on Combined Cycle Power Plants

NIPPON KOEI

Contents of Explanation

Pollution Control Items on the Operation of Thermal Power Plant

1. Air pollution control

- Emission gas from the chimney of thermal power plant

2. Water pollution control

- Thermal discharge from boiler

3. Noise pollution control

- Emission sound from noisy/heavy facility

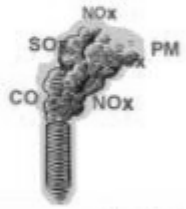
4. Conclusion

NIPPON KOEI 2

Air Pollution Control (1)

1.What is Emission Gas?

- ✓ Thermal plants generate electric power thorough burning fuel.
- ✓ In the process of burning fuel such as gaseous, liquid and solid fossil fuels, emission gas will be exhausted.
- ✓ Emission gas may have a significant influence on the environment including human health.
- ✓ Remarkable emission gas is as follows;
  - Sulfur Dioxide (SO_2)
  - Nitrogen Oxides (NOx)
  - Particulate Matter (PM)
  - Carbon Monoxide (CO)



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Air Pollution Control (2)

2. How to Control Emission Gas

- ✓ International Standard/Guidelines define the limitation of the concentration of emission gas from Thermal Power Plants.

【IFC】International Finance Corporation Environmental Health and Safety (EHS) Guidelines

- Prepare the emission guidelines for combustion turbine on PM, SO_2 and NOx in accordance with the combustion technology / fuel particulate.

【JAPAN】Air Pollution Control Act

- Define the specific facility, specific pollutant material and each limitation
- Define the volume and/or concentration of emission gas from each facility, or the total volume of emission gas from one factory.

- ✓ The project proponents examine and develop the adequate mitigation measurements under law and guidelines.

NIPPON KOEI 4

Air Pollution Control (3)

3. Current Status of Emission Gas from Thermal Power Plants in Myanmar

- ✓ There is no regulation on Emission gas in Myanmar, as of June 2014.
- ✓ There is no monitoring responsibility/system .
- ✓ There is no statistical data/results.

- ✓ Based on the current baseline data of emission gas from existing thermal power plant, adequate action plan for mitigation of environmental impact should be examined, if necessary.

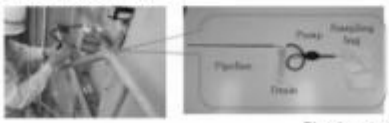
- ✓ As the first step, Air quality survey in Thaketa Power Station was conducted on June 2014 by JICA Expert Team for confirmation of current status.

NIPPON KOEI 5

Air Pollution Control (4)

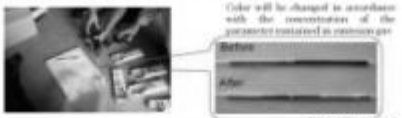
Methodology of Sampling and Analyzing of Emission Gas

Step 1: Emission gas is collected into the sampling bag from the flange in emission process, and;



Play the movie 1

Step 2: Sampled emission gas is analyzed by detector tube.;



Play the movie 2

NIPPON KOEI 6

Air Pollution Control (5)

4. Result of Emission Gas Quality Survey

Items	Unit	Survey Result*				Tentative Target value **
NOx	ppm	Flange1	1st	20	Average 20	25
			2nd	20		
			3rd	20		
		Flange2	1st	18	Average 19.3	
			2nd	20		
			3rd	20		

* preliminary figures

** Reference to IFC guidelines for Thermal Power Plant of Natural Gas

NIPPON KOEI 7

Air Pollution Control (6)

5.Draft EMP and EMoP

(1) Environmental Management Plan

- Repair /Replacement of old parts for good operation
- Install /development of NOx removing equipment/Method
- Install /development of High efficiency power generation

(2)Environmental Monitoring Plan

- Annual monitoring of emission gas
- Daily and/or monthly periodical facility maintenance by check list

NIPPON KOEI 8

Water Pollution Control (1)

1. What is Thermal Discharge?

✓ Thermal power plants with steam-powered generators use water to cool and condense the steam for return to the boiler.

✓ The heated water is normally discharged back to the source water (i.e., river , lake , or sea)

✓ Thermal discharge impair the integrity of the water body as a whole or endanger sensitive areas.

NIPPON KOEI

Water Pollution Control (2)

2. How to Control Effluent

✓ International Standard/Guidelines define the limitation of the concentration of effluent wastewater from Thermal Power Plants.

【IFC】International Finance Corporation Environmental Health and Safety (EHS) Guidelines

- Prepare the effluence guidelines for combustion turbine on temperature increase by thermal discharge from cooling system and other 12 water quality parameters. (e.g. pH, TSS, Oil and Grease, Total residual Chlorine, and etc.)

【JAPAN】Water Pollution Prevention Act

- Though Uniform National Effluent Standards are made up of two categories: the standards for protecting human health (27 items) and the standards for protecting the living environment (15 items), there is no limitation for hot wastewater.
- On the other hand, Electric Power Development Coordination Council examined the water temperature standard to discharging to water body.

NIPPON KOEI 10

Water Pollution Control (3)

3. Current Status of Effuluent from Thermal Power Plants in Myanmar

✓ Though effluent standard has not been stipulated by MOECAF, industrial wastewater effluent guideline value is determined by the Ministry of Industry (MOI) .

✓ There is no waste water temperature standard in Myanmar, as of June 2014.

✓ There is no waste monitoring responsibility/system. No accumulated data.

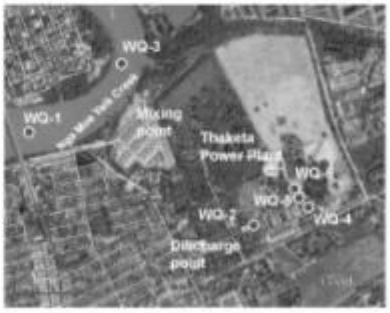
✓ Based on the current baseline data of effluent from existing thermal power plant, adequate action plan for mitigation of environmental impact should be examined, if necessary.

✓ As the first step, water quality survey in Thaketa Power Station was conducted on May and June 2014 by JICA Expert Team for confirmation of current status.

