Republic of Uzbekistan
SJSC UZBEKENERGO

Republic of Uzbekistan
Preparatory Survey on Turakurgan Thermal Power Station Construction Project

Final Report

August 2014

Japan International Cooperation Agency (JICA)
Tokyo Electric Power Services Co., LTD

Location of Turakurgan Power Station

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Abbreviations

ADB	Asian Development Bank
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
C/P	Counterpart
CCCGP	Combined Cycle Cogeneration Plant
CCPP	Combined Cycle Power Plant
CDM	Clean Development Mechanism
Df/R	Draft Final Report
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ES	Engineering Stage
EPC	Engineering, Procurement and Construction Contract
FIRR	Financial Internal Rate of Return
F/R	Final Report
F/S	Feasibility Study
GT	Gas Turbine
GTW	Gas Turbine World
HHV	Higher Heating Value
HP	High Pressure
HRSG	Heat Recovery Steam Generator
I&C	Instrumentation and Control
Ic/R	Inception Report
IP	Intermediate Pressure
IFC	International Finance Corporation
IPP	Independent Power Producer
ISO	International Standard Organization
JICA	Japan International Cooperation Agency
JSC	Joint Stock Company
LHV	Lower Heating Value
LP	Low Pressure
MW	Mega Watt
NOx	Nitrogen Oxide
NG	Natural Gas

NGO	Non-Governmental Organization
NHC	National Holding Company
O&M	Operation and Maintenance
ODA	Official Development Assistance
OEM	Original Equipment Manufacturer
PSS/E	Power System Simulator for Engineering
SJSC	State Join Stock Company
SOx	Sulfur Oxide
ST	Steam Turbine
TKG No.1	Turakurgan Thermal Power Station No.1
TKG No.1&2	Turakurgan Thermal Power Station No.1 and 2
TKG No.2	Turakurgan Thermal Power Station No.2
TOR	Terms of Reference
TPP	Thermal Power Plant
TPS	Thermal Power Station
USD	United States Dollar
VAT	Value Added Tax
W/S	Work Shop
WB	World Bank

Units

Prefixes

μ	:	micro- $= 10^{-6}$
m	:	milli- $= 10^{-3}$
c	:	centi- $= 10^{-2}$
d	:	deci- $= 10^{-1}$
da	:	deca- $= 10$
h	:	hecto- $= 10^{2}$
k	:	kilo- $= 10^{3}$
M	:	mega- $= 10^{6}$
G	:	giga- $= 10^{9}$

Units of Length

m	:	meter
mm	:	millimeter
cm	:	centimeter
km	:	kilometer
in	:	inch
ft	:	feet
yd	:	yard

Units of Area

cm^2	:	square centimeter
m^2	:	square meter
km^2	:	square kilometer
ft^2	:	square feet (foot)
yd^2	:	square yard
ha	:	hectare

Units of Volume

m^3	:	cubic meter
l	:	liter
kl	:	kiloliter

Units of Mass

g	:	gram
kg	:	kilogram
t	:	ton (metric)
lb	:	pound

Units of Density

kg/m^3	:	kilogram per cubic meter
t/m^3	:	ton per cubic meter
mg/m^3N	:	milligram per normal cubic meter
g/m^3N	:	gram per normal cubic meter
ppm	:	parts per million
μg/scm	:	microgram per standard cubic meter

Units of Pressure

kg/cm^2	:	kilogram per square centimeter (gauge)
lb/in^2	:	pound per square inch
mmHg	:	millimeter of mercury
mmHg abs	:	millimeter of mercury absolute
mAq	:	meter of aqueous
lb/in^2, psi	:	pounds per square inches
atm	:	atmosphere
Pa	:	Pascal
bara	:	bar absolute

Units of Energy

kcal	:	kilocalorie
Mcal	:	megacalorie
MJ	:	mega joule
TJ	:	tera joule
kWh	:	kilowatt-hour
MWh	:	megawatt-hour
GWh	:	gigawatt-hour
Btu	:	British thermal unit

Units of Heating Value

kcal/kg	:	kilocalorie per kilogram
kJ/kg	:	kilojoule per kilogram
Btu/lb	:	British thermal unit per pound

Units of Heat Flux

$kcal/m^2h$	:	kilocalorie per square meter hour
Btu/ft^2H	:	British thermal unit per square feet hour

Units of Temperature

deg	:	degree
°	:	degree

C	:	Celsius or Centigrade
°C	:	degree Celsius or Centigrade
F	:	Fahrenheit
°F	:	degree Fahrenheit

Units of Electricity

W	:	watt
kW	:	kilowatt
A	:	ampere
kA	:	kiloampere
V	:	volt
kV	:	kilovolt
kVA	:	kilovolt ampere
MVA	:	megavolt ampere
Mvar	:	megavar (mega volt-ampere-reactive)
kHz	:	kilohertz

Units of Time

s	:	second
min	:	minute
h	:	hour
d	:	day
y	:	year

Units of Flow Rate

t/h	:	ton per hour
t/d	:	ton per day
t/y	:	ton per year
m^3/s	:	cubic meter per second
m^3/min	:	cubic meter per minute
m^3/h	:	cubic meter per hour
m^3/d	:	cubic meter per day
lb/h	:	pound per hour
m^3N/s	:	cubic meter per second at normal condition
m^3N/h	:	cubic meter per hour at normal condition

Units of Conductivity

μS/cm	:	microSiemens per centimeter

Units of Sound Power Level

dB	:	deci-bell

Units of Currency

Sum	:	Uzbekisutan Sum
US$	:	US Dollar
¥	:	Japanese Yen

Chapter 1 Preface

1.1 Background of Survey

The maximum power demand in Uzbekistan reached a level of 8,260 MW in 2012 in contrast to the rated overall power generation capacity of 12,033 MW. There has been rapid dilapidation of the general equipment and facilities, and the peak generation capacity of the domestic facilities is unable to generate more than approximately 7,400 MW, exhibiting a remarkable reduction in power supply reliability. Many of the thermal power plants, which account for approximately 90% of the overall power sources, are old facilities that have been operating for more than forty to fifty years. The average power generation capacity of ten thermal power plants in this country has been reduced by approximately 30% below the rated capacity. Thus, it is urgently required to update the facilities in order to ensure power supply and improve reliability. Furthermore, the thermal efficiency of the thermal power plant is as low as approximately 30%. This is one of the causes of increased environmental load, and the introduction of highly efficient power generation facilities is anticipated for the purpose of reducing CO_2 emissions.

Amid this situation, the Ferghana area, which has a high population density where approximately 30% of the entire population resides, is supplied with electric power obtained by hydraulic power generation of this area and the power sent from the central portion of this country. Supplying a maximum demand of 1,650 MW results in a supply shortage of 540 MW in the winter and 322 MW in the summer favored with a rich supply of water. The shortage is covered by imports from Kyrgyzstan. An approximate 8% yearly increase in power demand is anticipated in this area in the future, and it is predicted that there will be further power shortages, so it is imperative to build power generation facilities that are capable of generating large amounts of power

Against this backdrop, in the "Electric Power Industry Development Concept up to 2030 in Uzbekistan" report, prepared by SJSC “Uzbekenergo”, Uzbekistan Reconstruction and Development Fund and Research Institute of the Government, priority is given to the Power Station Construction Project in Turakurgan of the Ferghana area. In May 2013, a formal request for yen loans was made by the Government of Uzbekistan to finance this Project.

The objective of the power plant construction project for this survey is to build a high efficiency thermal power plant (900 MW) in the suburbs of Turakurgan.

According to the Uzbekistan Aid Policy of Japan (April 2012), the "Updating and Development of Economic Infrastructure (Transportation and Energy)" is given as one of the priority fields. Furthermore, in JICA’s country-by-country analysis paper (July 2013), the "Development of Economic Infrastructure (Transportation and Electric Power in Particular)” is analyzed as constituting one of the major fields. This Project is in accordance with this policy and analysis. Improving the energy supply capacity by constructing a thermal power plant is a project of the utmost importance. This project, which top priority is to create a stable supply of energy, conforms to this policy.

This survey is based on the Minutes of the Consultation discussed between SJSC “Uzbekenergo” and JICA in August 2013. The objective is to conduct a survey required to examine the suitability as a Japanese ODA Loan project regarding such items as the purposes and overview of this Project, project expenses, project implementing system, operation/management system, and environmental/social considerations.

1.2 Purpose of Survey and Scope of Survey

1.2.1 Purpose of Survey

The purpose of this survey is to implement the conceptual design of the Project and feasibility survey (hereinafter referred to as "F/S" regarding two Gas Combined Cycle Construction Projects (900 MW (450 MW × 2 groups) characterized by high thermal efficiency) in the province of Namangan of Ferghana area, approximately 200 km east of Tashkent, capital of Uzbekistan, in response to JICA having been requested by the Republic of Uzbekistan (hereinafter referred to as "Uzbekistan") to implement a survey on the feasibility of yen loans for this Project, and to carry out surveys required to examine the implementation of the Japanese ODA Loan project.

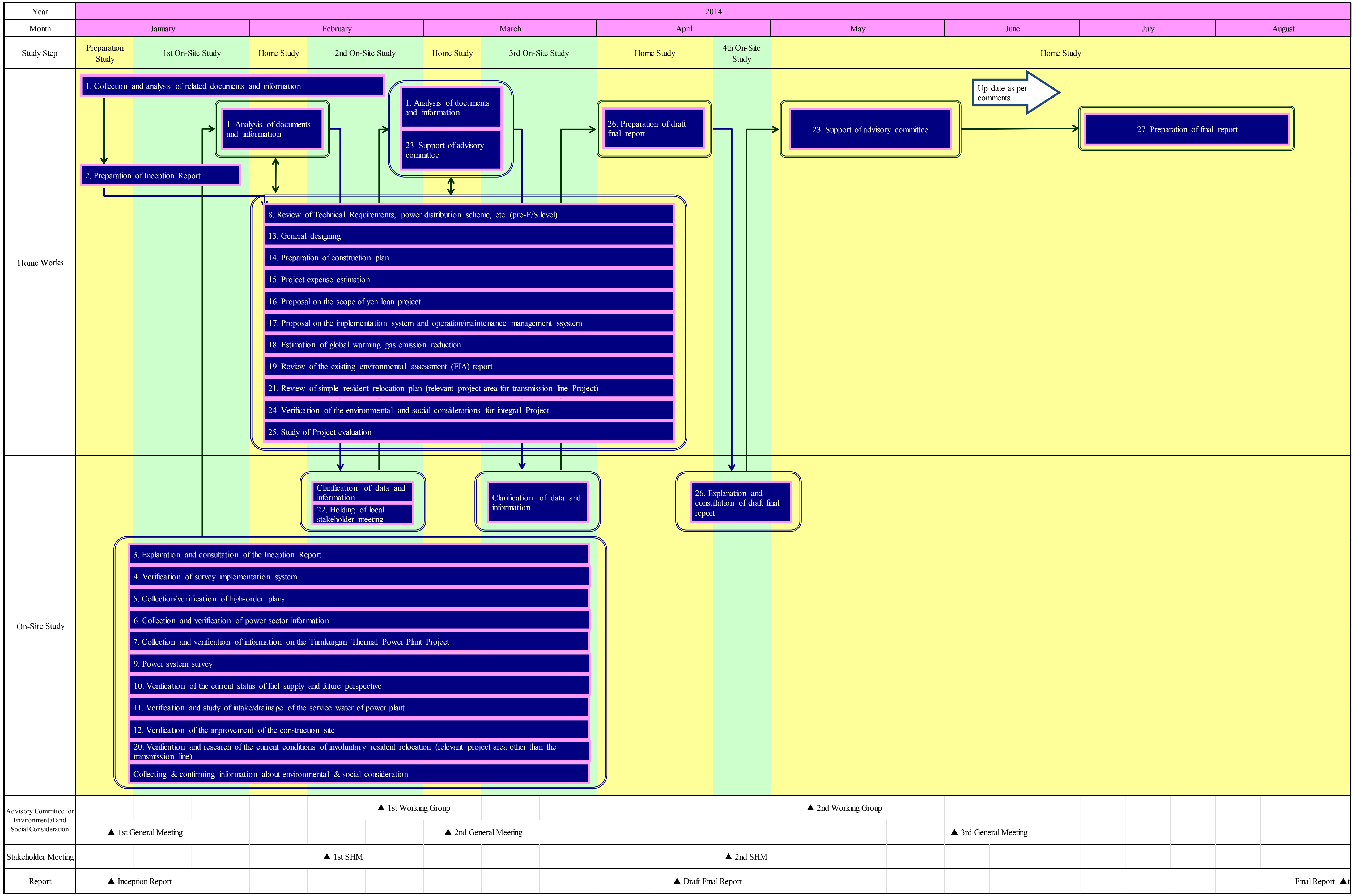
1.2.2 Scope of Survey

The scope of this survey includes the following:

(1) Collection and analysis of related documents and information
(2) Preparation of Inception Report
(3) Explanation and consultation of the Inception Report
(4) Verification of survey implementation system
(5) Collection/verification of high-order plans
(6) Collection and verification of power sector information
(7) Collection and verification of information on the Turakurgan Thermal Power Station Project
(8) Review of Technical Requirements, power distribution scheme, etc. (pre-F/S level)
(9) Power system survey
(10) Verification of the current status of fuel supply and future perspective
(11) Verification and study of intake/drainage of the service water of power plant
(12) Verification of the improvement of the construction site
(13) General designing
(14) Preparation of construction plan
(15) Project cost estimation
(16) Proposal on the scope of yen loan project
(17) Proposal on the implementation system and operation/maintenance management system
(18) Estimation of global warming gas emission reduction
(19) Review of the existing environmental assessment (EIA) report
(20) Verification and research of the current conditions of involuntary resident relocation (relevant project area other than the transmission line)
(21) Review of simple resident relocation plan (relevant project area for transmission line Project)
(22) Holding of local stakeholder meeting
(23) Support of advisory committee
(24) Verification of the environmental and social considerations for integral Project
(25) Study of Project evaluation
(26) Preparation, explanation and consultation of draft final report
(27) Preparation of final report

1.2.3 Duration of the Study

Schedule of the Study is shown in the next page.



Source: JICA Study Team

Figure 1.2.3-1 Schedule of the Study

1.3 Team Organization

Table 1.3-1 shows the names and duties of the study team members (hereinafter referred to as the Team).

Table 1.3-1 Team Organization

Name	Duty
Hideyuki OKANO	Team Leader / Power development planning
Hiroto ITAGAKI	Sub Team Leader / Fuel planning
Makoto KAMIBAYASHI	System analysis A
Hisashi SAITO	System analysis B
Hideki ASAYAMA	Mechanical facilities A
Kenji MIKATA / Toru KAMO	Mechanical facilities B
Masamichi SHOJI	Electric/control facilities
Mitsuaki SHIMADA	Civil engineering
Toshiyuki SAITO	Power transmission facilities
Hiroki TANIHATA	Substation facilities
Eiichi KATO / Norihiko FUKAZAWA	Environmental and social considerations (environmental)
Tadashi NAKAMURA	Environmental and social considerations (social)
Koichi ISHII	Economic and financial analysis

Source: JICA Study Team

Chapter 2 Socio-economic Situation

2.1 Overview

Uzbekistan, with the goal of becoming an industrialized, high middle-income country by around 2050, is continuing to transition to a more market-oriented economy to ensure equitable distribution of growth between regions and to maintain infrastructure and social services. The country's policy goals and priorities are: to increase the efficiency of infrastructure, especially in areas of energy, transport, and irrigation; to enhance the competitiveness of specific industries, such as agro-processing, petrochemicals, and textiles; to diversify the economy and thereby reduce its reliance on commodity exports; and to improve access to and the quality and outcomes of education, health and other social services.
Since the mid-2000s, Uzbekistan has enjoyed robust GDP growth, thanks to favorable trade terms for its key export commodities like copper, gold, natural gas, cotton, the government's macro-economic management, and limited exposure to international financial markets that protected it from the economic downturn. Still, the future is not without challenges.

Table 2.1-1 Basic Indicators

Country Name	Republic of Uzbekistan
Surface Area	447,400 square km
Population	29. 8 million (2012)
GDP (Nominal, Sums million)	96,589,800 (2012)
GDP (Nominal, USD million)	45,350 (2012)
GDP per Capita (USD)	1,572 (2011)
GDP Growth (Real, %)	8.2% (2012)
Merchandize export (USD million)	14,550 (2012)
Merchandize import (USD million)	11,000 (2012)
Exchange rate (Year average)	1,984 sums/USD (2013)
Exchange rate (Year-end)	2,240 sums/USD (2014)

Source: Ministry of Foreign Affairs of Japan (http://www.mofa.go.jp/), JETRO (http://www.jetro.go.jp/indexj.html), ADB "Key Indicators for Asia and the Pacific 2012"

2.2 Socio-economic Conditions

Uzbekistan is a lower middle-income, resource rich, doubly-landlocked country, located in the heart of Central Asia. Its population of about 29.8 million (mid-2012), about half of whom live in urban areas, accounts for about forty percent of Central Asia‘s total population. It is the world‘s sixth largest cotton producer and fourth largest raw cotton exporter. Other important commodities include natural gas, gold, copper and uranium. As the only country bordering five other Central Asian states including Afghanistan, Uzbekistan‘s economic and social development is important not only for its own young and rapidly growing population, but also for the management of the region‘s energy, water, and trade as well as for its political stability and security.
About 16 per cent of people in Uzbekistan live below the poverty line, 75 percent of whom live in rural areas. One of the most difficult challenges the country is facing is a lack of employment opportunities, with a high disparity between rural and urban areas. High unemployment and low wages have resulted in a mass labor migration to Russia and Kazakhstan, while remittances have accounted for about 12 to 15 per cent of the nation's GDP from 2010 to 2012.

Table 2.2-1 Socio-economic Indicators

Population Trends	1995	2000	2005	2010	2011	2012
Total population (million)	22.9	24.8	25.9	27.4	29.3	29.8
Population growth (annual change, %)	2.0	1.3	0.9	1.2	2.7	1.5
Density (persons per square km)	53	58	62	63	64	63

Labor Force	2006	2007	2008	2009	2010	2011	2012
Total labor force (thousands)	11,493	11,299	11,603	11,930	12,287	12,542	12,850
Employed	10,467	10,735	11,035	11,328	11,628	11,919	12,224
Unemployed (registered)	26	23	17	20	16	13	6
Annual grwoth of labor force (%)	3.0	2.0	3.0	3.0	3.0	2.1	2.5

Source: Asian Development Outlook (ADO) 2013 Update; ADB estimates.

2.3 Macroeconomic Conditions

Despite the deterioration in the global environment, the economy of Uzbekistan continued to grow rapidly. Strong fiscal and external positions, a stable banking system, and low public debt continue contributing to robust macroeconomic performance. Real GDP growth was maintained at 8 percent in 2013, supported by the state-led modernization investment program. Exports of goods and services rose by 42 percent in 2012. Despite rapid import growth spurred by capital goods, the current account surplus increased marginally and international reserves remained high.

Growth resulted mainly from the output gain of 5.8% in industry and 12.0% in services. Industry, especially the energy sector, benefitted from government-led investment spending, nearly a third of which went to industry, mainly for energy. Construction rose, led by housing, ongoing industrial modernization, and the start of the government’s electrified railway project. Continued lending by commercial banks and the lagged impact of remittances buoyed finance and other services, notably trade and catering. Communications and information technology recorded a high growth on the back of strong demand. Favorable weather during 2013 supported large increases in grain, fruit, and vegetable harvests, spurring agricultural growth.

Table 2.3-1 Selected Economic Indicators

GDP by Industry Origin	2006	2007	2008	2009	2010	2011	2012
GDP (% change, constant price)	7.4	7.7	9.0	8.1	8.5	8.3	8.2
Agriculture (% change, constant price)	6.2	6.5	4.7	5.8	6.6	6.6	7.0
Industry (% change, constant price)	7.5	6.6	6.8	4.1	4.2	4.5	5.8
Service (% change, constant price)	8.6	13.4	15.3	9.3	11.6	12.0	-
GDP by sector origin							
Agriculture (% change, constant price)	27.9	25.9	21.9	20.6	19.8	19.1	18.9
Industry (% change, constant price)	29.9	29.9	32.3	33.6	33.4	32.6	32.4
Service (% change, constant price)	42.2	44.2	45.9	45.8	46.8	48.3	48.7
Annual Growth of Production Indexes (Annual growth, %)							
Agricultural and Fishery Production Index	7.1	6.1	4.5	5.7	6.8	5.1	7.0
Industrial Production Index	7.8	12.1	12.7	9.0	8.3	4.5	5.8
Inflation and Money Supply							
Consumer price index (annual change, %)	8.7	6.1	7.2	7.8	7.6	7.3	7.2
Food price index (annual change, %)	7.4	2.0	3.3	4.4	4.8	3.5	5.1
Producer price index (annual change, %)	30.2	14.1	9.1	24.7	15.6	19.6	14.5
Money Supply (M2, billion Sums)	3,146	4,598	6,088	9,171	13,977	18,490	23,120
M2 (% of GDP at current market price)	15.2	16.3	15.6	18.6	22.4	23.7	23.9
Balance of Payment						(Unit: million USD)	
Trade balance	1,744	2,296	2,204	1,613	2,484	4,517	2,231
Merchandise exports	5,615	8,026	9,817	10,890	10,529	15,027	14,259
Merchandise imports	3,841	5,730	7,612	9,277	8,044	10,510	12,028
Current balance	2,933	4,267	4,472	4,136	5,663	3,677	2,400
Other goods, services, and income	-12	20	229	179	1,021	-637	-1,110
Unrequuired transfer	1,171	1,951	2,038	2,344	1,150	-40	-40
Overall balance	1,564	2,155	3,731	2,200	5,663	5,392	4,170
Direct investment	195	739	918	987	1,628	1,418	1,450
Current account balance (% of GDP)	17.2	19.1	17.4	12.6	6.6	8.1	5.3
Overall balance (% of GDP)	9.2	9.6	10.6	14.3	14.4	13.7	10.6
Exchange rate (Sums/USD, average)	1,215.6	1,260.8	1,314.2	1,458.8	1,576.8	1,706.6	1,897.6

Source: Asian Development Outlook (ADO) 2013 Update; ADB estimates.

The government reported that inflation in 2012 averaged 7.2% on an annualized basis. Slower growth in net foreign assets offset inflationary pressures from wage and pension increases and from higher import costs thought to be attributable to additional import restrictions introduced in early 2013. The inflation forecasts 9.0% for 2014. Inflation remains driven by regulated tariff increases aimed at cost recovery, exchange rate depreciation, and demand pressures stemming from general government spending.

The government reported that external trade in goods and services in 2012 recorded a surplus of $2,000 million, 49% below the corresponding period of 2011. Although total exports rose, exports of traditional earners of hard currency - cotton, metals, and machinery - were down from the first half of 2012. Meanwhile, imports increased by 14.4%, led by capital goods and chemical products. It is anticipated that falling external demand and international prices for the country's main export commodities would narrow the trade surplus. Its current account surplus is forecasted as 3.2% for 2014.

2.4 Government Finance and External Debt

The consolidated fiscal position was better-than-budgeted, benefitting from higher tax collection and expenditure in line with the state budget in 2013. Despite a drop in gold and copper prices, the Fund for Reconstruction and Development's revenue exceeded expenditure by 4.3 percent of semi-annual GDP.

The impact of recent increases in global food and energy prices is expected to be limited given Uzbekistan's policy of self-sufficiency in both food grains and energy. Given the government's plans to finance up to two-thirds of their investment program from external sources, including loans, external debt is expected to increase gradually.
The country has to contend with a combination of risk factors going forward, including deteriorating security conditions due to the situation in Afghanistan, and increasing tensions between with neighbors over regional issues—especially the management and use of trans-boundary energy and water resources. Domestically, Uzbekistan has to work to minimize its economy's vulnerability to possible external shocks affecting commodity prices and the anticipated inflow of foreign direct investment (FDI) and external loans to finance the large public investment program.

Table 2.4-1 Selected Indicators of Government Finance and External Debt

Government Finance	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total revenue	4,485.4	6,145.0	8,760.8	10,840.2	13,596.7	17,061.3	21,295.7
Current revenue	4,485.4	6,145.0	8,760.8	10,840.2	13,596.7	17,061.3	21,295.7
Taxes	4,184.9	5,666.5	8,132.8	10,224.5	12,740.5	15,710.2	19,620.2
Total expenditure	4,388.4	5,823.8	8,197.1	10,763.9	13,386.9	16,726.0	20,882.0
Overall budgetary balance	97.0	321.2	563.7	76.3	209.8	335.3	413.6
Total revenue (% of GDP)	21.2	21.8	22.5	22.0	21.8	21.9	22.0
Total expenditure (% of GDP)	20.8	20.7	21.0	21.8	21.5	21.5	21.6
Overall budgetary balance (% of GDP)	0.5	1.1	1.4	0.2	0.3	0.4	0.4
External Debt							
Total debt outstanding and disbursed	4,073.9	4,211.1	4,686.1	6,549.7	7,404.3	8,382.0	-
Long-term debt	3,915.9	4,012.7	4,465.3	6,386.3	7,166.7	7613.2	-
Public and publicly guaranteed	3,289.0	3,133.9	3,144.4	3,245.6	3,245.7	3695.3	-
External Debt (% of GNI)	24.0	18.8	17.0	20.1	19.0	17.8	-
Total loong-term debt (% of total debt;)	96.1	95.3	95.3	97.5	96.8	90.8	-
Principal repayment on long-term debt	677.4	649.0	710.5	717.0	470.6	459.0	1,561.3
Interest on long-term debt	170.2	167.7	141.0	120.3	118.1	157.0	122.9
interest of short-term debt	3.3	7.3	8.0	2.3	5.8	7.2	-

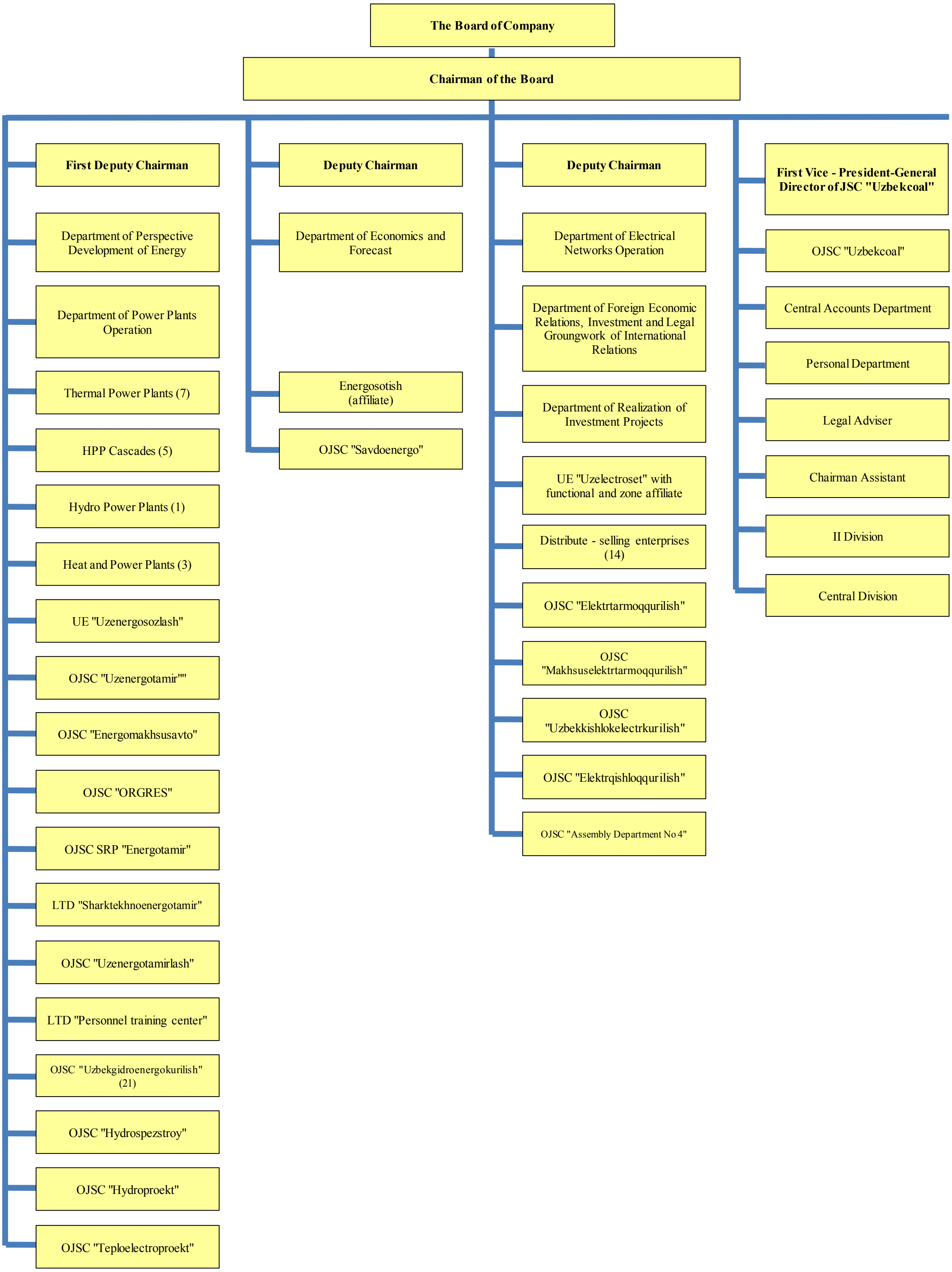
Source: Asian Development Outlook (ADO) 2013 Update; ADB estimates.

Chapter 3 Overview of the Power Sector in the Republic of Uzbekistan

3.1 Overview of power sector in the Republic of Uzbekistan

3.1.1 Organization

In the Republic of Uzbekistan, there was a structrual reorganization in August 2001; the Ministry of Electric Power and Electrification was changed into the State Joint Stock Company Uzbekenergo (hereinafter referred to as “SJSC Uzbekenergo”). The organization structure of the SJSC Uzbekenergo is shown in Figure 3.1.1-1. SJSC Uzbekenergo includes a power generation company, power transmission company, power distribution company, affiliated companies (Energosotish, etc), and a coal company (Uzbekcoal). The managerial body of SJSC Uzbekenergo is the Company Council and the Board. The Company Council is the supreme managerial body, which carries out the functions for the General Meeting and the Supervisory Council. The Company Council consists of 9 members, including the Chairman, who has been approved by the Cabinet of the Ministers of Republic of Uzbekistan.
The Company Board is an executive body which manages the company’s operations and represents the reports on the Council’s activity results. The Company Board consists of 5 members, including Chairman and four Deputy Chairmen, who has been approved by the Cabinet of the Ministers of the Republic of Uzbekistan for the presentation of the Company Council.



Source: SJSC Uzbekenergo

Figure 3.1.1-1 SJSC Uzbekenergo organization chart

3.1.2 Overview of existing power generation facilities

The power supply sources in the Republic of Uzbekistan consist of 46 power plants. The total generation capacity for all power generation facilities in the Republic of Uzbekistan exceeds 12,500 MW. The basic share is thermal power plants running on natural gas and coal. Other capacities are presented by small and medium hydro power plants.

In 2012, SJSC Uzbekenergo produced 51,201.2 GWh of electric power, of which 1,358.3 GWh was exported. In the same year, the SJSC Uzbekenergo imported 689.3 GWh of electric power.
The thermal power plants account for 85% of the power generation and the hydraulic power plant accounts for 12% of the power generation. They are run by the SJSC Uzbekenergo, and the remaining power generation facilities, accounting for 3% of the power generation, are run by other organizations.

The SJSC Uzbekenergo anticipates a substantial increase (around 4% from 2014 to 2020) in electricity demand. To meet this growing demand, the company is planning to maintain the capacity of self support through the introduction of new facilities in order to improve the reliability and quality of power supply, to save power, and to enhance operation efficiency of fuel and power. Furthermore, to protect the local ecosystem and to improve the global environment, the company is making efforts to develop on-site power generation technology and a renewable energy source.

Table 3.1.2-1 and Table 3.1.2-2 show the overview of the existing thermal power plants and hydraulic power plants. Power generation facilities in Uzbekistan consist of eleven (11) thermal power plants (three of which are cogeneration power plants) and thirty-five (35) hydraulic power plants. The total installed capacity is 12,824.7MW (as of 2013, 11,133MW by thermal power plants plus 1,691.7MW by hydraulic power plants). Of these, the following four power plants each have an installed capacity of over 1,000MW: These power plants are the Syrdarya TPP (with an installed capacity of 3,000MW), the Novo-Angren TPP (with an installed capacity of 2,100MW), the Tashkent TPP (with an installed capacity of 1,860MW), and the Navoi TPP (with an installed capacity of 1,250MW). Furthermore, three cogeneration power plants as well as thermal power plants supply heat to thirteen regions.
Many of these power plants have been operating for 40 to 50 years after the commencement of commercial operation and require renovation or replacement due to degradation. Recently, the construction of Talimarjan thermal power plant unit-1, having a generation capacity of 800 MW in 2004, the renovation of the Syrdaria thermal power plant units-7 & 8 in 2005, and the construction of Navoi combined cycle power plant in 2012 were performed to address this.

Hydroelectric power plants are mainly combined into cascades of hydroelectric power plants and operate under a watercourse.

Table 3.1.2-1 Overview of the existing thermal power plant facilities (as of 2013)

No.	Name of Plant	Type of Plant	No. of Turbine-Generator Units	Total Installed Capacity (MW)	Type of Fuel	Year of Initial Operation	Total Current Effective Capacity (MW)	Cumulative Operating Hours of All Unit (hours)	Owner
1	Syrdarya TPP	Steam Turbine & Boiler	10	3,000	Gas, Oil	1972-1981	2,600.0	226,916	SJSC Uzbekenergo
2	Novo-Angren TPP	Steam Turbine & Boiler	7	2,100	Coal, Gas, Oil	1985-1995	1,448.0	105,888	SJSC Uzbekenergo
3	Tashkent TPP	Steam Turbine & Boiler	12	1,860	Gas, Oil	1963-1971	1,712.0	268,288	SJSC Uzbekenergo
4-1	Navoi TPP	Steam Turbine & Boiler	11	1,250	Gas, Oil	1963-1980	812.7	310,000	SJSC Uzbekenergo
4-2	Navoi TPP	Combined Cycle	1	478	Gas	2012	478.0	-	SJSC Uzbekenergo
5	Takhiatash TPP	Steam Turbine & Boiler	3	730	Gas, Oil	1962-1990	460.0	220,627	SJSC Uzbekenergo
6	Angren TPP	Steam Turbine & Boiler	7	484	Coal, Oil, Coal gas	1957-1963	197.0	164,339	SJSC Uzbekenergo
7	Fergana CHP	Steam Turbine & Boiler	6	305	Gas, Oil	1956-1981	200.0	216,041	SJSC Uzbekenergo
8	Mubarek CHP	Steam Turbine & Boiler	2	60	Gas	1985-1986	60.0	125,778	SJSC Uzbekenergo
9	Tashkent CHP	Steam Turbine & Boiler	1	30	Gas	1939-1955	26.5	559,701	SJSC Uzbekenergo
10	Talimarjan TPP	Steam Turbine & Boiler	1	800	Gas, Oil	2004	720.0	68,369	SJSC Uzbekenergo
11	Departmental TPP	Steam Turbine & Boiler	N/A	36	N/A	N/A	N/A	N/A	Departmental TPP
	Total	-	-	11,133	-	-	8,714.2	-	-

Source: SJSC Uzbekenergo

Table 3.1.2-2 Overview of the facilities in the existing hydraulic power plants

No.	Plant Name	Plant Type	Unit Number	Total Installed Capacity	Year of Initial Operation	Total Current Effective Capacity (MW)	Operating Hours of All Units (hours)	Owner
1	Charvak HPP	Hydraulic Power	4	621.0	1970	620.5	233,533	SJSC Uzbekenergo
2	Hodzhikent HPP	Hydraulic Power	3	165.0	1976	165.0	165,344	SJSC Uzbekenergo
3	Farkhad HPP	Hydraulic Power	4	126.0	1948	118.0	447,742	SJSC Uzbekenergo
4	Gazalkent HPP	Hydraulic Power	3	120.0	1980	120.0	151,146	SJSC Uzbekenergo
5	Tavak HPP	Hydraulic Power	4	72.0	1941	72.0	132,120	SJSC Uzbekenergo
6	Chirchik HPP	Hydraulic Power	4	84.0	1940	84	129,315	SJSC Uzbekenergo
7	Ak-kavak HPP- 1	Hydraulic Power	2	35.0	1943	28	96,420	SJSC Uzbekenergo
8	Ak-kavak HPP- 2	Hydraulic Power	2	9.0	1946	9	88,700	SJSC Uzbekenergo
9	Kibrai HPP	Hydraulic Power	1	11.2	1943	11.2	125,400	SJSC Uzbekenergo
10	Kadiria HPP	Hydraulic Power	4	13.2	1933	13.2	121,300	SJSC Uzbekenergo
11	Salar HPP	Hydraulic Power	1	11.2	1944	10.2	120,350	SJSC Uzbekenergo
12	Bozsyi HPP	Hydraulic Power	4	4.0	1926	2.2	23,886	SJSC Uzbekenergo
13	Shfihantaur HPP	Hydraulic Power	3	3.6	1954	3.6	20,973	SJSC Uzbekenergo
14	Burdjar HPP	Hydraulic Power	2	6.4	1936	6.2	15,408	SJSC Uzbekenergo
15	Ak-tepa HPP	Hydraulic Power	1	15.0	1943	13.0	5,745	SJSC Uzbekenergo

No.	Plant Name	Plant Type	Unit Number	Total Installed Capacity	Year of Initial Operation	Total Current Effective Capacity (MW)	Operating Hours of All Units (hours)	Owner
16	HPP-14	Hydraulic Power	1	10.7	1944	0.0	0	SJSC Uzbekenergo
17	HPP-18	Hydraulic Power	3	7.0	1943	5.0	15,400	SJSC Uzbekenergo
18	HPP-19	Hydraulic Power	2	11.2	1950	8.5	21,230	SJSC Uzbekenergo
19	HPP-23	Hydraulic Power	2	17.6	1960	17.6	35,600	SJSC Uzbekenergo
20	HPP-22	Hydraulic Power	2	4.4	1953	4.2	34,750	SJSC Uzbekenergo
21	Hishray HPP-2B	Hydraulic Power	3	21.9	1957	16.0	22,800	SJSC Uzbekenergo
22	Irtishar HPP-3B	Hydraulic Power	2	6.4	1961	4.0	14,300	SJSC Uzbekenergo
23	Taligul HPP-1B	Hydraulic Power	2	3.0	1945	3.0	12,500	SJSC Uzbekenergo
24	Taligul HPP-5B	Hydraulic Power	2	8.8	1962	4.0	10,200	SJSC Uzbekenergo
25	Shahrihan HPP-5A	Hydraulic Power	2	11.4	1953	11.0	11,400	SJSC Uzbekenergo
26	Shahrihan HPP-6A	Hydraulic Power	2	7.7	1943	7.0	12,760	SJSC Uzbekenergo
27	SFC HPP-1	Hydraulic Power	1	2.1	1965	1.5	14,950	SJSC Uzbekenergo
28	SFC HPP-2	Hydraulic Power	1	6.7	1965	2.5	16,850	SJSC Uzbekenergo
29	Tuyamuyan HPP	Hydraulic Power	6	25.0	1983	25.0	N/A	Ministry of Agriculture
30	Andijan HPP-29	Hydraulic Power	4	140.0	1983	140.0	N/A	Ministry of Agriculture
31	Tupalang HPP-34	Hydraulic Power	2	31.0	2006	31.0	N/A	Ministry of Agriculture

No.	Plant Name	Plant Type	Unit Number	Total Installed Capacity	Year of Initial Operation	Total Current Effective Capacity (MW)	Operating Hours of All Units (hours)	Owner
32	Urgut HPP	Hydraulic Power	6	0.5	2004	0.5	N/A	Ministry of Agriculture
33	Gissarak HPP	Hydraulic Power	2	45.0	2011	45.0	N/A	Ministry of Agriculture
34	Ahangaran HPP-1	Hydraulic Power	2	10.5	2010	10.5	N/A	Ministry of Agriculture
35	Ahangaran HPP-2	Hydraulic Power	2	25.0	2010	25.0	N/A	Ministry of Agriculture
	Total	-	-	1,691.7	-	1,637.4	-	-

(Note)
TPP: Thermal Power Plant
CHP: Combined Heat and Power Plant
HPP: Hydraulic Power Plant
Source: SJSC Uzbekenergo

Table 3.1.2-3 shows available capacity of each thermal power plant. As shown in Table 3.1.2-3, average deterioration ratio (= (Installed capacity – Available capacity) / Installed capacity x 100) shows around 22%, that is, one third of installed capacity was lost. The thermal power plant with the largest amount of deterioration is Angren TPP which, exhibits around 60% deteriorate rate, that is, more than half of the installed capacity was lost. Recovery of this lost capacity is an urgent issue for the power sector in Uzbekistan.

Table 3.1.2-3 Transition of Available Capacity of the existing TPPs

Unit: MW

Name of Thermal Power Plant	Installed Capacity (MW)	Available capacities, MW					
		2008	2009	2010	2011	2012	2013
Syrdarya TPP	3,000	2,518.1	2,556.5	2,536.0	2,519.3	2,573.7	2,600.0
Novo-Angren TPP	2,100	1,497.5	1,491.0	1,448.0	1,448.2	1,449.2	1,448.0
Tashkent TPP	1,860	1,763.7	1,755.7	1,562.0	1,724.6	1,723.0	1,712.0
Navoi TPP	1,250	1,015.8	1,015.8	1,014.0	1,013.8	980.1	812.7
Navoi CHP	478	-	-	-	-	-	478.0
Talimarjan TPP	730	720.0	720.0	720.0	720.0	720.0	720.0
Takhiatash TPP	484	654.8	612.4	692.8	613.4	599.7	460.0
Angren TPP	305	247.0	197.0	197.0	197.0	197.0	197.0
Fergana CHP	60	200.0	200.0	200.0	200.0	200.0	200.0
Mubarek CHP	30	57.0	57.0	57.0	57.0	57.0	60.0
Tashkent CHP	800	26.5	26.5	26.5	26.5	26.5	26.5
Departmental TPP	36	NA	NA	NA	NA	NA	NA
Total TPP:	3,000	8,700.4	8,631.9	8,453.3	8,519.8	8,526.2	8,714.2

Source: SJSC Uzbekenergo

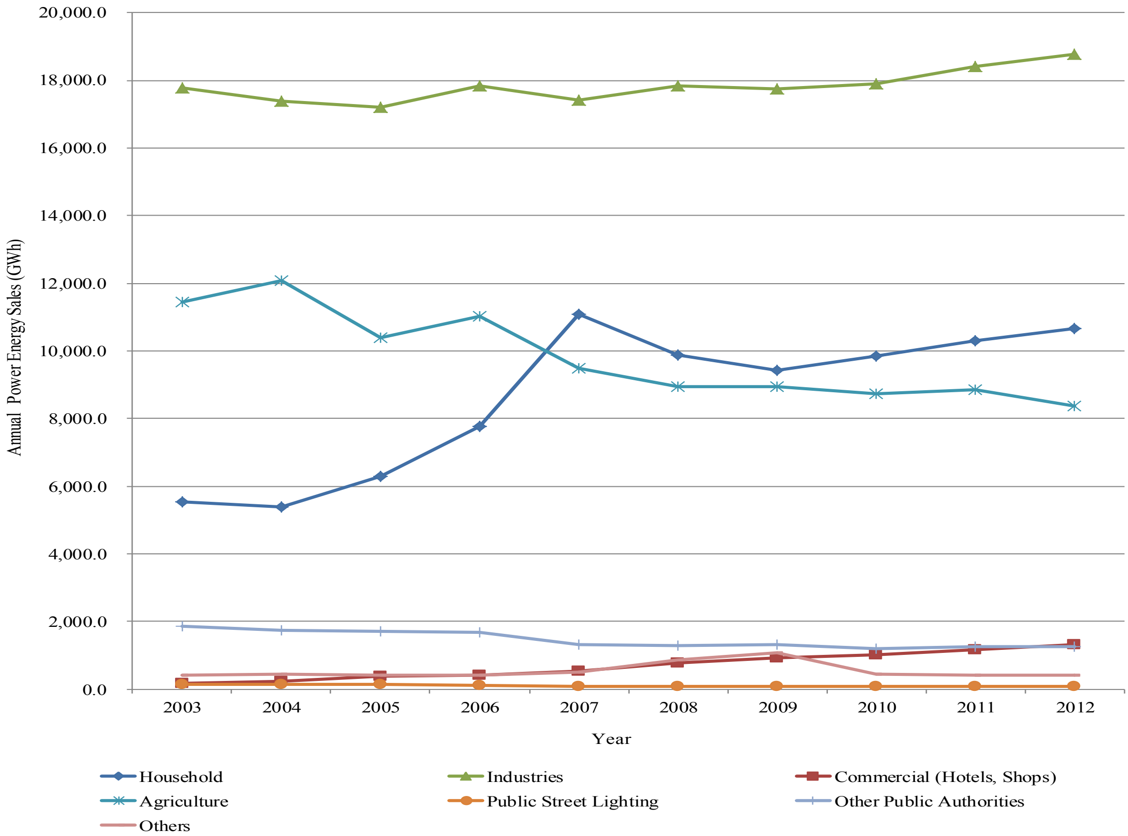
Table 3.1.2-4 and Figure 3.1.2-1 show power consumption in each category in the past ten (10) years. Generated power is primary consumed by industrial, residential, and agricultural sectors. Household power consumption is rapidly increasing.

Table 3.1.2-4 Power Consumption in each Category

Unit: GWh

Year	Household	Commercial (Hotels, Shops etc.)	Industries		Agriculture	Public Street Lighting	Other Public Authorities	Other	Total
			Small(1)	Large(2)					
2003	5,529.7	184.2	1,380.1	16,390.0	11,457.6	136.3	1,843.8	420.9	37,342.56
2004	5,398.1	233.6	1,553.0	15,818.1	12,088.4	134.9	1,748.2	454.8	37,428.91
2005	6,277.8	393.7	1,889.1	15,321.0	10,394.1	128.8	1,704.8	408.1	36,517.39
2006	7,767.8	412.0	2,536.7	15,297.6	11,010.3	117.9	1,669.4	409.3	39,220.95
2007	11,071.3	530.1	1,893.2	15,535.0	9,472.7	93.3	1,306.4	515.9	40,417.84
2008	9,891.4	767.9	2,178.2	15,670.9	8,939.9	81.6	1,299.4	869.0	39,698.34
2009	9,411.8	921.7	2,494.0	15,240.7	8,938.9	82.7	1,307.1	1,063.9	39,460.72
2010	9,836.2	1,002.3	1,937.0	15,958.2	8,719.7	84.7	1,193.9	450.6	39,182.57
2011	10,286.1	1,177.2	2,062.3	16,350.4	8,858.6	86.8	1,265.9	418.1	40,505.26
2012	10,647.8	1,318.7	2,199.7	16,574.0	8,360.5	91.8	1,258.2	424.9	40,875.48

(Note)
(1) Industries (Small): Less than 3,000kW
(2) Industries (Large): 3,000kW or more
Source: SJSC Uzbekenergo



Source: SJSC Uzbekenergo
Figure 3.1.2-1 Power Consumption in Each Category in the Past 10 Years

Table 3.1.2-5 shows fuel consumption records at thermal power plants, which include heat and power plants. Figure 3.1.2-2 shows the fuel ratio in thermal power plants in 2013. Natural gas is 90.7 %, heavy oil is 1.0 %, and coal is 8.3 %. Natural gas accounts for the majority of fuel consumption..
In 2013 the total amount of generated power was 47,857 GWh (excluding Hydro Power Plants) = 172,285 TJ: therefore, the overall average thermal efficiency for all thermal power plants is as follows:

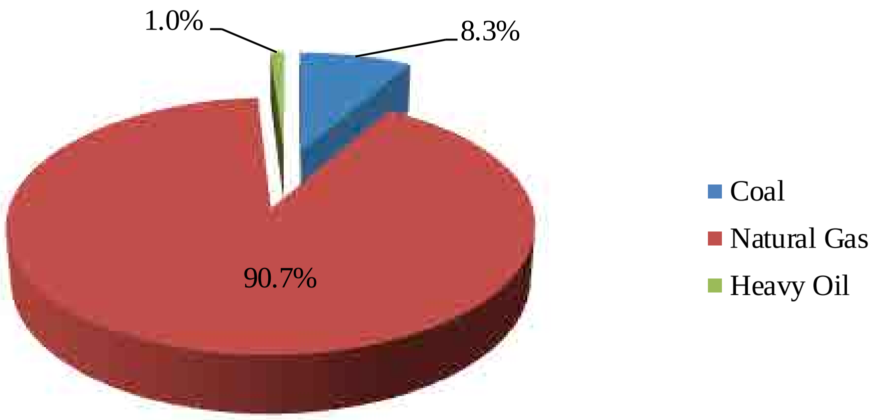
172,285 / 554,226 x 100 = 31.1%

Table 3.1.2-5 Fuel Consumption at Thermal Power Plants

Type of Fuel	Unit	2003	2004	2005	2006	2007
Coal	M tons/yr	1.80	2.60	2.05	2.77	2.66
	TJ/yr	18,760.4	27,069.4	21,303.4	28,809.6	27,715.4
Natural Gas	Gm^3/yr	12.49	13.06	12.69	12.95	12.97
	TJ/yr	420,907.6	440,075.3	427,601.8	436,352.4	437,007.8
Heavy Oil	M tons/yr	1.28	1.11	0.63	0.78	0.57
	TJ/yr	49,960.6	43,518.6	24,780.7	30,443.8	22,106.2
Total	TJ/yr	489,628.7	510,663.3	473,685.9	495,605.7	486,829.4

Type of Fuel	2008	2009	2010	2011	2012	2013
Coal	2.19	2.61	2.01	2.21	2.62	4.41
	22,745.8	27,178.3	20,905.1	23,027.3	27,287.2	45,832.8
Natural Gas	14.61	13.70	13.77	14.88	14.72	14.92
	492,302.7	461,549.0	464,203.6	501,289.7	496,136.0	502,642.2
Heavy Oil	0.24	0.24	0.25	0.20	0.17	0.15
	9,544.0	9,373.5	9,636.0	7,846.9	6,718.9	5,751.6
Total	524,592.5	498,100.8	494,744.7	532,163.9	530,142.1	554,226.7

Source: SJSC Uzbekenergo



Source: SJSC Uzbekenergo

Figure 3.1.2-2 Fuel ratio in thermal power plants (2013)

3.1.3 Overview of power transmission facilities

(1) Power grid system

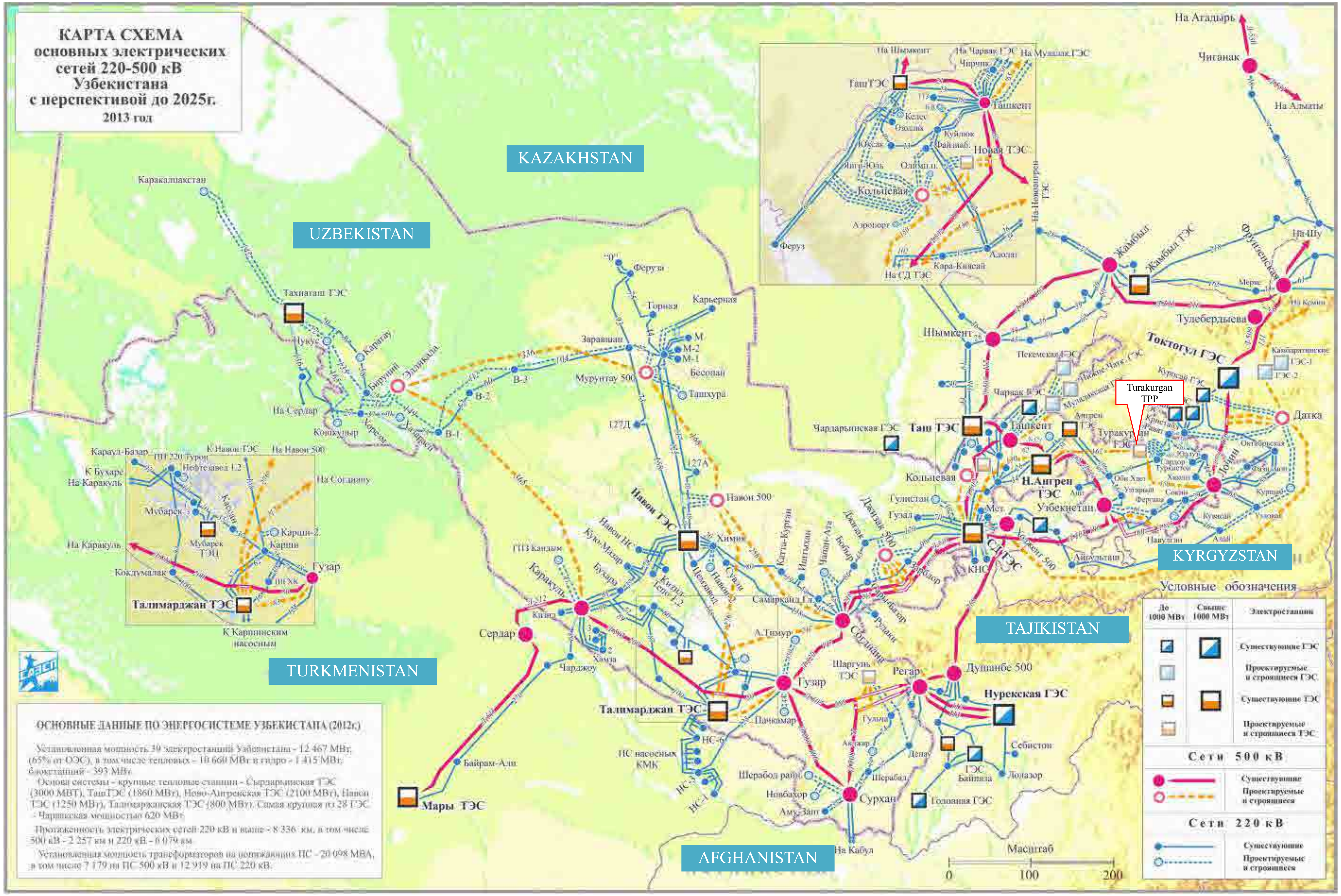
Figure 3.1.3-1 shows an Uzbekistan power grid system diagram. The figure shows the 500 kV and 220 kV transmission linesin Uzbekistan in 2025.

The power grid system in the Republic of Uzbekistan was constructed at the time of the former Soviet Union, where five countries, including Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan were assumed as constituting one integral area. Thus, after each country established independence, the power grid system constitutes an international connection system.
The 500 kV transmission line is also linked to Russia via Kyrgyzstan and Kazakhstan. Thus, the power grid system is characterized as a large scale system with stable frequency operation.

The 500 kV and 220 kV lines are used in the trunk network, and the 110 kV lines serve for local supply systems. The vast majority of the trunk network consists of one-circuit transmission lines. Power outages occurring when there are issues with the transmission line are minimized by the parallel operation of the 500 kV and 220 kV circuits.

Reinforcing the system with 500 kV transmission lines is planned. Furthermore, there are two (2) plans as described below.

a. Relocation of the 500kV transmission line going through the neighboring countries.
b. Disconnection of the power system that is interconnected with the neighboring countries.



Source: SAESP

Figure 3.1.3-1 Power grid system for the Republic of Uzbekistan

Table 3.1.3-1 shows the length of transmission lines and distribution lines in Uzbekistan.

The transmission system consists of 500 kV and 220 kV transmission lines. and the distribution system consists of 110 kV lines or less. Overhead lines are incorporated in the transmission system, but underground cables are not used at all.

Table 3.1.3-1 The length of transmission lines and distribution lines

	Transmission Line		Distribution Line		
Voltage [kV]	500	220	110	35	6-10
Length [km]	2,318	5,728	10,048	12,731	86,607

Source: Uzbekenergo

(1) Power Flow

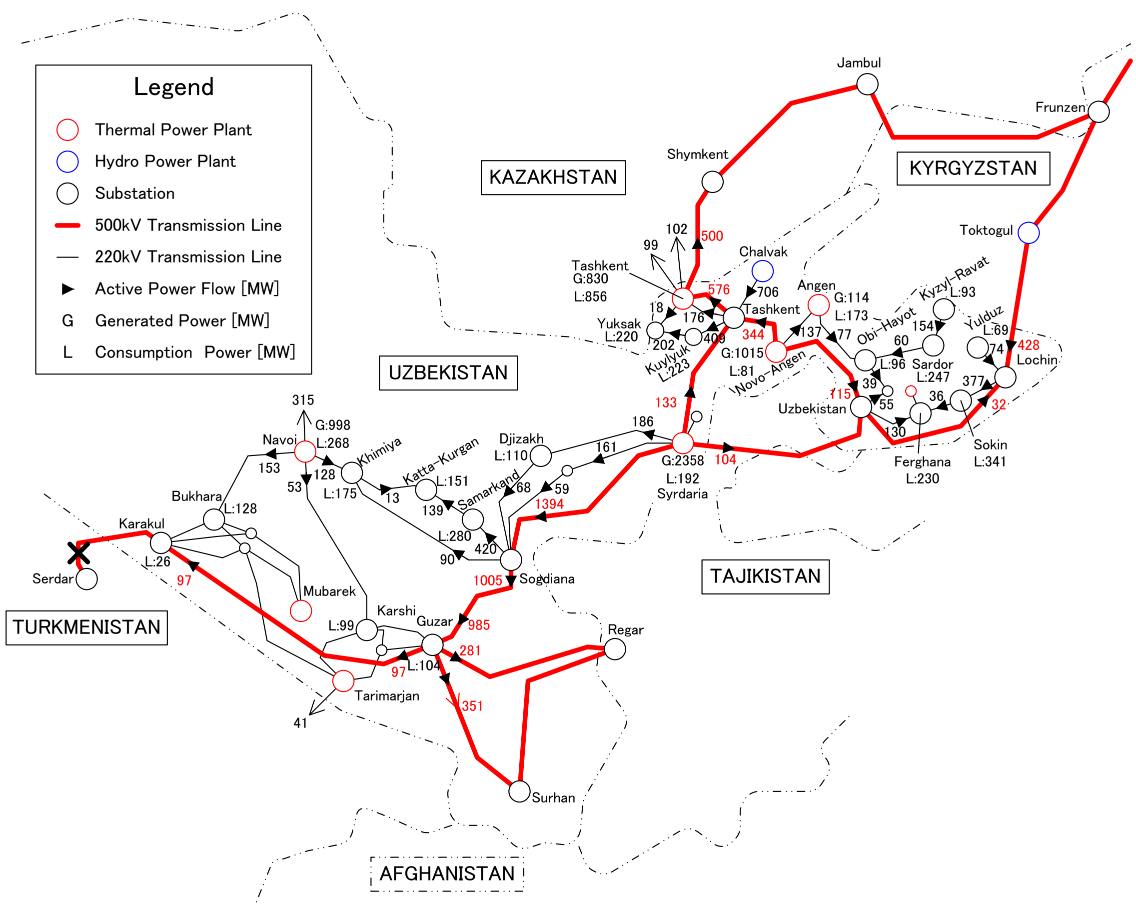
Figure 3.1.3-2 shows the power flow during the peak load. The peak load was observed on December 19th, 2012.

Thermal power plants are located near areas of power consumption. Major power plants that provide power to the country are Tashkent TPP, Novo-Angren TPP, Syrdaria TPP, Navoi TPP, and Chalvak HPP.
In the vicinity of Tashkent, large amounts of power were consumed by Tashkent TPP and Yuksak S/S and Kuylyuk S/S. Similarly, in the Ferghana region, large amounts of power were consumed by Sardor S/S and Sokin S/S and Ferghana S/S. Other major electricity consumption areas were Samarkand S/S and Navoi TPP.

Power system of Uzbekistan can be divided into the southeast system and the northeast system around Syrdaria TPP.

In the southwest system, large amounts of active power of about 1400 MW flowed toward the Sogdiana S/S from Syrdaria TPP. In addition, about 1000 MW of active power flowed toward the Guzar S/S via Sogdiana S/S. Most of active power had been sent by the 500 kV transmission lines.
Active power flowed to the 220 kV transmission lines of Navoi TPP around and Samarkand S/S around, but in the other area, active power didn't flow to the 220 kV transmission lines.

In the northeast system, since the power station and load consumption area were adjacent, it was difficult to send large amounts of active power on the 500 kV transmission lines.
However, large amounts of active power flow appeared on the 500 kV transmission lines between Tashkent TPP and Tashkent S/S and on the 500 kV tie line with Kyrgyzstan and with Kazakhstan.
Power supply to the Ferghana region has been carried out via the 500kV substation of LochinS/S and Uzbekistan S/S.
Some 220kV transmission lines showed a large amount of active power flowing to consumption areas that are not in the viscinity of the power station.



Source:Uzbekenergo

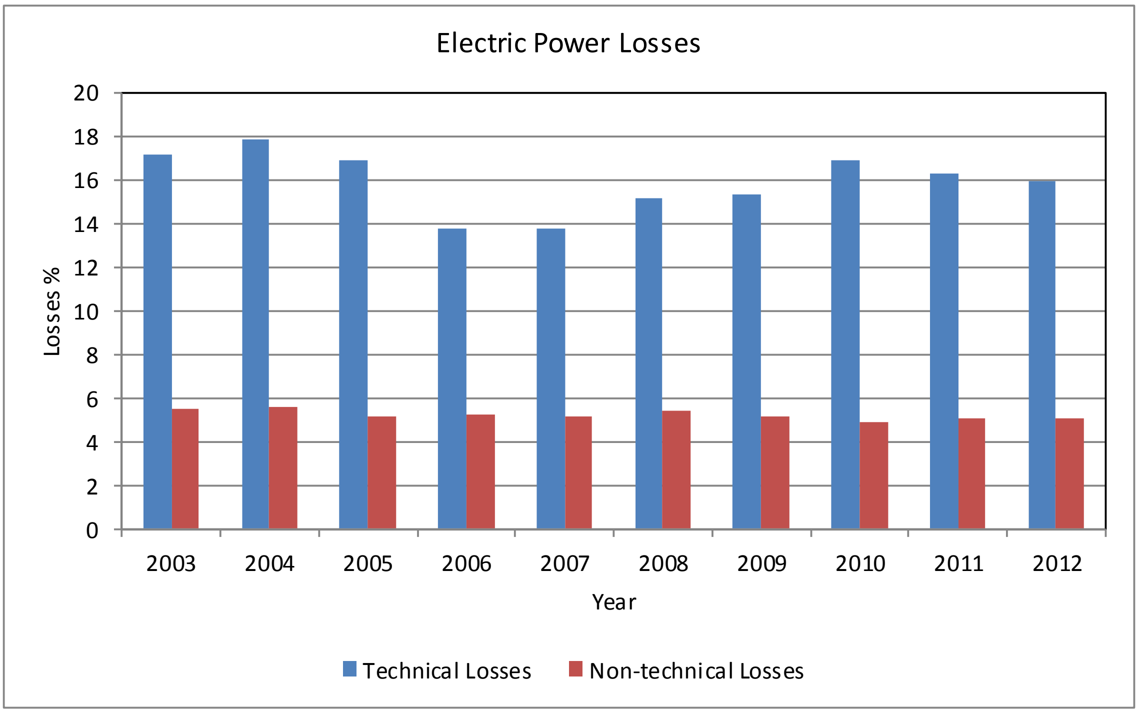
Figure 3.1.3-2 Power flow (Peak Load)

(2) Loss in Power Transmission and Distribution

The loss in power transmission and distribution can be divided into technical loss and non-technical loss. Figure 3.1.3-2 shows the change of the ratio of the transmission and distribution losses.

The technical loss rate fluctuates year to year, but the non-technical loss hardly fluctuates even on a yearly scale. In 2003-2012, the maximum value of technical loss rate is approximately 18 % of 2004, and the minimum value is approximately 14 % in 2007. Non-technical loss rate is about 5 % every year.

It is possible, to reduce the transmission losses by using thick wires and high voltage transmission lines. Future construction of new 500 kV transmission lines is planned; therefore, reduced transmission losses is expected.



Source: Uzbekenergo

Figure 3.1.3-2 Transition of power transmission and distribution loss rate

3.1.4 Power demand

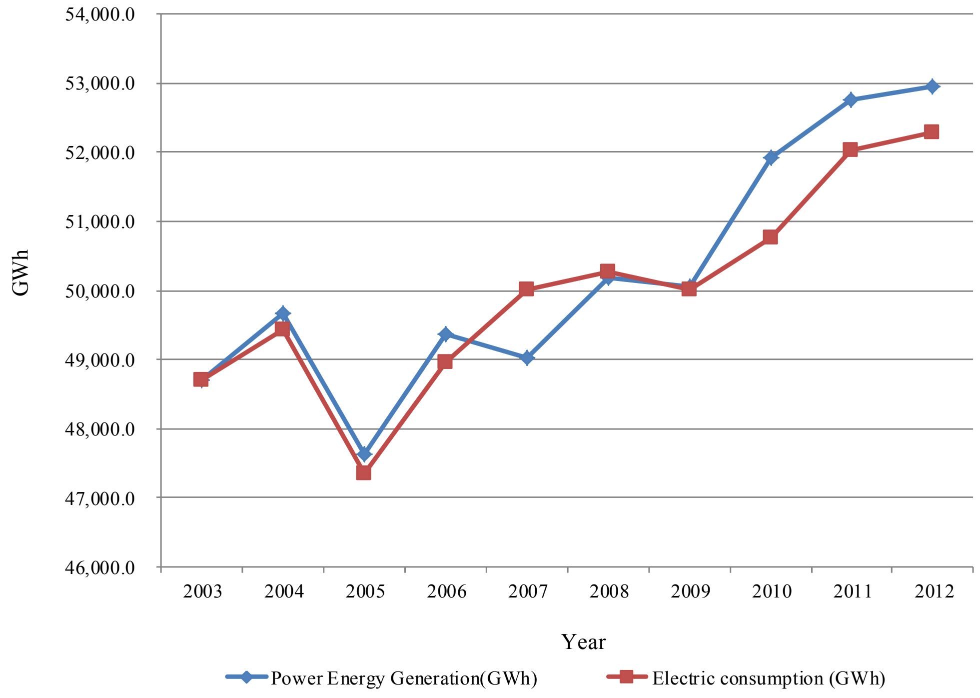
Table 3.1.4-1 and Figure 3.1.4-1 show the transition of the generation and consumption of power in the last ten (10) years. The overall demand for electric power in the Republic of Uzbekistan had exhibited an annual reduction for ten (10) years after independence in 1991 due to economic turmoil and stagnation of industrial activities. However, the economy has been on an upward trend after this period, and the overall demand for electric power is also on an upward trend. The electric power consumption in 2012 was 52,295.1GWh and was 1.1 times greater than the electric power consumption of 47,346.3GWh in 2005.

Figure 3.1.4-2 shows the transition of the imported and exported electric power. As described above, electric power is exchanged throughout Uzbekistan and the surrounding countries. The export volume of electricity has exceeded the import volume of electricity for the past four (4) years.

Table 3.1.4-1 Annual Power Energy Generation for Last 10 Years

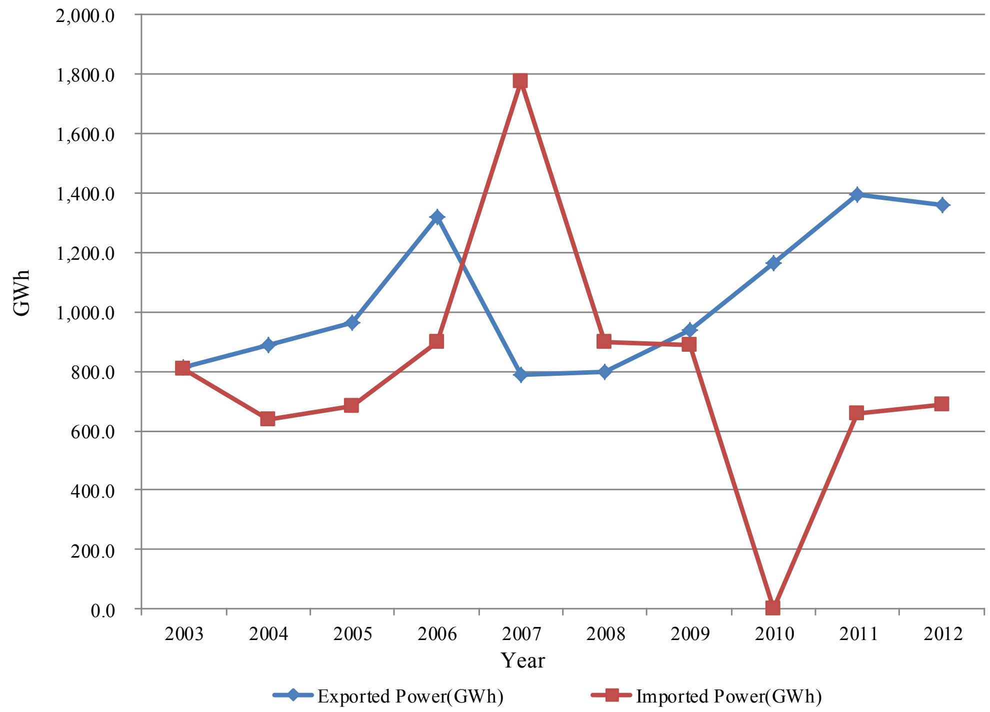
Year	Power Energy Generation(GWh)					Exported Power (GWh)	Imported Power (GWh)	Electric consumption (GWh)	Electric sales (GWh)	Trans. and Dist. Losses (GWh)	Non-technical Losses (GWh)	Total Losses (GWh)
	Hydro	TPP	CHP	Others	Total							
2003	6,284.6	39,699.2	1,210.1	1,520.0	48,713.9	814.0	809.0	48,708.9	37,658.0	8,375.2	2,675.7	11,050.9
2004	5,703.6	41,321.6	1,216.1	1,436.3	49,677.6	889.0	639.7	49,428.3	37,767.7	8,888.5	2,772.1	11,660.6
2005	6,039.3	38,998.3	1,175.4	1,414.2	47,627.2	964.4	683.5	47,346.3	36,831.3	8,051.8	2,463.1	10,515.0
2006	5,138.2	41,736.7	1,152.6	1,346.5	49,374.0	1,322.0	900.0	48,952.0	39,570.1	6,811.3	2,570.6	9,381.9
2007	5,671.7	41,140.3	1,220.0	1,000.9	49,032.9	787.0	1,775.9	50,021.8	40,737.1	6,750.6	2,534.1	9,284.7
2008	3,935.0	44,372.4	1,101.4	769.6	50,178.4	798.6	898.5	50,278.3	39,988.6	7,593.4	2,696.3	10,289.7
2009	5,361.4	42,325.5	1,028.6	1,347.6	50,063.1	936.7	887.3	50,013.7	39,752.3	7,668.3	2,593.1	10,261.4
2010	6,548.0	42,637.1	878.3	1,871.6	51,935.0	1,163.9	0.0	50,771.1	39,477.1	8,759.5	2,534.5	11,294.0
2011	4,597.4	45,923.9	914.0	1,336.7	52,772.0	1,392.8	657.9	52,037.1	40,770.2	8,605.2	2,661.7	11,266.9
2012	5,106.6	45,234.2	860.4	1,762.9	52,964.1	1,358.3	689.3	52,295.1	41,172.2	8,455.6	2,667.3	11,122.9

Source: SJSC Uzbekenergo



Source: SJSC Uzbekenergo

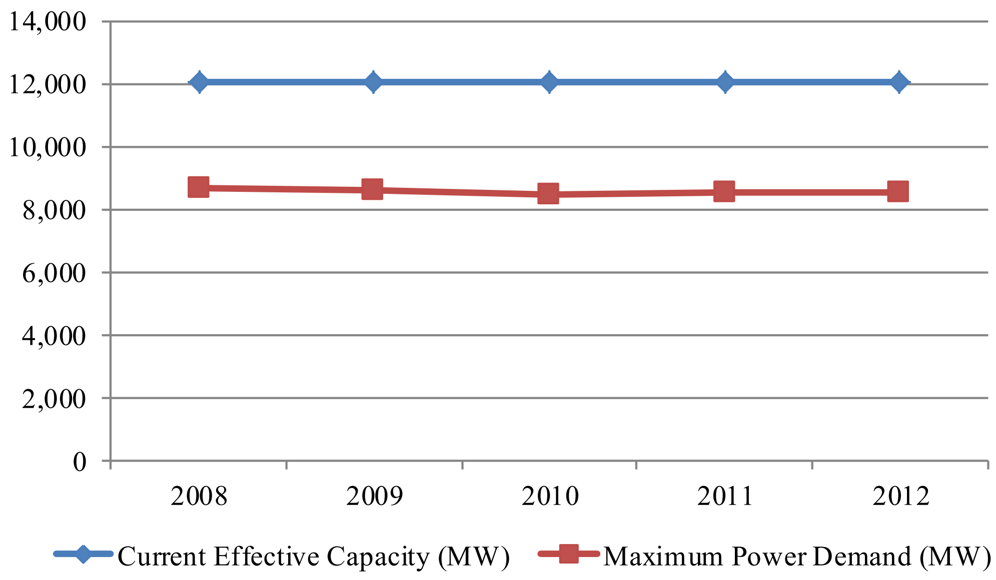
Figure 3.1.4-1 Transition of electricity generation and electricity consumption in the last 10 years



Source: SJSC Uzbekenergo

Figure 3.1.4-2 Transition of the imported and exported electric power in the last 10 years

Figure 3.1.4-3 shows the transition of the maximum demand of electric power and generation capacities during the last five (5) years. In the past five (5) years, the maximum power demand has nearly remained unchanged.



Source: SJSC Uzbekenergo

Figure 3.1.4-3 Transition of the maximum power demand for the last 5 years

3.1.5 Power generation development plan

In the Republic of Uzbekistan, the position of the most important national investment items for gas development, electric power development and others has been clearly defined by the Executive Order of the President in an effort to ensure a sustainable method of developing the economy.

According to Power Generation Development Plan made by SJSC Uzbekenergo, twenty one (21) projects have been planned up until the year 2022. Regarding funding for these projects, the SJSC Uzbekenergo relies primarily on the loans from JICA and other international cooperation agencies.

In this context, the Turakurgan TPP is located in the province of Namangan of Ferghana area and is considered the primary power source. Accordingly, if the construction project of this power plant is financed as a Japanese ODA Loan project and is implemented as planned, a significant contribution is anticipated to be made to a stable supply of electricity in Uzbekistan as well as Namangan.

Table 3.1.5-1 Power generation development plan up to 2022

No.	Plant Name	Plant Type	Installed Capacity, MW	Type of Fuel	Year of Commencement	Owner
1	Talimardjan TPP	Combined cycle	2 x 450	Natural gas	2016-2017	SJSC Uzbekenergo

No.	Plant Name	Plant Type	Installed Capacity, MW	Type of Fuel	Year of Commencement	Owner
2	Navoi CHP	Combined cycle	450	Natural gas	2017	SJSC Uzbekenergo
3	Tashkent TPP	Combined cycle	370	Natural gas	2016	SJSC Uzbekenergo
4	Taskhiatash TPP	Combined cycle	2 x 250	Natural gas	2017-2018	SJSC Uzbekenergo
5	Turakurgan TPP	Combined cycle	2 x 450	Natural gas	2017-2018	SJSC Uzbekenergo
6	Tashkent CHP	Combined cycle	2 x 27	Natural gas	2018	SJSC Uzbekenergo
7	New TPP of Syrdarya province	Combined cycle	2 x 450	Natural gas	2019-2020	SJSC Uzbekenergo
8	Angren TPP	Conventional	2 x 150	Coal	2016-2020	SJSC Uzbekenergo
9	Syrgarya TPP	Conventional	65	N/A	2014	SJSC Uzbekenergo
10	Kamolat HPP	Hydro	8	-	2016-2022	SJSC Uzbekenergo
11	Nejnechatkal HPP	Hydro	100	-	2016-2022	SJSC Uzbekenergo
12	Akbulak HPP	Hydro	60	-	2016-2022	SJSC Uzbekenergo
13	Irgaliksai HPP	Hydro	13.6	-	2016-2022	SJSC Uzbekenergo
14	Charvak HPP	Hydro	45	-	2016-2022	SJSC Uzbekenergo
15	Farkad HPP	Hydro	13	-	2016-2022	SJSC Uzbekenergo
16	Bozsyi HPP	Hydro	4.3	-	2016-2022	SJSC Uzbekenergo
17	Tupalang HPP	Hydro	2 x 75	-	N/A	Ministry of Agriculture

No.	Plant Name	Plant Type	Installed Capacity, MW	Type of Fuel	Year of Commencement	Owner
18	Sarchup HPP	Hydro	3 x 25	-	N/A	Ministry of Agriculture
19	Namangan HPP	Hydro	3 x 3.5	-	N/A	Ministry of Agriculture
20	N/A	Hydro	37.5	-	N/A	Ministry of Agriculture
21	N/A	Combined cycle	556	Natural gas	N/A	Departmental TPP

(Note)
TPP: Thermal Power Plant
CHP: Combined Heat and Power
HPP: Hydraulic Power Plant
Source: SJSC Uzbekenergo

3.1.6 Power demand forecast

Table 3.1.6-1 shows power demand forecast from 2014 to 2022. During this term, the growth rate will be approximately 4.1% per year. As described in item 3.1.2, the available capacity of the existing thermal power plants was reduced to 70% of their installed capacity in 2012. Therefore, new installation or modernization of power plants is necessary to compensate for such a large gap between maximum power demand and available capacity. On the other hand, 4,682MW generation capacity owned by SJSC Uzbekenergo is planned to be developed, as shown in Table 3.1.5-1. This figure accounts for including the additional capacity through replacing the existing power plants. Therefore, to maintain power supply stability with in accordance within creasing power demands, it is necessary to implement said power generation development plan steadily.

Table 3.1.6-1 Power Demand Forecast up to 2022

	2014	2015	2016	2017	2018	2019	2020	2021	2022
Electric Power Demand (GWh)	56,500	59,800	61,800	63,300	64,800	68,800	71,800	74,900	78,100
Growth Ratio (vs. previous year)	-	5.84%	3.34%	2.43%	2.37%	6.17%	4.36%	4.32%	4.27%

Source: SJSC Uzbekenergo

3.1.7 Renewable energy in Uzbekistan

Uzbekistan has an economically and environmentally effective domain of non-traditional Renewable Source of Power. The most promising sector of alternative energy is solar energy. For the purpose of developing solar energy, it is planned to construct twelve (12) photovoltaic solar plants with a total installed capacity of 1,000 MW by 2030.
This is in accordance with The Decree of the President of Republic of Uzbekistan, which was

established by the International Institute for Solar Energy, whose function is to promote the full use of solar energy. It has been planned to construct First Solar Electric Generating Station 200 MW in the territory of Samarkand province as early as 2016. In this regard, work is carried out for the development of the feasibility study and negotiated issues of data collection for preparation of Conceptual Design Materials of the other Solar Electric Generating Station.
Moreover, the Free Industrial Economic Zone "Navoi" will arrange the joint production of photovoltaic panels of 100 MW. Along with this there is an established a joint venture within Free Industrial Zone "Namangan" of solar collecting panel production for hot water supply treatment. Lead-in power for solar electric generating stations will allow heighted levels power generation capacity, up to 1.7 billion kWh, with an annual savings of more than 500 million cubic meters of natural gas,.

In the future, it is planned to considerably expand the possibilities of including wind in the energy balance. Gross energy potential wind flow, which was calculated according to the data of 10-year observations of wind speed at 88 meteorological stations in Uzbekistan at 10 m level, showed the possibility of installing at least 144.4 thousand units of wind turbines in a 4474 square km area. Placement of modern wind turbines in different regions will allow the production supply of more than 9.9 billion kWh of electricity.
It is provided that the priority construction of wind parks with total capacity of 150 MW in Tashkent and Bukhara regions with 400 million kWh of annual energy production. It is estimated that by leveraging the potential of wind energy throughout the whole country, natural gas saving could surpass 3.2 billion cubic meters.

SJSC Uzbekenergo is promoting Renewable Energy in Uzbekistan to diversify fuel and energy balance; SJSC Uzbekenergo plans to implement the following projects.

Table 3.1.7-1 Renewable energy development plan up to 2030

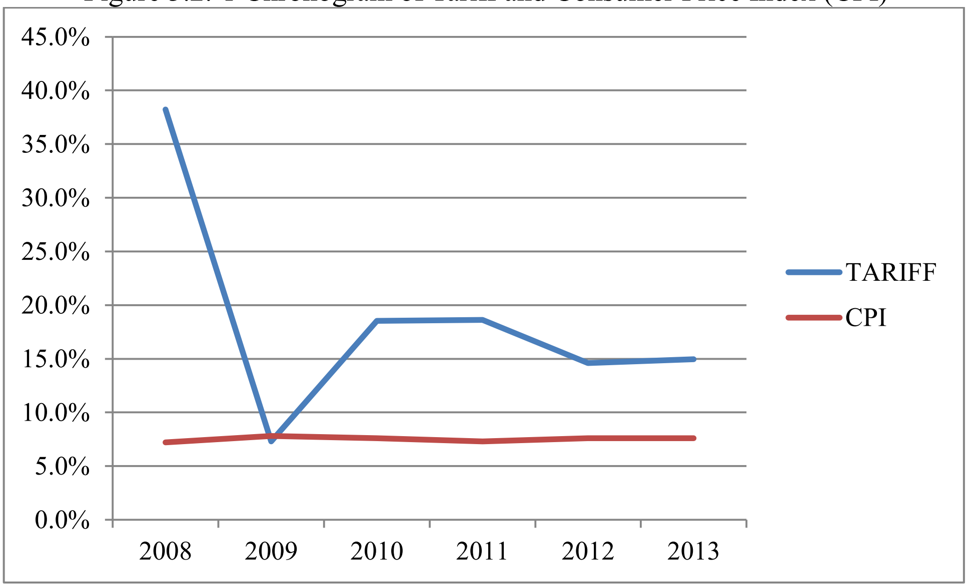
No	Project Name	Type of Plant	Capacity (MW)	Period of Construction	Year of Initial Operation
1	Smarkand province	Photovoltaic Power Plant	2 x 100	2013-2016, 2022-2025	2016, 2025
2	Namangan province	Photovoltaic Power Plant	2 x 50	2017-2019, 2020-2022	2019, 2022
3	Kashkadaria province	Photovoltaic Power Plant	100	2020-2023	2023
4	Navoi province	Photovoltaic Power Plant	2 x 50	2018-2020, 2021-2023	2020, 2023
5	Tashkent province	Photovoltaic Power Plant	2 x 100	2022-2027	2027
6	Surhandaria province	Photovoltaic Power Plant	2 x 100	2027-2030	2030
7	Republic of Karakalpakstan	Photovoltaic Power Plant	100	2025-2028	2028
8	Tashkent province	Wind Park	100	2016-2018	2018
9	Bukhara province	Wind Park	50	2020-2022	2022

Source: SJSC Uzbekenergo

3.2 Electricity Tariff

The electricity tariff has been traditionally low and driven primarily by the low cost of natural gas relative to international prices. This has distorted the market and discouraged demand-side energy efficiency improvements. Furthermore, inheriting the power infrastructure from the Soviet era without debt enabled the cost-recovery tariff to be set at a level that included only operation and maintenance costs, and not capital costs. Uzbekistan faces the challenge of accommodating the new financing required to undertake replacement of the aging utility infrastructure, most of which is operating beyond the end of its economic life.
In Central Asia, Uzbekistan is one of the countries where cross-subsidy is relatively small. In the period of 2002-2004, tariff reform was initiated. This effort brought a significant reduction of cross-subsidy to the power sector by the mid-2000s. Retail electricity tariffs increases have outpaced the annual rate of inflation for the period of 2004-2013. The retail prices of electricity have been revised two to three times per year for the period of 2010-2013. As a result, a direct subsidy to cover production costs is not provided for electricity.

Figure 3.2.-1 Chronogram of Tariff and Consumer Price Index (CPI)



Source: Uzbekenergo

In the current tariff table as shown below, there are ten types of customer categories. Cheaper tariffs for large industrial customers shows that tariff setting remains economically rational.

Table 3.2.-1 Electricity Tariff by Customer Category （Unit: Uzbekistan Sum）

№ group	Consumer groups	Unit	from 15.12 2010	from 1.04 2011.	from 1.10 2011.	from 1.04 2012	from 1.10 2012	from 1.04 2013	from 1.10 2013
I	Industrial and equated consumers with								
	a connected load of 750 kW and above.								
	Double-rate tariff:								
	per 1 kW of peak load	kW	126,630	137,800	150,150	160,400	171,800	184,740	197,700
	1 kWh of energy consumed	sum	60.45	65.80	71.70	76.50	81.90	87.84	94.02
II	Industrial and equated consumers								
	with capacity of up to 750 kVA								
	One-part tariff per kWh	sum	76.80	83.60	91.10	97.50	104.40	112.20	120.00
III	Industrial agricultural consumers	sum	76.80	83.60	91.10	97.50	104.40	112.20	120.00
IV	Electrified rail and urban transport	sum	76.80	83.60	91.10	97.50	104.40	112.20	120.00
V	Non-industrial consumers,								
	budgetary organizations, street lighting of cities	sum	76.80	83.60	91.10	97.50	104.40	112.20	120.00
VI	Organization of trade, cafes,								
	restaurants and services	sum	78.40	85.40	93.00	99.50	106.50	114.50	122.50
VII	Population, settlements	sum	76.80	83.60	91.10	97.50	104.40	112.20	120.00
	Population of houses, equipped								
	with electric stoves	sum	38.40	41.80	45.55	48.75	52.20	56.10	60.00
VIII	Electricity used for heating,								
	hot water and cooling (air conditioning)	sum	76.80	83.60	91.10	97.50	104.40	112.20	120.00
IX	Advertising and illumination	sum	110.00	110.00	110.00	110.00	110.00	118.30	126.60
X	Economic needs of grid system	sum	76.80	83.60	91.10	97.50	104.40	112.20	120.00

Source: Uzbekenergo

The data obtained from SJSC Uzbekenergo show that the average price of electricity tariffs has positive margin over production cost, which includes fuel costs, maintenance costs, depreciation and interest payment. The cost of generation in the country is 58.58sum per kWh in 2012, while the weighted average tariff is 95.3sum per kWh as shown below.

For the period of 2010-2012, the supply cost has been lower than tariff rates in most customer categories except for large industrial users, a customer category which is offered the most inexpensive tariff rate but is charged an additional fee. With the current level of electricity tariffs, it is plausible that SJSC Uzbekenergo obtains revenue sufficient for the recovery of both investment and operation costs for power generation.