NIPPON KOEI 11

Water Pollution Control (4)

Water sampling location



NIPPON KOEI 12

Water Pollution Control (5)

4. Result of Water Quality Survey (1)

Items	Unit	Result*			Tentative Target value Effluent
		WQ1 (Outside)	WQ2 (Inside)	WQ3 (Outside)	
		Down Stream	Thaketa Station	Upstream	
Water Temperature	°C	29.3	25.4	29.0	Δ 3 °C above ambient water **
pH	-	7.72	6.09	7.91	6-9**
EC	uS/cm	1,448	111	1,300	
TDS	ppm	710	61	650	
Turbidity	FNU	1,000	1,000	1,000	

* preliminary figures

** Reference to IFC guidelines for Thermal Power Plant of Natural Gas

NIPPON KOEI 13

Water Pollution Control (6)

4. Result of Water Quality Survey (2)

Items	Unit	Result*			Tentative Target value Effluent
		WQ4 (Inside)	WQ5 (Inside)	WQ6 (Outside)	
		Water tank for cooling tower	Outlet of cooling tower	Stream outside Thaketa PP	
Water Temperature	°C	23.4	23.9	21.9	Δ 3 °C above ambient water **
pH	-	8.88	9.39	7.72	6-9**
EC	uS/cm	80	3,256	869	
TDS	ppm	40	1,628	434	
Turbidity	FNU	8.8	116	28.9	

* preliminary figures

** Reference to IFC guidelines for Thermal Power Plant of Natural Gas

NIPPON KOEI 14

Water Pollution Control (7)

5. Draft EMP and EMoP

(1) Environmental Management Plan

- Repair /Replacement of old parts of boiler/cooling tower for good operation
- Repair/Clean the drain for good stream

(2) Environmental Monitoring Plan

- Annual/seasonal monitoring of discharged water
- Daily and/or monthly periodical facility maintenance by check list

NIPPON KOEI 15

Noise Pollution Control (1)

1.What is Noise?

✓ Noise source in combustion facilities include the turbine generators, boilers, diesel engine, transformer, cooling tower, fans, duct and auxiliaries

NIPPON KOEI

Noise Pollution Control (2)

2. How to Control Noise

✓ International Standard/Guidelines define the limitation of noise from Thermal Power Plants.

【IFC】International Finance Corporation Environmental Health and Safety (EHS) Guidelines

✓ Recommend ambient noise level

✓ Pay attention to working condition (e.g. identify and mark the high noise areas, provide that personal noise protecting gear, provide the sound – insulated control rooms with noise level)

【WHO】World Health Organization

✓ Define Daily (8hours) Equivalent Exposure Limits

【JAPAN】Noise Regulation Act, and Industrial Safety and Health Act

✓ Define Regulatory Standards for Noise emitted from Specified Factories

✓ Recommend working place noise level and adequate condition

NIPPON KOEI 17

Noise Pollution Control (3)

3. Current Status of Noise from Thermal Power Plants in Myanmar

✓ There is no regulation on Emission Noise in Myanmar, as of June 2014.

✓ There is no monitoring responsibility/system .

✓ There is no statistical data/results.

✓ Based on the current baseline data of emission noise from existing thermal power plant, adequate action plan for mitigation of environmental impact should be examined, if necessary.

✓ As the first step, Noise survey in Thaketa Power Station was conducted on June 2014 by JICA Expert Team for confirmation of current status.

NIPPON KOEI 18

Noise Pollution Control (4)

4. Result of Noise Survey

No.	Facilities	Maker/Model/ Specification	Noise Level* dB(A)	Remark	Tentative Target Value**
1	Gas Turbine No.2	HITACHI, PG5361 (P) 19,614kW	89	1.0m from facility	85dB (8-hours)
2	Steam Turbine	FUJI Electric, Single casing condensing type 34,900kW	82 (93)	Outside of Housing (Inside of Housing)	
3	Cooling Tower	Collmco, 6706-08-36N/G1.5, For steam turbine	80	3.0m from facility	
4	Cooling Fan	MEIDENSHA corporation, TISP85-8NR, For Gas Turbine No.2	88	1.0m from facility	
5	Transformer	FUJI Electronic, IEC-76, 1 phase / 50Hz	77	1.0m from facility	
		ARIVA, DFS-13, 1 phase forced-air cooling	71	1.0m from facility	
		Hitachi, IEC-76-1976, 3 phase / 50Hz	73	1.0m from facility	

* ordinary figures (70-grades), ** WHO, Occupational Noise

NIPPON KOEI 19

Noise Pollution Control (5)

5. Draft EMP and EMoP

(1) Environmental Management Plan

- Repair /Replacement of old parts of facilities for good operation
- Adapt noise control technique/facilities (e.g. Using acoustic machine enclosures, mufflers, silencers, noise protect cover/wall, Sound absorptive materials in the wall and ceiling) , if necessary
- Modification of the plant configuration or use of noise barriers such as beams and vegetation to limit ambient noise at plant property lines, especially where sensitive noise receptors may be present

(2) Environmental Monitoring Plan

- Annual monitoring of noise level
- Daily and/or monthly periodical facility maintenance by check list

NIPPON KOEI 20

Conclusion

Mitigation measurement on Thermal Plant Sector

- **Antipollution measures for Ambient Air**
  - -NOx removing equipment - Environmental Monitoring etc.
- **Antipollution measures for Ambient Water**
  - -Development/ Maintenance of drain system -Environmental Monitoring etc
- **Antipollution measures for Ambient Noise**
  - - Development/ Maintenance of noise reduction equipment -Soundproof wall -Environmental Monitoring etc.
- **Others**
  - -Daily maintenance -Environmental Monitoring etc.

NIPPON KOEI 21

Thank you very much for your kind attention.

NIPPON KOEI 22

Environmental Consideration of Electric Power Sector

Key topics on environmental management and monitoring on substations

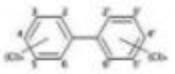
Key Topics on Environmental Management and Monitoring at Substation

- PCB containing oils management
- Hazardous chemicals and waste management
- Electric and Magnetic Fields

Management of PCB Waste Such as Transformer Oils Containing PCB

- Characteristics, impact on human health and environment, and requirement of PCB control by legal status are described on Basic Information of Polychlorinated Biphenyls (PCBs)

PCBs (Polychlorinated biphenyl)



Characteristics of PCB

PCBs have ideal properties for industrial applications as shown below;

- low dielectric constant,
- low volatility,
- good fire resistance,
- low water solubility,
- high solubility in organic solvents, and
- good ageing properties, with no deterioration in service.

PCBs were used widely in transformers, transformer bushings, capacitors, voltage regulators, hydraulic systems, small capacitors in fluorescent light ballasts, and heat transfer systems.

Impacts on human health by PCB

Acute exposures to high levels of PCBs cause;

- skin rashes, itching, inflammation or pigmentation if absorbed through the skin or fingernail, and
- disturbance in liver function and immune system.

Chronic effects of low-level PCB exposure include liver damage too. The US Department of Health and Human Services as well as the International Agency for Research on Cancer (IARC) consider PCBs to be provable carcinogens in humans.

Requirement on proper management of PCBs by international convention named "Stockholm Convention on Persistent Organic Substances"

PCBs are non-biodegradable, persistent and semi-volatile organic carbons. Therefore, PCBs once spilled or leaked may move globally through air, water, and soil environment without change of their toxic characteristics.

To avoid serious impacts by PCBs contamination, PCBs are listed up as one of chemicals to be controlled their usage and treated under an international convention named "Stockholm Convention on Persistent Organic Substances which was adopted on 22 May 2001 and entered into force on 17 May 2004.

Myanmar has also admitted to the convention in 2004. Currently, Ministry of Industry is drafting a Chemical Safety Law, and PCBs will have to be surveyed, controlled and treated after the law enters into force.

Difficulty of PCB Treatment

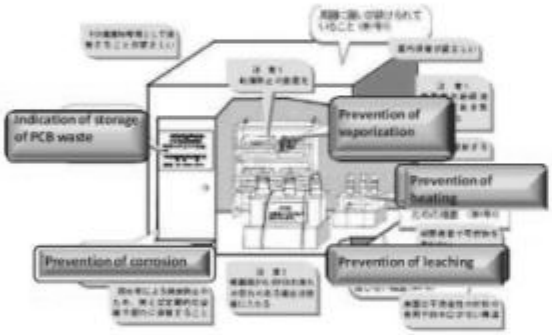
- In Japan, there are only five facilities to treat PCB.

- For treatment of PCB, complicated process should be carried out under regulated condition strictly.

Possible Process of PCB Waste Management in Current Status

Pre-construction phase	Prepare a list of replaced transformers etc. at each substation (Name of manufacturer, Produced year, Amount of oil etc.)
Construction phase	Check concentration of PCB in oil (If PCB concentration is more than 50ppm, it defines as PCB waste according to UNEP)
Operation phase	Store PCB waste under proper way

Recommended Condition of PCB Waste Storage



Hazardous Waste Management

(a) Currently, Ministry of Industry is preparing "Law on Chemical Safety". After enforcement of the law, it is considered that the hazardous chemicals and waste management will be strictly in your country.

(b) So far, the following activates are planned to be proposed as activities of environmental management and monitoring plan

a) Keep record of type and amount of hazardous chemicals used and stored

b) Store hazardous chemicals under proper condition

c) Keep safety data sheet of each chemical

Electric and Magnetic Fields (EMF)

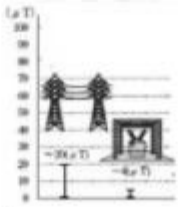
Environmental Health and Safety (EHS) Guideline of International Finance Cooperation (IFC) stipulates;

(a) Although there is public and scientific concern over the potential health effects associated with exposure to EMF, there is no empirical data demonstrating adverse health effects from exposure to typical EMF levels from power transmissions lines and equipment.

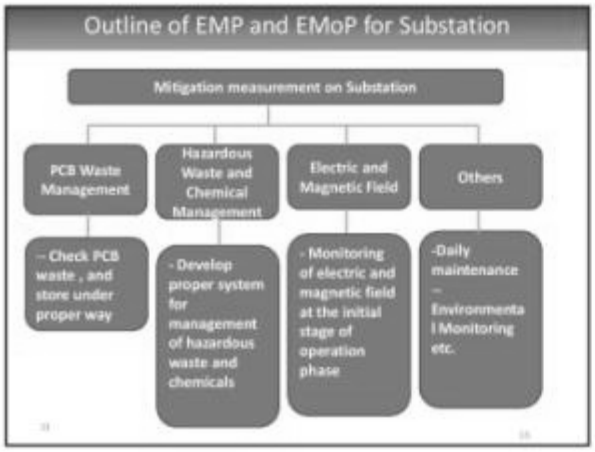
(b) However, while the evidence of adverse health risks is weak, it is still sufficient to warrant limited concern.

Occupational Standard of Electric and Magnetic Field

Frequency	Electric Field (V/m)	Magnetic Field (μT)
50 Hz	10,000	500
60 Hz	8,300	415



- Actual exposure of electric and magnetic field is considered much lower than the standard value set by IFC.
- To confirm above condition, it is recommended to carried out monitoring activity at the beginning of operation stage of substation

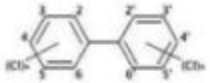

Outline of EMP and EMoP for Substation
Mitigation measurement on Substation
PCB Waste Management
Hazardous Waste and Chemical Management
Electric and Magnetic Field
Others
- Check PCB waste , and store under proper way
- Develop proper system for management of hazardous waste and chemicals
- Monitoring of electric and magnetic field at the initial stage of operation phase
-Daily maintenance
- Environmental Monitoring etc.

Thank you very much for your kind attention.

Basic Information of Polychlorinated Biphenyls (PCBs)

1. What are polychlorinated biphenyls (PCBs)?

PCBs (Polychlorinated biphenyl)



Chemical structure of PCBs
The chemical formula for PCBs is $C_{12}H_{10-n}Cl_n$

Polychlorinated biphenyls (PCBs) are synthetic organic chemical compounds (aromatic hydrocarbons) produced by substituting chlorine atoms for the hydrogen atoms on a biphenyl molecule. PCBs have ideal properties for industrial applications as shown below;

- low dielectric constant,
- low volatility,
- good fire resistance,
- low water solubility,
- high solubility in organic solvents, and
- good ageing properties, with no deterioration in service.

Accordingly, the majority of PCBs manufactured were used in electrical equipment because their properties made them ideal dielectric and heat transfer fluids. PCBs were used widely in transformers, transformer bushings, capacitors, voltage regulators, hydraulic systems, small capacitors in fluorescent light ballasts, and heat transfer systems. In addition, PCBs were sometimes used in electrical cable, switches, breakers, vacuum pumps, gas turbines, natural gas pipelines, carbonless copy paper, paints, adhesives, caulking compounds, and investment casting wax.

The synthesis of PCBs was first described in 1881 and commercial production began in the late 1920s. Around 1.7 million tones of PCBs were produced from 1929 to 1989*1. Applications of PCBs in some products ceased in the mid 1970s, but they continued to be used in transformers, capacitors, heat exchangers and hydraulic equipment.

*1 http://chm.pops.int/Implementation/PCBs/Overview/tabid/273/Default.aspx

2. Impacts on human health by PCB

Acute exposures to high levels of PCBs cause;

- skin rashes, itching, inflammation or pigmentation if absorbed through the skin or fingernail, and
- disturbance in liver function and immune system.

Chronic effects of low-level PCB exposure include liver damage too. The US Department of Health and Human Services as well as the international Agency for Research on Cancer (IARC) consider PCBs to be provable carcinogens in humans.

3. Requirement on proper management of PCBs by international convention named "Stockholm Convention on Persistent Organic Substances"

PCBs are non-biodegradable, persistent and semi-volatile organic carbons. Therefore, PCBs once spilled or leaked may move globally through air, water, and soil environment without change of their toxic characteristics. The half life of PCBs in environment is long, of which various values reported are from 3 days to around 1 years in air, from 2.5 hours to around 27 years in water, and from 10 days to around 37 years in soil *2. If PCBs are taken by organisms, they are accumulated in organisms, and human may take PCBs in a food chain with biological concentration effect.

To avoid serious impacts by PCBs contamination, PCBs are listed up as one of chemicals to be controlled their usage and treated under an international convention named "Stockholm Convention on Persistent Organic Substances which was adopted on 22 May 2001 and entered into force on 17 May 2004.

Myanmar has also admitted to the convention in 2004. Currently, Ministry of Industry is drafting a Chemical Safety Law, and PCBs will have to be surveyed, controlled and treated after the law enters into force.

End of Document

*2 http://www.env.go.jp/chemi/pops/pamph/

Questionnaire on the 1st Mini-workshop for Environmental Consideration of Electric Sector
(20th of June 2014)

1. General on Environmental Management Plan and Environmental Monitoring Plan

Comparing before and after presentation, how is your knowledge level on the subject changed?