This suggests that although the generation cost is expected to be below the prevailing per unit sales price of power, the tariff level should be carefully adjusted to reflect the cost of power supply to ensure Uzbekenergo's financial sustainability.

The Ministry of Finance in Uzbekistan currently supports SJSC Uzbekenergo in recovery of investment cost by maintaining electricity tariffs at an appropriate level and deducting taxes and duties. From the view point of the beneficiary payment principle, continuing tariff revisions above inflation is appropriate to ensure sufficient investments in the power sector in the long run.

Table 3.2-2 Weighted Average of Electricity Tariff (as of October 2012)

Type of user	Consumption 2011(GWh)	Electricity Tariff Sum/kWh
Industry-large	16,350	81.9
Industry-small	2,476	104.4
Industrial Agriculture	8,858	104.4
Commerce	1,174	106.5
Non-industrial	1,184	104.4
Residential	10,286	104.4
Others	177	-
Total /Weighted Average	40,505	95.3

Source: Uzbekenergo

Table 3.2-3 Production Cost of Electricity

Production Cost of Electricity	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Power Generation (GWh)	40,417.9	39,698.3	39,460.7	39,179.5	40,512.2	40,875.5
Total Production Cost (million sum)	1,483,508.1	1,882,782.0	2,130,853.6	2,428,727.4	2,493,510.0	2,394,392.1
Production Cost (Sum/kWh)	36.70	47.43	54.00	61.99	61.55	58.58

Source: Uzbekenergo

Chapter 4 Site Conditions

4.1 General

Republic of Uzbekistan is characterized by typical continental climate consisting of a very hot summer, comparatively cold winter, a great temperature difference between daytime and night time, and dry weather with little precipitation.
The planned project site Namangan is in the northwest of Fergana Valley of the Republic of Uzbekistan, in the north the region borders on the Kyrgyz Republic, in the south with Fergana region, in the West with Tashkent region, in the southwest with the Republic of Tajikistan and in the east with Andizhan region.
The planned project site is located in 11,0 km to the West from Namangan, in 4,0 km to the West from Turakurgan, in 1,0 km from the nearest human settlement in Turakurgan area of Namangan region of the Republic of Uzbekistan. The distance to the state boundary line with the Kyrgyz Republic makes up 35 km.

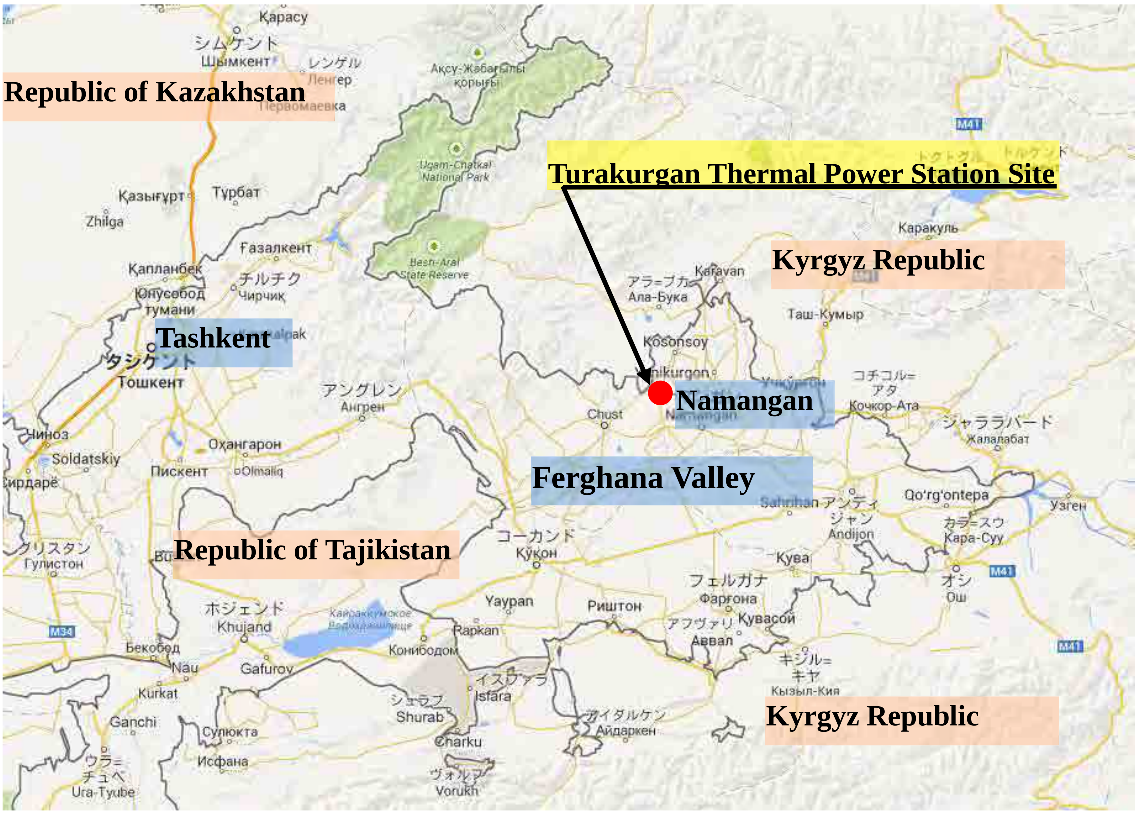


Figure 4.1 Location of Turakurgan Power Station site

4.2 Site condition

4.2.1 Site preparation

The Turakurgan Thermal Power Station site is fully free of any facilities and crops.
Only some pomegranate bushes that are to dry out because of water shortage were found. Considering the results of visiting and surveying the site for construction of the Turakurgan Power Station site is can be concluded:

There is no need for any resettlement for the Thermal Power Plant construction.
But transmission lines and gas pipe lines are locating near the the Turakurgan Thermal Power Station area, such as;

・From the south-west to north-east cross platform - one 220 kV and two 110 kV transmission lines.

・Two lines of a gas pipeline are located on the right bank of the channel.

4.2.2 Physiographical and Geological condition

The construction site of the Turakurgan Thermal Power Station is located in the district of Turakurgan and located at the right side bank of Grand Canal Namangan. The territory of the Turakurgan Power Station site is located in the Fergana Valley at the foot of the southern slope of the ridge Chatkalsk.
The Ferghana Valley is surrounded on the north, east and south by mountain ranges and has a length of 370km, a width of 200 km.
Considered territory is located on the sloping plain with merged cones Kasansai, Namangansay and Chartaksay. The terrain has slightly hilly areas with a total surface slope from the north to the south and the local slope toward the river Kasansai.
Vertical elevation between the northern and southern sublime lowland areas is 35-89 m.
The construction site is located on the alluvial fan of the river, so the pro-lyuvialal-luvial deposits consist of coarse-grained soils with capacity of more than 50 m from the surface of the boulder-pebble deposits overlain by fine-grained, sandyloam layer capacity from 0.2 to 2.2 m along the left bank of Kasansai river there are identified conglomerates.

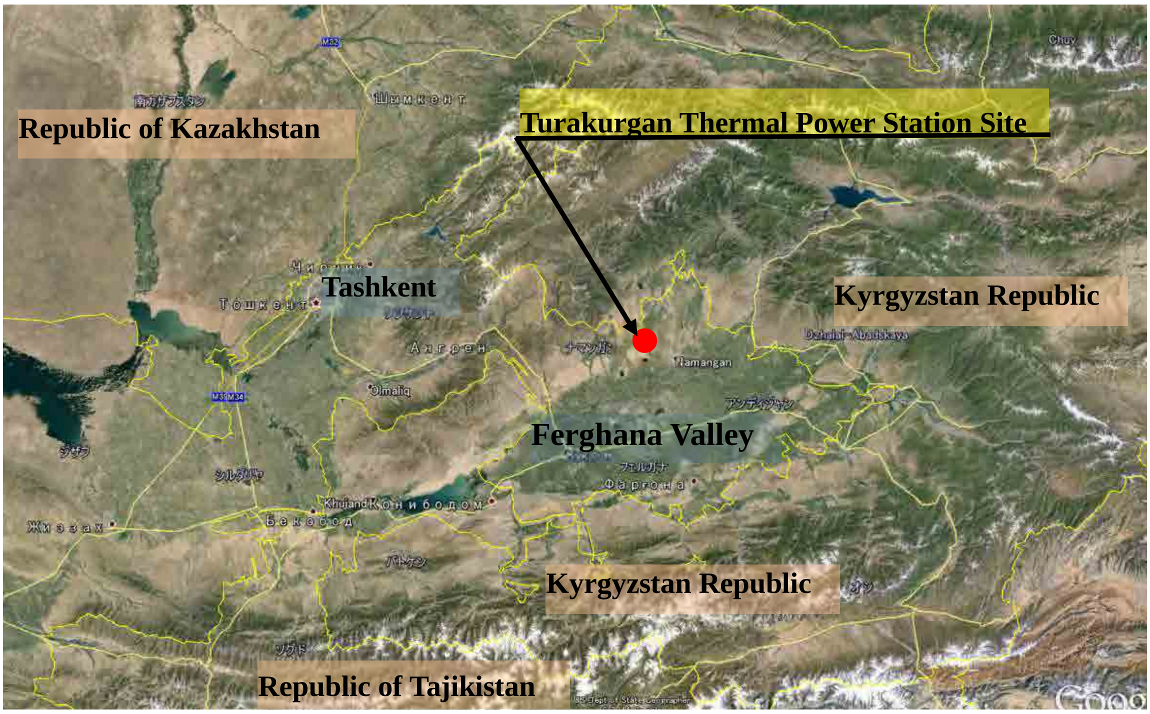


Figure 4.2.2 Physiographical and Geological condition of Turakurgan Power Station

4.2.3 Soil condition

Within the the Turakurgan Power Station site area, the following versions of soil are allocated:
1. Loamy (EGE-1)
2. Lrage debris (EGE-2)

(EGE-1)
The first engineering-geological element (No. 1 EGE) includes clay soil, sandy loams of light brown color, macroporous, with small pro-layers of sand and gravel with inclusions of separate pebbles from 10% to 30%, unimportant ones, from firm to a plastic consistence.
Strength properties of soil change in very wide limits.
Extreme values of a corner of internal friction are equal to 25-28 degrees, at standard value of 27 degrees.

(EGE-2)
The geological element (EGE-2) second engineer-pebble deposits with sandy and sandy filler. Pebble soil is opened in all the Turakurgan Power Station site area, at various depths from 0,5 to 10,0 m. Pebble, generally up to 10 cm in size, consists of sedimentary and abyssal rock.
Settlement resistance of pebble deposits with sandy filler is 500 kPas, with dusty and clay filler - 450 kPas. Density of soil is from 2,0 to 2,05 t/m3, a corner of internal friction is 37-39 degrees.

4.2.4 Groundwater condition

Groundwater remains the basic source for drinking water supply, and also for technological water supply and irrigating.
Withdrawal of groundwater is carried out by single running wells and soil drawoffs.
Depth of wells varies from 10 to 200 m, depending on depths level of groundwater.
In the upper part of an alluvial fan of Kasansai groundwater lies down on the depth of 20-50 m, and in the central part is on the depth of 3-10 metres.
Quality of groundwater is basically good.

4.2.5 Ground elevation of the site

The territory of the Turakurgan Power Station site is located at the foot of the southern slope of the ridge Chatcal.
To develop the Turakurgan Power Station land, a soil excavation work and a soil embankment work is required.
To decide power plant ground surface elevation, the economic study of a soil volume balance between excavated soil volume and embankment soil volume is needed.
As a result of the economic soil valance study, the uni ground surface elevation for the Turakurgan Power Station is not economical.
The Turakurgan Power Station ground surface elevations are recommended two-ground surface elevations type Power Plant.

The proportions of ground surface elevation are recommended;
・Power block area ground surface elevations is GL±0=BSL+596m
・Switch yard area ground surface elevations is GL±0=BSL+608m

(BSL; Baltic Sea Level)
(GL; Ground Level)

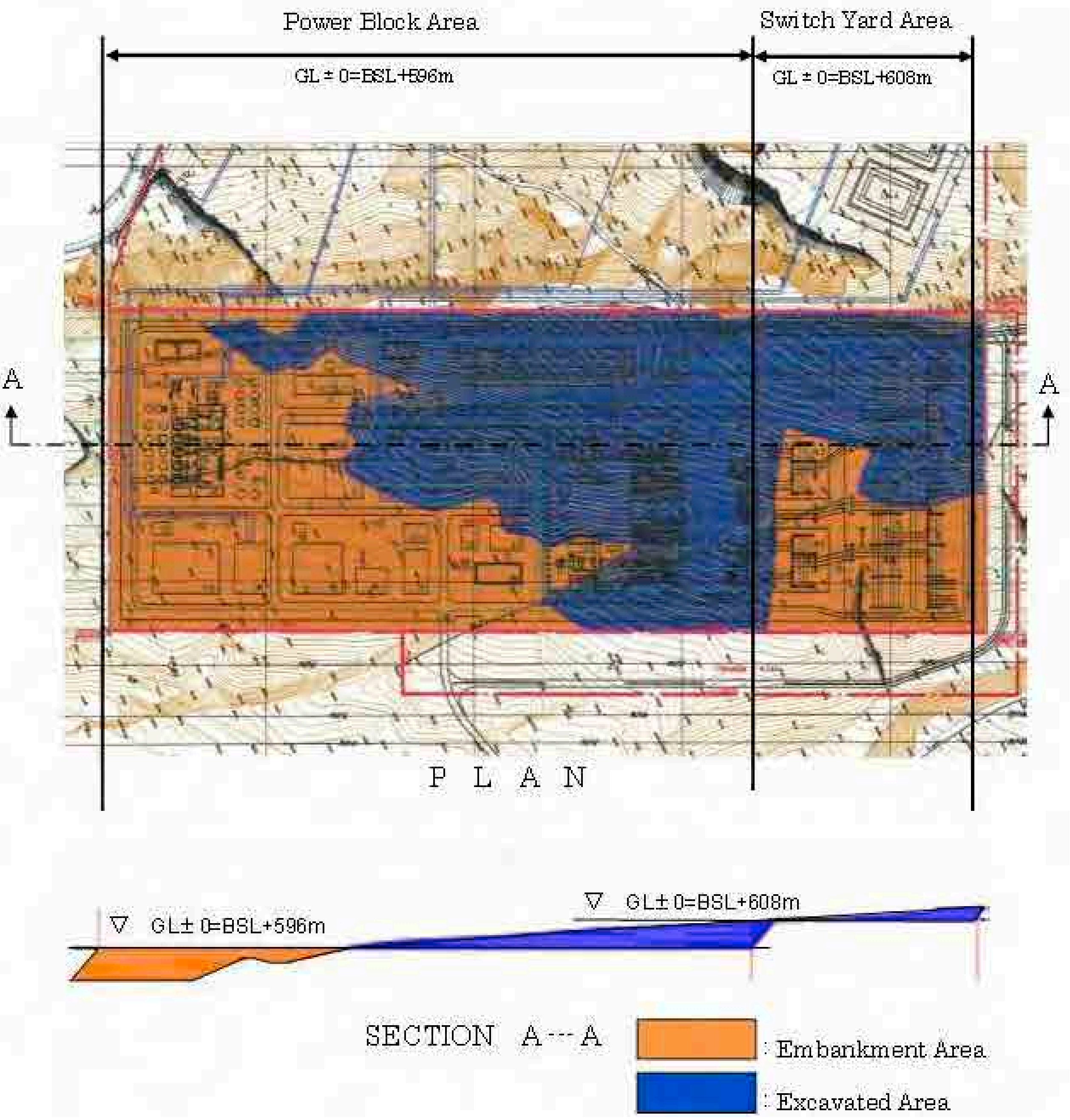


Figure 4.2.5 Embankment Area and Excavated Area

4.2.6 Meteorological condition

The place of construction is located in the Fergana Valley. Due to the closed position of the valley, its climate is different from the climate of the surrounding areas. The mountain ranges of the Tien Shan and Pamir-Alai protect Fergana Valley from the invasion of air masses bringing moisture and coldness. Therefore precipitation is falling behind in the foothills and mountains of the Western Tien-Shan. The mountain ranges of the Fergana Valley, affecting the circulation of the atmosphere, are leading to the development of mountain-valley circulation. This is especially evident in its periodic change in the daily wind directions.
The main features of the climate of Ferghana valley are the continentality and aridity.
(The air temperature)
The annual average temperature is 15.2 º C, the absolute mini-mum -17.5 º C, absolute maximum +42.5 º C. Average minimum temperature of the year -3.56 º C, the average maximum +35.7 º C. The average air temperature in January is 0.4 º C and the average temperature for July is 28.0 º C.
The average annual humidity is 64.2%.
(Precipitation)
Precipitation in the Ferghana valley falls throughout the year, the average annual rainfall - 207.3 mm. From October to April precipitation are usually of covering type, and from May to September there are torrential rainfall.

4.2.7 Cooling water

The possible the Turakurgan Thermal Power Station cooling methods are considered:

- Forcibly ventilated cooling tower cooling method

The Turakurgan Thermal Power Station depends on the cooling tower cooling method using the cooling water supplied from the Grand Canal Namangan, which in its turn is fed by the river Kasansai..
We would like to adopt the forcibly ventilated cooling tower cooling method, where make up water is supplied from the the Grand Canal Namanganr after pre-treatment.

Figure 4.2.7 Location of Grand Canal Namangan

4.2.8 Foundation design

All foundations Design and construction shall be based on the building / equipment exposed loading conditions and the site soil conditions.
The foundations should be constructed for satisfactory loads transmission on the foundation soil.
Foundations for Steam and Gas Turbines are made of cast reinforced concrete.
The foundations of the buildings complex and other structures are made of concrete.
Machinery and equipment foundations must be designed in such a way that they can carry the induced static and dynamic loads, and the natural frequencies of foundations and equipment vibrations can be compatible.
Adjacent equipment and structures must be protected from the effects of acceptable levels vibration.
All concrete foundations and structures that are in contact with the ground must be protected from moisture and other harmful effects of the soil using a system by the protective treatment.

Chapter 5 Fuel Supply Plan

5.1 Selection of main fuel in Turakurgan TPS

The basic policy of Uzbekistan for establishing a new power plant is as follows as mentioned in Chapter 3;

- In Uzbekistan, gas development and electric power development has been the the most important national items for investment for ensuring a sustainable way of developing the economy.
- According to the “Power Generation Development Plan up to 2022”, twenty one (21) power plant projects have been planned up until the year 2022
- The new power plant shall be capable of maintaining the capacity, improving the power supply reliability and quality, saving power and enhancing operation efficiency of fuel and power.

In line with the above basic policy, natural gas was selected as the main fuel source for the Turakurgan TPS from the following reasons:

- Natural gas is abundant and is the primary fuel for power generation in Uzbekistan; 90.7% of fuel used in thermal power plants is natural gas.
- Natural gas has clean emissions.
- The cost of a constructing a gas thermal power plant is low compared to those that use oil and coal.
- A natural gas pipeline has been extended to the Ferghana Valley, and it can be easily accessed from the new power plant without a large cost.
- Natural gas is suitable to establish a large-scale power plant, such as 900MW. It is not practical to establish large-scale power plant using renewable enegy like solar and wind.

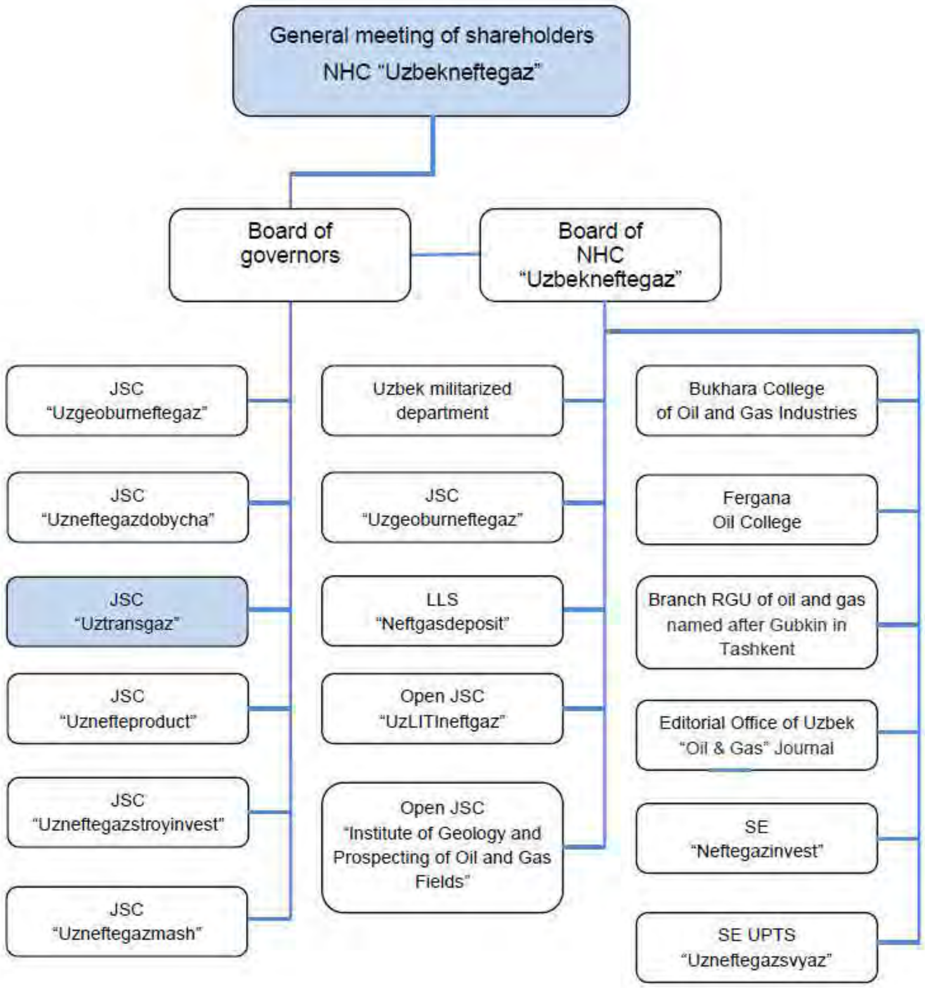
5.2 Overview of the natural gas sector in Uzbekistan

Uzbekneftegaz, the national holding company (NHC) of Uzbekistan, manages all oil and gas sectors in the country, and has integrated seventeen (17) joint stock companies (JSC) for oil and gas sector role assignment in Uzbekistan.

Figure 5.2-1 shows the organization chart for Uzbekneftegaz, and Table 5.2-1 shows the company role distributions.

The development and production of gas field is managed by the Uzbekneftegaz under the supervision of the Goverment. Transport and distribution of natural gas is operated by Uztransgaz.

Figure 5.2-2 illustrates the natural gas pipeline network of Uztransgaz in Uzbekistan including the related pipelines in the neighboring countries.



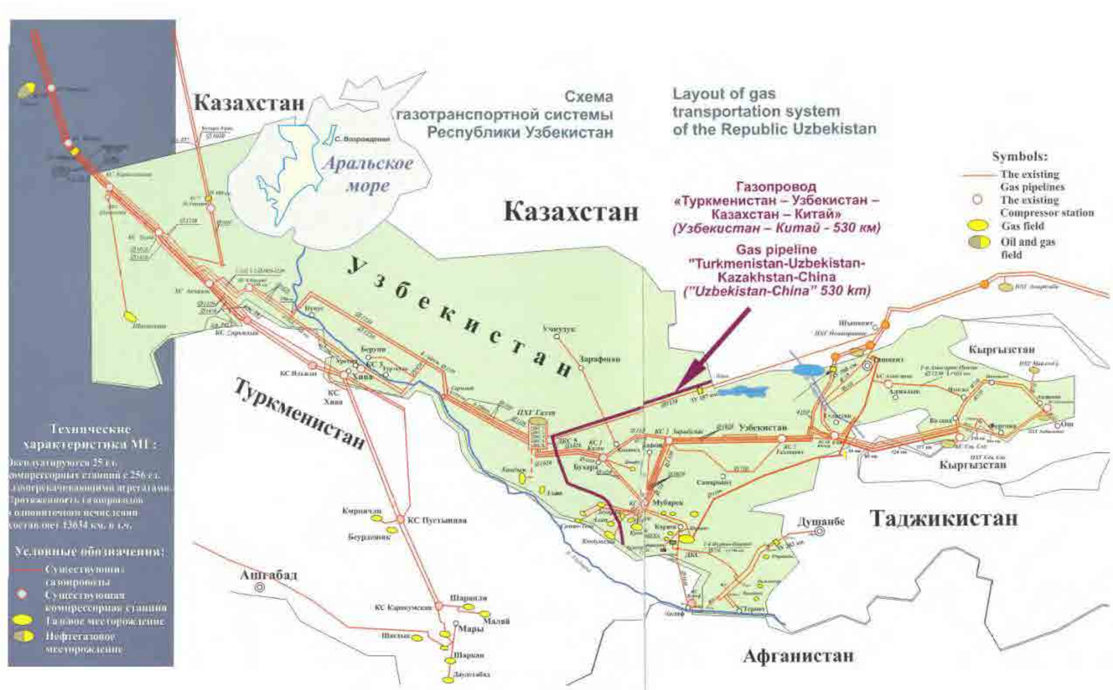
Source: Uzbekneftegaz

Figure 5.2-1 Organization Chart of Uzbekneftegaz

Table 5.2-1 Role Assignment among major companies

Company	Role
Uzgeoburneftegaz	Geophysical researches for oil and gas
Uzneftegazdobycha	Development of oil, gas, condensate fields and gas processing
Uztransgaz	Transportation of natural gas to the end user, its export and underground storage
Uznefteproduct	Refining of oil and condensate
Uzneftegazstroyinvest	Building for oil & gas, as well as other social uses
Uzneftegazmash	Support for oil and gas branch in mechanical engineering production
Neftgasdeposit	Procurement
UzLITIneftgaz	Uzbek research and project institute of oil and gas industry
Neftegazinvest	Monitoring the implementation of investment projects

Source: Uzbekneftegaz



Source: Uzbeknetegaz

Figure 5.2-2 Pipeline network of Uztransgaz

5.3 Natural gas reserves in Uzbekistan

Since the past data and forecasts regarding natural gas has not been disclosed by Uzbekneftegaz due to confidentiality reasons, the following information is based on papers obtained from public sources.

The proven natural gas reserves in Uzbekistan register a figure of 1.1 trillion cubic meters (hereinafter referred to as "Tcm") as of December 2012. This figure puts Uzbekistan in 4th place in the Eurasian region in terms of natural gas reserves, and in 23rd place in the world. The gas fields are concentrated in the Amu Darya Basin in the southwest of the country and in the Central Ustyurt plateau west of the Aral Sea.

The following illustrates the transition of the proven natural gas reserves in Uzbekistan.

Table 5.3-1 Amount of proven natural gas reserves in Uzbekistan Unit: Tcm

	At end of 2002	At end of 2011	At end of 2012
Proved reserves	1.2	1.1	1.1

Source: BP Statistical Review of World Energy 2013

Table 5.3-2 shows the natural gas development projects in Uzbekistan. Projects are currently being implemented by the Russian companies and Asian companies based on the license of exploration for natural gas. The development of these gas fields are expected to increase the proven natural gas reserves in Uzbekistan.

Table 5.3-2 Natural gas development projects in Uzbekistan

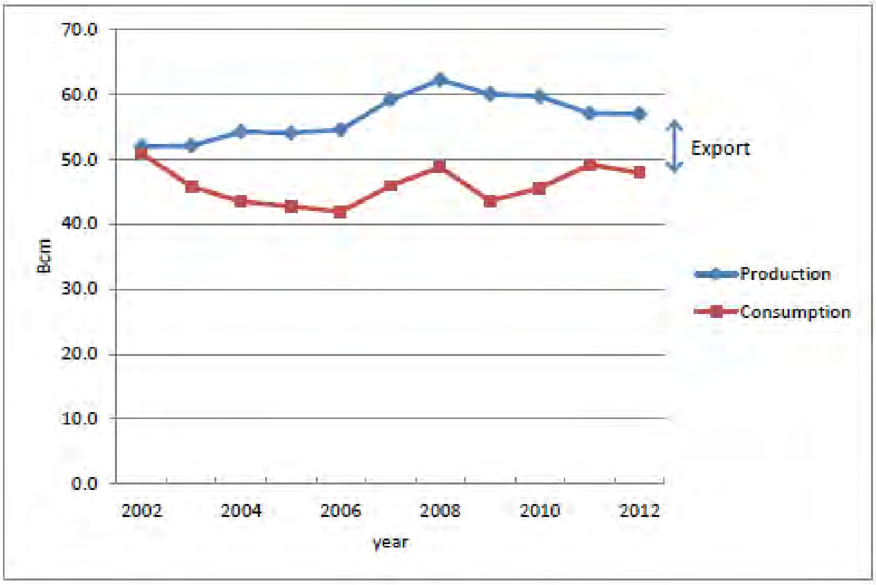
Field	Target production volume	Target reserves
Southwest Gissar and central Ustyurt region (7 fields)	3 Bcm/year	0.1Tcm
Western Ustyurt region (4 fields)	-	1Tcm
Khauzak and Kandym fields in Bukhara-Khiva and Gissar regions	4 Bcm/year	0.25Tcm
Aral Sea Surgli field	0.08 Bcm/year	-
Surkhandarya region Baisun field	2.2 Bcm/year	-
West Urga / Western Ustyurt region (3 fields)	0.7 Bcm/year	-

Source: JPEC Report, June 2012
based on original sources from Global Insight, IEA and Trade Press

5.4 Production and consumption volumes of natural gas in Uzbekistan

Since the past data and forecasts regarding natural gas has not been disclosed by Uzbekneftegaz due to confidentiality reasons, the following information is based on papers obtained from public sources.

The following describes the proven production and consumption volumes of natural gas in Uzbekistan during the period from 2002 to 2012. The natural gas production volume registers a gradual increase after 2002 to reach a peak value in 2008. This is followed by a slight decrease every year. The figure registered in 2012 was 56.9 Billion cubic meters (hereinafter referred to as "Bcm"). In the meanwhile, the consumption of natural gas in 2012 registers at 47.9 Bcm. Furthermore, since Uzbekistan does not import natural gas, the difference between production and consumption volumes indicates the export amounts. The export volume in 2012 was 9.0 Bcm, accounting for approximately 16 percent of the total production.



Source: BP Statistical Review of World Energy 2013

Figure 5.4-1 Proven production and consumption volumes of natural gas (2002-2012)

Table 5.4-1 shows the R/P obtained by calculation based on the reserves of natural gas and its consumption. R/P ratios represent the length of time that those remaining reserves would last if production were to continue at the previous year's rate. It is calculated by dividing remaining reserves at the end of the year by the production in that year. The R/P is an index that shows how many years natural gas can be produced continuously in the future.

As a result, the R/P in Uzbekistan at the end of 2012 is 19.7 years as the same value as that of at the end of 2011. This is estimated to be due to an increase in the proven natural gas reverses achieved by the development of the gas field currently under way. When consideration is given to the continued development of gas fields in future, sufficient reserves can be estimated, even if the life time of this project is assumed to be 30 years.

Table 5.4-1 Reserves / Production Ratio of Natural Gas

	Unit	At end of 2002	At end of 2011	At end of 2012
Proved reserves	Tcm	1.2	1.1	1.1
Production	Tcm	0.0519	0.0570	0.0569
R/P ratio	Year	22.6	19.7	19.7

Source: BP Statistical Review of World Energy 2013

5.5 Possibility of gas supply to Turakurgan TPS

5.5.1 Verification of natural gas supply agreement

An agreement for the supply of natural gas to the Turakurgan Themal Power Station was signed between Uztransgaz and Uzbekenergo on 30 May 2013. The agreement includes the following essential technical conditions;

- Terminal point is on the two existing Namangan - Suh pipelines (530mm dia. and 720mm dia.).
- The minimum supply pressure at the Terminal Point is 9kg /cm2g.
- The minimum supply volume at the Terminal Pont is 180,000 m^3N/h.

In addition to the above, Uzbekneftegaz has issued a letter on 10 March 2014, to guarantee continuous natural gas supply to the Turakurgan TPS, which includes the following declaration and confirmation;

- Due to existing natural gas reserves of the Republic and gas transmission capacity, a continuous supply of natural gas will be provided within operational lifetime in conformity with Gas Supply Agreements.

Following the commencement of the project implementation, the agreement will be renegotiated. It will be made between the Turakurgan Themal Power Station and Uztransgaz for the supply of natural gas, and it will be updated every year.

5.5.2 Verification of the adequacy and feasibility of the project from the viewpoint of gas supply

Table 5.5.2-1 shows the consumption of natural gas at the time of rated output in two (2) units of 450MW CCPP. Uztransgaz supply natural gas in the volume of 180,000 m^3N/h. By contrast, the total of natural gas consumption of the two units in Turakurgan TPS is 150,000 m^3N/h. This shows that Uztransgaz can supply a sufficient amount of natural gas to the Turakurgan Thermal Power Station.

Table 5.5.2-1 Hourly natural gas consumption of each unit at rated output

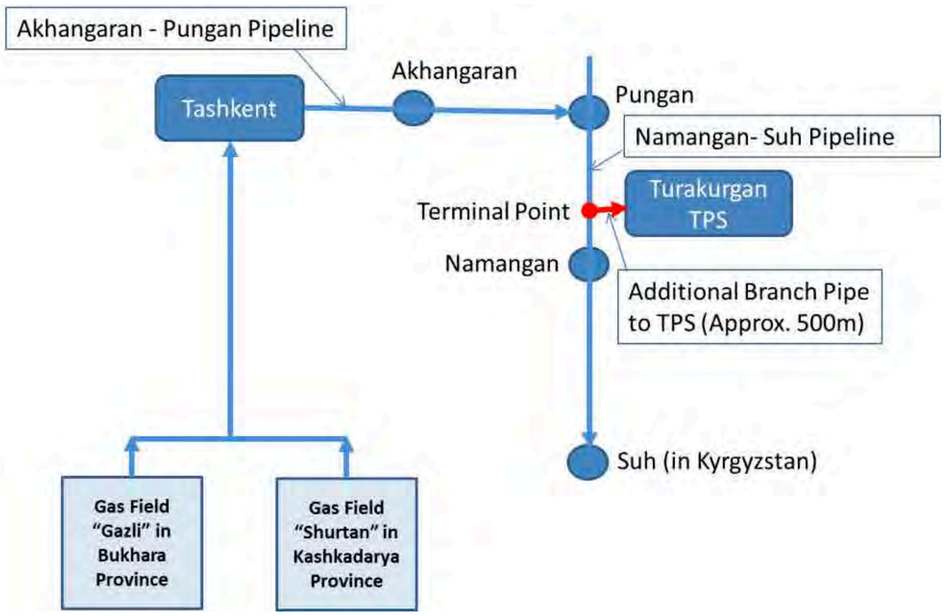
Unit : m^3N/h

Unit No	Approx. Natural Gas Consumption	Supply agreement
Unit 1	75,000	-
Unit 2	75,000	-
Total	150,000	180,000

Source: JICA Study Team

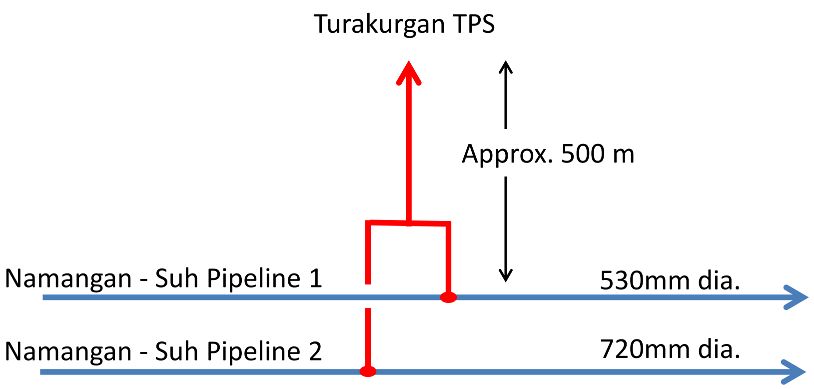
Figure 5.4.2-1 shows the supply route of natural gas to the Turakurgan TPS.
In Uzbekistan, almost all gas fields are located in the middle and west of the country, such as Karakalpakstan Region, Bukhara Province and Kashkadariya Province. The produced gas in the gas fields will be transported through Tashkent by Akhangaran - Pungan Pipeline and Namangan - Suh Pipeline to the Fergana Valley and the Turakurgan TPS.
Namangan - Suh Pipeline has two parallel pipes of 530 mm dia. (Namangan- Suh 1) and 730 mm dia. (Namangan- Suh 2), those run beside the Turakurgan TPS. The terminal point is located approximately 500 m south of the power plant construction site.

Figue 5.5.2-2 shows the concept of the terminal point on the existing two gas pipelines.



Source: Uzbekenergo

Figure 5.5.2-1 Natural Gas Supply Route from Gas field to TPS



Source: Uzbekenergo

Figure 5.5.2-2 Natural Gas Terminal Point

Table 5.5.2-2 shows the actual and forecast values of Natural gas supply balance of Namangan-Suh pipeline. It is expected that the Natural Gas consumption in Fergana Valley except the consumption in Turakurgan TPS will not be increased because of the electirication development instead of natural gas in future in the area. This table verifies that the total of the consumption in Fergana Valley and the additional consumption in Turakurgan TPS is sufficient while staying within the capable flow of the Namangan - Suh pipeline. Therefore, the existing pipline size is sufficient for the operation of a new power plant.

Table 5.5.2-2 Natural gas supply balance of Namangan- Suh pipeline

million m^3N/year

	2012 actual	2016 forecast	2020 forecast	2025 forecast
Natural Gas consumption in Fergana Valley	4,960	4,750	4,750	4,800
Natural Gas consumption in Turakurgan TPS	-	660	1,320	1,320
Total flow in Namangan- Suh pipeline	4,960	5,410	6,070	6,120
Capable flow in Namangan- Suh pipeline	10,000	10,000	10,000	9,000

Source; Uztransgas and JICA Study Team

Chapter 6 Basic Design

This chapter describes the basic design ofthe two (2) units of Combined Cycle Power Plants (CCPPs) to be introduced as the Trakurugan Thermal Power Station. For this purpose conceptual designs were first created, where design conditions and specifications are determined, and the types of essential components and facilities which comprise the Plant are discussed. The plant plot plan is also depicted based on the study team's past experiences with similar plants to confirm that all the components and facilities necessary to complete the Plant are properly provided in the candidate site area. Secondly, basic systems that are part of the plant, such as gas turbines, steam turbines, HRSG and so on are qualitatively designed based on the specified design conditions and study results of the essential components. Lastly, the construction schedule of the Plant is createdin consideration of the results of the said basic design and the background of this project.

6.1 Conceptual Design

6.1.1 Design Conditions

Design conditions shall be specified to complete the feasibility study for this Project. However, not all the detailed design conditions have been decided because of the tight time schedule for discussion and study during the preparation period of the feasibility study. Some design conditions may be tentatively specified or assumed at this feasibility study stage and may be revised or finalized in the further detailed design stage of this project. The following Table 6.1.1-1 shows the design conditions necessary for completion of the preparatory survey on Turakrugan Thermal Power Station. Parameters regarding the capacity of equipment are specified for one (1) unit of CCPP.