	Very much 5	4	3	2	Not at all 1
Your knowledge on EMP and EMoP before attending this mini-workshop	☐	☐	☐	☐	☐
Your knowledge on EMP and EMoP after attending this mini-workshop	☐	☐	☐	☐	☐

If you attend some kind of workshop, what kind of topic do you want to have related to environmental management plan and environmental monitoring plan?

_____

_____

2. Environmental Management Plan and Environmental Monitoring Plan in Power Plant

Do you agree to implement any actions to control and monitor the following environmental items as environmental management plan and environmental monitoring plan in power plant?

	Very much 5	4	3	2	Not at all 1
Emission gas control	☐	☐	☐	☐	☐
Thermal discharge from gas turbine and cooling system	☐	☐	☐	☐	☐
Noise	☐	☐	☐	☐	☐

3. Environmental Management Plan and Environmental Monitoring Plan at Substation

Do you agree to implement any actions to control and monitor the following environmental items as environmental management plan and environmental monitoring plan in substation?

	Very much 5	4	3	2	Not at all 1
Hazardous waste	☐	☐	☐	☐	☐
PCB	☐	☐	☐	☐	☐
Electric and magnetic field	☐	☐	☐	☐	☐

3. Your Opinion on Environmental Management and Monitoring Plan

If you think that there are environmental topics to be managed and monitored, but we did not mention in the presentation, please kindly point out.

_____

_____

If you think that any equipment for environmental management or occupational safety should be procured, please kindly describe.

_____

_____

If you think that any action for environmental management or occupational safety has been already implemented in your power plant / substation, please kindly describe.

_____

_____

Please write down any comment/opinion on this mini-workshop

_____

_____

_____

If you do not mind, please write your name and position

_____

Thank you very much for your participation and cooperation!

Appendix-4: Materials for 2st Mini-workshop (9th July,2014)

Table 4-1 Participant List (9th July,2014)

No.	Name of Power Plant/Substation	Name of Person	Position
1	Power Transmission Project Dept.	U Kyaw Thu	Deputy Chief Engineer
2		U Myo Min Tun	Executive Engineer
3	Power System Dept.	U Thein Thura	Deputy Chief Engineer
4		U Aung Thura Win	Senior Engineer
5		Daw Khin Myat Thu	Executive Engineer
6		U Myo Zaw Htwe	Assistance Engineer
7		Daw Le Thandar Win	Assistance Engineer

Table 4-2 Workshop Program (9th July,2014)

Time	Contents	Persons in Charge
13:30– 14:00	Introduction speech Topic-1: Interim result of prediction and evaluation of environmental impact by the Phase I Project - Q&A and short discussion -	JICA Expert Team All participants
14:00 – 14:30	Topic-2: Framework of environmental management and monitoring plan - Q&A and short discussion -	
14:30 – 14:40	Coffee break	-
14:40 – 15:20	Discussion on obstructive factors against preferable implementation of environmental management and monitoring plan, Providing suggestion on required actions to address the identified obstructive factors	All participants

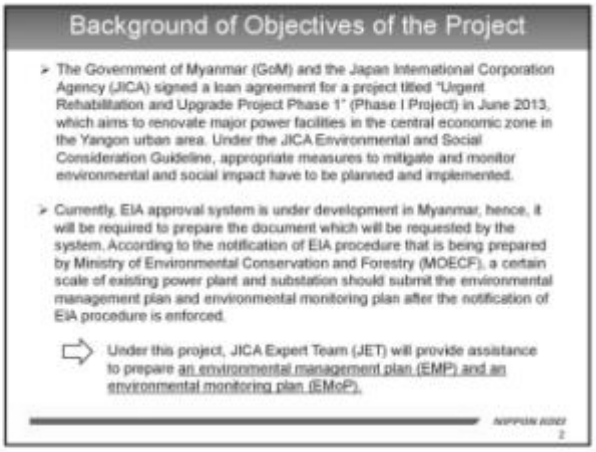
Questions and Answers (9th July,2014)

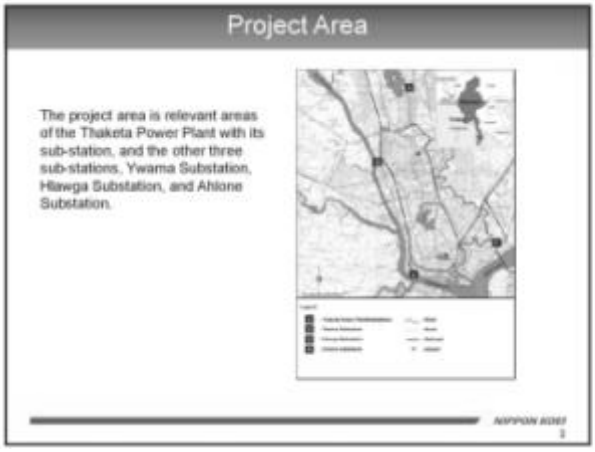
No.	Comment and Question from participant	Comment and answer from JET
1.	Most of the participants would like to know why other power plants was not included in this project. And why the field study on substations was not conducted.	JET answered that this project background is based on "Urgent rehabilitation project" in which Thaketa Power Plant and other three substations are included. Currently, the impact on substation such as PCB content in transformer oil is considered to be studied. But field study was not done so far.
2.	U Myo Min Tun (EE) from PTPD asked how the increase of noise level in power plant can be reduced or prevented.	JET replied that there are many possible ways to reduce noise impact. JET suggested as follows, (i) If someone worked beside the facility which produces high level of noise, the facility should be replaced with new low noise facility which possesses same capacity like previous one. And the noise level of new facility also should be considered at the time of selection of new facilities for the replacement. (ii) One of the another possible ways to reduce noise impact to the individual, is to manage the assignment of working shift to the staffs and engineers who are working near a high noise level