Table 6.1.1-1 Design Conditions and Specifications

Description	Conditions and/or Specifications	
(1) Basic Design Conditions	**Rated (Performance Evaluation Point)**	**Range (for equipment design)**
a. Dry bulb temperature (°C)	13.7	-25.8 to 42.3
b. Barometric pressure (kPa)	94.38	
c. Altitude (m)	600.0	
d. Relative humidity (%)	66.0	20.0 to 80.0
e. Wet bulb temperature (°C)	10.4	-26.4 to 38.6
f. Type of fuel	Specified natural gas	
g. Use of standby fuel	No	
h. Supply pressure of natural gas at terminal point (MPa(g))	1.5	0.6 to 2.3
i. Supply temperature of natural gas at terminal point (°C)	12.0	-5.0 to 22.0
j. In-house heat requirements per HRSG (Gcal/hr)	16.3	0.0 to 40.0
k. Conditions to define the maximum capability of bottoming and electrical	Ambient conditions: Dry bulb temperature	0.0°C

Description	Conditions and/or Specifications
systems	Relative humidity 80.0% Wet bulb temperature -4.6°C Heat supply 0.0 Gcal/hr
l. Economically operable service life	30 years with reasonable repair and/or replacement of consumable and/or normal wear and tear parts
m. Type of make-up water for processing	Demineraized canal water
n. Type of make-up water for cooling tower	Pre-treated canal water
(2) Specification of Main Equipment	
1) Plant	
a. Number of units	Two (2)
b. Type of shaft configuration	1 on 1 Multi-shaft configuration with a bypass stack
c. Type of operation	Combined cycle operation for base load with a function of GT simple cycle operation
d. Auxiliary boiler fueled with specified natural gas	Yes
e. Type of control system	DCS type
f. Type of steam turbine condenser cooling system	Mechanical draft wet type cooling tower
2) Gas turbine	
a. Number of gas turbines	Two (2)
b. Type of supplier	Original equipment manufacturers who conducted the full development of the prototype of the proposed type of machine and have performed successive upgrades so far.
c. Applicable design standards	ISO 3977 Part 3 or equivalent
d. Type of configuration	Open cycle, single shaft, heavy duty, natural gas fired, cold end drive, axial exhaust type
e. Type of installation	Indoor installation with sound attenuation enclosure
f. Rating	Continuous base load rating with the load weighing factor of 1.0 for EOH calculation
g. Rotating speed	3,000 rpm
h. Type of coupling	Directly coupled with generator by integrated solid coupling
i. Shaft strength	To be designed to withstand the transient torque due to short circuit or out-of-phase synchronization, whichever is greater.
j. Temperature class	F-class with a wealth of commercial operating experience

Description	Conditions and/or Specifications
k. Shaft lateral vibration	As per ISO 7919-Part 4 “Gas Turbine ets”
l. Allowable speed variation range on continuous load operation	3,000 rpm ±3%
m. Dry low NOx combustion system for natural gas	Yes
n. Inlet air cooling system	No
o. Type of starting device	- A synchronous generator/motor with a thyristor frequency converter or - A squirrel cage motor with a torque converter
p. Air compressor on-line and off-line cleaning device	Yes
q. Pre-heater of natural gas fuel	As per manufacturer's option
r. Type of inlet air filter	Multi-stage or self-cleaning type with dust removal efficiency of more than 98 % for ASHRAE test dust
s. Bypass stack	Self-standing type fabricated with steel plates with a height of 60 m
3) HRSG	
a. Number of HRSGs	Two (2)
b. Application standard	Relevant ASME Pressure Vessel Codes or equivalent
c. Type of configuration	Lateral or vertical gas flow type with evaporation drums and natural circulation
d. Type of cycle	Triple-pressure, reheat
e. Flue gas exit temperature	Not lower than 90°C in consideration of the impact on the environment
f. Type of installation	Indoor installation
g. Supplementary duct firing	No
h. Flue gas stack	Stand alone type fabricated with steel plates supported by steel structures with a height of 90 m in consideration of the impact on the environment
i. Flue gas velocity at flue gas stack exit	Not more than 25 m/s
4) Steam turbine	
a. Number of steam turbines	Two (2)
b. Applicable design standard	ISO 14661 or equivalent
c. Type of configuration	Single or two (2)-casing, three (3)-admission, sliding pressure, full condensing, axial or downward exhaust type
d. Type of cycle	Triple-pressure, reheat

Description	Conditions and/or Specifications
e. Type of installation	Indoor installation with sound attenuation cover
f. Rotating speed	3,000 rpm
g. Minimum allowable speed variation range on continuous load operation	3,000 rpm ±3%
h. Type of coupling	Directly coupled with generator by integrated solid coupling
i. Shaft strength	To be designed to withstand the transient torque due to short circuit or out-of-phase synchronization, whichever is greater
j. Shaft lateral vibration	As per ISO 7919-Part 2 “Large Land-based Steam Turbine Generator Sets”
k. Steam bypass	Yes
5) Condenser	
a. Number of condensers	Two (2)
b. Type	Shell and tube surface cooling type with vacuum deaeration function
c. Type of cooling system	Mechanical draft wet type cooling tower to be made up by pre-treated canal water
d. Type of cooling water	Pre-treated canal water
e. Temperature rise across the condenser	8.0°C
f. Mechanical type tube cooling device	Yes
6) Generator	
a. Number of generators	Two (2) for gas turbines Two (2) for steam turbines
b. Application standard	IEC 60034-3 or equivalent
c. Type	Horizontally mounted, cylindrical rotor, rotating field, air or hydrogen cooled synchronous type
d. Rated voltage	24 kV (GTG) / 17.5kV (STG)
e. Type of exciter	Static or brushless type
f. Coil temperature rise	IEC B class
g. Insulator temperature limit	IEC F class
7) Main transformer	
a. Number of main transformers	Two (2) for gas turbine generators Two (2) for steam turbine generators
b. Type of cooling	Oil natural and air forced type
c. Primary voltage	24 kV (GTG) / 17.5kV (STG)
d. Secondary voltage	220 kV
8) Cooling tower	
a. Number of cooling towers	Two (2)
b. Type	Mechanical draft wet counter flow type

Description	Conditions and/or Specifications	
c. Number of cells	To be specified by the supplier with one (1) spare cell	
d. Wet bulb temperature (°C)	10.4	-26.4 to 38.6
e. Approach (°C)	8.0	To be specified by supplier
f. Cooling range (°C)	8.0	To be specified by supplier
g. SS concentration ratio (times)	2.4	
h. Type of frame structure material	Reinforced concrete	
i. Control of plume abatement	Yes	
j. Control of icing in freezing weather	Yes	
9) Hot water heat exchanger		
a. Number of heat exchanger	Two (2) of 50 % capacity	
b. Type	Shell and tube type with drain cooler	
c. Heating medium	Low pressure steam branched from LP steam turbine inlet	
d. Parameters		
a) Hot water side		
(a) Inlet temperature (°C)	70.0	60.0 to 80.0
(b) Outlet temperature (°C)	90.0	80.0 to 100.0
(c) Flow rate (t/hr)	814.0	0.0 to 1,000
(d) Inlet pressure (MPa)	0.5	0.4 to 0.6
b) Heating steam side		
(a) Inlet temperature (°C)	To be specified by supplier	
(b) Outlet temperature (°C)	To be specified by supplier	
(c) Inlet pressure (MPa)	To be specified by supplier	
(d) Outlet pressure (MPa)	To be specified by supplier	
(e) Flow rate (t/hr)	To be specified by supplier	
(3) Operational Requirements		
1) Type of operation		
a. Type of basic operation	Continuous base load operation with 8,000 hours of annual operating hours	
b. Anticipated range of plant controllable power load without steam bypass	30 to 100%	
c. Speed droop power load operation	Yes	
d. Constant power load operation	Yes	
e. Frequency control operation	Yes	
f. Constant gas turbine inlet temperature operation	Yes	
g. Gas turbine simple cycle operation	Yes	
h. Operation manner	LCD operation from remote control room by keyboard and mouse	
i. Blackout start	No	

Description	Conditions and/or Specifications
j. Isolated operation of gas turbine from network in an emergency	Yes
2) Time required for start-up to full power after pushing start-up button (time for purge and synchronization is not included)	
a. Cold start	At longest 4 hours
b. Warm start	At longest 3 hours
c. Hot start	At longest 2 hours
d. Very hot start	At longest 1 hours
3) Voltage rating of auxiliary equipment power source	
a. AC power	
a) 200 kW≦P	AC 6,300 V
b) 3 kW≦P< 200 kW	AC 400 V
c) P< 3 kW	AC 200 V
b. DC power	DC 220 V
c. Lighting	AC 200 V
d. Instrumentation	AC 200 V
e. Control power	AC 100 V
f. Control signal	DC 24 V
(4) Basal Conditions for Arrangement of Main Equipment	
1) Gas and steam turbine generators	To be installed inside the gas and steam turbine separate buildings with a ventilation system, an overhead travelling crane and laydown bay for carrying bulky components in and out.
2) HRSG	To be installed inside on the same center axis as the gas turbine generator.
3) Arrangement of axes of gas and steam turbine generators	To be arranged in parallel
4) Gas turbine air filter	To be located as highly as possible above ground level
5) Control and monitoring and electrical equipment	To be located in the rooms integrated with the gas turbine building
(5) Emission	
1) Exhaust gas emissions (O_2 15% dry basis) (75 - 100% load of gas turbine over specified all ambient conditions)	
a. NO_x (ppmv)	< 25
b. SO_x (ppmv)	Changeable depending on sulfur content
c. CO (ppmv)	< 15

Description	Conditions and/or Specifications
d. PM_{10} (mg/Nm^3)	< 10
2) Airborne noise emission with steady state conditions without background noise	
a. Sound pressure level at a height of 1 m on the plant boundary	< 55 dB(A): Daytime < 45 dB(A): Nighttime
b. Sound pressure level at a height of 1 m and a distance of 1 m from equipment or enclosure	< 85 dB(A)
(6) Properties of Fuel Gas	
a. Temperature (^oC)	Performance point 12 Max. 20.0 Min. 8.0
b. Pressure (MPa(g))	Performance point 1.5 Max. 2.3 Min. 0.6
c. Composition	Performance point
CH_4	93.44 %
C_2H_6	3.14 %
C_3H_8	0.56 %
i-C_4H_{10}	0.08 %
n-C_4H_{10}	0.09 %
i-C_5H_{12}	0.03 %
n-C_5H_{12}	0.03 %
C_6H_{14}	0.01 %
N_2	0.54 %
CO_2	2.08 %
O_2	0.00 %
	100.0 %
d. Net specific energy (Lower calorific value)	46,750 kJ/kg
e. Gross specific energy (Higher calorific value) at performance point	51,920 kJ/kg
f. Density at 101.3 kPa, 0 °C	0.7763kg/Nm^3
g. Wobbe Index (Gas Index) defined by ISO 3977-4	46,820 kJ/m^3 N
(7) Make-up Water for Bottoming System	
a. Type of water	Canal water
b. Temperature	10 °C to 30 °C
c. Required flow rate	50 m^3/hr
(8) Operation and Maintenance	
1) Gas turbine	Supply of spare parts as per LTSA Contract for one (1) cycle up to the first major inspection inclusive.

Description	Conditions and/or Specifications
2) Other equipment	Supply of spare parts for two (2) years of actual operating hours.
3) Training of O&M staff at EPC contractor's works	Yes
4) Three (3) resident engineers (mechanical, electrical and control) of EPC contractor during defect liability period for operation and maintenance support	Yes
5) Inspection intervals of gas turbine on an EOH basis	
a. Combustion inspection	12,000 hours
b. Turbine inspection	24,000 hours
c. Major inspection	72,000 hours
6) Inspection intervals of other equipment	As per recommendation of manufacturer
7) Replacement intervals of filter elements	More than 6,000 actual operating hours for ASHRAE test dust with a load of 0.1 mg/m^3.
(9) Guarantee Items	
1) Plant net power output	Yes
2) Plant net thermal efficiencies for 100, 75, 50% loads	Yes
3) Exhaust gas emissions at 75 - 100% load of gas turbine over all specified ambient conditions	
a. NO_x	Yes
b. CO	Yes
c. PM_{10}	Yes
4) Airborne noise emissions on steady state conditions under all specified operating conditions	
a. Sound pressure levels at a height of 1 m on the plant boundary limit	Yes
b. Sound pressure level at a distance of 1 m and a height of 1 m from equipment or noise attenuation cover	Yes
5) Successful completion of two (2) weeks reliability run	Yes
6) Shaft vibration of gas and steam turbine sets based on related ISO standards during the reliability run	Yes

Source: JICA Study Team

6.1.2 Outline of Plant System

This power plant is comprised of two (2) units of combined cycle power plants (CCPPs) which produce power energy and in-house hot water which is used as heating energy source and hot-water supply. The plant shaft configuration is of multi-shaft type where the gas and steam turbine shafts are separated. The power plant consists of main components of two (2) gas turbines, two (2) gas turbine generators, two (2) heat recovery steam generators (HRSGs), two (2) steam turbines, two (2) steam turbine generators, a subplant, buildings, and associated ancillary facilities.

The gas turbine is of a large capacity F class type which is available in the world market with a wealth of commercial operating experience to evaluate the operating reliability.

The HRSG is of triple-pressure and reheat cycle indoor installed type. The gas turbine is commonly coupled with the triple-pressure and reheat cycle HRSG to elevate the plant thermal efficiency.

The steam turbine is of single or two (2)-casing, three (3)-admission, sliding pressure, condensing, axial or downward exhaust type covered with heat insulated and noise attenuated cover. It is indoor installed type with an overhead crane for lifting heavy pieces on maintenance. The heating steam for production of hot water is brached at the low pressure turbine (LPT) inlet after the steam leaving the intermediate pressure turbine (IPT) is mixed with the low pressure superheated steam of the HRSG. The steam in the condenser is cooled down by the circulating water, which is cooled in turn by a mechanical draft wet type cooling tower.

The heating steams branched at the LPT inlet are introduced to the common hot water heat exchanger to produced the hot water. The hot water heat exchanger consists of two (2) 50 % capacity heat exchangers.

6.1.3 Study on Shaft Configuration

(1) Type of Shaft Configuration

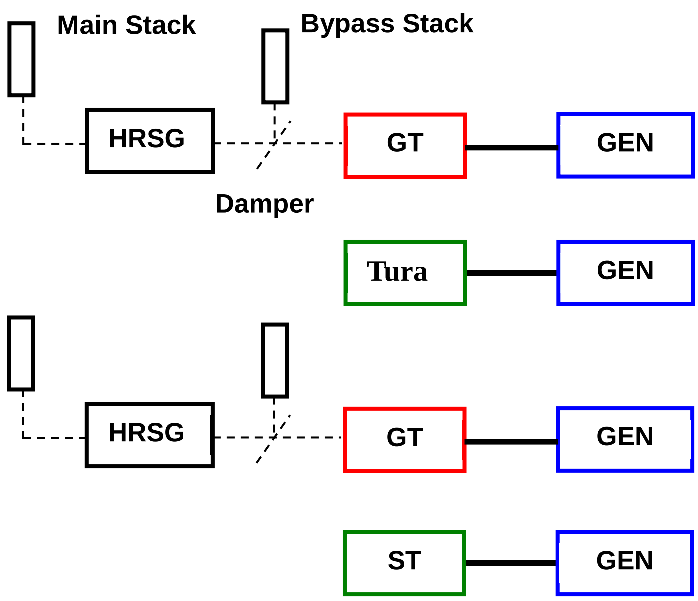
Here made is the simple comparison study on the type of the shaft configuration of the combined cycle power plant (hereinafter to be collectively called as CCPP) comprised of the two (2) gas turbines, two (2) heat recovery steam generators (hereinafter to be collectively called as HRSGs), one (1) or two (2) steam turbines and generator(s).

Basically, there are two (2) types of shaft configurations. One is called single-shaft configuration where the gas turbine and steam turbine shafts are connected on the same shaft. In the former case, the larger capacity generator common to gas and steam turbines is employed and the plant is consisted of two (2) units of single-shaft CCPPs. The other is called a multi-shaft configuration where the gas turbine and steam turbine shafts are separate. In case of this shaft configuration, two (2) types could be considered. One is that one (1) gas turbine is accompanied with one (1) steam turbine, which can be called 1 on 1 multi-shaft configuration type. The other is that two (2) gas turbines are accompanied with one (1) common steam turbine to which the steam from two (2) HRSGs is introduced. This configuration is called as 2 on 1 multi-shaft type. Therefore, the steam turbine capacity in this configuration doubles approximately the preceding shaft configuration.

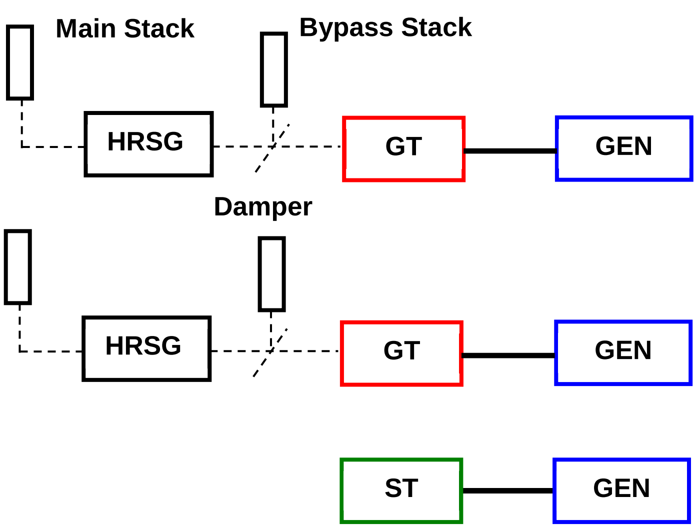
The multi-shaft type is equipped with a bypass stack for a simple cycle mode operation of the gas turbine. The single-shaft type cannot be operated as a simple cycle mode because the gas and steam turbine shafts are connected. These three (3) types of Type A, Type B and Type C shaft configurations are depicted in Figure 6.1.3-2.

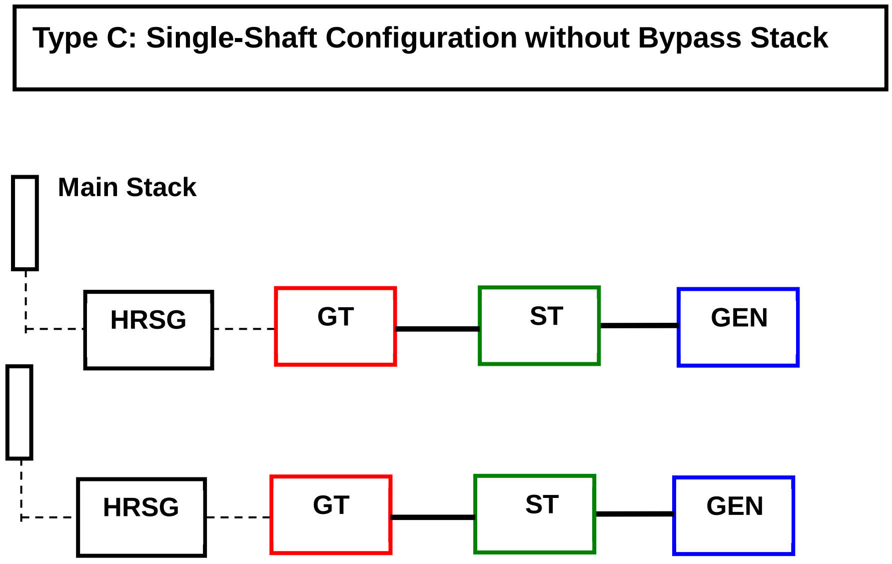
The comparison study is performed from the viewpoints of plant thermal efficiency, operating flexibility, ease of operation, start-up steam provision, application experiences, operating reliability, maintainability, installation area requirement, construction cost and transportation among above three (3) types of CCPP shaft configurations.

Type A: 1 on 1 Multi-shaft Configuration with Bypass Stack Stack



Type B: 2 on 1 Multi-shaft Configuration with Bypass Stack





Source: JICA Study Team

Figure 6.1.3-1 Shaft Configuration

As shown above, in cases of Types A and B CCPPs, two (2) generators are individually employed for the gas and steam turbines. In these cases, both types of CCPPs are equipped with the bypass system consisting of a bypass stack and a damper, which are installed between the gas turbine and HRSG to allow for the gas turbine/generator to operate as a simple cycle. In addition, in case of Type B CCPP, one (1) steam turbine with a double capacity, into which steams from two (2) HRSGs are introduced, is employed.

In case of Type C CCPP, one (1) large capacity generator common to both gas and steam turbines is employed and this type is not equipped with the bypass system.

A comparison study was performed from the viewpoints of thermal efficiency, operational flexibility, operability, start-up steam and auxiliary power requirement, application experiences, operating reliability, maintainability, installation footprint area requirement, construction cost, generation cost and transportation among the above three (3) types of CCPPs.

(2) Plant Thermal Efficiency

The generator of Type C CCPP has the highest efficiency, while Type A CCPP has the lowest efficiency. The thermal efficiency of the steam turbine of Type B is higher than other two (2) Types since the capacity size of Type B CCPP is double of other Types. In the case of a multi-shaft configuration with the bypass system, the leakage from the bypass system of the exhaust gas will affect the plant efficiency. It is reportedly said that the leakage over the life time of the plant is from 0.5 to 1.5 %, meaning the steam turbine efficiency drops by 0.5 to 1.5 %. Consequentially, plant efficiency drops by 0.17 to 0.50 %. In total, the plant thermal efficiency for the Type B CCPP at full load is higher by about 0.2 % than the Type A CCPP. Similarly, Type C CCPP is higher by about 0.5 % than Type A CCPP.

(3) Operational Flexibility

In case of Type C CCPP, the plant could not be operated unless the components of the gas turbine, the heat recovery steam generator and the generator are all healthy.

On the other hand, in cases of Types A and B CCPPs, since the bypass stack with the damper is equipped, even if any components of the HRSG, the steam turbine, and the steam turbine generator are out of service for any reason, the gas turbine/generator could be operated as a simple cycle where the exhaust gas from the gas turbine is discharged into atmosphere through the bypass stack.

Thus, Types A and B CCPPs will be more flexible than Type C CCPP in terms of operation.

(4) Operability
The CCPP can be operated only by automatic adjustment of the fuel flow into the gas turbine and the operation cycle of start-up, steady operation and shut down can be fully automated irrespective of the type of the shaft configuration. There is, therefore, no essential difference with the operability between both types of shaft configurations. The operational sequence of the multi-shaft CCPP may be slightly more complicated compared to the single-shaft CCPP because of an increased number of components.

(5) Steam and Auxiliary Power Requirements for Plant Start-up
In cases of Types A and B CCPPs, the gas turbine can be started up together with the HRSG separately from the steam turbine/generator. After a certain period of the time, the necessary steam for building up the condenser vaccum will be made available from the HRSG and then the steam turbine/generator can be started up by catering for necessary steam for flow passage cooling and gland sealing provided that the demineralized water is available. Thus, the plant can be started up without steam supply from external source.

In case of Type C CCPP, however, the steam for the flow passage cooling and gland sealing of the steam turbine which must be started up together with the gas turbine is required from an external source. For the purpose, auxiliary steam from the existing boilers or a standalone auxiliary boiler will be needed.

In cases of Types A and B CCPPs, the power requirement for the starting device is approximately 2.0 % of the gas turbine power output, while it is approximately 2.5% in case of Type C CCPP.

There is no difference with the auxiliary power requirements among above three (3) types of CCPPs during the start-up cycle except for the starting device of the shaft train.

(6) Application Experiences
There are many application experiences with single and multi-shaft types of CCPPs. It can be deemed that both types of CCPPs are mature technologies without any technical difficulties.

(7) Plant Operating Reliability
The plant operating reliability of each type of CCPP can be evaluated by the plant operating reliability factor to be theoretically calculated with the reliability factors of the main equipment which are assumed as shown below:

Main Equipment	Equipment Reliability Factor

	Unit No.1	Unit No.2	Common Unit (for Type C)
Gas turbine:	A1 = 0.975	B1 = 0.975	
Bypass system:	A2 = 0.975	B2 = 0.975	
Heat recovery steam generator:	A3 = 0.980	B3 = 0.980	
Steam turbine:	A4 = 0.985	B4 = 0.985	C4 = 0.985
Gas turbine generator and transformer:	A5 = 0.990	B5 = 0.990	
Steam turbine generator and transformer:	A6 = 0.990	B6 = 0.990	C6 = 0.990

The plant operating reliability factor can be divided into two (2) types of reliability factors on an operating hour basis (PORH) and power energy basis (PORE). For calculation of PORH, operation modes of each type of CCPP shall be considered. In case of Type A CCPP, the five (5) operation modes in percent plant power output can be expected. They are 100 %, 83.3 %, 66.7 %, 50.0 % and 33.3 %. For example, the plant power output of 83.3 % can be attained by operating either unit on the full combined cycle mode and another unit on the simple cycle mode. Those of Type B CCPP are five (5) operation modes consisting of 100 %, 83.3 %, 66.7 %, 50.0 % and 33.3 % as well as the Type A CCPP. Those of Type C CCPP are two (2) operation modes of 100 % and 50.0 %. For the purpose of calculating the plant power output as a percentage, the power output on the GT simple cycle mode is assumed to be two thirds of that during the combined cycle mode. The following table 6.1.3-1 shows the theoretical calculation results of PORH of three (3) types of shaft configurations.

Table 6.1.3-1 Theoretical Calculation Results of Plant PORH

Plant Power Output (%) (Number of operating GTs)	PORH		
	Type A CCPP	Type B CCPP	Type C CCPP
100 (2)	0.80888	0.82949	0.86817
83.3 (2)	0.07508	0.03386	-
66.7 (2)	0.00174	0.02236	-
50.0 (1)	0.10591	0.10591	0.12717
33.3 (1)	0.00492	0.00492	-
Total	0.99653	0.99653	0.99534

The total figure in the above table is the plant PORH of each type of CCPP. In other words, the plant PORH means the summation of the theoretically expected operating hours at the each operation mode in power output of the CCPP under the assumed reliability factors of main equipment consisting of the CCPP.

Similarly, the PORE denotes the theoretically expected power generation amount. Therefore, the plant PORE can be calculated by multiplying the PORH at each plant power output by the plant power output value in percent and summing up all the POREs. The results are as shown below:

Type of CCPP	A	B	C
Plant PORE	0.92718	0.92718	0.93176

From above theoretical calculation results, the following relationships among plant PORHs and POREs of three (3) types of CCPPs are confirmed.

$PORH_A$ (99.65 %) = $PORH_B$ (99.65 %) > $PORH_C$ (99.53 %)

As shown in the above relationship among theoretical plant PORHs, it is certain that the plant PORH of the CCPP consisting of two (2) gas turbines is very high and that any difference due to the type of shaft configuration insignificant. In other words, there are no differences among the plant reliability on an hourly basis;they are virtually equal.

Similarly, the relationship among the theoretical plant POREs of three (3) types of CCPPs is as shown below:

$PORE_C$ (93.18 %) > $PORE_A$ (92.72 %) = $PORE_B$ (92.72 %)

Regarding the plant PORE, it is certain that the PORE of Type C CCPP is slightly higher than Types A and B CCPPs. The plant PORE with the single-shaft type is theoretically higher than the multi-shaft type due to the presensce of the bypass system.

(8) Maintenance Cost
The maintenance cost is severely dependent upon the amount of main equipment employed, including the exhaust gas bypass system. Therefore, it is envisaged that the maintenance cost is highest in this order: Type C, Type B and Type A CCPP.

(9) Footprint Area for Instruction
Generally, the installation footprint area of a multi-shaft type CCPP is larger than the single-shaft type CCPP because the number of the main equipment of the former is highter than the latter. In addition, the space utilization effect of the former is inferior to the latter due to the gas turbine/generator and steam turbine/generator being installed separately. From our experience, the installation footprint area of the former is larger by about 15 ~ 25% than the latter depending upon if the bypass system is installed or not.

The larger footprint area for installation of equipment means a larger amount of civil, architectural and construction work, which in turn leads to higher costs. For reference, figures 6.1.3-2 and 6.1.3-3 attached hereto show typical installation plan drawings of one (1) unit of single-shaft type CCPP without the bypass system and multi-shaft type CCPP with the bypass system using an F-class gas turbine, respectively.

As Turakrugan Thermal Power Station is comprised of two (2) gas turbines, one (1) unit of 2 on 1 multi-shaft type CCPP such as Type B can be considered. In this type, one (1) common large capacity steam turbine and generator are to be employed. Therefore, its installation footprint area is envisaged to be somewhat narrower than two (2) units of 1 on 1 multi-shaft CCPPs such as Type A.

(10) Phased Construction
The multi-shaft type CCPP with the bypass system such as Type A and Type B CCPPs has the advantageous feature that the phased construction can be possible. The completion time of the gas turbine/generator package is normally faster than the bottoming system, which means that it can be put into commercial operation in advance. This feature is advantageous for the project which must handle sharp increases for power demand.

(11) Construction Cost
The multi-shaft type CCPP has more components than the single shaft type CCPP as previously mentioned. In addition, the former type is equipped with the bypass system consisting of a stack, a silencer and a damper. Therefore, it can be easily determined that the former construction costs will be higher than the latter. According to construction cost

estimation results using a software program, the relative cost differences among Types A, B and C CCPPs can be calculated as below as referential values for this study.

Type of CCPP	Construction Cost (%)
A	100% (Base)
B	minus 5.6 %
C	minus 8.5 %

(12) Power Generation Costs

The relative power generation costs of Type B and C CCPPs against Type A CCPP can be calculated as shown below.

1) Fuel cost

Fuel cost (fuel consumption) is proportional to the sum of products of the PORH and number at each plant operation mode, which can be calculated in accordance with Table 6.1.3-1. The calculation results are tabulated below:

Type of CCPP	Sum of Product
A	1.8822
B	1.8822
C	1.8635

Therefore, fuel costs of the other two (2) types of CCPPs against Type A CCPP are estimated as tabulated below:

Type of CCPP	Sum of Product
A	100 % (base)
B	plus/minus 0.0 %
C	minus 1.0 %

2) Capital recovery cost

The capital recovery cost is proportional to the construction cost. Therefore, the relative recovery costs of three (3) types of CCPPs can be estimated as shown below referring to the results in the previous sub-section (11).

Type of CCPP	Sum of Product
A	100 % (base)
B	minus 5.6 %
C	minus 8.5 %

3) Power energy sales

Power energy sales are proportional to the plant thermal efficiency and the plant operating reliability factor on a power energy basis. Therefore, the their relative values can be expressed as below:

Type of CCPP	Sum of Product
A	100 % (base)
B	plus 0.2 % (=0.2+(92.72–97.27))
C	plus 0.96 % (=0.5+(93.18–92.72))

Therefore, the power generation cost of Type B CCPP can be calculated to be lower than

Type A CCPP by 1.4% (= ((1–0.056)×1/(1+3)+(1+0.000)×3/(1+3))/(1+0.002)–1.0 = –0.016). In this case, the ratio of the fuel cost to the capital recovery cost is assumed to be 3.0. The generation costs of Type C CCPP can be similarly calculated. The calculation results are as follows:

Type B CCPP	minus 1.6 %
Type C CCPP	minus 3.8 %

(13) Inland Transportation

Uzbekistan is a land-locked country surrounded by countries on all sides. The Project is to be installed at a new site where heavy and bulky components have never been transported. However, one (1) unit of CCPP with similar power output capacity has been installed at Navoi in Uzbekistan where it is situated about 700 km southwest from the new site. This experience will be valuable and will be reffered to to run this project effeciently.

Among main components of the gas turbine, HRSG, steam turbine, generaor and step-up transformer, the heaviest and bulkiest components which cannot be divided in parts for transportation are the generator stator and step-up transformer. Since the gas turbine generator capacities in both cases of Types A and B CCPPs are the same, there is no difficulty with the transportation between both types of CCPPs.

However, the capacity of the generator common to the gas and steam turbines of Type C CCPP is about 1.5 times the capacity of the gas turbine generator of the Type A CCPP. Therefore, the transportation of Type C CCPP is deemed to be more difficult compared with Types A and B CCPPs.

The tranportation route and methods from Navoi to the site were investigated during this feasibility study, and the results can be foundin the relevant section of this study report

(14) Study Summary

The study results described above are summarized in Table 6.1.3-2. The cells highlighted in yellow show that the type of CCPP of the cell is preferred in terms of the related comparison item. As shown in this table, as long as the overall priority is determined by the total area of highlighted cells; the Type B CCPP is ranked first, Type C CCPP second and Type A CCPP last.

However, the priority is changeable depending upon where the weight is placed, the site conditions and requirements for the project. If the priority, for example, is placed on the economy of the project, the Type C CCPP is best suited.

In the case of this project, the priority is placed on the requirement of the availability of a gas turbine with simple cycle operation. For the purpose, a multi-shaft type CCPP shall be selected for this project. In such case, Types A and B CCPPs are to be considered.

When comparing Type A and Type B CCPPs, the latter CCPP is more advantageous as can be seen from the comparison study results shown in Table 6.1.3-2.
However, since the required power output per unit is 450MW, the output of Type B CCPP dose not meet this requirement because the output of Type B CCPP applying F-class gas turbein is more than 900MW per unit at ISO condition. Therefore, the study concludes that Type A CCPP can be recommended for this project.

Table 6.1.3-1 Summary of Comparison Study Results on Type of Shaft Configuration of CCPP

Comparison Item		Type of Shaft Configuration		
		A	B	C
1. Thermal Efficiency		Base (100%)	+ 0.2 %	+ 0.5 %
2. Operational Flexibility (Simple Cycle Operation)		Base (Yes)	Similar (Yes)	Less flexible (No)
3. Operability		Base	Similar	Slightly simple
4. Start-up Requirement	**Steam**	Own steam	Own steam	External steam
	Power for Starting device	App. 2.0 % of GT capa.	App. 2.0 % of GT capa.	App. 2.5 % of GT capa.
5. Application Experience		Base	Similar	Similar
6. Operating Reliability	**PORH**	Base (100%)	Same	△ 0.1 %
	PORE	Base (100%)	Same	+ 0.5 %
7. Maintenance Cost		Base	Similar	Slightly less
8. Footprint Area of Power Train		Base (100%)	Similar	△ 20 %
9. Phased Construction		Yes	Yes	No
10. Construction Cost		Base (100%)	△ 5.6 %	△ 8.5 %
11. Power Generation Cost		Base (100%)	△ 1.6%	△ 3.8%
12. Inland Transportation		Base	Similar	Slightly difficult

Source: JICA Study Team

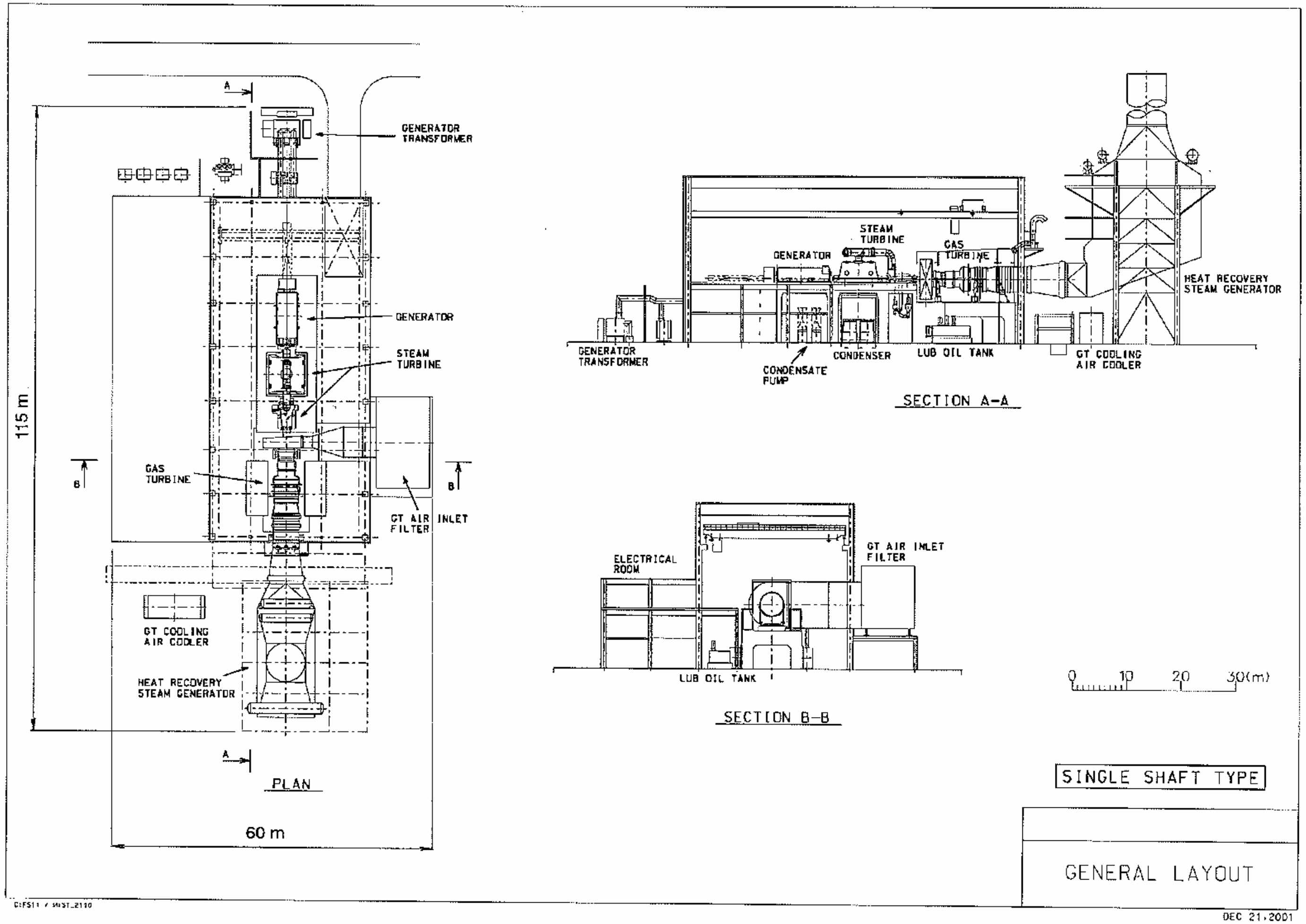


Figure 6.1.3-2 Typical Layout of One (1) Unit of Single-shaft Configuration CCPP

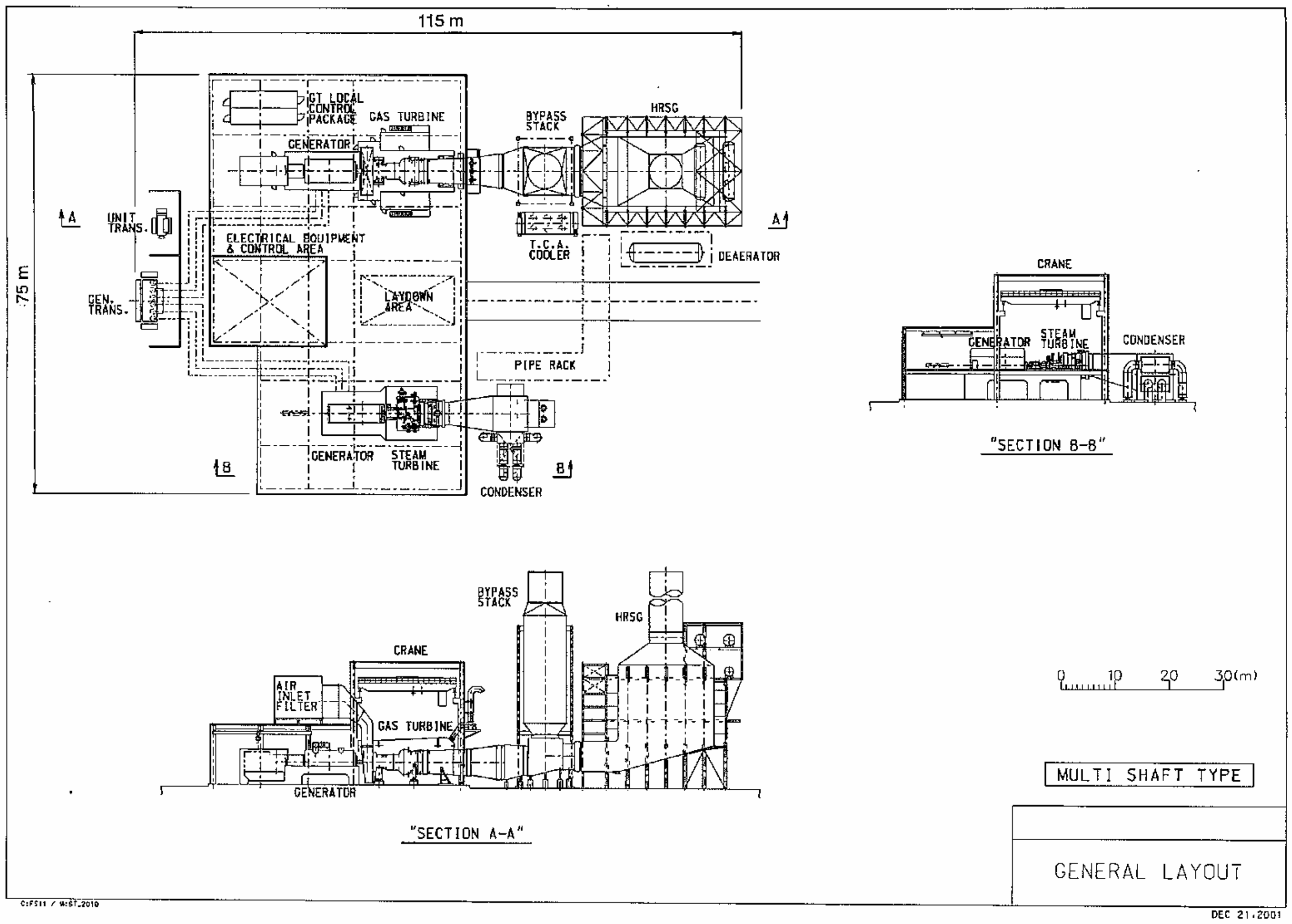


Figure 6.1.3-3 Typical Layout of One (1) Unit of Multi-shaft Configuration CCPP

6.1.4 Candidate Gas Turbine and Performance

(1) Design Codes and Standards

The gas turbine system shall be basically designed as per ISO 3977-3 “Gas turbines-Procurement-Part 3: Design requirements” and ISO 21789 “Gas turbine applications-Safety” or equivalent codes and standards.

(2) Candidate Models

The gas turbine is the most important component to influence the operating reliability of the combined cycle power plant,so it is necessary that it possesses the highest operating reliability. Unlike custom-made steam turbines which are designed every time an order is placed, gas turbines are normally from the manufacturer’s predetermined design as to avoid a long development period before delivery and reduce costs due to custom design. It is normal practice to select proper gas turbine models to meet the requirements for the project among the standard lineups of gas turbine OEM manufacturers. Here the OEMs are manufacturers who have completed the full development of the prototype of the proposed type of machine and have performed successive upgrades. The reason for the supply of the machine by an OEM is because the OEM has the full concept of the essential design nature of the machine, which is developed by itself, and it can take new approaches to any problems which may occur.

Gas turbines are being continually developed, and their design parameters are being upgraded every year. Nowadays, gas turbine models with higher performances than F class of which the turbine inlet temperature are specified to operate at approximately 1,300°C are being made public. However, they are not always mature machines with sufficient commercial operating hours. Therefore, it must be confirmed whether the latest version of the same model the manufacturer may offer has the commercial operating experience sufficient to verify the operating reliability of the model. For the purpose of confirming such a such situation, the proposed gas turbine shall meet certain criteria requirements. The criteria requirements shall be such that the proposed gas turbine shall be a machine technically similar to the reference gas turbines which have such commercial operation experience one (1) month before the closing date of the international competitive bidding as described below:

- The total successful commercial operating hours of at least three (3) reference gas turbines shall be no less than 30,000 actual operating hours.
- At least one (1) gas turbine out of three (3) reference gas turbines shall be outside of the domicile country of the gas tubine manufacturer.
- The successful commercial operating time for the unit having the longest operating hours of the three (3) reference gas turbines shall be more than 16,000 actual operating hours.
- The minimum successful commercial operating time for each of the three (3) reference gas turbines shall be no less than 6,000 actual operating hours.

In addition, the Bidder shall provide the data and information required by the Table 6.1.4-1 in the Proposal Documents to confirm it that the technical similarity of the proposed gas turbine with the reference gas turbines is reserved.

Table 6.1.4-1 Technical Similarlity Evaluation Sheet of Proposed Gas Turbine

<table>
<tr><th colspan="2" rowspan="2">Description</th><th rowspan="2">Proposed Gas Turbine</th><th colspan="3">Identification Number of Reference Gas Turbines</th></tr>
<tr><th>1</th><th>2</th><th>3</th></tr>
<tr><td colspan="2">(1) Performance</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Model No.</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Type of cycle</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">No. of shafts</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Power output (MW)</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Thermal efficiency (%)</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Compressor inlet air flowrate (kg/s)</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Pressure ratio (-)</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Reference turbine inlet temp. as per ISO 3977-3 (^oC)</td><td>HPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td>LPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Turbine outlet temperature (^oC)</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">(2) Compressor</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Type</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Rotating speed (rpm)</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Inlet guide variable vane</td><td>Yes/No</td><td>Yes/No</td><td>Yes/No</td><td>Yes/No</td></tr>
<tr><td colspan="2">No. of stages</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">No. of stages of variable stator vanes</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Material of rotor</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Materials of plantary blades</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Materials of rotating blades</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">(3) Combustor</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Type</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">No. of combustion chambers for cannular type</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">No. of nozzles assemblys for annular type</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Material of combustion chambers</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Material of transition pieces</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">(4) Turbine</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Type</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Rotating speed (rpm)</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Material of 1st stage nozzle</td><td>HPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td>LPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Material of 1st stage blade</td><td>HPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td>LPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Material of 2nd stsge nozzle</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Material of 2nd stage blade</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Material of rotor disc</td><td>HPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td>LPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Type of cooling methid of 1st stage nozzle</td><td>HPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td>LPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Type of cooling method of 1st stage blade</td><td>HPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td>LPT</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Type of cooling method of 2nd stage nozzle</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Type of cooling method of 2nd stage blade</td><td></td><td></td><td></td><td></td></tr>
</table>

All performance parameter values in the above table shall be provided with one (1) figure on ISO conditions at the full open position of the compressor inlet gude vane.

The data and information on the commercial operating experience of the reference gas turbines shall be testified with written confirmation letters signed by the plant owners.

In consideration of the above statements, therefore, the JICA Study Team has decided that the models of the gas turbines to be employed for this project shall be of F class as specified in the Gas Turbine Handbook 2012.

In selection of the candidate models of gas turbines, it shall be considered that the proposed gas turbine can be operated in a simple cycle mode taking into account that it may be put into a commercial operation in advance to solve the impending shortage of power supply in Uzbekistan. For example, Alstom can supply two (2) types of GT26 gas turbines. One is GT26 with an air quench cooler, while the other is GT26 with a once through cooler that uses steam to cool the air extracted from the air compressor for internal cooling of hot parts of the gas turbine. Therefore, the latter type of GT26 gas turbine cannot be operated in a simple cycle mode without a cooling medium of steam from the bottoming system. For such reason, the GT26 gas turbine where ambient air is used as a cooling medium can be chosen as a candidate CCPP for the plant.

General Electric (GE) has two (2) versions of F class gas turbines of 9FA and 9FB to meet the requirements for this project. However, the former is does not meet the heat and power capacity specified hereinafter. Therefore, the former model shall be excluded from consideration for this study.