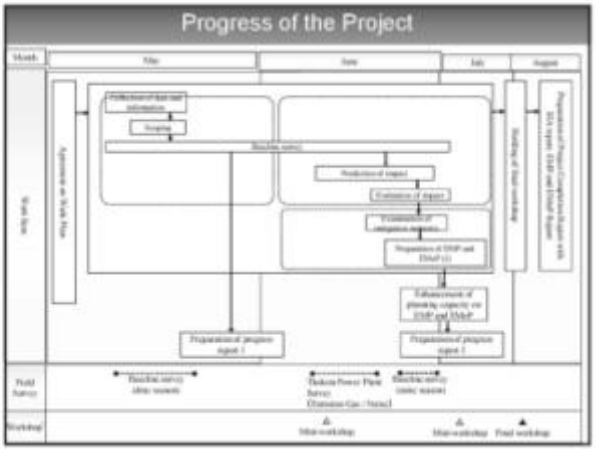
No.	Comment and Question from participant	Comment and answer from JET
		facility. It is not good to assign only one person to work for long time shift near such facility. So, it is better to provide short time working shift to the individual by sharing with more than three or four persons. (iii) In Japan, sometimes the noise barrier wall is constructed between workers and facility. This is also one of the ways to prevent high noise level. (iv) In Japan, engineers and staffs in some facilities use anti-noise device such as ear cover to protect themselves against high noise level. Even it is a small device, it can be helpful to reduce noise impact. JET will include these possible ways for prevention of noise level in Environmental Management Plan.
3.	U Thein Thura (Dy. CE) from PSD asked that the field noise level measurements at Thaketa power plant (for example, measurements conducted a certain distance from the facility) are conducted by following any rules or regulations.	JET answered that there is no certain rules. The distance for the noise level measurement from each facility is defined as a distance where the maximum noise level of the relative facility is detected. It depends on the height of a noise source from the facility, surrounded area of the facility and body of facility. Then, JET also explained the way how to measure the noise level of a facility.
4.	U Kyaw Thu (Dy. CE) from PTPD was curious about the job description for Tokyo Electric Power Company (TEPCO) regarding the Urgent Rehabilitation Project in which EIA is included to conduct for Thaketa Power Plant and three substations. So, he would like to know that current project is a part of Urgent Rehabilitation Project by TEPCO.	JET replied that Environmental experts will conduct EIA during the construction phase after contracting with TEPCO. Based on EMP and EMOP prepared by current project, MEPE can instruct or ask the experts what they should carry out regarding EIA during construction phase. The JICA expert team was hired directly by JICA. The EMP and EMOP reported by this team will contain all phases (before construction, during construction, and during operation). Basically, in construction phase, contractor and subcontractor will conduct EIA including EMP and EMOP. MEPE will prepare TOR for contractor in which the information provided by this project will be helpful (for example, MEPE can ask the contractor to conduct noise level measurement every one or two month based on this study). In addition, after construction phase, these EMP and EMOP will be prepared by MEPE, itself. Thus, JET should propose the feasible actions for MEPE.
5.	U Myo Min Tun (EE) from PTPD would like to know what kind of actions should be done by MEPE side after submitting of EMP and EMOP by JET.	JET suggested that for power plants, the NOx gas and discharge waste water temperature should be checked periodically. Moreover, noise level condition should be aware and it should be considered whether serious impacts exist or not. For substation, during the construction phase, the transformers will be checked whether PCB contain or not. If PCB contains in transformer oil, MEPE will be requested to store such transformers and oils safely in the storage facility which will be recommended by JET. Currently, JET collected information about transformers in all three substations and recorded. Then, JET will approximately determine whether the transformers contain PCB or not. This type of action should be conducted and continued throughout the operation phase to report to JICA.
6.	U Aung Thura Win (SE) from PTPD would like to suggest that the information of safety clearance (e.g., between power transformer and operation staff) shall be included in the prepared EMP and EMoP by the current	JET agreed to describe safety condition clearly in EMP and EMoP which may note the referred guideline as well.

No.	Comment and Question from participant	Comment and answer from JET
	project.	
7.	JET raised a question to MEPE officers that there are any plan to secure some budget for environmental management activities after "Urgent Rehabilitation Project". Any specific step are necessary for JET to explain to whether finical section of MEPE or M.D of MEPE about the budget and what kind of action by JET need to do.	U Aung Thura Win (SE) from PTPD replied that currently there is a budget for the maintenance of substations in which environmental safety partially is included. . However, there is not budget for environmental management of substation so far. U Myo Min Tun (EE) from PTPD also suggested if JET should suggest the approximate budget amount in EMP and EMoP for the implementation of environmental activities, it would be better. At the moment, there is some amount of budget for construction phase of Urgent rehabilitation project. Also, in fact, M.D is a main responsible person who manages the budget of MEPE. It is important that M.D realizes well why the budget is required for Environmental Impact Assessment/Monitoring during operation phase after implementation of the Urgent Rehabilitation Project.
8.	U Aung Thura Win (SE) from PTPD informed that there is no laboratory in MEPE even if it is required to conduct some environmental studies/research analysis (e.g. measurement of PCB content).	JET answered that JET is planning to propose simple kit tester for measuring PCB concentration not exactly but whether the concentration is below or above of the limited amount (500ppb of PCB) can be checked if some transformers in substation has high possibility of PCB content.

Hand Out and Explanatory Material







JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MYANMA ELECTRIC POWER ENTERPRISE (MEPE)

Environmental Consideration of Electric Power Sector

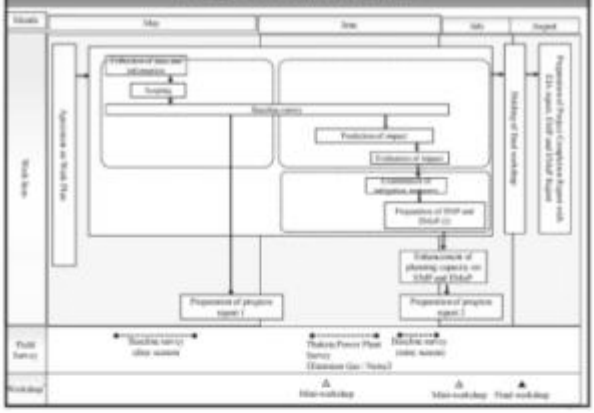
Interim result of prediction and evaluation of environmental impact by the Phase I Project

July 2014

NIPPON KOEI CO., LTD.

NIPPON KOEI 1

Progress of the Project



Process for Preparation of Environmental Management Plan and Environmental Monitoring Plan

Phase I: Predict and evaluate impacts

Scoping → Baseline survey

Prediction of impacts

Evaluation of impacts

Technical information on methodology for predicting and evaluating impacts, will be provided by JICA Expert Team (JET).

Phase II: Prepare EMP and EMoP

JET will co-work with MEPE for preparation of EMP and EMoP. The MEPE will be expected for finalizing EMP and EMoP reflecting the local actual situation with identification of available and needed resources in order to implement these plans in the future.

NIPPON KOEI 3

Environmental and Social Items to be Examined for Scoping

Pollution	air quality, water quality, solid waste, soil contamination, noise/vibration, subsidence, odor, sedimentation
Natural Environment	natural reserve, flora and fauna, ecosystem, hydrology, topography and geography
Social Environment	resettlement, poor, indigenous and ethnic minority group, local economy, land use and local resource, water use, existing infrastructure and service, social structure, uneven distribution of harm and benefit, conflicts of interest within the region, cultural heritage, landscape, gender, children' s right
Health and Safety	Occupational health and safety, risks of infection disease, traffic accident
Emergency Risk	Emergency risk by flooding and fire
Climate Change	green house gas (GHG) emission reduction

NIPPON KOEI 4

Environmental and Social Items to be Examined for Scoping

NIPPON KOEI 5

Draft Scoping Results of Urgent Rehabilitation Project – Power Plant

	Construction Phase	Operation Phase
Some positive impact (Environmental benefit)	Increase of job opportunity	improvement of emission gas quality, local economy, infrastructure and service, woman and children's light, GHG emission reduction
Some negative impact	air pollution, solid waste, soil contamination, noise/vibration, occupational health and safety, occupational health and safety, community health and safety, risks of infection disease, accident	impact by thermal discharge, solid waste, noise/vibration, occupational health and safety, accident
Impacts are not clear, need further investigation		hydrology and water use, emergency risk on flooding and fire

NIPPON KOEI 6

Draft Scoping Results of Urgent Rehabilitation Project - Substation

	Construction Phase	Operation Phase
Some positive impact (Environmental benefit)	Increase of job opportunity	local economy, infrastructure and service, woman and children's light, climate change
Some negative impact	**solid waste** and hazardous **chemicals** (including PCB), noise/vibration, occupational health and safety, accident	**solid waste and hazardous chemicals** (including PCB), soil contamination, noise/vibration, occupational health and safety, occupational health and safety, community health and safety, risks of infection disease, accident
Impacts are not clear, need further investigation		Electric and magnetic field

NIPPON KOEI 7

Outline of Baseline Survey

For conducting further study on selected environmental assessment items, a detailed survey including field survey was conducted in and around Thaketa Power Station.

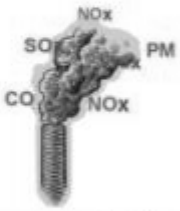
No	Items	Description
1	Environmental and social baseline data (existing documents)	Data was collected and analyzed based on existing data and information. As necessary, interview surveys with relevant organizations were conducted by a local consultant contracted by JET to collect required information.
2	Field survey of the study area (air quality, noise and vibration, water quality)	Survey during the two seasons (dry and rainy) on air quality and water quality, and one-time noise and vibration measurement for understanding of the ambient baseline conditions was conducted by a local consultant contracted by JET.
3	Field survey of the Thaketa Power Station (emission gas quality, noise and vibration from existing facilities)	A Japanese subconsultant with the capacity to conduct emission gas sampling had been selected by JET. The subconsultant was conduct the survey to measure unit emission gas and noise from existing facilities in the Thaketa Power Station.

NIPPON KOEI 8

Baseline Survey – Air Quality -

What is Emission Gas?

- ✓ Thermal plants generate electric power thorough burning fuel.
- ✓ In the process of burning fuel such as gaseous, liquid and solid fossil fuels, emission gas will be exhausted.
- ✓ Emission gas may have a significant influence on the environment including human health.
- ✓ Remarkable emission gas is as follows;
  - Sulfur Dioxide (SO_2)
  - Nitrogen Oxides (NOx)
  - Particulate Matter (PM)
  - Carbon Monoxide (CO)



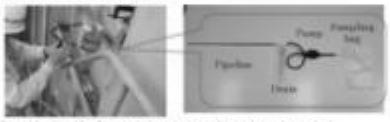
NIPPON KOEI

Baseline Survey – Air Quality -

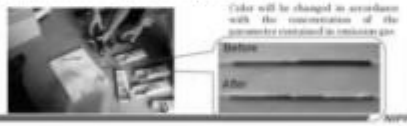
In Thaketa Power Plant, the following survey was implemented in June 2014.

- Emission gas measurement (NO, NO_2, CO, CO_2, O_2) by gas detector tube

Step 1: Emission gas is collected into the sampling bag from the flange in emission process, and;



Step 2: Sampled emission gas is analyzed by detector tube.;



NIPPON KOEI 10

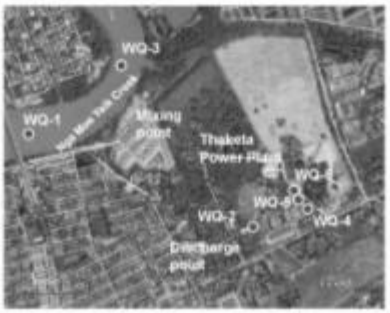
Baseline Survey – Water Quality -

What is Thermal Discharge?

- ✓ Thermal power plants with steam-powered generators use water to cool and condense the steam for return to the boiler.
- ✓ The heated water is normally discharged back to the source water (i.e., river , lake , or sea)
- ✓ Thermal discharge impair the integrity of the water body as a whole or endanger sensitive areas.

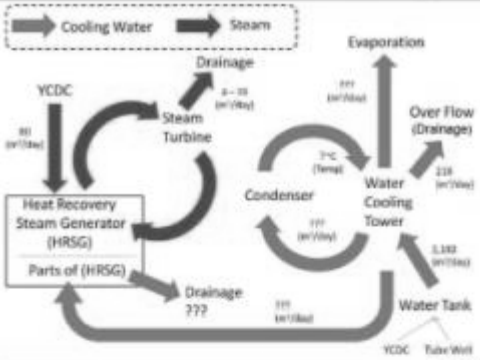
NIPPON KOEI

Baseline Survey – Water Quality -



NIPPON KOEI 12

Baseline Survey – Water Quality -



Baseline Survey – Water Quality -

- River flow and water temperature measurement (for evaluation of impacts by discharging of hot wastewater)
- Water quality measurement (odor, color, electrical conductivity, pH, suspended solid (SS), oil and grease, Total chlorine residual, total chromium, copper (Cu), iron (Fe), zinc (Zn), lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As)):

Baseline Survey – Noise and Vibration -

In Thaketa Power Plant, the following survey was implemented in June 2014.

- Noise and vibration measurement around facilities generating noise

Tentative Evaluation Result – Air Quality -

Result of Emission Gas Quality Survey

Items	Unit	Survey Result*				Tentative Target value **
NOx	ppm	Flange1	1st	24	Average 20	25
			2nd	24		
			3rd	24		
		Flange2	1st	22	Average 23	
			2nd	24		
			3rd	24		

* preliminary figures

** Reference to IFC guidelines for Thermal Power Plant of Natural Gas

Tentative Evaluation Result – Water Quality (1) -

Result of Water Quality Survey (1)

Items	Unit	Result*			Tentative Target value Effluent
		WQ1 (Outside)	WQ2 (Inside)	WQ3 (Outside)	
		Down Stream	Thaketa Station	Upstream	
Water Temperature	°C	29.3	25.4	29.0	Δ 3 °C above ambient water **
pH	-	7.72	6.09	7.91	6-9**
EC	uS/cm	1,448	111	1,300	
TDS	ppm	710	61	650	
Turbidity	FNU	1,000	1,000	1,000	

* preliminary figures

** Reference to IFC guidelines for Thermal Power Plant of Natural Gas

Tentative Evaluation Result – Water Quality (2) -

Result of Water Quality Survey (2)

Items	Unit	Result*			Tentative Target value Effluent
		WQ4 (Inside)	WQ5 (Inside)	WQ6 (Outside)	
		Water tank for cooling tower	Outlet of cooling tower	Stream outside Thaketa PP	
Water Temperature	°C	23.4	23.9	21.9	Δ 3 °C above ambient water **
pH	-	8.88	9.39	7.72	6-9**
EC	uS/cm	80	3,256	869	
TDS	ppm	40	1,628	434	
Turbidity	FNU	8.8	116	28.9	