Mitsubishi Hitach Power Systems (MHPS) has at moment two (2) versions of F class gas turbines of M701F4 and M701F5 to meet the requirements for this project. The former model has a lot of commercial operation experience. However, the latter model doesn't have the required operating experience as specified in the previous page at this stage although having superior performance. Therefore, the latter model is not to be considered as a candidate model for this project.

Consequently, the following four (4) models of gas turbines shall be eventually selected as candidate models for this project with the performance values shown in the Table 6.1.4-1 on ISO conditions as per the said Handbook:

Table 6.1.4-1 Performance Values of Four (4) Candidate Models of Gas Turbines

Model of Gas Turbine	GT26	9FB	M701F4	SGT5-4000F
ISO base rating (MW)	296.4	298.2	324.3	289.0
Efficiency (%)	39.6	38.5	39.9	39.4
Pressure ratio	33.3	18.4	18.0	18.2
Air flow rate (kg/s)	644.1	666.8	712.1	687.2
Exhaust gas temp (°C)	621.1	642.2	591.7	583.9

Source: Gas Turbine World 2012 GTW Handbook (Volume 29)

(3) Gas Turbine Manufacturers

According to the said Handbook, the gas turbine manufacturers of the above four (4) models of gas turbines are as tabulated in the following Table 6.1.4-2:

Table 6.1.4-2 OEM Manufacturer of the Four (4) Models of Gas Turbines

Model of Gas Turbine	OEM Manufacturer
GT26	Alstom
9FB	GE
M701F4	MHPS
SGT5-4000F	Siemens

Source: Gas Turbine World 2012 GTW Handbook (Volume 29)

6.1.5 Plant Performance by Candidate Gas Turbine

The CCPP shall be comprised of the candidate gas turbine which is available in the present world market and the bottoming system suited to it. Therefore, the plant performance shall be naturally changeable depending upon the type of candidate gas turbine which may be employed for this project. This section describes the plant performance calculated for each candidate gas turbine.

(1) Basic Calculation Conditions
Such basic calculation conditions as ambient conditions and fuel gas composition are specified as figures at the performance evaluation point in Table 6.1.1-1.

(2) Candidate Models of Gas Turbines
The plant performance shall be calculated for the four (4) candidate models of gas turbines of which performance values are shown in Table 6.1.4-1 of the previous section.

(3) Type of the Bottoming System
The combined cycle plant is a combination of a “Topping System” of a gas turbine with Brayton Cycle and a “Bottoming System” of a boiler-steam turbine with Rankine Cycle. The performance and construction cost of the combined cycle plant is changeable due to how the bottoming system is designed for the given topping system of the gas turbine. In general, the more complicated is the cycle of the bottoming cycle, the higher is the performance and construction cost of the combined cycle plant. In case of employment of the F class gas turbine, the triple-pressure and reheat cycle bottoming system is commonly employed.

(4) Design Parameters of the Bottoming System
The cycle design parameters of the bottoming system may be individual depending upon design concepts to be proposed of the manufacturers of combined cycle power plant. The cycle design parameters of the bottoming system shall be specified in consideration of the expected operating range under the specified range of ambient conditions. For the purpose of calculation of heat and mass balances of the four (4) candidate models of CCPPs, therefore, the cycle design parameters of the bottoming system are preliminarily assumed as tabulated below.

• GT Inlet Air Cooling System	Not considered
• GT Inlet Pressure Loss	1.0 kPa
• GT Exhaust Back Pressure	3.75 kPa
• Exhaust Gas Leakage from Bypass Stack	0.0%

- Cycle Configuration — Triple-pressure, reheat
- HRSG Type — Unfired type
- Steam Conditions at Turbine Throttle Valve Inlet at Rated Site Ambient Conditions
  - HP Steam
    - Temperature — 540 °C
    - Pressure — 12.7 MPa (130.0 ata)
  - IP Steam
    - Temperature — 540 °C
    - Pressure — 2.75 MPa (28.0 ata)
  - LP Steam
    - Temperature — Mixed temperature of LP SH and IPT outlet steams
    - Pressure — 0.49 MPa (5.0 ata)
- Pre-heater Inlet Temperature — 60 °C
- Heat (steam) supply for in-house hot water — 16.3 Gcal/hr for one (1) unit
- Condenser
  - Temperature Difference — 5.0 °C
  - Temperature — 31.4 °C
  - Pressure — 4.6 kPa
  - Temperature rise — 8.0°C
- Cooling System
  - Type — Mechanical draft wet type Cooling tower
  - Type of cooling water — Pre-treated cannal water
  - Cooling tower inlet temperature — 26.4 °C
  - Cooling tower outlet temperature — 18.4°C

(5) Heat and Mass Balance Calculation Results

The heat and mass balances of the combined cycle power plants by the four (4) candidate models of gas turbines are calculated based on the conditions stated in the previous sub-section. The calculation results are summarized as tabulated in Table 6.1.5-1.

Table 6.1.5-1 Expected Performance Values of CCPPs by the Four (4) Models of Gas Turbines

Type of Model of Gas Turbine	GT26	9FB	M701F4	SGT5-4000F
Plant Gross Power Output (MW)	802.2	840.0	867.6	778.2
GT Total Gross Power Output (MW)	539.4	551.0	598.6	526.0
ST Total Gross Power Output (MW)	262.8	289.0	269.0	252.0
Total Heat Supply for in-house hot water	32.6	32.6	32.6	32.6
Plant Gross Thermal Efficiency (%)	60.9	61.0	60.1	60.3
Plant Gross Power Output Efficiency (%)	58.2	58.3	57.6	57.5
Total Auxiliary Power Requirement (MW)	25.4	24.2	25.2	22.6
Plant Net Power Output (MW)	776.8	815.8	842.4	755.6
Plant Net Power Output Efficiency (%)	56.1	56.6	55.9	55.8

Source: JICA Study Team

As can be seen in the above table, the plant net power outputs of the four (4) CCPPs are estimated to range from 755.6 MW to 842.4 MW on the specified calculation conditions stated above. The required range of the plant net power output to be prescribed in the international competitive bidding documents should be “720 MW ~ 880 MW” in consideration of proper allowance for the calculated power output values. The nominal net power output of the plant should be 800 MW as the mean value of the expected power outputs of four (4) candidate CCPPs.

The plant net power efficiencies are predicted to range from 55.8 % to 56.6 % on the same conditions. Therefore, the requirement of the plant net power efficiency should be specified as “not less than 54.5 %” in the bidding documents in consideration of proper allowance for the calculated net power output.

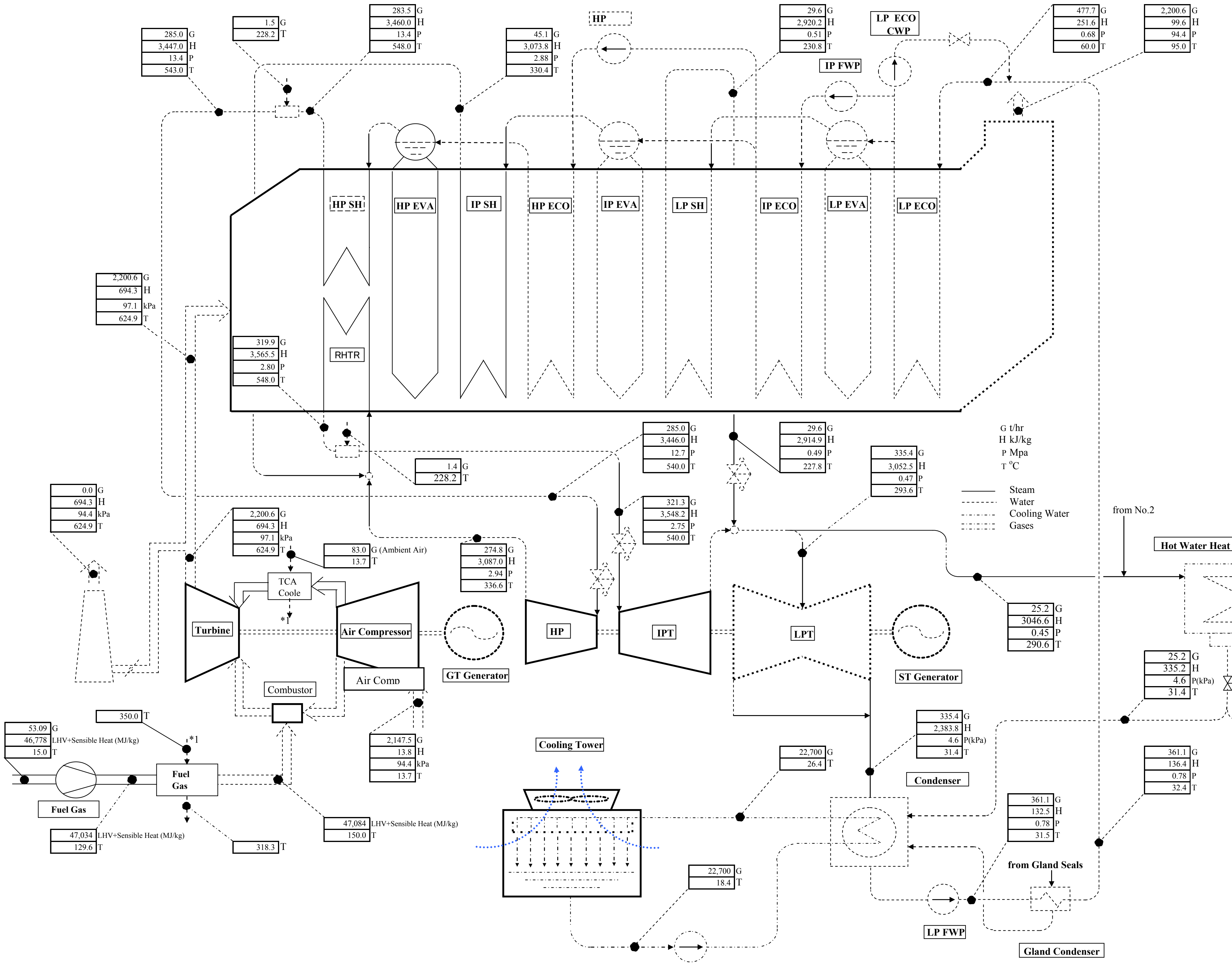
The heat and mass balance diagrams of one (1) unit of CCPP out of two (2) units of CCPPs consisting of the plant are shown in the following figures.

Figure 6.1.5-1 Heat and Mass Balance Diagram of One (1) Unit of CCPP by Alstom GT 26 Gas Turbine

Figure 6.1.5-2 Heat and Mass Balance Diagram of One (1) Unit of CCPP by GE 9FB Gas Turbine

Figure 6.1.5-3 Heat and Mass Balance Diagram One (1) Unit of CCPP by MHPS M701F4 Gas Turbine

Figure 6.1.5-4 Heat and Mass Balance Diagram One (1) Unit of CCPP by Siemens SGT5-4000F Gas Turbine



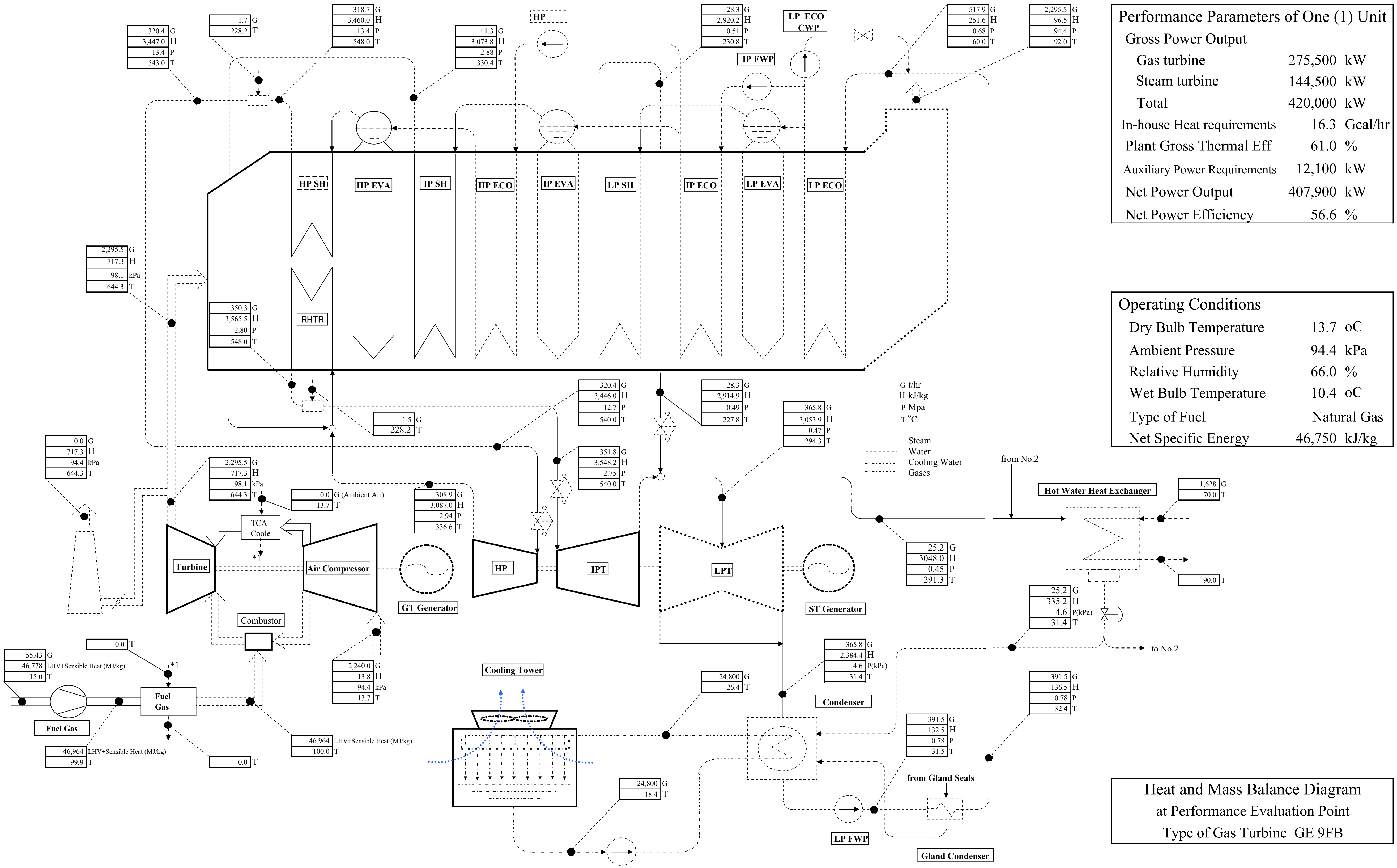
Performance Parameters of One (1) Unit		
Gross Power Output		
Gas turbine	269,700	kW
Steam turbine	131,400	kW
Total	401,100	kW
In-house Heat Requirements	16.3	Gcal/hr
Plant Gross Thermal Eff	60.9	%
Auxiliary Power Requirements	12,700	kW
Net Power Output	388,400	kW
Net Thermal Efficiency	59.1	%
Net Power Efficiency	56.3	%

Operating Conditions		
Dry Bulb Temperature	13.7	oC
Ambient Pressure	94.4	kPa
Relative Humidity	66.0	%
Wet Bulb Temperature	10.4	oC
Type of Fuel	Natural Gas	
Net Specific Energy	46,750	kJ/kg

Heat and Mass Balance Diagram
at Performance Evaluation Point
Type of Gas Turbine Alstom GT26

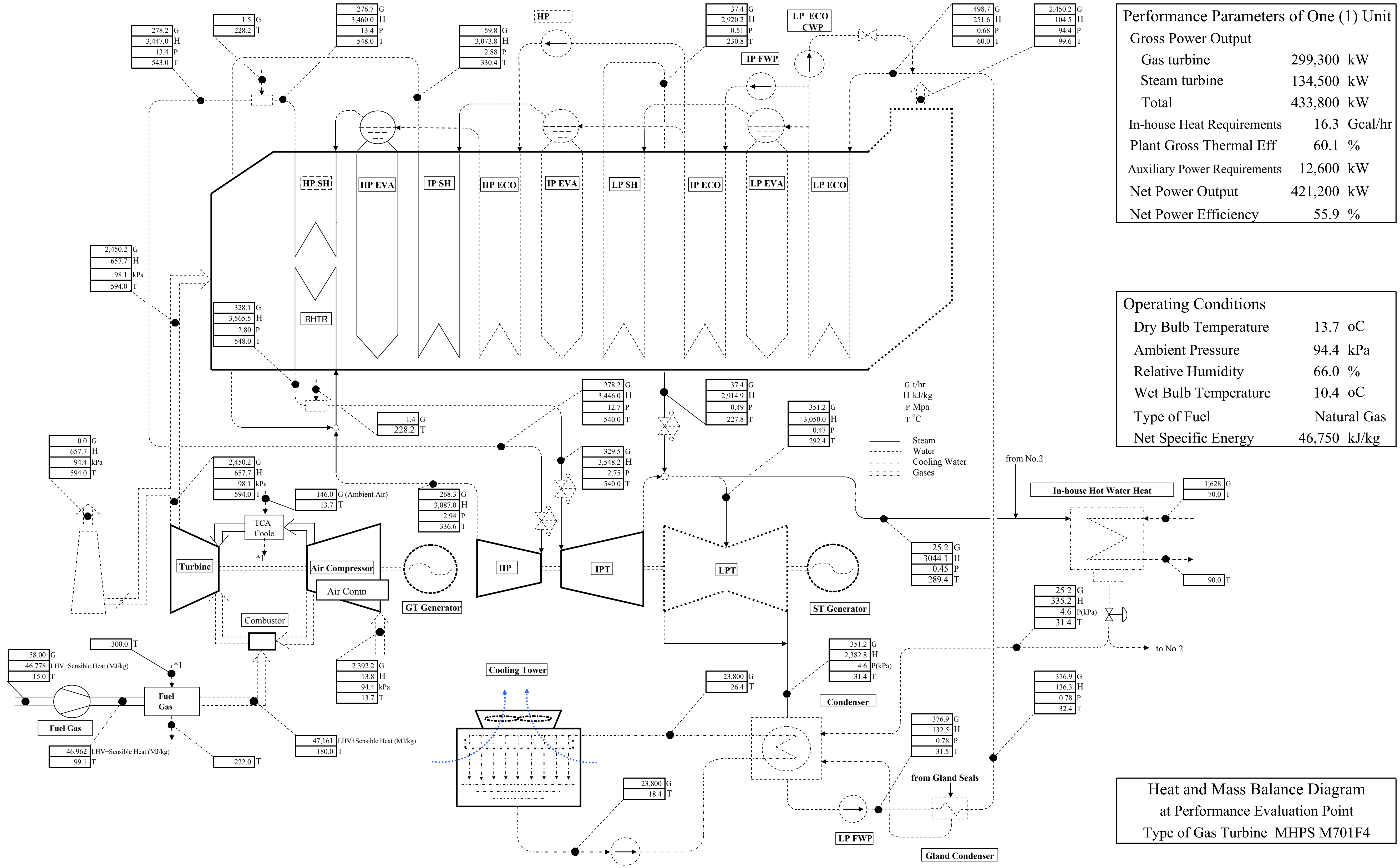
Source: JICA Study Team

Figure 6.1.5-1 Heat and Mass Balance Diagram of One (1) Unit of CCPP by Alstom GT26 Gas Turbine



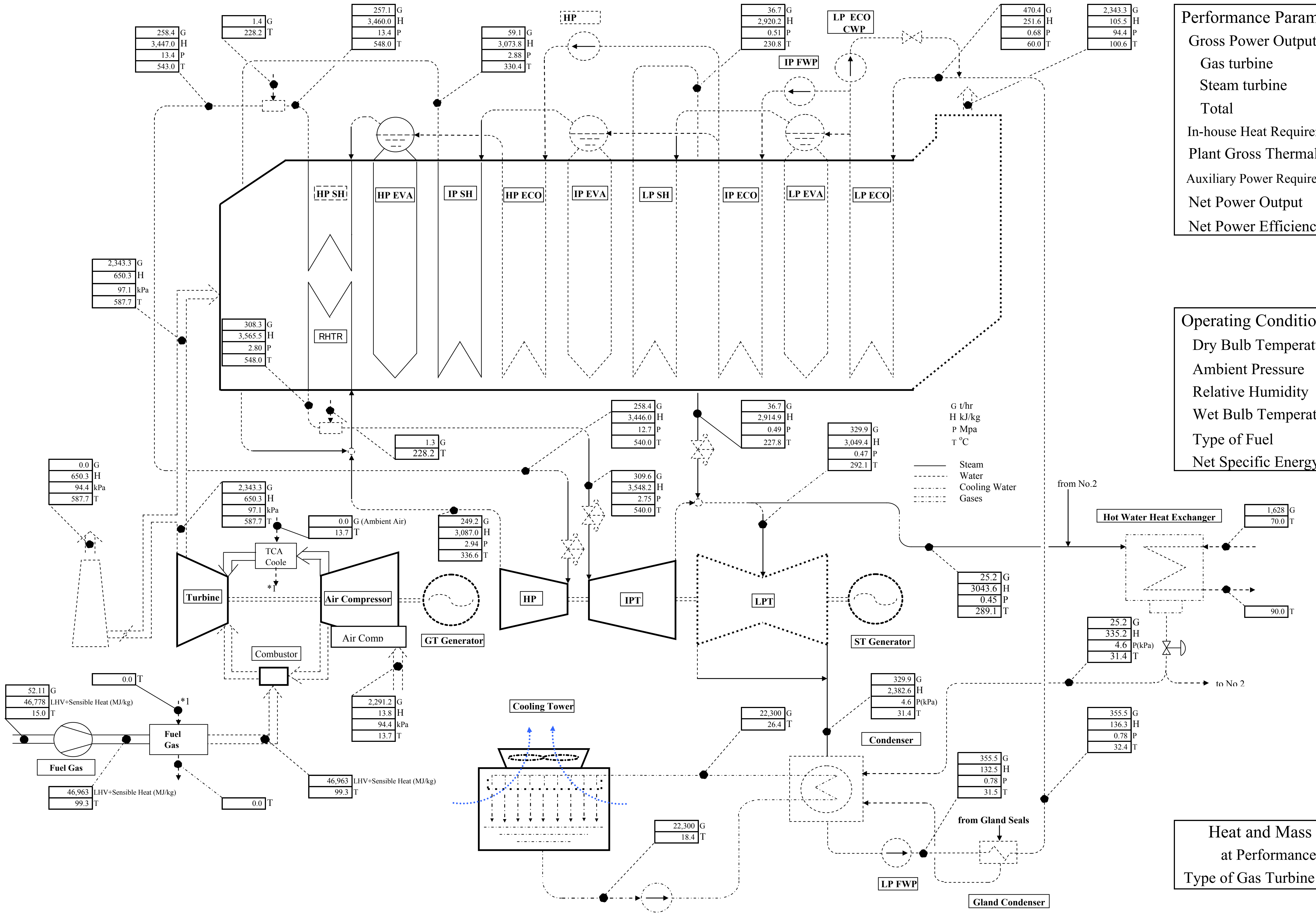
Source: JICA Study Team

Figure 6.1.5-2 Heat and Mass Balance Diagram of One (1) Unit of CCPP by GE F9B Gas Turbine



Source: JICA Study Team

Figure 6.1.5-3 Heat and Mass Balance Diagram of One (1) Unit of CCPP by MHPS M701F4 Gas Turbine



Performance Parameters of One (1) Unit		
Gross Power Output		
Gas turbine	263,000	kW
Steam turbine	126,000	kW
Total	389,000	kW
In-house Heat Requirements	16.3	Gcal/hr
Plant Gross Thermal Eff	60.3	%
Auxiliary Power Requirements	11,300	kW
Net Power Output	377,700	kW
Net Power Efficiency	55.8	%

Operating Conditions		
Dry Bulb Temperature	13.7	oC
Ambient Pressure	94.4	kPa
Relative Humidity	66.0	%
Wet Bulb Temperature	10.4	oC
Type of Fuel	Natural Gas	
Net Specific Energy	46,750	kJ/kg

Heat and Mass Balance Diagram
at Performance Evaluation Point
Type of Gas Turbine Siemens SGT5-4000F

Source: JICA Study Team

Figure 6.1.5-4 Heat and Mass Balance Diagram of One (1) Unit of CCPP by Siemens SGT5-4000F Gas Turbine

6.1.6 Condenser Cooling System

There are three (3) types of condenser cooling systems to be considered as the cooling system of the steam turbine condenser for the Project. Those are a once-through cooling system, a cooling tower cooling system and an air cooled condenser system. The merits and demerits of the cooling systems are variable depending upon the site conditions, operating conditions, and economic conditions such as electric power sales price, cooling water cost, chemical cost, etc.

The type of once-through cooling is commonly employed in case that the site is located on a seaside and that the circulating cooling water flow rate sufficient to cool the condenser is available economically without any environmental impacts. The condenser pressure is normally the lowest among the above three (3) types. Therefore, the steam turbine power output is highest. This system is most economical from the plant performance point of view.

The cooling tower cooling system is commonly used in case where sufficient circulating cooling water flow rate is not available economically and the water flow rate to compensate for the evaporation and blow-down losses is obtainable.

The air cooled condenser system is commonly used in case where the site is located in such places as desert and inland areas and water is scarce. The condenser pressure is normally the highest among the three (3) types. Therefore, the steam turbine power output is the lowest. The auxiliary power required to operate the cooling system is the highest because many air draft fans must be operated. The installation footprint area for this system is the largest. However, the system is most friendly to the environment where no water is used.

The once through cooling type is not applicable for the site which is not located on the seaside. The natural draft cooling tower and natural draft air cooled condenser could be conceived, these types, however, are precluded from the study because a huge land area is necessary for the installation of equipment. From these reasons, the Study Team carried out the technical and economical comparison study between the mechanical draft cooling tower cooling system (COOLING TOWER) and the mechanical draft air cooled condenser system (AIR COOLED CONDENSER). The schematic diagrams of the two (2) types of cooling systems are shown in the next page.

(1) Comparison Study of Condenser Cooling Systems

1) General

The merits and demerits of the cooling system are variable depending upon the site ambient conditions, operating conditions and economic conditions such as an electric power sales price, make-up water cost, etc. This study is carried out from technical and economical points of view for the selection of the most suitable cooling system for the Project. The impact on circumferential environments is also examined.

The schematic diagrams of the above two (2) types of cooling systems are shown in Figure 6.1.1-1.

In the combined cycle plant, the performances of the gas turbine which is a topping cycle are not affected by the type of cooling system, but those of the steam turbine of a bottoming cycle are affected. Therefore, it is effectively enough for technical and economic evaluation if the performance that differences only due to the cooling system type of steam turbine are examined.

2) Conditions

a. Type of Combined Cycle Cogeneration Plant

This study shall be conducted for the combined cycle power plant (CCPP) which uses the F-class gas turbine presently available in the worldwide market. Out of several candidate Models of CCPPs, one using M701F gas turbine is used as the case for selection study of the cooling system. As for the parameter of bottoming system, three pressure stage reheat cycle is adopted which is the same system as of Turakurgan CCPP.

b. Site Ambient Conditions

The heat load of the cooling system of CCPP is significantly changeable depending upon the ambient conditions. Therefore, the study shall be performed at the averaged ambient conditions through the year.

For the purpose, the following site ambient conditions are assumed as averaged values through the year.

Averaged dry bulb temperature	13.7 °C
Averaged relative humidity	66.0 %
Averaged wet bulb temperature	10.4 °C

c. Plant Operating Conditions

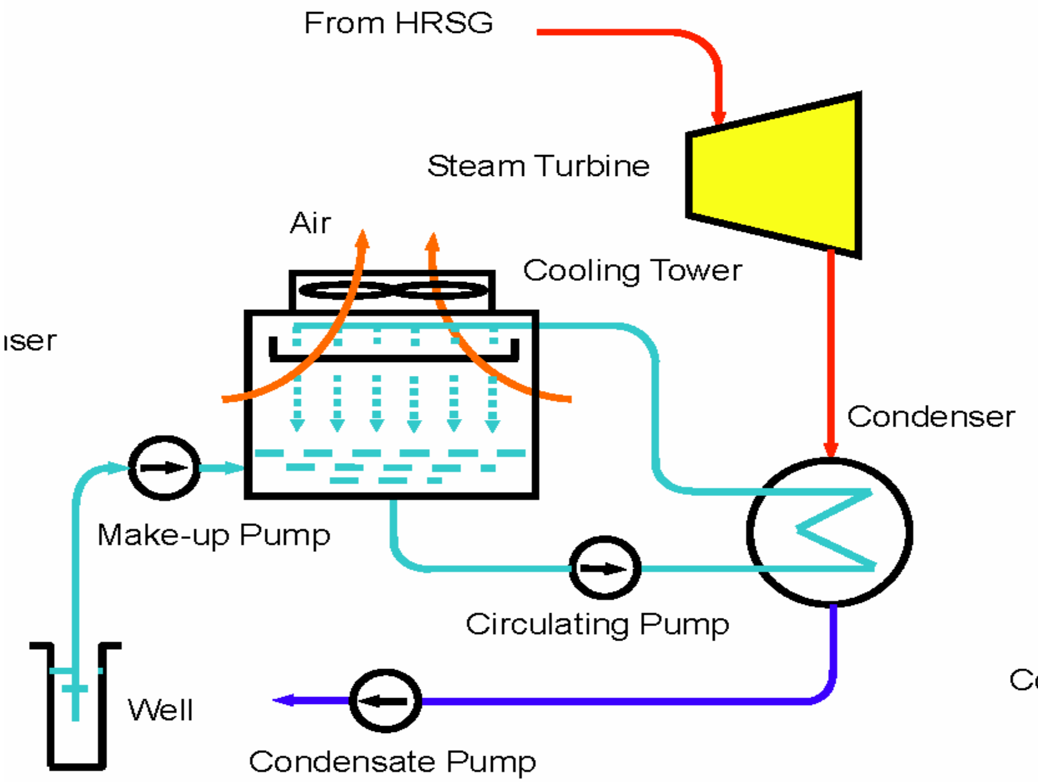
The comparison study is conducted provided that the plant is scheduled to be run at a full power output load with the in-house heat supply of 16.3 Gcal/h per each unit (total 32.6 Gcal/h) and with an annual plant capacity factor of 80.9 % (annual operating hour of 8,000 h and plant load factor of 88.6%).

d. Economic Conditions

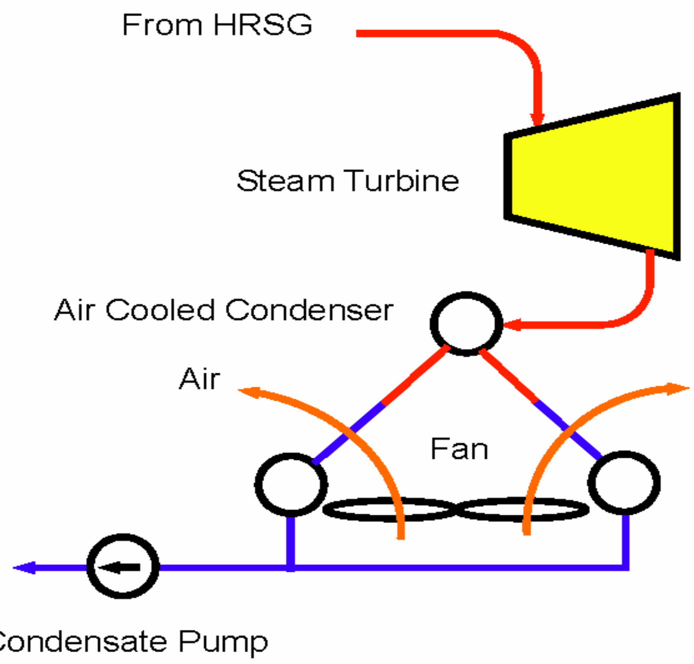
The economic evaluation of the cooling system is conducted comparing the construction cost for the condenser and cooling system plus the loaded costs as the net present values due to the shortage of the annual power sales of the steam turbine and the difference of the maintenance costs among the two (2) types of cooling systems. For the purpose, the following economic indexes are utilized:

Power sales tariff	0.043 US$/kWh (95.9 Sum/kWh)
Canal water unit price	0.058 US$/m3 (129 Sum/m3)
WT chemical unit price	0.50 US$/kg (1,115 Sum/kg)
Annual maintenance cost	
For COOLING TOWER	5.0 % of CT construction cost
For AIR COOLED CONDENSER	1.5 % of ACC construction cost
Discount rate	12.0 %
Transmission and distribution loss	13 %
Evaluation periods	30 years

Escalation rate for power sales tariff and operation & maintenance costs are not considered. And the construction period is not settled for simplification.



Mechanical Draft Cooling Tower Cooling System



Mechanical Draft Air Cooled Condenser System

Source: JICA Study Team

Figure 6.1.6-1 Schematic Diagram of Conderser Cooling System

3) Net Power and Annual Net Sales Power Energy

The steam turbine gross power output at the generator terminals can be obtained through the heat mass balance calculation by estimating the steam turbine exhaust pressure which will be defined at the used energy end point (UEEP) of the steam turbine. The said pressure will be determined for each type of cooling system on specified site ambient conditions. It is normally deemed that the said pressure is equal to the condenser pressure except for the air-cooled condenser. In case of the air-cooled condenser, pressure loss will occur in the steam duct between the steam turbine and the air-cooled condenser.

The net power output (MW) at the power station is defined as the value after the auxiliary powers related to the cooling system are deducted from the gross power output.

The annual net sales energy is estimated by multiplying the net power at the full load by the annual calendar hour of 8,760h and the annual plant capacity factor and deducting the transmission and distribution loss.

a. Estimation of pressure at UEEP

The pressure at UEEP can be estimated from the commonly acceptable characteristic values for each type of cooling system on the site ambient conditions specified above. The estimated pressures for each cooling system are as tabulated in the table shown below:

Description	Temperature and Pressure
COOLING TOWER	
a. Approach temperature (°C)	8.0
b. Cooling range (°C)	8.0
c. Temperature difference (°C)	5.0
d. Condenser saturated temp. (°C)	=10.4+8.0+8.0+5.0 = 31.4
e. Condenser saturated pressure (kPa)	4.60
f. Pressure loss (kPa)	0
g. Steam turbine exit pressure (kPa)	4.60
AIR COOLED CONDENSER	
a. Air temperature rise (°C)	13.7
b. Temperature difference (°C)	8.0
c. Condenser saturated temp. (°C)	=13.7+12.0+8.0 = 33.7
d. Condenser saturated pressure (kPa)	5.24
e. Pressure loss (kPa)	2.45
f. Steam turbine exit pressure (kPa)	7.69

b. Gross power of steam turbine

The gross power of the steam turbine for two (2) types of cooling systems can be obtained from the heat mass balance calculation results for the specified exhaust pressures at UEEP. They are as tabled below:

	COOLING TOWER	AIR COOLED CONDENSER
Gross Power	131,400 kW	127,140 kW

c. Auxiliary power related to cooling system

The auxiliary power of the equipment pertaining to the cooling system is different depending upon its type. The auxiliary powers for the foresaid two (2) types of cooling systems are roughly estimated by correcting the relevant data of similar plants to the site conditions of this Project. The study results are summarized as described below.

COOLING TOWER	
Circulating water pump (Q=25,700 m^3/h, H=21 mH_2O)	1,870 kW
Make-up water pump (Q=497 m^3/h, H=46 mH_2O)	110 kW
Cooling tower air fan (Q=492 m^3/s, H=13.6 mmH_2O)	1,270 kW
Total	3,250 kW
AIR COOLED CONDENSER	
Draft fan for condenser (Q=16,100 m^3/s, H=15 mmH_2O)	4050 kW
Draft fan for other air radiators (Q=1,270m^3/s, H=15 mmH_2O)	350 kW
Total	4,400 kW

d. Net power

From the gross powers and auxiliary powers estimated above, the net powers of steam turbines are calculated as shown below:

	COOLING TOWER	AIR COOLED CONDENSER
Net Power	128,150 kW	122,740 kW

e. Annual net sales power energy

The annual net sales power for two (2) types of cooling systems are estimated as shown below in consideration of the net power, the transmission and distribution loss, and the plant capacity factor.

	COOLING TOWER	AIR COOLED CONDENSER
Annual net sales power energy	790.2 GWh (Base)	756.9 GWh (-33.4 GWh)

4) Technical Evaluation

a. Mechanical draft cooling tower cooling system (COOLING TOWER)

This system is built in areas where the water source with necessary amount of flow rate capacity for a once-through type is not available. The circulating cooling water flow rate of the cooling tower is estimated to be some 25,700 m^3/h including the cooling water for equipment other than a condenser.

In the case of using the cooling tower, some percentage of the circulating water flow rate must be made up to compensate for the blow-down water and evaporation and water drift losses depending upon the design parameters of the cooling tower. The evaporation loss can be calculated as 1.03 % (264 t/h) of the circulating water flow rate for the cooling tower design parameters previously specified and the heat and mass balance previously shown. Some part of the circulating water must be so blown down that the solid concentration in the circulating water is 2 or 4 times that in the make-up water. If the concentration is 2.4 times, the make-up water flow rate shall be 1.93 % of the circulating water flow rate. Therefore, the required make-up water flow rate can be calculated at some 497 t/h (=0.0193×25,690). The blow-down water flow rate can be calculated as 207 t/h. The drift loss is approximately 26 m^3/h.

Depending upon the quality of the make-up water and the contamination of ambient air, any kinds of slime and algae may occur in the cooling system and the tower fills may be scaled. Therefore, any measures by dosing of suitable chemicals must be taken to protect this system from them. However, these matters shall be engineered at the detailed design stage of the project in consideration of types of chemicals which will be locally available.

The maintenance cost of the COOLING TOWER is assumed to be 5.0 % of the construction cost of it. According to preliminary study results, the cooling tower is of a counter flow type and is configured of nine (9) cells each of which is sized at approximately 14 m in length, 14 m in width and 16 m in height with a fan of 9 m in diameter. The total footprint area is approximately 16 m by 130 m. This type of cooling tower is technically matured and many installation experiences exist for various types of power and heat and power plants.

The make-up water for cooling tower will be supplied from the Grand Namangan Canal after treated by clarifiers and brighteners. The study team has had information that the Navoi Nos. 11 and 12 units are suffering from some problems caused by improper make-up water quality where the river water is used as the make-up water. In this connection, slime, algae and scaling may happen on the parts in contact with the circulating water. In order to protect from such problems, water quality control and chemical dosing may be required. Cleaning of the condenser tubes must be carried out off-line.

The mechanical sounds from the axial flow fans and water circulating pumps and dripping sounds of water drops could be supposed as noise sources of this system. The sounds from the axial air fans can be attenuated by employment of low noise type of fans and cylindrical hood at the air exit. The circulating pumps could be covered with the noise attenuation enclosure for reduction of noise as required. The dripping sounds could be minimized by installation of the air inlet louvers. By such noise protection measures as described above, the sound pressure levels around the cooling tower could be suppressed to less than 85 dB (A). As the noise simulation analysis results (the detail of analysis results in the sub-section 8.4.1 to be referred) based on noise data of the main equipment consisting of the plant, the sound pressure levels on the border of the plant was found to be less than the prescribed value.

The cooling tower may be confronted by any inherent problems which occur in freezing weather conditions. Examples include visible plume, ice formation inside the air intake structure and formation of ice board on the ground in the vicinity around the tower. For instance, the installation of the cooling tower is prohibited in the vicinity of highways in the northern parts of USA.

b. Mechanical draft air cooled condenser system (AIR COOLED CONDENSER)
This type of system has been used for the power or heat and power plants which are built in areas where water sources are not available in the vicinity of plants as inland and desert areas. The steam from the steam turbine is directly condensed by ambient air through the finned tubes. For this purpose, large amount of surface area is required for the heat transfer finned tubes because of less heat transfer coefficient between the air and steam.

As described in the previous sub-section, the net power output of the steam turbine with the AIR COOLED CONDENSER is less than that with the COOLING TOWER.

The finned tubes can be kept clean by employment of automatic water wash devices which will be periodically operated on-line. The cleaning interval shall be decided, depending upon the fouling tendency of them. In case of clean air condition, the cleaning interval is said to be commonly a half year. The site for this Plant belongs to a clean, uncontaminated area, unlike other industrial areas. It is supposed for the finned tubes to be less contaminant. The air leakage into tubes could be detected by use of an infrared camera. The finned tubes where the leakage will be detected could be blinded with plugs and be replaced when the plant is at standstill. Therefore, any routine maintenance is basically not required.

In consideration of above statements, the annual maintenance cost of AIR COOLED CONDENSER is assumed to be 1.5 % of the construction cost of it.

The air cooled condenser may also confront any inherent troubles which happen in the freezing weather season. However, according to our study results, many air cooled condensers are installed in areas where the ambient temperature is far lower than minus 20 °C. Table 6.1.6-1 shows a sample application experience with air cooled condensers installed in areas where the lowest ambient temperature is lower than minus 20 °C.

According to study results for the Project, the air cooled condenser system is configured of twenty four (24) modules with four (4) streets. Each module is approximately sized at 12 m by 13 m with a fan of 9 m in diameter of 140 kW power requirements. The totally required footprint area for installation of the air cooling system is approximately 60 m by 80 m. The height is some 20 m.

The AIR COOLED CONDENSER is technically matured and there are many installation experiences with such large capacity systems as required for this Plant as shown in the Table 6.1.6-1 this table shows the worldwide reference list of one (1) major air cooled condenser manufacturer for combined cycle plants installed in sites where the minimum ambient temperature is lower than minus 20 °C. From this table, it is definitely clear that there are many experiences with air cooled condensers for the combined cycle plants, which have been installed in sites of freezing weather conditions. In addition, many AIR COOLED CONDENSERs are installed in desert areas where there is no cooling water. This means that the AIR COOLED CONDENSER is applicable for ambient conditions as high as 40 °C.

The mechanical sounds from the axial air fans are supposed to be the noise source of the mechanical draft direct air cooled condenser. It is possible that the sound pressure levels around the condenser will be allowable from the environmental consideration point of

view by employment of lower noise fans and installation of noise protection skirts at the air inlet. For example, it is confirmed that the noise levels on the ground level around the similar mechanical draft air cooled condenser located in Japan are less than 85 dB(A).
As the noise simulation analysis results in accordance with the noise data of the main equipment consisting of the plant, the sound pressure levels on the border of the plant are found to be less than the prescribed value.

5) Economic Evaluation

a. Loaded cost due to shortage of annual net sales power

The loaded cost is defined to be equal to the net present value (NPV) due to the shortage of the annual net sales power by the steam turbine between COOLING TOWER and AIR COOLED CONDENSER. In this case study, the annual net sales power energy is 790.2 GWh for COOLING TOWER and 756.9 GWh for AIR COOLED CONDENSER as shown in the previous sub-section 3) e. The net present value (NPV) of the cost to be loaded to AIR COOLED CONDENSER can be calculated with the following formula.

$NPV= f_{NPV}$ x S x P

Where,

P: Power sales tariff (US$/kWh)

S: Shortage of annual sales power enrgy (kWh/annum).