* preliminary figures

** Reference to IFC guidelines for Thermal Power Plant of Natural Gas

Tentative Evaluation Result – Noise Level -

Result of Noise Survey

No.	Facilities	Maker/Type/ Specification	Noise Level* (dB(A)	Remark	Tentative Target Value**
1	Gas turbine No.2	HITACHI, PG5361 (P) 19,014kW	89	1.0m from facility	85dB (8-hours)
2	Steam Turbine	FUJI Electronic, Single Casing Condensing Type 34,900kW	82 (93)	Outside of Housing (Inside of Housing)	
3	Cooling Tower	For Steam Turbine	80	1.0m from facility	
4	Cooling Fan	For Gas Turbine No.2	88	1.0m from facility	
5	Transformer	FUJI Electronic IEC-76	77	1.0m from facility	
		AREVA DFS-11	71	1.0m from facility	

* preliminary figures

** WHO Occupational Noise

NIPPON KOEI 19

Tentative Conclusion of Prospected Environmental Impact

Air Quality

- ✓ Based on the baseline survey result, NOx concentration of emission gas from Thaketa Power Plant satisfies IFC guideline value.
- ✓ By rehabilitation of gas turbine, it is expected that the emission gas quality will be improved with proper operation of gas turbine.

Water Quality (thermal power discharge)

- ✓ Based on the baseline survey result, it is considered that Thaketa power plant does not discharge high temperature wastewater that affects natural condition of receiving body.
- ✓ It is recommended to record water balance of power plant

Noise

- ✓ For occupational safety viewpoint, it is recommended to monitor noise impact to engineers and staffs of power plant and substation.

NIPPON KOEI 20

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MYANMA ELECTRIC POWER ENTERPRISE (MEPE)

Environmental Consideration of Electric Power Sector

Framework of environmental management and monitoring plan

July 2014

NIPPON KOEI CO., LTD.

NIPPON KOEI 1

Why environmental management plan and monitoring plan is necessary for power plant and substation? – general requirement

1. To avoid serious pollution on surrounding air, water and soil environment
2. To avoid serious impacts to residents and society around power plants and substations
3. To secure safe working condition for engineers and staffs
4. To conserve surrounding natural environment and use natural resource wisely

For urgent rehabilitation project, from the item 1 to item 4 are mainly concerned.

NIPPON KOEI 2

Function of EMP and EMoP for Power Plant and Substation

Power Plant / Substation Operation Plan

Provide suggestion from environmental viewpoint

Environmental Management Plan (EMP)

Secure safety and reduce risk on health and environmental pollution

Managers, engineers and staffs of power plants and substations

Review effectiveness of EMP

MOEP and MEPE headquarter

Relevant ministries such as MOECF

Environmental Monitoring Plan (EMoP)

Report environmental compliance to relevant stakeholders

Local residents surrounding power plants and substations

International donors such as JICA

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Draft Framework of Environmental Management Plan

Chapter 1: Objectives of EMP
Chapter 2: Project Description
Chapter 3: Relevant Policy and Legal Requirement
Chapter 4: Summary of Predicted Impacts and Mitigation Measures
Chapter 5: Planned Environmental Management Activities
(1) Power Plant
1) During Pre-construction Phase
2) During Construction Phase
3) During Operation Phase
(2) Substations
1) During Pre-construction Phase
2) During Construction Phase
3) During Operation Phase
Chapter 7: Emergency Response Plan ???
Chapter 8: Organization Structure
Chapter 7: Implementation Schedule
Chapter 8: Cost for Implementation

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Draft Framework of Environmental Monitoring Plan

Chapter 1: Objectives of EMoP
Chapter 2: Project Description
Chapter 3: Relevant Policy and Legal Requirement
Chapter 4: Summary of Environmental Management Plan
Chapter 5: Planned Environmental Monitoring Activities
(1) Power Plant
1) During Pre-construction Phase
2) During Construction Phase
3) During Operation Phase
(2) Substations
1) During Pre-construction Phase
2) During Construction Phase
3) During Operation Phase
Chapter 6: Reporting
Chapter 7: Organization Structure
Chapter 8: Implementation Schedule
Chapter 9: Cost for Implementation
Attachment: Reporting Form

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Items to be discussed for preparation of feasible environmental management plan and monitoring plan

1. How can power plant and substation allocate persons in charge of EMP and EMoP?
2. How will required budget be allocated?
3. What kinds of equipment have to be procured?
4. What kind of training is necessary to obtain required knowledge and skills?

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Key topics on environmental management and monitoring on power plant

Air Pollution Control

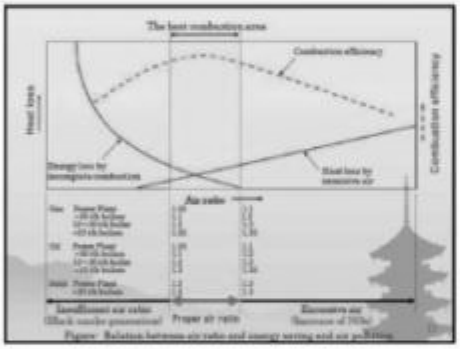
(1)Environmental Management Plan

- Repair /Replacement of damaged parts
- Install /development of NOx removing equipment/method as necessary
- Proper operation of gas turbine to sustain preferable air ratio with fuel

(2)Environmental Monitoring Plan

- Annual monitoring of emission gas
- Periodical maintenance with check lists

Air Pollution Control – Air Ratio Control



Water Pollution Control

(1)Environmental Management Plan

- Repair /Replacement of damaged parts of boiler/cooling tower for good operation
- Control usage of reagents under proper condition

(2) Environmental Monitoring Plan

- Annual/seasonal monitoring of discharged water
- Monitor amount and quality of discharged wastewater
- Periodical maintenance with check lists

Noise Impact Control

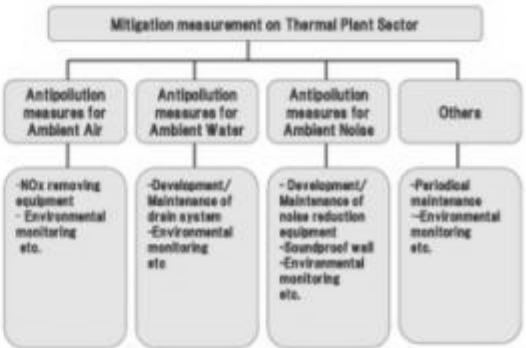
(1)Environmental Management Plan

- Adapt noise control technique/facilities (e.g. Using acoustic machine enclosures, mufflers, silencers, noise protect cover/wall, Sound absorptive materials in the wall and ceiling) , if necessary
- Modification of the plant configuration or use of noise barriers such as beams and vegetation to limit ambient noise at plant property lines, especially where sensitive noise receptors may be present

(2) Environmental Monitoring Plan

- Annual monitoring of noise level
- Periodical facility maintenance with check lists

Conclusion



Key topics on environmental management and monitoring on substations

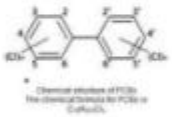
Key Topics on Environmental Management and Monitoring at Substation

- PCB containing oils management
- Hazardous chemicals and waste management
- Proper management of sulfur hexafluoride (SF_6)
- Electric and Magnetic Fields

Management of PCB Waste Such as Transformer Oils Containing PCB

- Characteristics, impact on human health and environment, and requirement of PCB control by legal status are described on Basic Information of Polychlorinated Biphenyls (PCBs)

PCBs (Polychlorinated biphenyl)



Characteristics of PCB

PCBs have ideal properties for industrial applications as shown below;

- low dielectric constant,
- low volatility,
- good fire resistance,
- low water solubility,
- high solubility in organic solvents, and
- good ageing properties, with no deterioration in service.

PCBs were used widely in transformers, transformer bushings, capacitors, voltage regulators, hydraulic systems, small capacitors in fluorescent light ballasts, and heat transfer systems.

Impacts on human health by PCB

Acute exposures to high levels of PCBs cause;

- skin rashes, itching, inflammation or pigmentation if absorbed through the skin or fingernail, and
- disturbance in liver function and immune system.

Chronic effects of low-level PCB exposure include liver damage too. The US Department of Health and Human Services as well as the international Agency for Research on Cancer (IARC) consider PCBs to be provable carcinogens in humans.

Requirement on proper management of PCBs by international convention named "Stockholm Convention on Persistent Organic Substances"

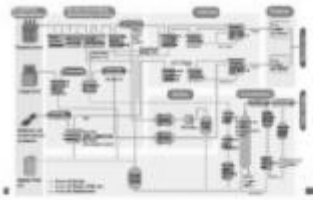
PCBs are non-biodegradable, persistent and semi-volatile organic carbons. Therefore, PCBs once spilled or leaked may move globally through air, water, and soil environment without change of their toxic characteristics.

To avoid serious impacts by PCBs contamination, PCBs are listed up as one of chemicals to be controlled their usage and treated under an international convention named "Stockholm Convention on Persistent Organic Substances which was adopted on 22 May 2001 and entered into force on 17 May 2004.

Myanmar has also admitted to the convention in 2004. Currently, Ministry of Industry is drafting a Chemical Safety Law, and PCBs will have to be surveyed, controlled and treated after the law enters into force.

Difficulty of PCB Treatment

- In Japan, there are only five facilities to treat PCB.

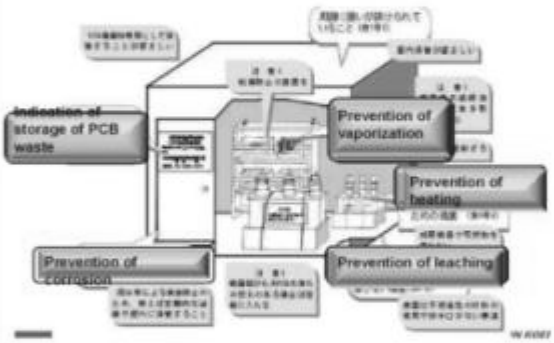


- For treatment of PCB, complicated process should be carried out under regulated condition strictly.

Possible Process of PCB Waste Management in Current Status

Pre-construction phase	Prepare a list of replaced transformers etc. at each substation (Name of manufacturer, Produced year, Amount of oil etc.)
Construction phase	Check concentration of PCB in oil (If PCB concentration is more than 50ppm, it defines as PCB waste according to UNEP)
Operation phase	Store PCB waste under proper way

Recommended Condition of PCB Waste Storage



Hazardous Chemical Waste Management

(a) Currently, Ministry of Industry is preparing "Law on Chemical Safety". After enforcement of the law, it is considered that the hazardous chemicals and waste management will be strictly in your country.

(b) So far, the following activates are planned to be proposed as activities of environmental management and monitoring plan

a) Keep record of type and amount of hazardous chemicals used and stored

b) Store hazardous chemicals under proper condition

c) Keep safety data sheet of each chemical

Proper Management of SF_6

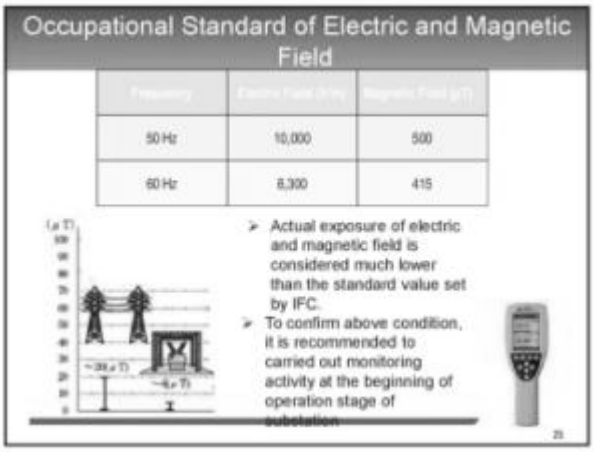
- Sulfur hexafluoride which is used for GIS (Gas Insulated Switchgear) is one of green house gases affecting global warming. Therefore, proper management should be conducted.

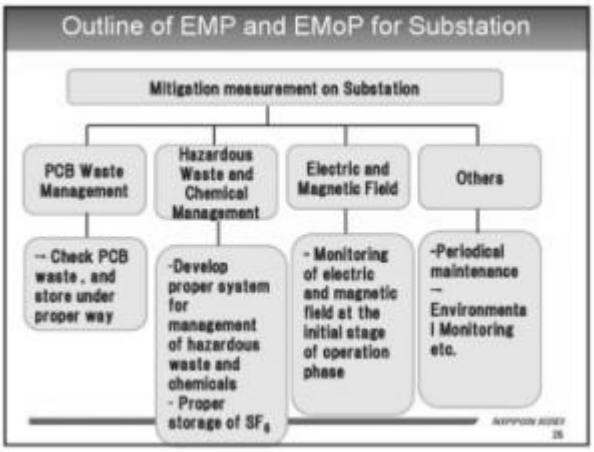
Electric and Magnetic Fields (EMF)

Environmental Health and Safety (EHS) Guideline of International Finance Cooperation (IFC) stipulates;

(a) Although there is public and scientific concern over the potential health effects associated with exposure to EMF, there is no empirical data demonstrating adverse health effects from exposure to typical EMF levels from power transmissions lines and equipment.

(b) However, while the evidence of adverse health risks is weak, it is still sufficient to warrant limited concern.


Occupational Standard of Electric and Magnetic Field
50 Hz
10,000
500
60 Hz
8,300
415
Actual exposure of electric and magnetic field is considered much lower than the standard value set by IFC.
To confirm above condition, it is recommended to carried out monitoring activity at the beginning of operation stage of substation


Outline of EMP and EMoP for Substation
Mitigation measurement on Substation
PCB Waste Management
Hazardous Waste and Chemical Management
Electric and Magnetic Field
Others
-- Check PCB waste , and store under proper way
-Develop proper system for management of hazardous waste and chemicals
- Proper storage of SF6
- Monitoring of electric and magnetic field at the initial stage of operation phase
-Periodical maintenance -- Environmental Monitoring etc.