F_{NPV}: Net present value factor which is defined as the ratio of the present value of annual costs for a lifetime to the annual cost continued for the lifetime and given by the following equation.

f_{PV} = Present value of annual costs for a lifetime / Annual cost

= 1/(1+i/100)^1 +1/(1+i/100)^2+1/(1+i/100)^3+…….+1/(1+i/100)^n

= {1-1/(1+i/100)^n} / {(1+i/100)-1} = 8.06

where,

i: Annual discount rate (%), 12%

n: Plant service life (year) , 30 years

Substituting the said preconditioned values in the previous sub-section 2) d and the shortage of annual net sales power energy (33.3 GWh/annum) of AIR COOLED CONDENSER into the above equation, the net present value factor f_{NPV} = 8.06 and the loaded cost due to the shortage of annual sales power can be calculated as shown below:

	COOLING TOWER	AIR COOLED CONDENSER
Loaded Cost	(Base)	+11.6 MMUS$

b. Equipment Maintenance Cost

The present values of equipment maintenance cost for the both systems can be calculate from the annual maintenance costs using the same present value factor as that of the previous sub-section. The costs are calculated as shown below.

	COOLING TOWER	AIR COOLED CONDENSER
Annual cost	0.98 MMUS$/annum	0.32 MMUS$/annum
Present value of annual cost	7.9 MMUS$	2.6 MMUS$

c. Makeup water cost

COOLING TOWER needs the canal water to make up the evaporated and blown down water. Therefore, the cost of water and the cost of dosing chemical is required. The net present values of these costs can be calculated as shown below.

	COOLING TOWER	
	Make up water	Chemical
Chemical dosing	497t/h	100ppm
Annual consumption	3.63 million ton	363 ton
Annual cost	0.21 MMUS$	0.18 MMUS$
Present value of annual cost	1.6 MMUS$	1.4 MMUS$

d. Construction cost for both cooling systems

The construction costs for the both cooling systems are estimated through the computer software referring the relevant cost of similar projects and hearing from certain manufacturer of the air cooled condenser. The estimated costs are summarized as shown below:

	COOLING TOWER	AIR COOLED CONDENSER
Water Cooled Condenser	4.1	-
Cooling tower system	13.4	-
Canal water treatment system	2.0	-
Air Cooled Condenser	-	21.2
Total	19.5	21.2

As shown in this table, the construction cost of AIR COOLED CONDENSER is higher by 1.7 MMUS$ than COOLING TOWER.

d. Construction cost plus Operation & Maintenance cost

The construction cost plus the operation and maintenance cost for both types of cooling systems are as tabulated below from values estimated above.

	COOLING TOWER	AIR COOLED CONDENSER
Construction cost	19.5 MMUS$	21.2 MMES$
Shortage of sales power	Base	+11.6 MMES$
Other O & M cost	10.9 MMES$	2.6 MMES$
Total	30.4 MMES$	35.3 MMES$
	(Base)	(+4.9 MMES$)

As can be seen from above figures, the COOLING TOWER is more advantageous by 4.9 MMUS$ compared to the AIR COOLED CONDENSER.

Table 6.1.6-1 Reference List of Air Cooled Condensers for Combined Cycle Plants with Minimum Ambient Temperature less than Minus 20 °C

Project Name	Country	Plant Capacity (MW)	Steam Flow Rate (t/h)	Number of Units	Start-up Year	Min. Operating Temp (°C)
Dominion-Front Royal	USA	1,329	1,467	1	2013	-28.9
Deer Creek	USA	300	395	1	2011	-41.0
Nikiski	USA	80	145	1	2011	-43.9
Dominion-Sait Paul	USA	585	1,353	1	2010	-20.0
Haibowan	China	400	480	2	2009	-32.6
Torino North	Italy	400	374	1	2009	-20.0
Turano Lodigiano	Italy	800	680	1	2009	-25.0
Halton Hils	Canada	670	766	1	2009	-31.0
Goreway Ontario	Canada	800	942	1	2007	-31.0
Astoria, Newyork	USA	500	460	1	2005	-25.0
Poletti, NY	USA	650	490	1	2004	-25.0
Ravenswood, NY	USA	250	278	1	2002	-25.0
Fore River, MA	USA	800	658	1	2002	-25.0
Mystic I & II, MA	USA	1,600	658	2	2002	-25.0
Bellingham, MA	USA	250	256	2	2001	-30.0
Blackstone, MA	USA	250	256	2	2000	-30.0
Lake Road, CT	USA	250	256	3	2000	-30.0
Quetta	Pakistan	130	145	1	1997	-25.0

6) Recommendation
For selection of cooling system for this project, two (2) possible candidates of COOLING TOWER and AIR COOLED CONDENSER were studied and compared.

The total evaluation cost of the COOLING TOWER is lower by 4.9 MMUS$ (per each unit of CCPP) than the AIR COOLED CONDENSER.

For the reasons stated above, the Study Team would like to recommend the COOLING TOWER as the type of cooling system of this project where there is no water suitable for make-up available in the project site.

6.2 Plot Plan

The Turakurgan Thermal Power Station will be located in the district of Turakurgan, located on the right side of the bank of Grand Namangan Canal.
The conceptual arrangement of Turakurgan Thermal Power Station is as shown in Figure 6.3-1.

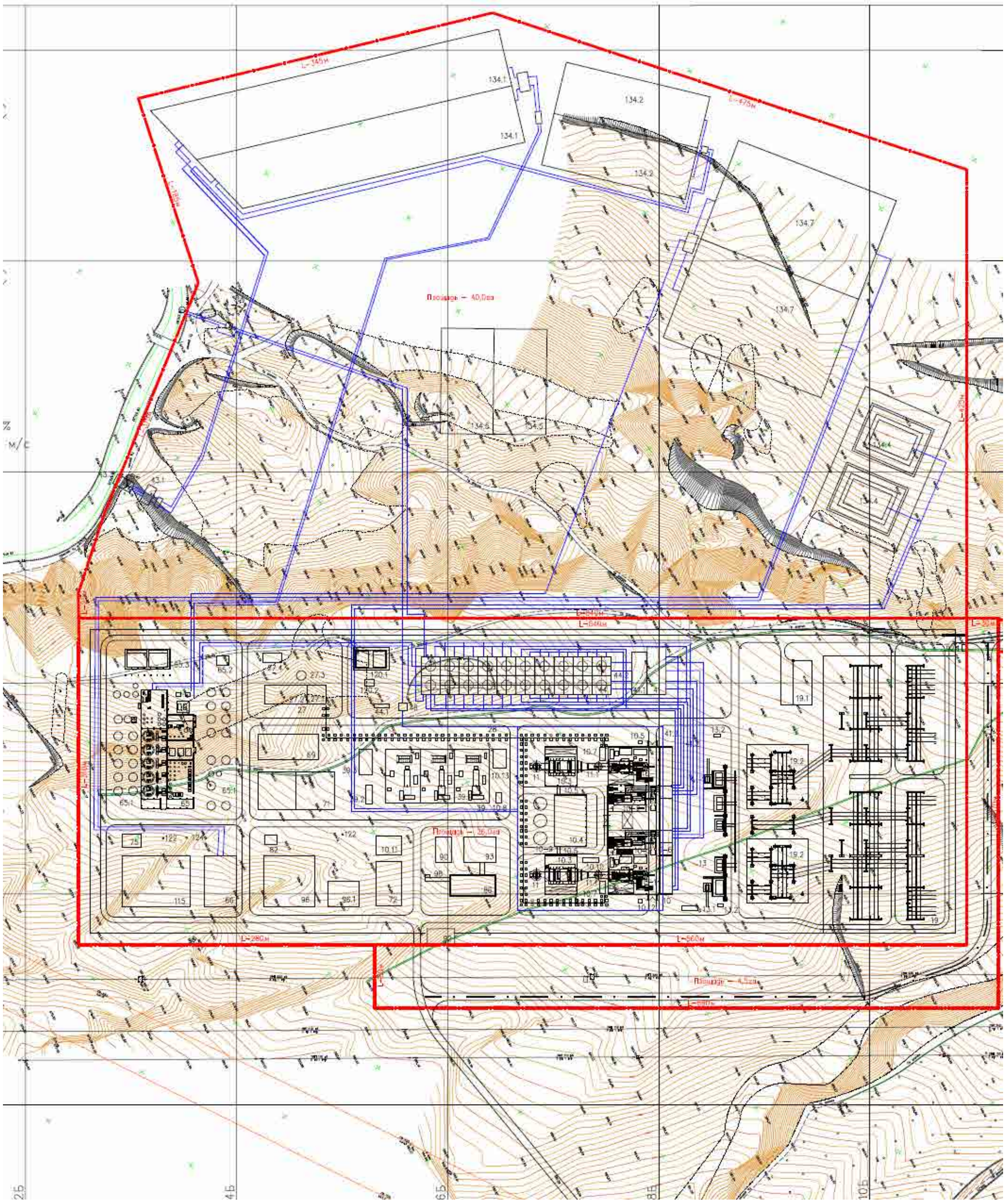


Figure 6.3-1 Plot plan

6.3 Basic Systems for Plant Design

6.3.1 Gas Turbine System

(1) Design Codes and Standards

The gas turbine system shall be basically designed as per ISO 3977-3 “Gas turbines-Procurement-Part 3: Design requirements” and ISO 21789 “Gas turbine applications-Safety.”

(2) Gas Turbine

The gas turbine shall be of single shaft configuration, open cycle, heavy duty F class temperature level type with dry low NOx design suitable for the specified natural gas.

The gas turbine design shall be with a minimum number of bearings, and shall be located on a steel frame or on adequate steel structures and concrete foundation, so sized as to withstand the transient torque imposed on the shaft in case of short circuit of the generator or out-of-phase synchronization, whichever is larger. The power output shall be taken out at the cold end of the shaft.

The gas turbine shall be complete with all auxiliary systems such as starting system, lube oil supply system, inlet air filtration system, fuel gas supply system, turning device, control and monitoring equipment necessary for safe, reliable and efficient operation with the fuel specified. The gas turbine shall be designed for indoor installation in an enclosure to meet the specified noise requirements.

The gas turbine shall be designed for continuous base load operation according to the manufacturer’s standard, burning natural gas with the specified composition range. The gas turbine shall be capable of start-up, loading and shut down using the specified natural gas.

The gas turbine shall be provided with an automatic start-up and control system capable of being operated from the central control room of the plant.

The control system of the gas turbine shall be such that it is capable of performing the following operations as a simple and combined cycle:

- Constant load operation at all loads between the minimum and full loads
- Governor free (droop) operation
- Turbine inlet temperature constant operation
- No load operation for certain periods of time without being not synchronised as a simple cycle
- Minimum load operation not more than 30% of the full load as a combined cycle on the full power of the steam turbine keeping all the bypass valves closed.
- Automatic purging cycle to ensure that specified natural gas is removed from the gas turbine and entire exhaust system up to the exit of the stacks. Purging time shall be adjustable.
- The load rejection from the full load without tripping for easy re-synchronization.

The gas turbine shall be of horizontally split case construction for convenience for maintenance and shall permit easy access to plantary and moving blades without undue difficulties.

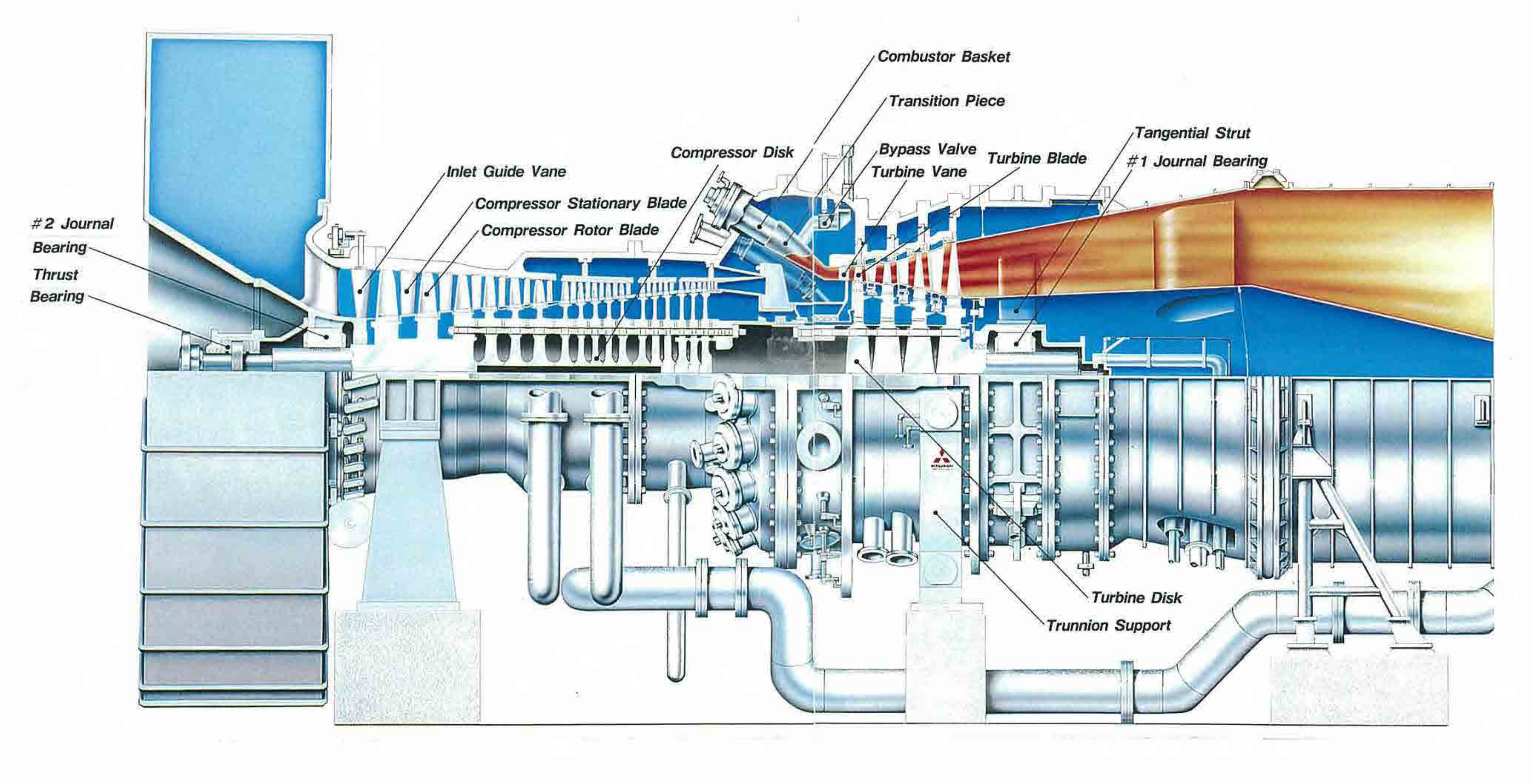
The entire gas turbine casing shall be heat and sound insulated in such a manner as to allow easy removal and replacement for overhaul and inspection. The insulation material shall be of asbestos free non-combustion and chemically inert material and shall be covered by sheet metal. The design of the heat and sound insulation shall be in a manner to avoid the lube oil soaking in.

Around the gas turbine there shall be working space of at least 0.8 m width without any interference by piping, cabling, walls, etc.

The journal bearings shall be of sleeve bearing type. The axial thrust force shall be oriented in one direction during all steady state operating conditions and shall be absorbed by an adjusted axial thrust bearing. All main bearings of hydrodynamic type shall be equipped with bearing oil outlet temperature indicators and monitors and vibration indicators and monitors. The monitors shall be capable to actuate alarm and/or trip as per manufacturers' practices.

Borescope parts for inspection of all critical inner parts shall be provided.

Figure 6.3.1-1 shows the longitudinal cross section of the typical F-class gas turbine which is one of the candidate gas turbines applicable for this Project.



Source: MHPS Catalogue

Figure 6.3.1-1 Longitudinal Cross Section Drawing of Typical F-class Gas Turbine

(3) Starting System
The starting device and associated power supply equipment shall be suitable for the acceleration of the gas turbine/generator and the extended operation during purge and compressor cleaning cycles. The rating of the starting device shall be determined so as to produce the starting and acceleration torque with a proper margin to allow for the gas turbine/generator to accelerate to the rated speed from standstill within 25 minutes (excluding the purge and synchronization time) on all machine state conditions without any difficulties throughout the specified ambient temperature range. The starting device and starting power supply capacity shall be minimized as long as the train will be accelerated within the specified time.

The following two (2) types of starting devices are conceivable for such a large capacity gas turbine and generator of the separate shaft type CCPP as required for this plant.

- A synchronous generator/motor with a static frequency converter
- A squirrel cage type motor with a torque converter

The starting system should preferably be rated without limit on the number of starts attempted in succession and without restricting the rate of starting.

Interlocks shall be provided to prevent the gas turbine/generator from starting in case the lube oil pressure is not sufficient to rotate the gas turbine/generator rotor.

Any starting device shall disengage automatically and shut down before it reaches the maximum allowable speed. The starting device is normally disengaged at the self-sustaining speed or idle speed and is at rest during operation. Failure of the disengagement shall automatically abort the starting sequence.

The gas turbine/generator shall be capable of starting instantaneously from any standstill conditions as long as it is on reserve condition.

The starting control system, including any pre-start actions such as turning, shall be of manual and automatic as defined below:

Manual start: The start-up sequence shall be held and advanced at the events such as cranking, purging, firing and at the minimum governor setting speed.

Automatic start: The start-up sequence shall be automatically advanced to the minimum governor setting speed or the readiness to synchronizing or to the pre-set load.

The starting control system shall be provided with an automatic purge function to ensure safe operation.

(4) Lube Oil Supply System
The lube oil supply system shall be basically designed as per the requirements of the latest version of API 614. A complete lube oil system shall be provided and shall be fully integrated with jacking oil system (if applicable), oil purification system and dirty oil drains for the gas turbine/generator. The lube oil system shall have sufficient capacity to accommodate the requirements of the systems that will be supplied with the lube oil.

The system shall include sufficient standby equipment to allow any items of equipment within the lube oil system to be taken out of service for maintenance without restricting the operation of the plant.

The lube oil system shall be preferably separated from that of the steam turbine/generator.

The retention time of the oil reservoir shall not be less than eight (8) minutes based on the normal flow rate of oil and the retention capacity which is the total volume below the minimum operating level in accordance with API Standard 614.

Alarms shall be at least made on the occurrence of the following situations:

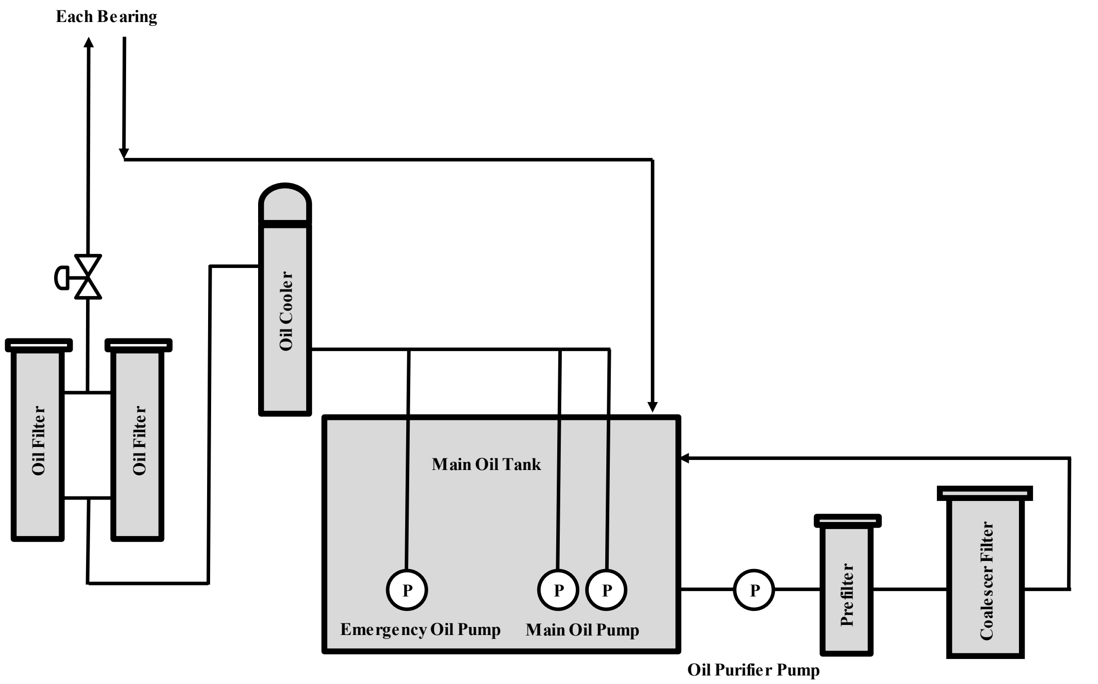
- Lube oil supply pressure low
- Lube oil reservoir level low
- Lube oil discharge temperature high
- Lube oil supply temperature high
- Lube oil filter differential pressure high

All bearing drain lines and oil wells are to be provided with visual indicators capable of being observed from a local platform or operating floor level.

The outlets of relief valves shall be routed to the oil reservoir tank.

In the event of AC power failure, the emergency DC oil pump to be operated for rundown of the rotating shafts and bearing cool-down shall be automatically put into operation. A combined AC/DC tandem motors-driven pump shall not be accepted.

Where oil is supplied from a common system to two (2) or more machines, the characteristics of the oil shall be specified by the Contractor. The Contractor shall ensure that the specified oil meets the requirements of the different machines and is locally procurable. Figure 6.3.1-2 is a typical flow diagram of lube oil supply system



Source: JICA Study Team

Figure 6.3.1-2 Typical Flow Diagram of Lube Oil Supply System

(5) Fuel Supply System

The gas turbine combustion system shall be of a single-fuel design burning the specified natural gas indigenous in Uzbekistan.

The natural gas pipeline terminal point is located outside the power plant boundary fence. The pressure at the terminal point is specified from 0.6 to 2.3 MPa (g). The dust particle distribution data necessary for design of the pre-treatment facility will be examined in due course of time.

The fuel gas supply system shall be such that it can supply the gas turbine with the specified natural gas under normal conditions with a proper pre-treatment, and the necessary booster compressor plant as per required under worst supply conditions.

The fuel gas supply system shall cover all the equipment required for the start-up, shut down and continuous operation of the gas turbine. A flow metering valve, pressure-regulating valve, shut-off valve, flow meter, fine filter and distributing manifold, but not limited to such equipment, shall also be included in the scope.

Any fuel gas heating facility where the fuel gas may be heated with hot air extracted from the gas turbine compressor as a turbine cooling media for improvement of the thermal efficiency of the plant may be provided depending upon the gas turbine manufacturer.

Any other conditions necessary for the design of the gas turbine shall be examined at the detailed design stage.

(6) Air Intake System

1) General

The air supply for a gas turbine shall be taken from a high-level atmospheric air inlet external to the gas and steam turbine building. The air intake shall also be positioned to avoid the ingress of any exhaust gases from the main stack of the heat recovery steam generator.

The design of the hood shall permit ready access to the air filtration system. After filtration, the air shall be directed to the inlet flange of the gas turbine compressor.

The intake system shall be complete with inlet screen and louvers, filters, airtight duct from filters to compressor inlet, foreign object damage protection screen, sound attenuators and all controls and instrumentation necessary for safe control.

The number of access points and penetrations into the air inlet system for maintenance and inspection shall be minimized. Any door or hatch shall be capable of being securely locked, and interlocks shall be provided to prevent any attempted start with any door or hatch not properly closed.

2) Air Filtration System

The air intake filtration system shall be accomplished by a multi-stage dry system. The filter elements shall be preferably of washable reuse type to minimize industrial waste. The air filtration system shall be so designed that its initial weight arrestance efficiency will not fall below 95.0 % for ASHRAE test dust.

The replacement interval of filter elements shall not be shorter than 6,000 operating hours for the dust concentration of 0.1 mg/m^3 with ASHRAE test dust.

The air intake shall be equipped with a silencer downstream of the filtration system and the whole of the ducting shall be sealed to avoid ingress of unfiltered air.

The air filters chosen shall be suitable to reduce the sand, dust and salt content of the atmospheric air to a level which is not detrimental to the life of the gas turbine unit and under the most adverse atmospheric conditions of the site.

A self-cleaning type air filtration system shall be acceptable as an alternative. The filter system shall be composed of high efficiency media filter cartridges, which can be cleaned automatically by reverse pulses of compressed air taken from the intermediate stage of the gas turbine air compressor. The sound pressure level during the reverse cleaning operation shall not exceed 85 dB (A) at the distance of 1 m from the system.

The design shall minimize the inlet system pressure drop. The instrumentation and control equipment shall also be kept to a minimum but must include a differential pressure monitor across every stage of the filtration system.

3) Air Inlet Ductwork

The ductwork shall be complete with all the necessary expansion joints, guide vanes, supports and supporting steelwork, vibration isolators, flanges, silencing equipment, cladding and any other items necessary to complete the system.

The expansion joint shall be such that no loads or forces are transmitted to the gas turbine inlet flange.

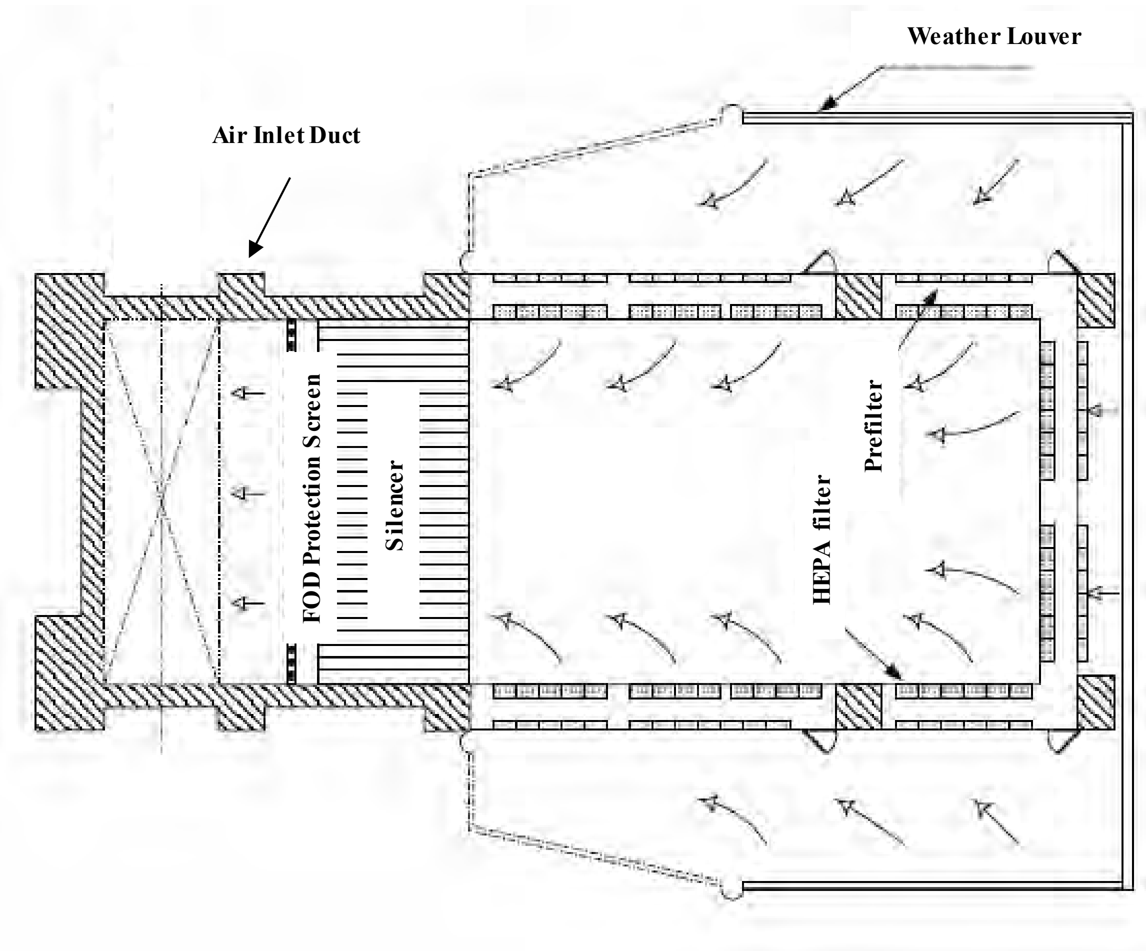
Sliding joints shall not be used in the ductwork. All expansion joints shall be flanged for removal without disturbing the main sections of the ductwork.

No entrapped nuts, bolts or rivets shall be used inside the ductwork downstream of the filtration system.

Bypass doors shall be provided in the ductwork to allow the air filtration system to be bypassed in the event of excessive differential pressure across the filtration system. The construction of the bypass door shall be preferably of a counter weight type. An alarm in the control room shall be initiated on high filter differential pressure. On further increase in differential pressure, a further alarm shall be initiated together with automatic opening of the bypass doors.

4) Silencer
A silencer shall be provided to control the noise from the air compressor to the specified level. The silencer acoustic panels shall be designed for the service life of thirty (30) years at the full load condition of the gas turbine. The silencer shall be capable of being removed from the ductwork without dismantling or removing any other ductwork than that containing the silencer. The silencer acoustic panels shall be constructed from stainless steel. The infill and panels shall be fully resistant to the worst atmospheric conditions anticipated on the site. Precautions shall be taken to prevent settling or packing of the infill material. The infill material shall be vermin proof.

5) Foreign Object Damage (FOD) Protection Screen
Since there is a possibility of foreign objects entering the gas turbine and causing damage of rotating parts, the FOD protection screen shall be installed at the compressor inlet to reduce the size of objects that can enter to a size that is not liable to cause such damage. The location of the screen shall be sufficiently upstream to avoid the potential for large objects to cause significant localized flow blockage that may induce blade failure.



Source: JICA Study Team

Figure 6.3.1-3 Typical Air Intake System

6.3.2 Steam Turbine System

(1) Design Codes and Standards

The steam turbine system shall be basically designed as per the latest version of ISO 14661 “Thermal turbines for industrial applications” or equivalent codes and standards.

(2) Steam Turbine

The steam turbine shall be of a reheat, three (3)-admission, two (2)-casing, full condensing type directly connected to the generator. The steam shall be downward exhausted to a surface condenser which is cooled by circulating seawater of a once through type cooling system.

The steam turbine shall be of a three (3) pressure-level turbine with HP, IP and LP sections.

The steam turbine and ancillary systems shall be designed to run continuously under all specified conditions over the specified lifetime of the plant.

The steam turbine maximum capability shall be defined so as to cope with such parameters as steam pressure, temperature and flow rate to be developed by the HRSG under conditions where the gas turbine is operated at the maximum capability ambient temperature.

The steam turbine shall be complete with all auxiliary systems such as a steam condenser, lube oil supply system, control oil supply system, admission steam stop and throttling valves, governing system, steam bypass system, turning device, and control and monitoring equipment necessary for safe, reliable and efficient operation. The steam turbine shall be designed for indoor installation in an enclosure suitable for specified noise level requirements.

The steam turbine design shall be with a minimum number of bearings, and shall be located on a steel frame or on adequate steel structures and concrete foundation, so sized as to withstand the transient torque imposed on the shaft in case of short circuit of the generator or out-of-phase synchronization, whichever is larger. The power output shall be taken out at the LP turbine section side.

The turbine blading shall be designed so that it withstands the continuous operation under any loads at any network frequency from 48.5 to 51.5 Hz with any allowable time limitation for frequency less than 48.5 Hz.

Blades shall be thoroughly protected against erosion from moisture. The last stage blades shall be protected against erosion by flame hardening or by erosion shields of stellite or other suitable material. Other erosion protection provisions, such as drain grooves on the last few stator blades and turbine casing, will also be considered if such provisions are proven to be effective.

The steam turbine shall be designed so that the expected life expenditure of the main components shall not exceed 75% of their expected lives through the specified service hours when it will be operated under specified conditions.

The turbine shall be provided with the necessary number of borescope parts to inspect the conditions of the blades at periodical intervals.

The steam turbine shall be designed with proven materials having a wealth of commercial operating experiences under similar operating conditions. In particular, special attention shall be paid to the material of the integrated single rotor where operating conditions are different in the front and rear parts.

As for the design of the casing and its pipe connections, it shall be taken into account that the most severe conditions of pressure and temperature may simultaneously be applied to them. In addition to the calculated minimum thickness of the casing, allowance shall be made for corrosion if the casing is not of a corrosion-resistant material.

The rotor shall be designed to be safe against the speed of at least 10% above the momentary speed which may be liable to occur when the full load is shed under the maximum capability ambient conditions. If the rotor is of built-up construction, the disc shall remain secure at the speed mentioned above.
Figure 6.3.2-1 is a longitudinal cross section of a typical steam turbine which may be applicable for this project.

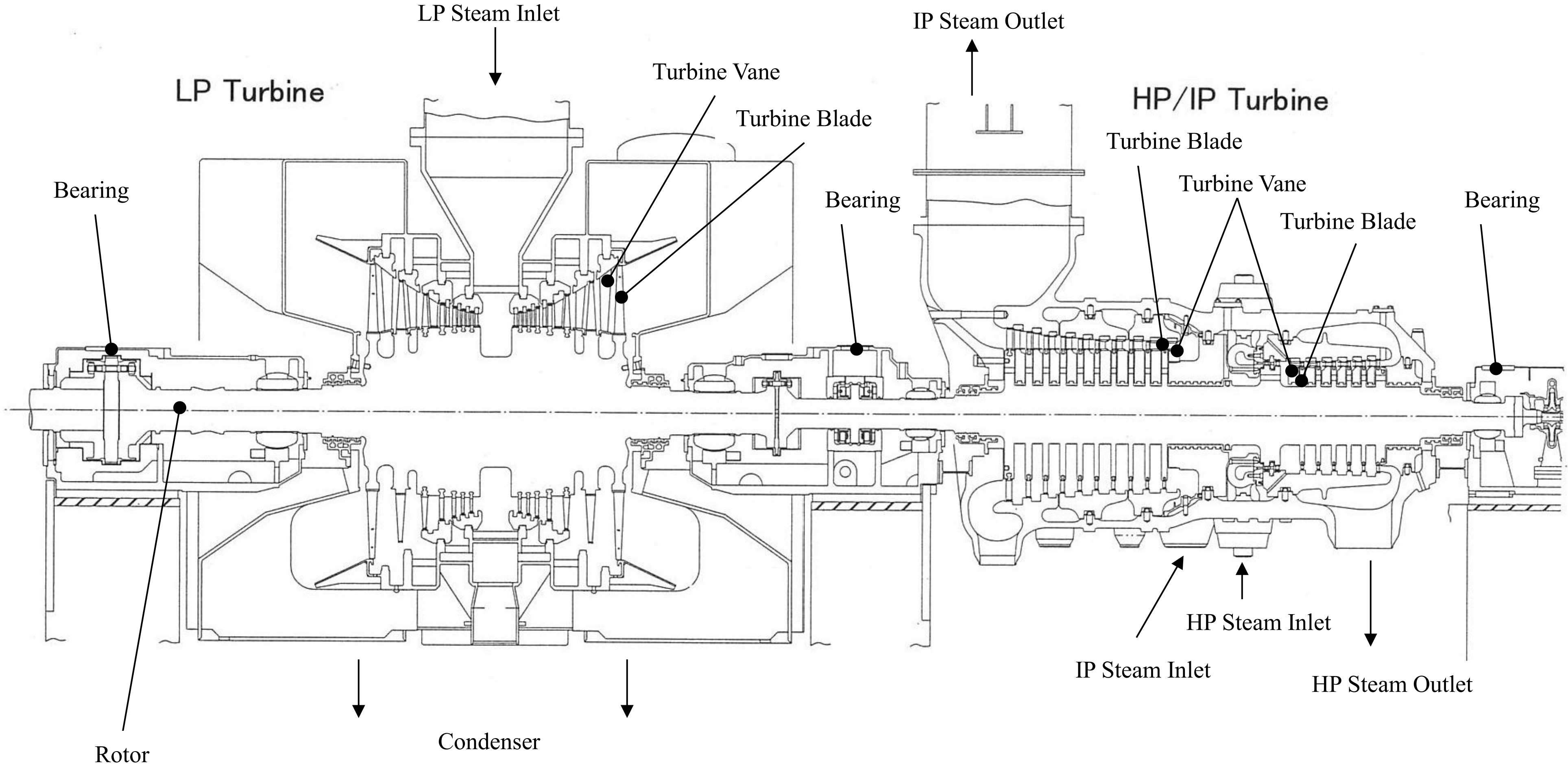


Figure 6.3.2-1 Longitudinal Cross Section of a Typical Steam Turbine

6.3.3 Heat Recovery Steam Generator (HRSG) System

(1) Introduction and Scope

This part of the specification covers the two (2) Heat Recovery Steam Generators (HRSGs) complete with ducting, mountings, integral valves and pipes, and other specified items associated with the two (2) gas turbine generators of the combined cycle block.

The HRSG shall be of triple-pressure, natural or forced circulation, reheat type indoor installation of proven design in accordance with the requirements of the ASME B&PV Code or equivalent, where applicable. It shall be designed to accept the maximum exhaust gas mass flow from a gas turbine at base continuous output with minimum specified ambient temperature, and the heating surfaces shall be designed to take into account the variation on the temperature/flow profile which will occur in the gases leaving the gas turbine under differing loads and ambient conditions.

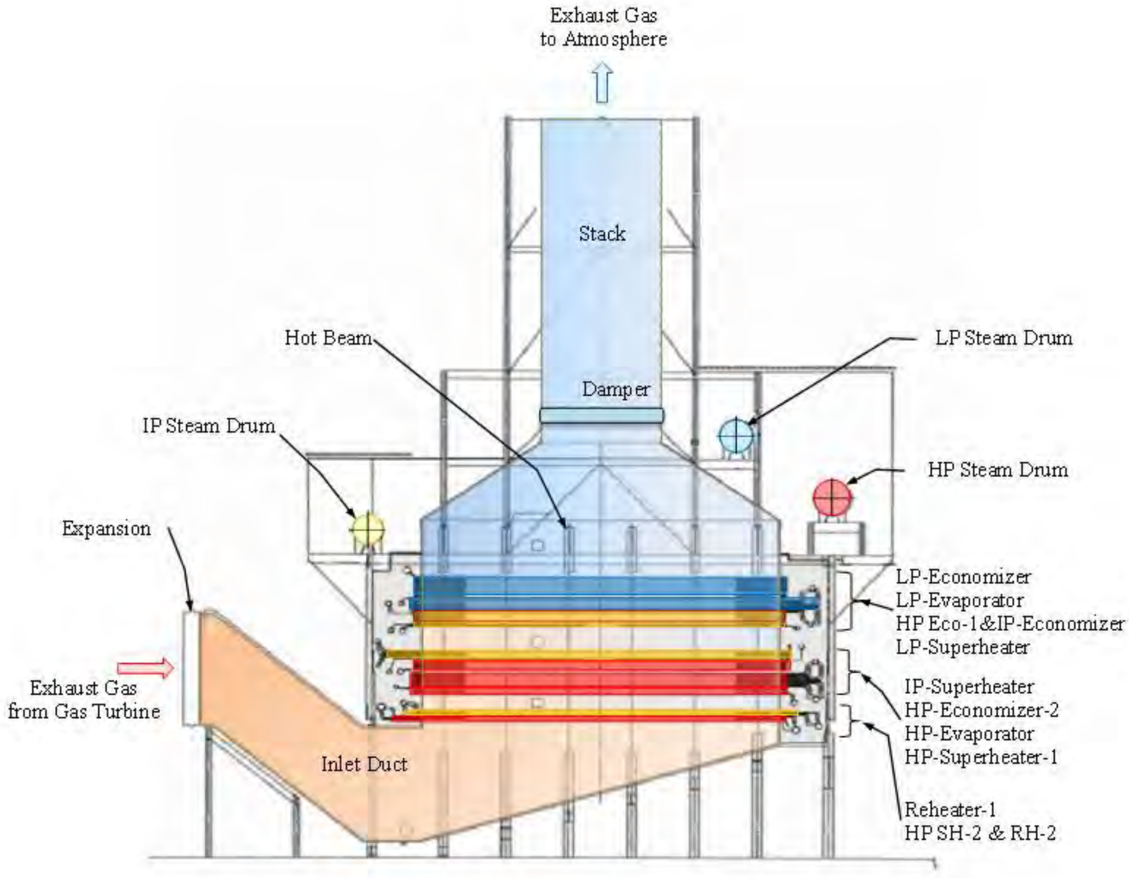
The HRSG shall be capable of following, with use of the modulating control damper, the inherent rapid start-up and shut down of the gas turbine without undue thermal stress. It shall be designed to operate on the exhaust gas of the gas turbine when fired exclusively with natural gas fuel.

An exhaust gas bypass system with bypass stack shall be incorporated to improve flexibility of the combined cycle operation.

The HRSG design shall be such as to minimize the back-pressure on the gas turbine while maintaining the rated output and steam conditions. It should be constructed of large, factory-tested, shippable modules to reduce installation time.

The following heat transfer modules shall be considered, as applicable, for the HRSG design:

① High Pressure Superheater Section
② High Pressure Evaporator Section
③ High Pressure Economizer Section
④ Reheater Section
⑤ Intermediate Pressure Superheater Section
⑥ Intermediate Pressure Evaporator Section
⑦ Intermediate Pressure Economizer Section
⑧ Low Pressure Superheater Section
⑨ Low Pressure Evaporator Section
⑩ Low Pressure Economizer Section
⑪ Condensate Preheater Section (if required)



Source: JICA Study Team

Figure 6.3.3-1 HRSG of Vertical Gas Flow Type

To minimize the outage time for inspection and maintenance, provision shall be made to allow ready access to the flue gas path, tubing, and other pressure parts. Access doors with integral seals to prevent gas leakage into the atmosphere shall be provided.

The HRSG shall be designed for outdoor installation and shall be entirely weatherproof. Canopies shall be provided to protect both personnel and equipment (drum fittings, valve and circulating pumps) from the external environment.

The steam drums shall be sized sufficiently large to accommodate water level variations during start-up and during operating transient conditions without resorting to wasteful water dumping or risk of carry over. The drum capacity shall also be sufficient such that tripping of any one (1) operating boiler feed water pump shall not cause the HRSG to trip prior to standby boiler feed water pump reaching its operating load. Particulars of the general layout of the water circulating system, including the number and internal diameters of the feeders and mains for each circuit, shall be provided.

The HRSG shall be arranged with the total pressure parts comprising steam drums, superheaters, reheaters, evaporators, economizers, headers, down comers and integral pipe work in the form of a self-contained unit supported by its own steel structure. This structure is to be quite independent of any building except for normal points of interconnection with access galleries, platforms, or stairways.

The design of the HRSG and associated ancillary and auxiliary systems shall have been developed for both base load and cycling service in particular where component material stress and structural design are concerned. Any special features for the HRSG necessary to permit both constant and variable pressure operation for the turbine steam temperature matching shall be incorporated.

(2) Design and Operating Conditions
The HRSG shall be suitable under normal and abnormal operating conditions to match the proven combined cycle plant design as per the Heat Balance Diagrams. The gas side of the HRSG passages shall be designed for the maximum temperature, pressure and mass flow that can be anticipated under all operating conditions (including a trip situation). The maximum values will not necessarily be concurrent.

The HRSG shall be able to meet the requirements of a sustained base load as well as two (2)-shift operation.

The HRSG shall be capable of automatic variable pressure operation both for sustained base load as well as two (2) cycling regimes, to minimize the turbine thermal stress levels and obtain the desired flexibility and efficiency. The manufacturer shall define the variable pressure characteristics of the HRSG including the minimum load at which variable pressure operation can be sustained.

Under conditions of total load rejection, the thermal load on the HRSG shall be rapidly reduced to the capacity of the steam bypass system by means of the exhaust gas bypass modulating control dampers.

The starting and loading to full load of the gas turbine shall not be restricted in combined cycle operation. It is intended that the diverter damper shall be capable of being operated in a number of pre-fixed intermediate positions to cater for hot, warm and cold starts of the HRSG with the gas turbine operating at full load as well as during HP/LP bypass operation.

The HRSG is to be designed such that it can be started-up in the following two (2) operating modes:

⑫ Start-up together with GT; and
⑬ Start-up of HRSG when the GT is already operating at full load. Flue gas regulation shall be achieved by regulating the diverter damper.

The HRSG design shall be optimized for continuous efficient operation over the entire operating range of the gas turbine. The efficiency between 70% and 100% MCR shall be maximized.

The feed water quality shall meet the requirements of the HRSG and steam turbine as per the applicable codes.

(3) Design Standards and Codes of Practice
All materials, designs, manufacture, construction, and inspection and testing shall conform to criteria and recommendations of the relevant codes and standards.

All pressure parts, mountings, fittings and sub-assemblies shall be designed, constructed, and tested to conform to the requirements of the approved Inspection Authority.

(4) Design and Construction of HRSG

1) HRSG Gas Path

The gas turbine exhaust gas path through the HRSG shall be horizontal or vertical with water and steam tubing located horizontally/vertically across the gas stream to suit the plant layout and as per the manufacturer's standard design.

The heating surfaces of various modules in the gas stream shall reduce the gas temperature to the lowest value practicable, with each of the fuels available to the gas turbine, without risk of damage from corrosive sulfur products at the economizer outlet or within the stack. Control of the feed water temperature to ensure that metal temperatures in any part of the economizer remain above the dew point shall be achieved via the deaerator.

The tubes and headers in each plenum shall be completely drainable and provision shall be provided to gain access to the tubing for inspection and maintenance.

2) Tubes

The tubes shall be of solid drawn or electrical resistant welding (EWR) steel as per the manufacturer's experience. The design, manufacture and testing of the tubes shall be in accordance with the relevant standard specification.

Adequate circulation ratio shall be provided to minimize circulation upsets that may occur during rapid start-up or load change. Fins added to the heat exchanger tubing to improve the heat transfer characteristics must be continuously welded to the outside surface of the tubes. All welds and tube connections to headers shall be outside the gas passage and readily accessible for inspection and maintenance.

3) Superheaters and Reheaters

The HP superheater tubing shall be designed and located in the HRSG unit such that the steam temperature at delivery to the steam turbine will not exceed the HP steam chest and rotor stated limits, with the gas turbine at base continuous output with the highest anticipated ambient temperature, without recourse to desuperheating the steam.

The design will be compatible with the requirements of constant and variable pressure operation and the variable characteristics of the gas turbine exhaust gas flow.

The design of the HP, IP and LP superheaters within the HRSG units shall ensure even distribution of steam through the tubes at all loads. Superheaters and reheaters shall be in the form of fully drainable elements. Superheater and reheater tubes are to be designed with no steam flow in the tubes during start-up. Material selection shall conform to the same.

Austenitic stainless steel shall not be used anywhere in the superheater.

4) Evaporators

The HP, IP and LP evaporator plenums will be designed to achieve a steam generation rate such that the gas leaving the zones is not more than 17.5ºC above the steam saturation temperature in that zone (i.e., temperature difference at the pinch point: maximum 17.5ºC).

The evaporator shall be designed to operate over the full load range of the HRSG without drumming or vibration and the design will ensure an even distribution of water through the tubes. The evaporator elements shall be drainable completely.

5) Economizers
The HP, IP and LP economizers shall be designed to ensure stable non-steaming operation/single phase flow throughout the full operating range of the HRSG. Connections shall be arranged between the steam drum and the economizer inlet to enable circulation of water to be maintained through the economizer during start-up. Should recirculation of water through the economizer be necessary during start-up or low load conditions, the connections shall be arranged complete with a pump to allow this.

The economizer elements shall be completely drainable.

6) Condensate Preheater (if applicable)
A condensate preheater for the HRSG as the last heat recovery module shall be provided, if necessary for maximum heat recovery. The condensate preheater shall be designed for the condensate extraction pump shut off head. Material selection for the preheater shall be suitable for undeaerated condensate water.

7) Steam Temperature Control
The steam temperature at the outlet of the superheaters and reheaters shall be controlled using direct spray type desuperheaters. The capacity of each desuperheater shall be selected taking all operating conditions, especially operations with the duct firing system, into consideration.

The spray water control plant shall have a motorized isolation valve in the common line, interlocked to close automatically when the steam temperature reaches below a set point and to prevent water induction into the steam turbine.

8) Safety Valves
Safety valves of the approved number, design, and capacity shall be mounted in approved locations in accordance with the requirements laid down by the relevant regulations. The safety valves at the superheater outlet shall be sized to have a discharge capacity equal to at least 20% of the maximum steam quantity generated by the HRSG. The safety valves at the steam drum shall have total discharge capacity equal to at least the remaining of the maximum steam quantity required for the protection of the HRSG.

Safety valves on the reheater must be sized to pass the maximum reheater flow without a rise in reheater inlet pressure of more than 10% of the highest set pressure.

9) HRSG Insulation and Cladding
The whole of the HRSG shall be insulated internally and/or externally and all external insulation shall be cladded in accordance with the specification to provide an entirely weatherproof unit suitable for outdoor operation.

The insulation shall be of proven material and suitable for continuous service at the maximum operating temperature.

10) Access and Inspection Doors
Adequate access and inspection doors of an approved type and size shall be provided to

allow free entry for maintenance and cleaning of the HRSG gas-path and pressure parts.

11) Blowdowns and Drains
The steam drum shall be provided with a continuous drum water blowdown connection, located to ensure preferential discharge of concentrated drum water, complete with parallel slide isolating and regulating valves in accessible positions adjacent to the drum connection, capable of controlling the rate from 0.05% minimum to 4% maximum of the HRSG steam rating.

Intermittent blowdown and drain piping shall be included where necessary from all drainable sections of the HRSG down to the intermittent blow down tanks. And the HRSG shall be provided with continuous and intermittent blowdown tanks.

An adequate number of electrically operated blowdown valves and superheater and reheater drain valves shall be provided for automatic operations during start-up, load operation, and shut down of the HRSG.

12) Economizer/Condensate Preheater Recirculation System (if applicable)
Economizer/condensate preheater recirculation pumps shall be provided if the overall plant design demands such an arrangement for the safe and efficient operation with the desired flexibility and reliability of the plant as specified in the Design Consideration under start-up and low load operation.

(5) HRSG Control & Instrumentation Requirements
1) General
The control and protection requirements for the HRSG are principally bounded by the following:

- On the gas side, by the gas turbine exhaust and HRSG diverter damper position
- On the feed/steam side, by the HP/IP and LP feed pumps discharge and the HRSG HP/IP and LP steam stop valves.

The control system for the HRSG shall be implemented in the Distributed Control System (DCS). All necessary control functions and interlocks required for safe and efficient operation of the HRSG shall be incorporated within the DCS. Separate DCS Field Control Plants/Remote I/O Plants shall be provided for interlock and protection related parameters and signals meant for control and monitoring purposes.
The control functions of the HRSG shall comprise of the following as a minimum:

① HP, IP and LP feed water control
② Start-up/load rate control
③ Superheated steam temperature control
④ Reheated steam temperature control, etc.

The main protection/interlock associated with the HRSG shall be implemented by utilizing the signals associated with the following as a minimum:

⑤ Gas Turbine Trip
⑥ High-High and Low-Low Drum Levels
⑦ Steam Turbine Trip
⑧ Steam Turbine steam bypass failure

⑨ Local and Remote Emergency Trip, etc.

The start-up, operation within the normal load range and shut down of the HRSG shall be fully automated up to the functional group level. However, the initial HRSG filling operation and the establishment of the initial HRSG drum level shall be manually controlled and supervised from the Central Control Room and only local control may be provided for minor drain and vent valves, where these are not automatic and which are not required during normal steam rating.

The HRSG shall be capable of constant pressure operation up to a 60% load and thereafter on variable pressure operation.

In the incidence of a steam turbine trip (at any load), an excessive rate of increase of the HP/IP superheater temperature within the HRSG or a HRSG trip due to say a loss of feed water supply shall initiate the appropriate interlocks to move the diverter flap to the blast stack position and not trip the gas turbine unless the diverter flap fails to move to the correct position within a preset time. HRSG permissive signals shall be required for moving the diverter flap from the bypass stack position to the HRSG position.

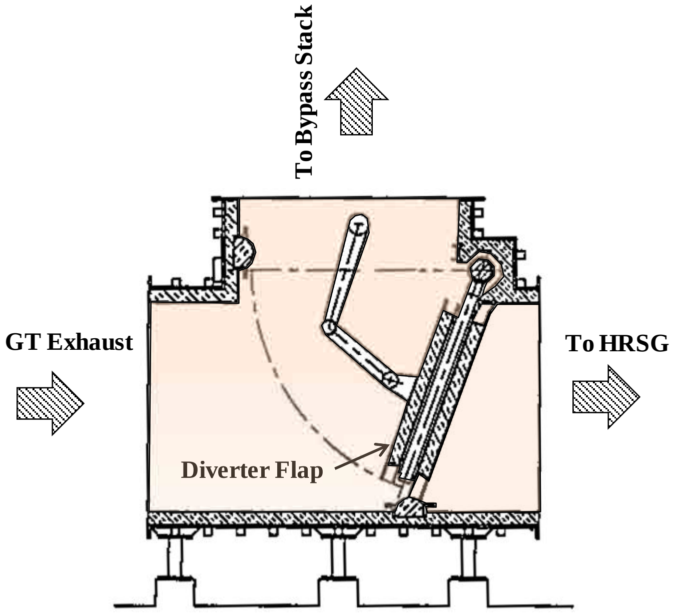
The following, as a minimum, shall move the diverter flap to the bypass stack position:

⑩ Gas Turbine Trip
⑪ Low-Low Drum Level
⑫ Steam Turbine steam bypass failure
⑬ Local and Remote Emergency Trip
⑭ In the case of a steam turbine trip, the diverter flap shall be moved to a predetermined intermediate position to maintain the HRSG in a ready condition for reloading.

In the case of a steam turbine trip, the steam turbine bypass system shall be functioned to maintain the HRSG in a ready condition MTBF (Mean Time Between Failure) of the HRSG control and protection system, except for the transmitter, detecting elements and regulating devices, shall be more than one hundred thousand (100,000) hours of design.

The manufacturer shall supply the following instrumentation, control and protection system with all necessary components and accessories, but not limited to:

⑮ HRSG modulating control system
⑯ HRSG system sequence control
⑰ HRSG autonomous control system
⑱ HRSG instrumentation, etc.



Source: JICA Study Team

Figure 6.3.3-2 Diverter Damper

2) Turbine Exhaust Gas Control Requirements

All control and instrumentation systems required for the regulation and supervision of the heat input to the HRSG shall include the controls for the turbine exhaust gas (TEG) diverter flap position for the direct regulation of TEG flow through the HRSG, as well as all temperature and pressure measurement both on the gas and feed/steam sides.

The control system shall regulate the TEG flow into the HRSG to achieve the maximum rate of initial steam raising, steam load and delivery temperature variation compatible with the design thermal stress limitations associated with the critical HRSG and steam turbine components. Automatic HRSG start-up shall be possible under the full spectrum of operating conditions which shall include the following:

⑲ The run up and loading of the gas turbine generator and HRSG

⑳ The start-up of the HRSG from any initial temperature condition (i.e., cold to full load temperature) with the associated gas turbine generator operating under part or full load conditions.

To control the temperature and pressure rise of the HRSG and steam piping during start -up, the diverter flap shall be set to predetermined positions based on the gas turbine load as well as the condition of the HRSG at start-up. This function may not be necessary if the HRSG can accommodate the full exhaust gas flow for all conditions of start-up and during transient operating conditions without the need to set the diverter flap to intermediate positions.

In addition to the start-up requirements, the control system shall meet the following disturbance conditions:

21 It shall maintain maximum steam generation compatible with the turbine bypass capacity in the event of the steam turbine tripping to permit the reloading of the latter with the minimum of delay.

22 It shall minimize the effect of a partial or total block load rejection and maintain the HRSG in a state which shall minimize the delay in the subsequent re-connection and loading of the steam turbine.

The control and supervisory functions of the following plant items shall be considered:

23 The TEG diverter flap
24 The gas passage between the inlet diverter flap and the HRSG exhaust
25 The HRSG LP economizer, drum, evaporator and superheat sections
26 The HRSG HP/IP economizer, drum, evaporator and superheater sections

The principal sequence and protection control functions shall include the following as a minimum:

27 The start-up and HRSG Loading Control

The requirement for these control functions is sequential in nature. In addition to the TEG diverter flap, the sequence controls of HRSG stop valves and associated bypass valves, including all necessary state monitoring, shall be controlled by these control functions.

A check to ensure that the diverter flap is fully closed in the bypass stack position shall form a pre-check in the HRSG start-up sequence. Only local controls are considered necessary for the operation of the diverter flap, to be restricted by a Permit-to-Work system.

28 Shut down

This function shall be capable of being initiated both manually and automatically from the central control system. The shut down function shall initiate coordinated closing of the TEG inlet and closing of HRSG stop valves after an appropriate delay. The stopping of HRSG feed pumps and circulation pumps may be regarded as a manual action.

This sequence function shall initiate the tripping of the gas turbine if the diverter flap fails to move to the bypass stack position within a preset time after the HRSG is tripped and the operation of the diverter flap is initiated.

The HRSG supervision shall not exercise any direct control functions but shall comprise all measurement hardware required for the monitoring of the operational state of the HRSG.

3) Feed Control Requirement
The control and instrumentation system required to regulate feed water supply to the HRSG shall include feed water regulation valves, instrumentation associated with drums, main steam and feed water together with the feed water pumps.

The feed control system shall comprise of a single element drum level control operating on a low load feed water control valve and three element control operating on the full load feed water control valve nominally rated for 0% to 100% MCR feed water flow. Differential pressure across the feed water control plant shall be maintained at a constant value by varying the scoop position of the feed water pumps.

The system shall be designed to maintain the drum level within acceptable limits under all anticipated HRSG load changes and disturbances, such as transfers from the duty feed water pump to the standby feed water pump, etc.

The principal modulating control functions to be associated are:
a. Start-up feed water control
b. Normal load feed water control

4) Drum Level/Feed Water Control
The control system shall comprise of a single element drum level control operating on a low load feed water control valve and a three element control operating on a full load control valve (in case of HP & IP on one of the full load control valve). A low load feed water control valve is envisaged for controlling the drum level during plant start-up and low load operation up to 30% MCR. For normal load up to 100% MCR, a full load control valve is envisaged to maintain the drum level. A stand-by full load feed water control valve (in HP & IP feed water control plants) shall be provided for improving the availability during on-line maintenance of the main valve. The facility shall be provided for both a manual and automatic changeover from single element to three element control and vice versa.

The three element function shall consist of the steam flow, feed water flow and drum level. Steam flow measurements shall be pressure and temperature compensated and the drum level measurements shall be pressure compensated.

The feed water control shall develop the flow control signal for matching between feed water flow and steam flow using drum level deviations from the drum level set-point.

5) Main Steam Temperature Control
The steam temperature shall be designed to maintain the main steam temperature at the turbine inlet by means of the spray control valves. One or more stages spray control based on the HRSG design shall be used for the control of superheater temperature.

The spray desuperheater shall be provided with shut-off valves. The feed forward circuit shall be used for sufficient control response.

6) HRSG Autonomous Control System
The HRSG autonomous control system (ACS) shall interface with the data highway of the Distributed Control System (DCS) through process I/O interface devices. The process I/O system shall have duplicated system architecture. The interface type shall be of either the conventional hardwired I/O interface (I/O) or the remote I/O interface (R-I/O).

The following ACS of the HRSG auxiliaries shall be interfaced to the data highway through I/O interface devices but not limited to:

- HRSG metal temperature measurement system
- Environmental measurement system
- Water/steam sampling system
- Instrument air compressor system
- Service air compressor system

7) Instrumentation
The manufacturer shall provide all necessary instruments for the HRSG and auxiliaries to allow centralized control and monitoring facilities from the operators' consoles in the Central Control Room, through a microprocessor based Distributed Control System (DCS).

The following field control and instrument devices shall be provided:

- Gauges, Transmitters, etc.
- Detecting elements such as flow elements, thermocouples, pressure switches and temperature switches, etc.
- Regulating devices such as control valves, vanes, dampers, and drives, etc.
- Local instrument panels (if necessary)
- All piping, tubing and wiring necessary for satisfactory operation shall be provided.

This shall include instruments for measuring the following minimum process parameters:
- Feed water
- Drum
- Steam
- HRSG metal temperature, drum level viewing system including indicator (optical fiber system) and all other necessary pertinent items.

The manufacturer shall provide all local instruments.

- Pressure gauges
- Thermometers
- Flow indicator
- Level gauges
- Limit switches, etc.

6.3.4 Water Treatment Plant

(1) General
The source for cooling tower makeup water, service water and demineralized water shall be drawn from the Grand Namangan Canal in this project.
Complete water treatment system comprising raw water supply facility, pretreatment facility, desalination plant, and demineralized water plant, shall supply the sufficient quantity and quality of service waters and make-up waters for Turakurgan CCPP.

Potable water (drinking water) required for Turakurgan CCPP shall be provided through the city water supply system in Namangan city. Potable storage tank, potable water supply system from the storage tank is included in the scope of works.

Potable water is also used as the makeup water of hot water supply system. The hot water supply system is installed to supply hot water for in-house heating in the CCPP. The maximum water supply capacity which is required in winter season is 1628t/h, the temperatures at the inlet and exit of hot water heater are 70 °C and 90 °C and the heat supply capacity is 33 Gcal/h. The water treatment system such as preheaters and dearators for the hot water makeup water of the maximum 100 t/h shall be included in the scope of this project.

The provisional analysis of canal water and city water are as shown in the Table in Chapter 8 of this report.

(2) Scope of Work

The scope of work shall include design, manufacturing, supply, delivery to site, installation at site, and commissioning and testing of complete water treatment system comprising the following equipment as major system components.

1) Canal water supply and pre-treatment facilities:
- Canal water supply pumps (2 x 100%)
- Clarifires (2 x 100%)
- Filter (2 x 100%)
- Filtered water tank for back wash (1tank)
- Filtered water pumps (2 x 100%)
- Backwash equipment (2 x 100%)
- Chemical dosing eqipment (1 set)
- Sludge tank, press, container (1set)

2) Desalination Plant:
- UF filters (2 x 100%)
- Reverse osmosis feed pumps (2 x 100%)
- Reverse osmosis trains (2 x 100%)
- Pretreatment equipment (1 set)
- Anti-scalant dosing equipment or pH adjustment equipment (1 set)
- Sodium bisulfite dosing equipment

3) Service water supply facilities:
- Service water tank (1tank x 3 days storage capacity)
- Service water pumps (2 x 100%)
- Fire fighting water pumps (1 x 100% diesel driven, 2 x 100% electric motor driven, and 1 x 100% jockey pump) and necessary piping valves and accessories

4) Demineralization Plant:
- Activated carbon filters with 10 micron cartridge filter (2 x 100%)
- Demineralizers including resins (2 trains x 100%)
- Demineralized water storage tank (1 x 3 days storage)
- Demineralized water transfer pumps (2 x 100%)
- Chemical regeneration system including storage tanks, regeneration pumps backwash tower and measuring equipment

5) Make-up water supply facilities:
- Condensate storage tank (1tank x 3 days storage)
- Make-up water supply pumps (2 x 100%) and necessary piping valves and accessories

6) Potable water facilities:
- Storage tank (1tank x 3 days storage)
- Potable water distribution pumps (2 x 100%)
- Hypochlorite tank (1 tank)

- Hypochlorite metering pumps (2 x 100%) and necessary piping valves and accessories

7) Hot water supply system
   - Raw water (tap water) storage tank (1tank x 3 days storage) , common with potable water supply system
   - Raw water supply pumps (2 x 100%)
   - Makeup water preheaters (2 x 100%)
   - Makeup water deaerating system (2 x 100%)
   - Hot water supply pumps (2 x 100%)
   - Hot water heaters (2 x 100%)
   - Hot water supply piping and valves
   - Heating units for power station buildings

8) Pipe work and valves, supports, fittings and interconnections
9) Electrical equipment
10) Instrumentation and control system
11) Spare parts for two (2) years operation after taking over.
12) Special tools and standard tools set

(3) Applicable Codes and Standards
The water treatment plant shall be designed and constructed in accordance with the requirements of international codes and standards.

(4) Design and Performance Requirements
1) Water Balance
The main water demand for the desalination and demineralization plant is described below:
a. Demand for Demineralized Water
The demand of demineralized water is estimated as shown in Table 6.3.4-1.
The demand of demineralized water for Turakurgan CCPP is estimated to 285 t/day for the two generating units and the common facilities. The plant will consist of two (2) 100% capacity trains. The capacity has to be of 290 t/day including water for regeneration. Deminerarization plant of two (2) trains x 290 t/day is proposed.

The storage capacity of deminerarized water tank will be at least 3 days of water production demmand: that is 285 t/day x 3 days = 856 m^3 (effective capacity)

Table 6.3.4-1 Demand of Demineralized Water

Item	Unit	Value	Remark
Make-up for condencer	t/day	111 x 2	1.2% of steam flow
Make-up for closed cooling water	t/day	4 x 2	
Make-up for steam to Demi. Plant	t/day	1 x 2	
Margin of 10%	t/day	12 x 2	
Total demand of demineralized water	t/day	255	
Water for Regeneration	t/day	29	
Capacity of Demi. Plant	t/day	285	Say 290 t/day/train

Source: JICA Study Team

b. Demand for Service Water (Desalinated Canal water)
The demmand of service water (desalinated canal water) is summerized in Table 6.3.4-2).

Table 6.3.4-2 Demand of Service Water (RO treated water)

Item	Unit	Value	Remark
Demineralized water	t/day	285	From item a) above.
General service	t/day	20	Washing water in Building
Sealing water for pumps	t/day	51x2	For canal water pumps and chemical dosing pumps
HRSG blow drain cooling water	t/day	180x2	
Total demmand of service water	t/day	740	
Margin of 10%	t/day	74	
Capacity of desalination plant	t/day	814	Say 850t/day

Source: JICA Study Team

c. Operation Time and Capacity of Water Treatment Plant
The capacity of Demineralized Water Plant shall be determined based on the operating time of twenty (20) hours a day excluding regenerating or cleaning time of four (4) hours a day.

Table 6.3.4-3 Operation Hour and Capacity of Water Treatment Plant

Item	Unit	Desalination plant	Demineralizer
Demmand	t/day	810	280
Operating hour	h/day	24	20
Required capacity	t/h	34	14

Source: JICA Study Team

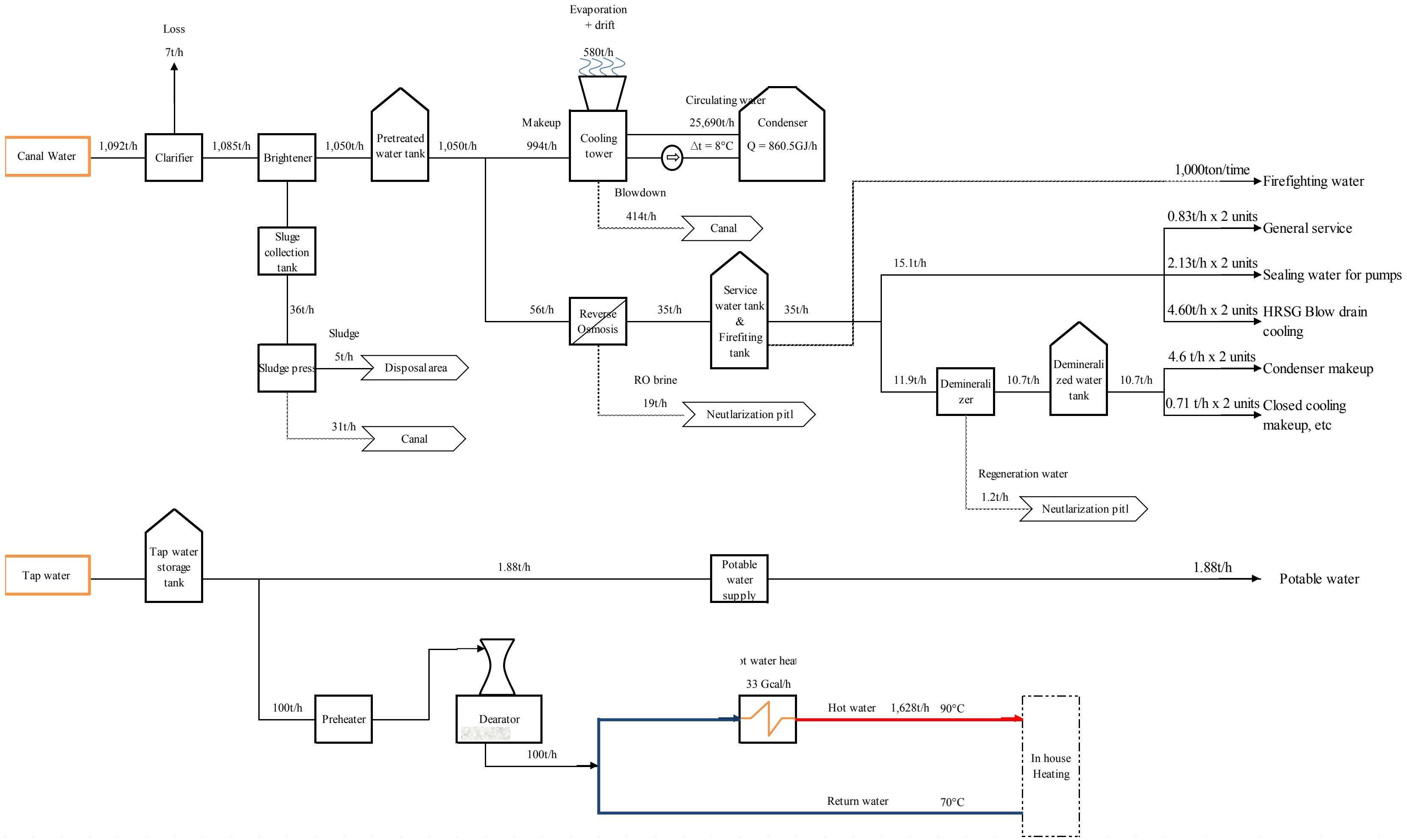
d. Capacity of Treated Water Tank
The capacity of each water storage tank shall be determined taking account of three days storage and effectiveness factor of 0.85.

Table 6.3.4-4 Capacity of water storage tank

Item	Unit	Service water tank	Make-up water tank	Potable water tank	Fire Tank
Water Flow Rate	t/day	845	285	45	-
Storage day	day	3	3	3	-
Effective storage capacity	m^3	2,534	856	135	1000
Effectiveness factor	-	0.85	0.85	0.85	0.85
Required storage capacity	m^3/tank	3,000	1007	159	1,176
No. of tanks	tank	1	1	1	1
Selected storage capacity	m^3/tank	3,000	1100	160	1,200

Source: JICA Study Team

Water balance of Turakurgan CCPP is as shown in Figure-6.3.4-1 attached hereinafter.



Source: JICA Study Team

Figure 6.3.4-1 Water Balance of Turakurgan CCPP

2) Water Pre-treatment (Filtration) Plant

The water pretreatment system consists of a rapid filtering device, various pumps, blowers, pipes and valves. This system shall be capable of removing particulates that are difficult to settle or remove by conventional filtration, or whose concentration would result in excessive solids loadings to conventional filtration equipment.

The water pre-treatment plant components shall include provision for the following:

- The clarity of water treated by the filtered water plant shall be below 50mg/l for the makeup water of cooling tower and below 1 mg/l for service water.
- Two (2) sets of 100% duty each raw water pumps shall be installed. The capacity of each pump shall have a enough margin to keep the service water production capacity of two (2) streams x 35 t/h.
- The type of the filter shall be cylindrical, vertical, mild steel (designed per ASME standard), rubber coating inside, gravity or pressure dual media sand-anthracite filters.
- Two (2) sets of filter air blowers (each 100% duty) shall be equipped for filter air scouring.
- Puddle pipes and fittings for filtered water sump shall be constructed in reinforced concrete.
- Two (2) sets of 100% duty each filter backwash pumps shall be installed.
- Filter water tank with appropriate capacity shall be installed for backwashing of filters.

3) Desalination Plant

The service water for Turakurgan CCPP is produced from seawater by desalination process and will be stored to the service water tank.

The type of desalination system will be the seawater reverse osmosis type. The process has proven records of reliability in current operating installations, however special attention must be paid to avoid frequent replacement of the membrane which will increase the operating and maintenance costs.

Since the number of pumps, especially high pressure pumps are used in the RO plant, operation and maintenance works are also important to keep the reliability.

Consideration must be given to the following:

- Pretreatment of the seawater before transfer into the RO plant is very important for the membrane life time and reliability of the plant.
- The membrane provided shall be suitable for the water of the Great Namangan Canal.
- A comparison of the water quality produced by the RO plant shall be investigated and the impact on the demineralized plant has to be evaluated.

The desalination plant will be sized to supply water for the demineralized water plant, service water system, waste water treatment plant, firefighting system, others. The required amount of service water will be designed to be 35 t/h.

Under all operating conditions the plant shall produce water equal to or better than the specified quality for the demineralizer feedwater, which shall be as follows:

Table 6.3.4-5 Quality of Service Water

Item	Unit	Service Water Quality
Total dissolved solid	mg/l	Less than 10 mg/l
Total ion	mg/l	Less than 0.2 mg/l
pH (@ 25ºC)	-	6.5~7.0

Source: JICA Study Team

Design data for the desalination plant will be as following:

a. Installation: Indoor
b. Type: Seawater reverse osmosis
c. Number: Two trains
d. Capacity: 35 t/h
e. Number of stage: To be defined by the contractor

Quality of desalinated water: see Table 6.3.4-5

4) Demineralized Water Plant

The demineralized water stream will consist of mixed bed polishing system (MBP) (or cation tower, anion tower, mixed bed polisher, vacuum degasifier, regeneration system), pumps, tanks, and pipes.
The demineralized water plant shall have two (2) streams with each production capacity of 12 t/h.

The period between regenerations shall not be less than twenty (20) hours, and the regeneration period shall be less than four (4) hours.
The raw water quality shall be taken into account in the design of the Demineralizer plant.
Under all operating conditions the plant shall produce water equal to or better than the specified quality for the boiler feedwater, which shall be as follows:

Table 6.3.4-5 Quality of demineralized water

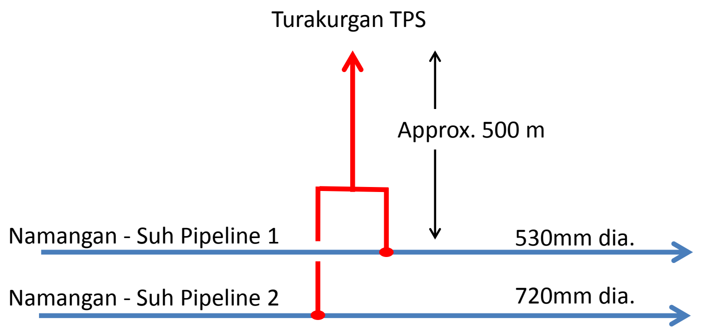
Item	Unit	Demineralized Water
Conductivity(@ 25ºC)	μS/cm	Max. 0.2
Total Silica	mg/l	Max 0.02
pH (@ 25ºC)	-	-
Suspended Solids	mg/l	-
Turbidity	Degree	-
Total Fe	mg/l	Max 0.01
Total Cu	mg/l	Max 0.005
CO_2	mg/l	Max 2
Cl^-	mg $CaCO_3$/l	-
SO_4^{-2}	-	-
TDS	mg/l	-
Residual C1	mg/l	-
Sodium and Potassium	mg/l	Max 0.01

Source: JICA Study Team

6.3.5 Fuel Gas Supply System

Natural gas was selected as the main fuel for this project. The natural gas is supplied to the Turakurgan Thermal Power Station from two (2) parallel pipeline systems having a diameter of 530 mm and 720 mm.

The following describes the natural gas terminal point and its supply conditions.



Source: JICA Study Team

Figure 6.3.5-1 Location of the terminal point

Table 6.3.5-1 Supply condition at the terminal point

Item	Unit	Value
Temperature	^{o}C	8 ~ 20
Pressure	MPa	0.5 ~ 2.3

Source: JICA Study Team

After the extraction from the main pipelines at the terminal pont, the natural gas is led to the pre-treatment system having a filtering function to remove foreign substances. The system of gas supply to the TPS shall be safe and uninterruptable, and also shall have an on-load switching device between two pipelines.

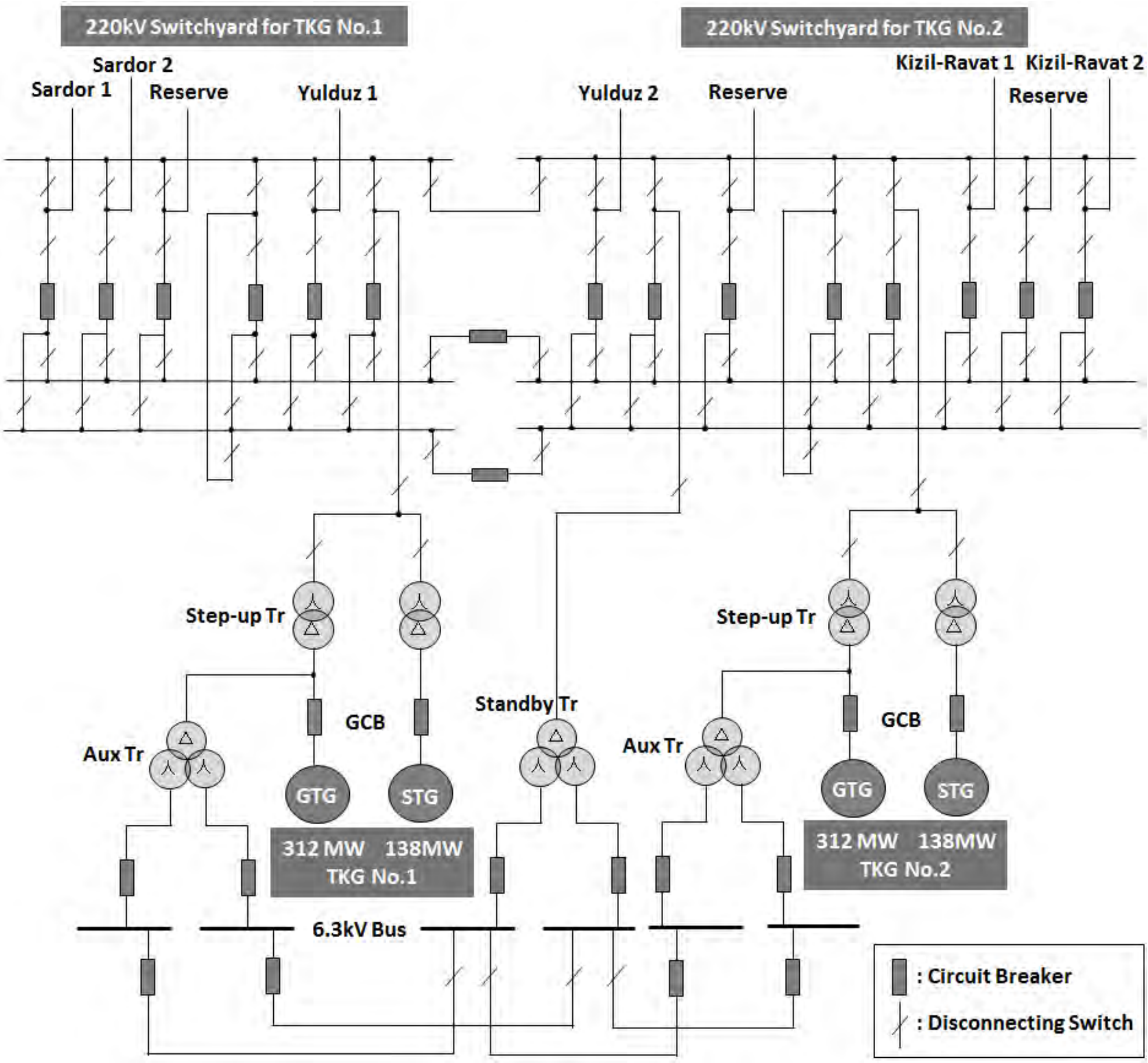
After the foreign substances have been removed, the natural gas is led to the fuel gas compressor so that the pressure is increased up to the level required at the inlet of the gas turbine. This required pressure level is approximately 3 through 5MPa depend on the designed value of the gas turbine manufacturer. Since the operation of the gas turbine depends on the fuel gas compressor, it is recommended to install two fuel gas compressors including one standby for each unit.

6.3.6 Electrical Equipment

(1) Scheme of generator main circuit and switchyard

1) Evacuation of Generating Power

Figure 6.3.7-1 shows the scheme of generator main circuit and switchyard.



Source: JICA Study Team

Figure 6.3.7-1 Scheme of generator main circuit and switchyard

The electrical system for one CCPP will be designed on the basis of the multi shaft configuration having two (2) generators, Gas Turbine Generator (hereinafter called as "GTG") and Steam Turbine Generator (hereinafter called as "STG") and two (2) transformers, Gas Turbine step-up Transformer (hereinafter called as "GT transformer") and Steam Turbine step-up Transformer (hereinafter called as "ST transformer"). The voltage of the power output from the GTG and STG will be stepped up to 220kV via GT transformer and ST transformer. The output from these two transformers is merged and transmitted to the 220kV switchyard. The bus switching arrangement utilizes double main bus with transfer bus scheme.

During the unit operation, the power source to the unit auxiliary loads under 6.3kV unit bus will be fed from the GTG via Auxiliary transformer and 220kV switchyard via Standby transformer. During the unit shut down and the unit start-up, the power source to the unit auxiliary loads will be fed from 220kV switchyard via Auxiliary transformer and Standby transformer. The Auxiliary transformers shall be connected to 6.3kV unit bus via the circuit breakers. On the other hand, Standby transformer shall be connected to the 6.3kV common bus via the circuit breakers. The power will be distributed to the auxiliary loads from the 6.3kV unit bus and common bus.

The auxiliary system and associated equipment shall be designed with flexibility and adequate redundancy to provide a reliable source of power for all auxiliaries that will be required for the new plant.

GTG shall be synchronized by GTG circuit breaker when GTG is attained at rated speed and voltage. STG shall be synchronized by STG circuit breaker when STG is attained at rated speed and voltage likewise.

Generating power from TKG No.1&2 is sent to 220kV switchyard. Double main bus with transfer bus is installed for 220kV switchyard. 220kV switchyard is composed of 2 sections for each CCPP and the sections are connected by the bus tie bar.

(2) Generators

1) GT Generator and ST Generator

The overview of the generators specifications are shown below.

Table 6.3.7-1 Overview of the generators specifications

Generator	GTG	STG
Type	Three Phase Synchronous	Three Phase Synchronous
Number of Poles	2	2
Number of Phases	3	3
Power (at 13.7 ^{o}C)	312 MW	138 MW
Maximum Power (at 0 ^{o}C)	326 MW	142 MW
Rated Capacity	408 MVA	178 MVA
Frequency	50Hz	50Hz
Rated Speed	3,000rpm	3,000rpm
Terminal Voltage	24.0kV	17.5kV
Power Factor	0.80 (Lagging) 0.95 (Leading)	0.80 (Lagging) 0.95 (Leading)
Rotor Cooling Method	Hydrogen	Hydrogen or Air Cooled
Stator Cooling Method	Hydrogen or Water Cooled	Hydrogen or Water or Air Cooled

Source: JICA Study Team

2) Generator Circuit Breaker and Disconnecting Switch

GT/ST circuit breaker and GT/ST disconnecting switch are set at primary side of GT and ST transformer for synchronization.

GTG is synchronized at 220kV power system via GT circuit breaker when GTG is attained at rated speed and voltage. Next STG is synchronized at 220kV power system via ST circuit breaker when STG is attained at rated speed and voltage.

3) GT Start-up Method

GT start-up method shall be selected thyristor or motor driven torque converter start-up method.

4) Excitation System

Each generator will be provided with thyristor static excitation system which makes it possible to provide full ceiling voltage, either positive or negative, almost instantaneously under conditions of system disturbances. The system shall include transformer, automatic voltage regulator system (hereinafter called as “AVR”) cubicle, thyristor, convertor cubicle and field circuit breaker. Current transformer for control, regulation, protection and metering of the generator would be either provided in the generator stator terminal bushing both on the lines as well as neutral sides, or would be housed in IPB.

The generator manufacturer shall have AVR. AVR detects generator voltage and control the reactive power to control the generator voltage.

5) Type of Generator Cooling System

The generators cooling system shall be adopted of hydrogen gas, water or air cooled type.

As a result of recent technological advance of cooling performance and wind age loss reduction, an air-cooled system is adopted in generators of 300MVA class. It is not possible to select air cooled type for GTG because of the capacity shortage (GTG rated capacity: 390 MVA > Maximum air cooled generator capacity: 300 MVA). Hydrogen supply system for generator cooling is necessary and shall be included in Scope of Works by the Contractor.

However it is possible to select air cooled type for STG (STG rated capacity: 173 MVA < Maximum air cooled generator capacity: 300 MVA). Air-cooled system has some advance from hydrogen gas-cooled system such as; simpler system, easy operation and maintenance, allowing for cost savings.

6) Seal Oil Equipment

Seal oil equipment is necessary when hydrogen cooling method is adopted. The generator seal oil system shall be designed to minimize leakage. The system shall be designed single sided or double sided depending on the manufacture’s standard. It shall consist of AC motor driven seal oil pumps with a 100% capacity emergency backup DC motor driven seal oil pump.

7) Hydrogen Supply System

Hydrogen generation system is adopted for hydrogen cooling system if necessary. Hydrogen generation system currently provides an economical hydrogen supply solution for generator cooling system.

8) Isolated Phase Bus

The isolated phase bus (hereinafter referred to as “IPB”) duct shall be forced-air cooled and shall deliver the generator output to the GT/ST step-up transformer with GT/ST circuit breaker, potential transformers, generator surge protection equipment, auxiliary transformer, standby transformer and excitation transformer.

(3) Transformers

1) GT Transformer

GT Transformer shall step up from GTG voltage (24.0kV) to transmission line voltage (220kV).

GT Transformer shall have tap changing mechanism, oil insulation three (3) phase transformers. Cooling type shall be Oil Natural Air Forced (hereinafter called as “ONAF”) type. Phase connection shall be Delta-Star (hereinafter called as “Δ-Y”) type.

2) ST Transformer
ST Transformer shall step up from STG voltage (17.5kV) to transmission line voltage (220kV).
ST Transformer shall have tap changing mechanism, oil insulation three (3) phase transformers. Cooling type shall be ONAF type. Phase connection shall be Δ-Y type.

3) Auxiliary transformer
Auxiliary transformer shall step down from GTG voltage (24.0kV) to Unit Bus (6.3kV).
Auxiliary transformer shall have tap changing mechanism, oil insulation three (3) phase transformers. Cooling type shall be Oil Natural Air Natural (hereinafter called as "ONAN") type. Phase connection shall be Star-Delta-Delta with Stabilizing Winding (hereinafter called as "Δ-Y-Y") type.

4) Standby transformer
Standby transformer shall step down from transmission line voltage (220kV) to Unit Bus CA and CB (6.3kV).
Standby transformer shall be oil insulation three (3) phase transformers. Cooling type shall be ONAN. Phase connection shall be Δ-Y-Y type.

The overview specifications of the transformers are shown below.

Table6.3.7-2 Specifications for transformers

Transformer		GT Transformer	ST Transformer	Auxiliary Transformer	Standby Transformer
Rated Voltage	1st	24.0kV	17.5kV	24.0kV	220.0kV
	2nd	220.0kV	220.0kV	6.3kV	6.3kV
Rated Capacity	1st	370MVA	170MVA	25MVA	40MVA
	2nd	370MVA	170MVA	12.5/12.5MVA	20/20MVA
Phase Connection		Δ-Y	Δ-Y	Δ-Y-Y	Δ-Y-Y
Cooling Type		ONAF	ONAF	ONAN	ONAN

Source: JICA Study Team

(4) Unit Power Supply
The unit power supply shall be configured from auxiliary transformer and standby transformer.
Unit equipment that is used for power plant operation shall be powered from auxiliary transformer. Common equipment (water handling, waste water handling, etc) shall be powered from standby transformer system.
Moreover, as electric power source for emergencies, 1 set of 3 phase diesel fueled generator is installed for power plant and this enables obtaining safety electricity upon total cessation of the operation of the power plant.
Table 6.4.7-4 shows house load apportion.

Table 6.3.7-3 House Load Apportion

Type	Power supply voltage [V]	Power supply board classification	Usage classification
Three (3) phase AC	6,300	6.3kV Medium Voltage switchgear	Load>200kW
	400	400V Low Voltage switchgear	90kW<Load<200kW
		Motor Control Center	3kW<Load<90kW
	200	Motor Control Center	Load <3kW
	100	Motor Control Center	Valve<1kW
One (1) phase AC	100	AC distribution board	
DC	220	DC Motor Control Center DC distribution board	DC load

Source: JICA Study Team

1) 6.3kV unit / common bus
6.3kV unit / common bus shall supply necessary auxiliary power for plant operation.
The design of 6.3kV unit bus shall be based on the four buses.
Auxiliary transformer shall step down from GTG voltage (24.0kV) to unit bus.
Standby transformer shall step down from transmission line voltage (220kV) to common bus.
Unit / common bus shall be connected via bus-tie circuit breaker and disconnecting switch. Basically the bus-tie circuit breaker shall be opened. The bus-tie circuit breaker and disconnecting switch shall be closed in case of auxiliary or standby transformer accident. Common bus evacuates unit bus the electric power when plant accidentally tripped. Also unit bus evacuates common bus the electric power.
6.3kV unit bus shall supply necessary auxiliary power and 400kV unit bus.

2) 400kV unit bus
400kV unit bus shall supply medium motors and auxiliary power for switching.

3) 220V DC supply system
220V DC supply system shall have battery equipment and DC load shall be supplied by the power from DC distribution board. Plant can stop safely by DC power from battery under blackout condition.

4) Uninterruptible power system
Uninterruptible power system (UPS) shall be to supply continuous AC power to the essential AC bus. Uninterruptible power system shall be supplied with AC supply source and 220V DC supply system.

5) Emergency diesel generator equipment
Plant shall have one emergency diesel generator at least.
It shall be capable to supply emergency power from emergency diesel generator equipment to 400V emergency unit bus.

6) Site grounding
IEEE-80 recommendations shall be used to determine grounding system requirements for this plant. The entire ground grid system shall exclusively utilize copper conductors with exothermic connections for in-ground connections.

(5) Generator Main Circuit Protection

The typical protections for GTG, STG, GT transformer and ST transformer are shown in the following table.

Table 6.3.7-4 Generator Main Circuit Protection

Name	Factor
GT Generator differential	$87G_{GT}$
GT Transformer differential	$87T_{GT}$
ST Generator differential	$87G_{ST}$
ST Transformer differential	$87T_{ST}$
Current unbalance	46
Loss of excitation	40
Reverse power	67
Stator ground detection	51GN
Generator overexcitation	24
Generator overvoltage	59
Generator undervoltage	27G
Generator over/under frequency	81

Source: JICA Study Team

Generators and transformers shall be protected by 87G and 87T. As a back-up protection for generator, restricted earth fault relay as well as voltage type ground fault relay is also proposed.

(6) 220kV Switchyard

Figure 6.3.7-1 shows the scheme of 220kV Switchyard. The overview specification of the 220 kV Switchyard is shown below.

Table 6.3.7-5 Overview specifications of the 220 kV switchyard

Switchyard	220 kV switchyard for TKG No.1	220 kV switchyard for TKG No.2
Type of bus bar	Double main bus and transfer bus	Double main bus and transfer bus
Type of substation	Outdoor Conventional Type	Outdoor Conventional Type
Number of bay	6	8
Number of circuit breaker	6	8
Number of circuit breaker for bus tie	2	

Source: JICA Study Team

TKG No.1&2 are connected 220 kV switchyard with air insulated outdoor type. The bus switching arrangement utilizes double main bus with transfer bus scheme.

There are three separate and independent buses; two main and one transfer. Normally, all circuits, incoming and outgoing, are connection the main bus. If maintenance or repair is required on a circuit breaker, the associated circuit can be fed and protected from the transfer bus, while the original breaker is isolated from the system.

Table 6.3.7-6 shows advantage and disadvantage of double main bus and transfer bus scheme.

Table 6.3.7-6 Advantage and Disadvantage of double main bus and transfer bus scheme

Advantage	Disadvantage
· Maintain service and protection during circuit breaker maintenance · Reasonable in cost · Fairly small land area · Easily expandable	· Additional circuit breaker needed for bus tie · Protection and relaying may become complicated · Bus fault causes loss of the entire substation

Source: JICA Study Team

Circuit breakers shall adapt the load capacity. The typical specifications of circuit breakers are shown below.

- Rated Normal Current：2,000 - 3,000 A
- Rated Short Circuit Breaking Current：40.0 - 50.0 kA

Transmission capacity of each circuit of 220kV connection line shall satisfy the maximum output from GTG and STG of TKG No.1&2.

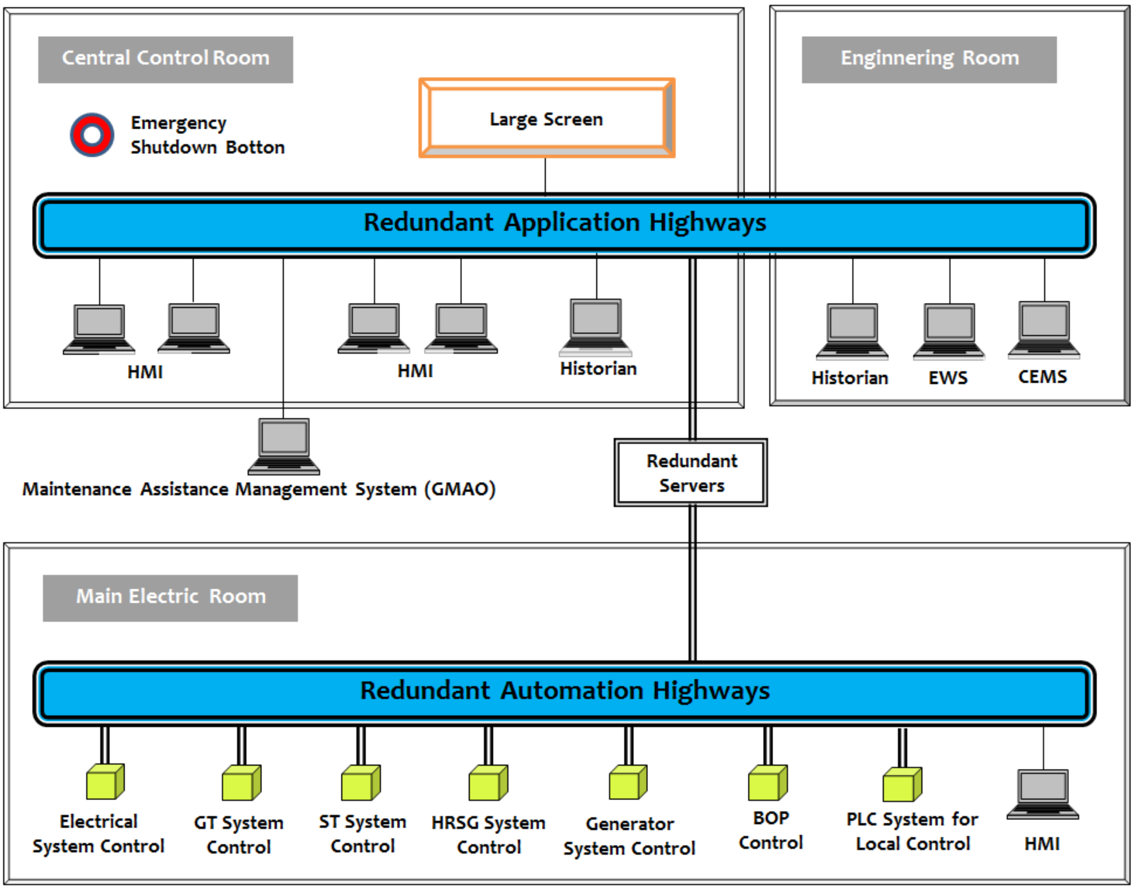
6.3.7 C&I Equipment

(1) Control Philosophy

The control system shall control and monitor the status of equipment and process variables associated with the CCPP to ensure safe and efficient operation with the applicable specifications and performance requirements. All control and monitoring functions necessary for start-up, normal operation and shut down of the CCPP shall be provided in the Central Control Room (CCR). The CCR will be normally manned.

(2) System Configuration and DCS Installation

Figure 6.3.8-1 shows the configuration for CCPP control.



Source: JICA Study Team

Figure 6.3.8-1 Configuration for CCPP Control

The design of all instrumentation and control systems shall provide maximum security for plant personnel and equipment, while safely and efficiently operating the new plant under all conditions with the highest possible availability.

Operator workstation with Human Machine Interface (HMI) and a microprocessor based Distributed Control System (DCS), including redundant controllers using a plant-wide redundant communication highway, shall be provided to allow the operators to control CCPP and to receive monitoring and alarm information.

- The computing and electric power section shall be duplex and the input and output of the DCS will be single.
- Power supply shall be redundant with both AC and DC (butted method).
- Operation during normal times will be through the use of a mouse while confirming the Liquid Crystal Display (LCD) screen.

The operating and monitoring system of the power station are configured by DCS, the information management system, maintenance and repair system, network system and related equipment. The DCS is comprised of the LCD operation system, turbine control system, data assembly system, sequence control system, process I/O system and peripheral equipment. Each independent system is interfaced with DCS.

(3) Plant Control and Monitoring System

The design of the control system for the new plant shall utilize state-of-the-art DCS with data logging system in combination with proprietary controls furnished with the gas turbine/ generator, steam turbine/ generator, HRSG and Balance of Plant (BOP), gas compressor system and so on.

The operator console of the plant installed in the CCR shall be used for the primary operator interface and shall contain LCD with keyboards and mouse. The CCR shall be equipped with a shift operator's room, locker room, WC & shower room, etc., in order to create better environment condition for operators.

The gas turbine control system, steam turbine control system, HRSG and BOP control system shall be tied into the DCS with redundant communications networks and hardwired signals for critical control signals. The remaining control and monitoring signals for the gas compressor control system, heat sources supply control system and so on shall be brought directly or via Remote I/O into the DCS I/O cabinets.

The LCD graphics shall provide the operator with control, monitoring, recording/ trending, status, and alarms of equipment and process conditions. The detectors/ instruments for protection/ control of gas turbines, steam turbines and HRSG shall be double or triple configuration to enhance the reliability of the plant.

The control system shall be designed to operate and control the plant automatically, and shall give information of conditions of the new plant and guidance of operation/trouble shootings during start-up, steady state operation and shut down to the operators. The configuration of control logic and graphic display of the control system shall be designed for maintenance engineers to be able to easily and correctly modify and change them on site.

DCS shall have the following functions.

1) Turbine automatic operation control system
   - Gas turbine operation, control and protection including gas turbine supervisory instruments
   - Steam turbine control and protection including turbine supervisory instruments
   - HRSG control and protection
   - Generator protection, excitation, voltage regulation and synchronization systems
   - Electrical equipment control and protection including supervisory instruments
   - Balance of plant control

2) Data collection equipment
   - Scan and alert
   - Process computation (including performance computation)
   - Data log function and data display

3) Common equipment in DCS function
   - Gas Booster Compressor System (if necessary)
   - Water treatment system
   - Waste water treatment system
   - Substation System, etc.

4) Maintenance function

Maintenance tools so called Engineering Work Station (EWS) for the maintenance of DCS shall be installed and these tools shall have the following functions.

- Control system setting/modification function
- System diagram setting/modification function

These systems have independent monitoring and control. In the event of a defect in the devices, the impact on the power station will be large. For this reason, the calculation system, power supply system, etc., are multiplexed in order to contribute to the reliable operation of system.

The operator can select each mode to correspond to the plant condition. The typical control modes are shown in the following table.

Table 6.3.8-1 Control Mode by DCS

Control Mode	Event
Full-Automatic	In the "Full-Automatic" mode, the start-up or shut down shall be done by a one-push button. The main master sequence is connected to each master sequence and operation status on the unit side, e.g., boiler start preparation to absorber system start-up, and absorber system start-up completed to limestone system start-up. As a result, start-up is automatically executed from boiler preparation to full load under normal operation via CCPP start-up process.
Semi-Automatic	In the "Semi-Automatic" mode, the start-up or shut down shall be done step by step. The operator can proceed to the CCPP startup and shut down process to recognize each breakpoint accomplishment by master sequence.
Manual	In the "Individual" mode, the start-up or shut down shall be manually done.

Source: JICA Study Team

(4) C&I equipment power supply

C&I equipment power supply will be from the following switchboards:

- 3 x 400/ 200 V, 50 Hz network supply
- 200 V, 50 Hz Safe AC
- 220 V Battery DC

DC supply system for CCPP shall not rely on existing units and shall be independent.

Other I&C equipment power shall be supplied, as follows:

- 24 VDC redundant
- 48 VDC redundant (if necessary)

(5) Central Control Room (CCR)

CCR shall be enabling to accommodate operating staff. The lockable cabinet, desk and chair sets shall be installed there.

Lighting shall be designed for maximum comfort and LCD glare shall be adjustable. Co-ordinate colors and materials for floors, walls and ceilings shall be provided. Rooms shall be designed to absorb noise. CCR shall contain HMIs.

Double doors and the corridors shall be of sufficient size. The raised floor (i.e. free-access floor) shall be installed.

(6) Field Instrumentation

Field instrumentation for CCPP such as pressure / level / flow / temperature – transmitters /

switches / instruments, flue gas analyzers, vibration detector, etc., will be provided for monitoring the status of equipment and the process variables associated with the CCPP to ensure safe, efficient operation and performance requirements.

All units are established according to the International System of Units (SI).

The main field instrumentations are as follows:

- Pressure / differential pressure measurements
- Level indicating measurements
- Flow measurements
- Temperature measurements
- Density measurements
- Chemical measurements (pH, conductivity, etc.)
- Vibration measurements
- Position indicators of dampers/valves
- Continuous Emission Monitoring System (CEMS)

All outdoor mounted instruments shall be designed to withstand outdoor ambient temperatures. Adequate freeze protection system installations shall be set up in case of the instrument line freezing.

(7) Telecommunication System
Telecommunication shall be included in the following systems:

- CCTV System by IP cameras, Video server and IP Network
- IP telephone system
- Master Clock System
- Uninterruptible power supply (UPS) system

(8) Fire Detection and Alarm System
Fire Detection and Alarm System including smoke detectors, alarm sirens and cable infrastructure shall be provide on the plant.

6.3.8 Civil Engineering and Architectural Facilities

The following list describes the the planned structures and buildings for the TKG No.1&2:

Table 6.3.9-1 List of planned TKG No.1&2 structures and buildings

№	Name of building and construction	Note
Main Site		
10	Main building consists of:	
10-1	Turbine building for gas turbines - IAFU (frame and foundations) - gas turbines generator room	For 2 GTs For 2 GTs
10-2	- Steam turbines and SG generators compartment	4 generators
10-3	Boiler room	

10-4	Integrated auxiliary body	
10-5	Transition bridge	Bottom set 5.00
10-6	Set of shelves for electrical devices and OSU	3 storeys 4 storeys
10-7	Gas fuel skid (container)	2 pcs
10-8	Compressed air compressor unit and nitrogen generating station with receivers	
10-9	Power generating unit tank farm (CST, BCG) - tanks V=1000 v^3	3 pcs
10-10	Standby diesel generator (container)	
10-11	Materials live storage	
10-12	Accidental discharge of turbine oil tank (subterranean) - oil line arrangement Ø100	
10-13	SCD building	
11	- smokestack H=90m. Ø-6m	
11a	- bypass smokestack with gas lines H=90m. Ø-8m	
13	Open transformer unit with rerolling railways	
	- transformer 400 MVA	
	- transformer 200 MVA	
	- standby transformer 40 MVA	
	- auxiliary transformer GT 25 MVA	
	- fire-rated partitions	
13-1	- Oil collector for (subterranean) collecting transistors emergency oil	
	- emergency oil drainage networks Ø400	
13-2	Fire suppression distributive point	overhead
	- railway tracks for transformers rerolling	
	- transformers enclosure H=1.6m	
14	Flexible couplings - HV line -220kV	
19	OSG-220kV	
19-1	Relay cabinet on OSG - 220 kV	

	- territory enclosure H=1.6 m	
19-2	Busbar assembly for OSG -220 kV - enclosure H=1.6m	
19-3	Searchlight towers	
25	Territorial cable pathways cross-section - 600x600 - 1200x1200	
27	Startup boiler room including:	
	a. boiler compartment with c WPP	
	b. pumping station and boiler room	
	c. smokestack H=40m, Ø=3m	
	г. diesel fuel oil storage warehouse	
28	Technological trestle bridge	
	- high pressure gas transmission pipeline	
	- pipe racks with heat network	
	- heat networks in channek - KL-60-45 - KL - 90-45	
	- cable constructions	
39	Gas treatment spot (GTS) consists of:	
	a) gas booster station (GBS)	
	b) gas metering station	
	c) gas distributing unit (GDU)	
	- GTS territory enclosure H=1.6m	
65	Chemical treatment of water - main building - auxiliary building	
65-1	WPP tank farm (ground)	
65-2	Hydrozene compartment	
65-3	Salt storage warehouse	
66	IWIT facilities	
	underground tank - 100 m^3	
	tank- 40 m^3	
	Drying evaporator system in the container form	

	Oily water treatment facility building	
69	Chemical reagents and filtering materials warehouse	
75	Electrolysis room with hydrogen, oxygen, and carbon dioxide receivers, including: A) Building B) Shed	
82	Laundry	
96	Oil facilities	
96-1	Drummed oil storage warehouse	
71	Central storage warehouse - building - discharging area	
72	Central maintenance stations	
86	Administrative and service building	3 floors
90	Contracting organizations disposition building	2 floors
98	Civil defense facilities	Under administrative and service buildings
93	Cafeteria	2 floors
92	Central control post - watchman enclosure	
92-1	Control post №2	
115	Garage and car fleet for 40 cars	
120	Drinking and household water supply construction consists of:	
	a) Drinking and household water supply storage reservoirs of 600m^3 in volume with simplified filter-absorber (2pcs)	
	b) Drinking and household water supply water-pumping station (1 pc.)	
	c) Drinking and household water supply external supply line	
	d) Switch boxes	subterranean
	- heat supply system power-up pipeline (125 m^3/hour) Ø200	

121	Industrial site fire-fighting water conduit external supply lines Ø300	
	a) Switch boxes	subterranean
	b) Industrial site fire-fighting water conduit external supply lines and ODU-220	
	c) Switch boxes	subterranean
122	Utility fluids water-pumping station Ø1,5 m	
	a)Household sewerage systems external line (self-flowing)	
	b) Household sewerage systems external line (pressure-tight)	
124	Oil-contaminated water sewage pumping pump station Ø1,5 m	
	Oil-contaminated drainage external lines (self-flowing)	
	Oil-contaminated drainage external lines (pressure-tight)	
	Storm water drainage – tray-type (on-site)	
	Process Water Supply	
41	Circulation pump station, combined with fire extinguishing pump station, grading tower blowoff station and manufacturing water pump station. - aboveground part - subterranean part	
41.1	Circulation pump station receiving water body	
41.2	Circulation water conduits - pressure-tight (4 branches Ø1600) - waste (4 branches Ø1600) - waste (8 branches Ø1200) - waste (40 branches Ø800)	
41.3	Manufacturing water conduit on industrial site - pressure-tight (1 branch Ø900) - waste (1 branch Ø900)	
43-5	Make-up water conduit on industrial site - pressure-tight (2 branches Ø400)	
43.6	Flow meter component enclosure on make-up water conduit on industrial site	subterranean

44	Ventilatory graduating tower 15x15m (20 sections). Equipped with electric fans (20 pcs, N=125kV each) - aboveground part - subterranean part	
44.1	Graduating tower TS (container)	
44.2	Offtake waste water conduits from graduating towers to circulation pump station receiving water body 4Ø2440x10	
46	Main building drainage pumping station - aboveground part - subterranean part	
46.1	Main building perimeter drainage	
46.2	Main building drainage forced conduit Ø100	
99	Piezometric network on CCGT industrial site Piezometers Ø70	
134.9	Pipelines for pulp supply to the sludge pit of WTP and for return of clarified water from the sludge pit to the WTP of Ø100	subterranean
	- Safeguard arrangements territory enclosure	
	- On-site highways	
	- Territory illumination	
	- Territory landscaping and improvement	
120-1	Off-site drinking and household water supply system	
120-2	Drinking and household water supply system boosting pumping station (3pcs)	
120-3	100m3 cubic capacity reservoir with complanate absorbent-type filter (3pcs)	Near the pumping station
120-4	Technological communications (binding)	
122-1	- Off-site domestic sewerage system network (pressure-tight) to Turakurgan city - Off-site storm water drainage	

43.1	Make-up water pump station I with water delivery to precipitation tank - aboveground part - subterranean part	
43.2	Make-up water pump station II flow up (from precipitation tank to CTW) - aboveground part - subterranean part	
43.3	Water intake mouth of MWPS I lidting in monolith ferroconcrete with trashtrack structures up to 1500m^3/hour expense	subterranean
43.4	Intake mouth with BNK uncapped incased channelway conjugation	
43.5	Approach dredging tube to MWPS I lifting -3 branches Ø600	
43.6	Pressure-tight make-up water supply pipelines from MWPS I lifting to precipitation tank: -2 branches Ø400 in ground	subterranean
43.7	Valve chamber at make-up water pipeline after MWPS I. - subterranean part	subterranean
43.8	Make-up water pressure-tight pipeline on the trestle from the MWPS II lifting to the station fence - 2 branches Ø400 in the ground	 subterranean
43.9	Valve chamber at make-up water pipeline after MWPS II. - subterranean part	subterranean
43.10	Valve chamber on make-up water pipeline after MWPS II. - subterranean part	subterranean
134.1	2 section make-up water precipitation tank	
134.2	2 section sludge dirtpile	
134.3	Clarified water pump station at the sludge pit - aboveground part - subterranean part	
134.4	- 2 section boiler chemical washing evaporation pond	
134.5	- 2 section waste disposal site for temporary stock-keeping of oily silt and sediment	

134.7	- 2 section CTW waste water disposal site	
134.12	Clarified water supply pipeline from pulp sludge to the precipitation tank of Ø200	
134.8	- CTW drilling waste disposal site pumping station for neutralized and settled water pumpdown in LNC - aboveground part - subterranean part	
134.9	Pipelines for pulp supply to the sludge pit from the CWP and return of clarified water from the sludge pit to the CWT Ø100	subterranean
134.10	Graduating towers blow-off pipelines - waste (2 branches Ø500)	
134.13	Flow meter component compartment on graduation tower blow-off pipe installation	subterranean
134.14	Shock-absorber pit on graduation tower blow-off pipe installation.	subterranean
	- territory enclosure	
	- Highway stream crossing	
94	Fire-engine station for 2 cars - territory enclosure H=2.4m - on-site highways - territory illumination	
	- HV – 6 kV (main building – fire-engine station)	
	- HV – 6 kV (main building – make-up water pump station II)	

Source: JICA Study Team

6.4 Construction Program

The construction plan is made based on the results of the investigation for the current conditions of the plant construction site, the surrounding area, and the conceptual design for the facilities for the project.

The construction schedule is planned by examining of the results of the investigation and will be indicated hereafter using a bar chart on a monthly basis, in accordance with the JICA form. Milestones of key construction items are as shown in the construction schedule. The appropriateness of the construction schedule has been examined taking into consideration the schedule of the commissioning.

The commissioning date is set to be in March 2017 for the gas turbine system and April 2018 for the combined cycle, respectively.

6.4.1 Material/Equipment Procurement Program

6.4.1.1 Material/Equipment Procurement

Materials and equipment will be procured from Uzbekistan, Japan and other countries.

While the main equipment will be procured from abroad, other equipment can be procured in Uzbekistan.

Civil and architecture works will be executed by national contractors.

Table 6.4.1.1-1 Procurement Program

Categories	Item	Procurement Countries		
		Uzbekistan	Other Countries	Japan
Equipment	1. Gas Turbine		○	○
	2. Heat Recovery Steam Generator		○	○
	3. Steam Turbine		○	○
	4. Fuel Supply System	○	○	○
	5. Wastewater System	○	○	○
	6. Fire Fighting System	○	○	○
	7. Electrical System	○	○	○
	8. Protection and Control System		○	○
	9. Subplant	○	○	○
	10. Transmission Line	○	○	○
	11. Water desalination system	△	○	○
	12. Ancillary	○	○	○
Civil and Architecture Works		○		

Source: JICA Study Team
Remarks: ○ Available, △ Partially available

Table 6.4.1.1-2 Available Materials in Uzbekistan

Item	Available Materials in Uzbekistan
Fuel Supply System	Steel plates, valves, etc., for fuel tank construction
Wastewater System	Steel plates, valves, etc., for wastewater treatment tank construction, and some chemicals for operation
Fire Fighting System	Fire extinguishers, hoses, etc.
Electrical System	Cables, transformers, electric panels, cabinets, battery systems, etc.

Source: JICA Study Team

6.4.1.2 Material for Civil and Architecture Works

Main materials like cement, re-bars, H-beams, aggregate, RC-pipes and GRP (Glass-fibered reinforced pipes) for the project are manufactured in Uzbekistan, and materials like bituminous can be purchased in the Uzbekistan's market.

Table 6.4.1.2-1 Purchase of Main Materials for Civil/Architecture Works

Item	Description	Procurement Plan		
		Uzbekistan	Other countries	Japan (reference)
Bituminous		○		
Cement		○		
Sand		○		
Aggregate		○		
Re-Bars		○		
H-beams		○		
RC pipes & GRP		○		

Source: JICA Study Team

6.4.1.3 Equipment for Erection of Heavy Equipment and Civil/Architecture Works

Cranes and other machines for the erection of heavy equipment with sufficient hanging and/or jacking up capacity are owned by contractors in Uzbekistan. They have the experience executing of the erection of heavy equipment in other similar projects in the past in Uzbekistan.

Common construction equipment for civil/architecture works are available in Uzbekistan. Ready mixed concrete and asphalt concrete can be purchased in Uzbekistan.

Table 6.4.1.3-1 Procurement of Main Equipment

Item	Description	Procurement plan		
		Uzbekistan	Other countries	Japan (reference)
Piling Driving Machines	RC-pile, L = 20-25 m	○		
Jacking Pipe Machines	Inlet Tunnel, D = 2 m	○		
Bulldozers	15 - 20 ton	○		
Backhoes	0.8 m^3	○		
Dump Trucks	10 ton	○		
Trucks	10 ton	○		
Cranes	10-100 ton	○		
Cranes for heavy equipment erection	400-600 ton	○		

Source: JICA Study Team

6.4.2 Material/Equipment Transportation Program

Since Uzbekistan is an inland country without a coast line, difficulties are found in transporting large, heavy products.
In the 450MW-class CCPP, the maximum weight of a product will exceed 300 tons even when the heavy product is divided into several parts for transportation.
Several months will be required for transportation when considering the utilization of the canal transportation route - via the Volga canal from the Black Sea (the Black Sea through the Caspian Sea) - and the inland transportation route - through the Republic of Turkmenistan and Republic of Tajikistan.
Again, when a construction program is to be worked out, a sufficient period of time is required for transportation while taking into account frozen period of the Volga, as well as the distance of transportation.
The potential transportation route for heavy items is shown in Figure 6.4.2-1.and Figure 6.4.2-2

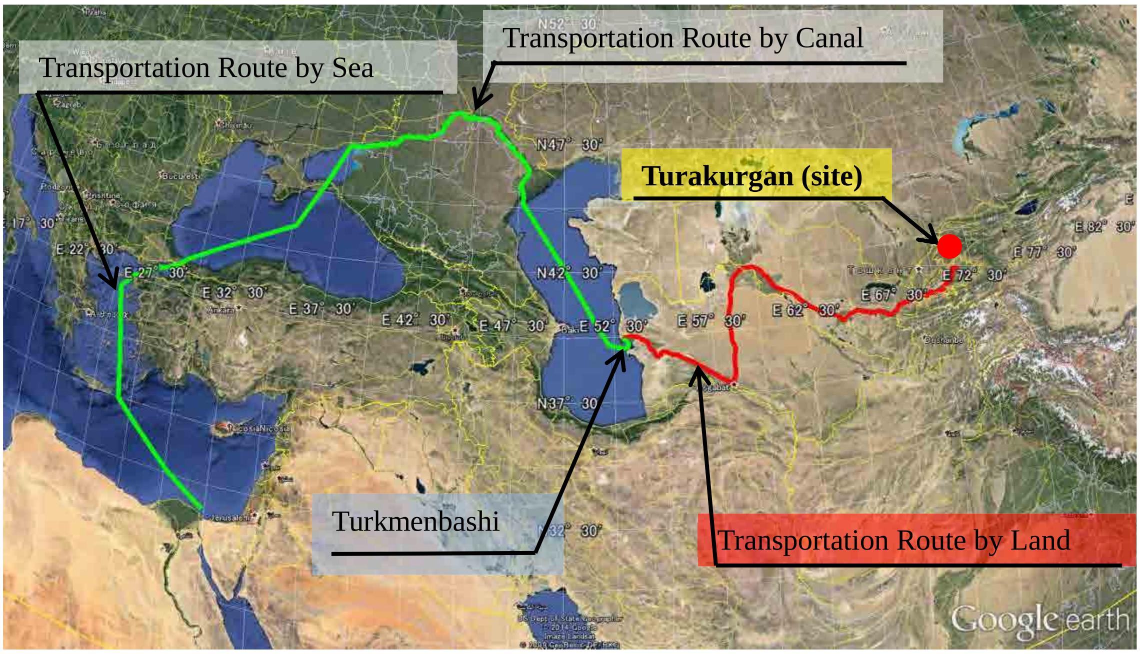


Figure 6.4.2-1 Transportation Route to Turakurgan Thermal Plant Site

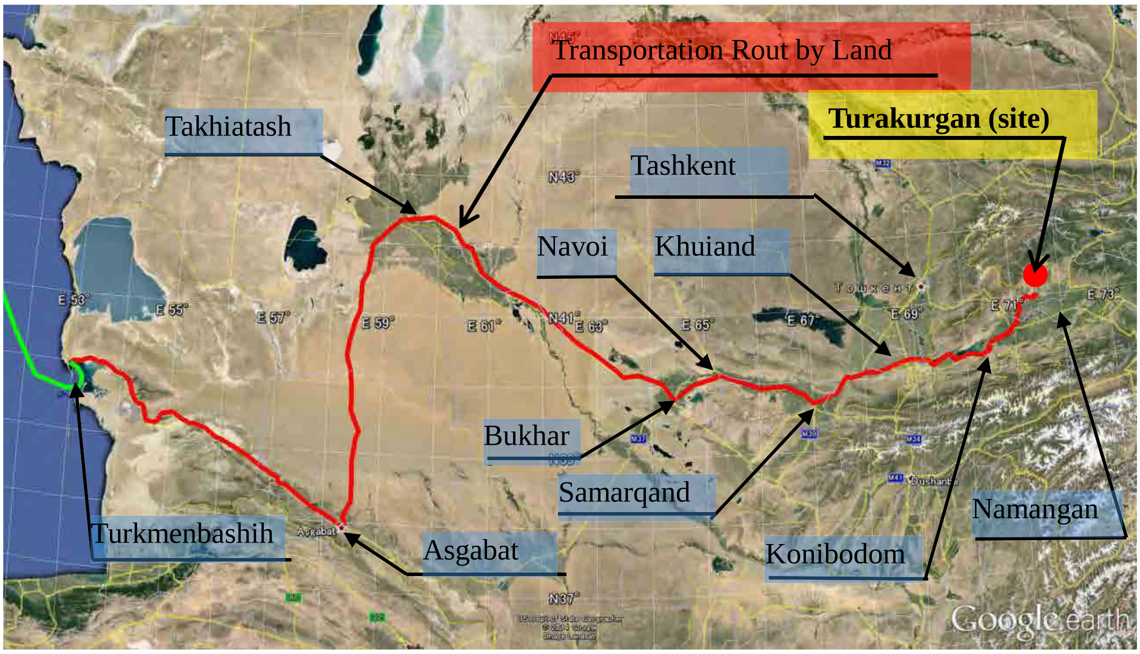


Figure 6.4.2-2 Transportation Route to Turakurgan Thermal Plant Site by Land

Chapter 7 System Analysis and Grid Connection Plan

7.1 System analysis

7.1.1 Objective

As noted in the previous chapters, SJSC Uzbekenergo (Uzbekenergo) made a plan to construct Turakurgan Thermal Power Station No.1 & No.2 (TKG No.1&2) in Turakurgan area in Namangan. The objective of this analysis is to verify expected impact on the power system when the plant is interconnected to the grid. The JICA Study Team has carried out three types of analyses which are power flow, fault current and dynamic stability. Methodologies for the analyses are shown below.

- Power Flow Analysis
  In terms of reliability, power flow has been calculated under normal conditions and single contingency (N-1*) conditions to find out if the voltages of all buses are within the allowable limit and to verify no equipment is overloaded.
  *An N-1 is the state that single electric facility is stopped from operating at normal conditions.

- Fault Current Analysis
  Fault current at each bus in any substations and power stations has been calculated to determine if the fault current is within the rated current breaking capacities of existing circuit breakers.

- Dynamic Stability Analysis
  In dynamic stability analysis, a sequence of occurring and clearing of a fault has been simulated under each fault location condition to determine if all generators can sustain their synchronicities.

7.1.2 Premise

The analyses have been conducted using PSS/E (Version 33.0.1) developed by Siemens Power Technologies International (Siemens PTI). A PSS/E data set has been constructed on the basis of the information provided by Uzbekenergo and SAESP.
Table 7.1.2-1 shows conditions of the analyses.

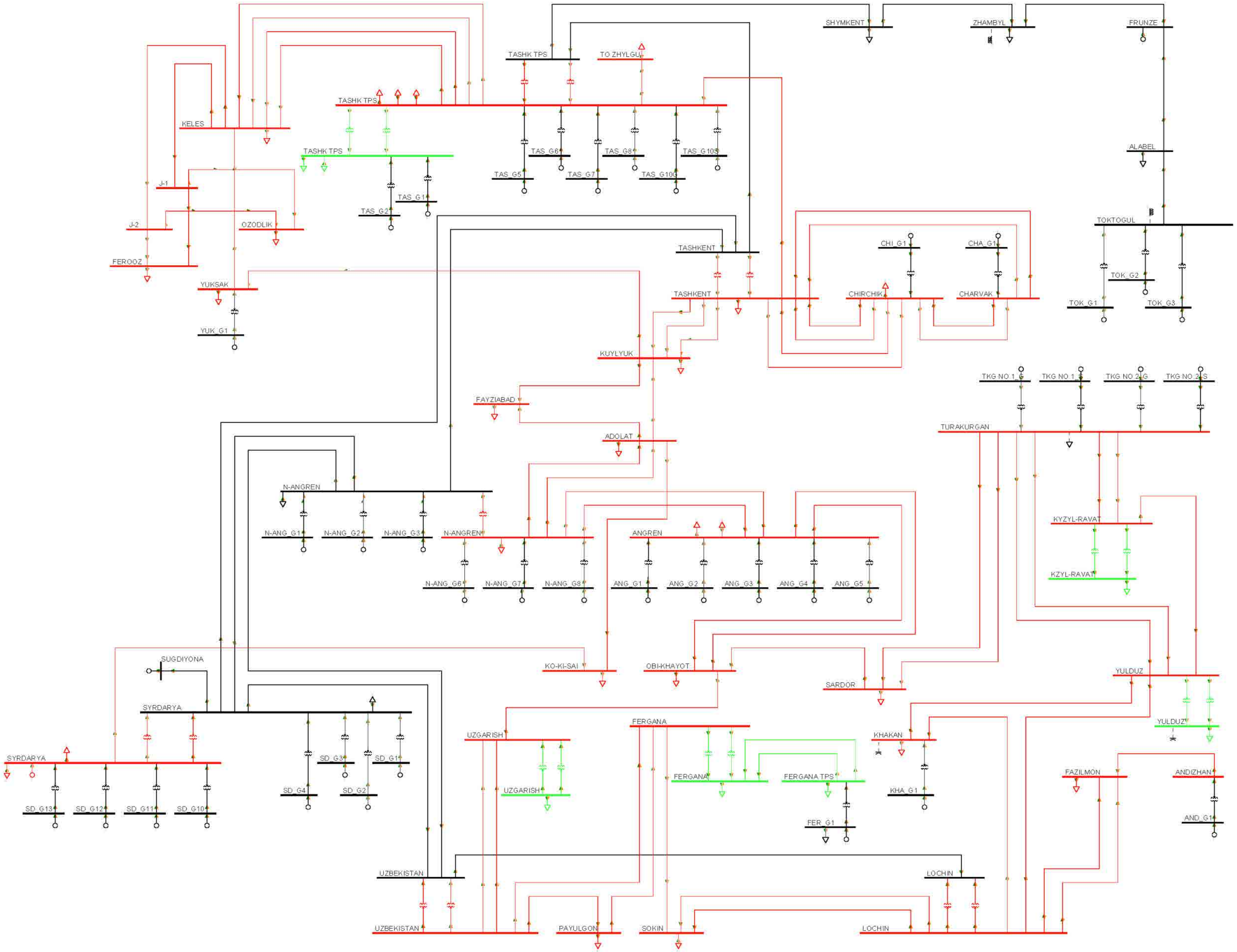
Table 7.1.2-1 Conditions of Analyses

No.	Year	Season	Time	Ambient temperature [degree C]	Situation
Case 1	2019	Summer	21:00	30	Summer Peak Load
Case 2			11:00	40	Maximum Temperature
Case 3	2020	Winter	21:00	-5	Winter Peak Load

Source: JICA Study Team

In Uzbekistan, a daily maximum power demand appears at night time, and that of the winter season is larger than that of the summer season. In general, analyses are conducted under the maximum demand condition, which occurs at night time in the winter season. On the other hand, in the summer season, transmission line capacity decreases due to ambient temperature increase. Therefore, analyses should be also conducted under summer season conditions

considering the transmission capacity decreases.
The construction of the new power plant is expected to be completed in the summer of 2019. Therefore, these analyses have been conducted at the peak power demand in summer condition of 2019 and winter condition of 2020. Moreover, the analysis has been also conducted at the maximum temperature condition in summer of 2019.
The figure below shows the connection diagram of the power system for the analyses.



Source: JICA Study Team

Figure 7.1.2-1 Connection Diagram of the Power System for the Analyses

Facility centered on TKG No.1&2 has been modeled in 500 kV, 220 kV and 110 kV systems including Tashkent thermal power plant (TPP), Tashkent S/S, Novo-Anglen TPP, Anglen TPP, Syrdaria S/S, Uzbekistan S/S and Lochin S/S in Uzbekistan, and Shimkent S/S, Zhambyl S/S, Frunzenskaya S/S and Toktogul hydro power plant (HPP) in even neighboring countries.

- Generator input data

  The table below shows generator data modeled in the PSS/E data set.

Table 7.1.2-2 Generator Data (1/2)

Bus		PG [MW]			QG [Mvar]			Base [MVA]	Type		
No.	Name	Case1	Case2	Case3	Case1	Case2	Case3		Generator	Exciter	Governor
201	N-ANG_G1	222.0	205.0	266.7	183.8	185.9	108.5	352.9	GENROU	IEEET1	IEESGO
202	N-ANG_G2	222.0	-	266.7	183.8	-	108.5	352.9	GENROU	IEEET1	IEESGO
203	N-ANG_G3	-	-	266.7	-	-	108.5	352.9	GENROU	IEEET1	IEESGO
501	N-ANG_G6	218.0	231.0	233.3	-55.5	6.2	-1.0	352.9	GENROU	IEEET1	IEESGO
502	N-ANG_G7	-	-	233.3	-	-	-1.0	352.9	GENROU	IEEET1	IEESGO
503	N-ANG_G8	-	-	233.3	-	-	-1.0	352.9	GENROU	IEEET1	IEESGO
600	SUGDIYONA	-500.0	-370.0	-700.0	-100.0	-74.0	-16.0	13500.0	GENCLS	None	None
801	ANG_G1	58.0	34.0	105.9	53.2	89.1	30.7	176.5	GENROU	ESDC1A	IEESGO
802	ANG_G2	-	-	48.0	-	-	30.2	80.0	GENROU	ESDC1A	IEESGO
803	ANG_G3	-	-	48.0	-	-	30.2	80.0	GENROU	ESDC1A	IEESGO
804	ANG_G4	-	-	48.0	-	-	30.2	80.0	GENROU	ESDC1A	IEESGO
805	ANG_G5	-	-	48.0	-	-	30.2	80.0	GENROU	ESDC1A	IEESGO
1901	KHA_G1	-	-	20.0	-	-	10.0	117.6	GENSAL	ESDC1A	IEESGO
3301	SD_G1	260.0	199.0	277.5	51.1	-19.9	30.4	352.9	GENROU	IEEET1	IEESGO
3302	SD_G2	260.0	199.0	277.5	51.1	-19.9	30.4	352.9	GENROU	IEEET1	IEESGO
3303	SD_G3	260.0	199.0	277.5	51.1	-19.9	30.4	352.9	GENROU	IEEET1	IEESGO
3304	SD_G4	260.0	199.0	277.5	51.1	-19.9	30.4	352.9	GENROU	IEEET1	IEESGO
3305	SD_G5	260.0	-	-	51.1	-	-	352.9	GENROU	IEEET1	IEESGO
3700	FRUNZE	-701.4	-752.9	-543.9	-56.7	-17.1	-153.3	5000.0	GENCLS	None	None
4801	TOK_G1	270.0	270.0	233.1	54.3	54.3	-6.8	352.9	GENSAL	ESDC1A	IEESGO
4802	TOK_G2	270.0	270.0	233.1	54.3	54.3	-6.8	352.9	GENSAL	ESDC1A	IEESGO
4803	TOK_G3	270.0	270.0	233.1	54.3	54.3	-6.8	352.9	GENSAL	ESDC1A	IEESGO
4804	TOK_G4	270.0	270.0	-	54.3	54.3	-	352.9	GENSAL	ESDC1A	IEESGO
5801	AND_G1	190.0	190.0	17.0	16.9	28.0	5.0	37.1	GENSAL	ESDC1A	IEESGO
6101	FER_G1	30.0	30.0	80.0	70.2	18.0	76.4	235.3	GENROU	ESDC1A	IEESGO
6801	TAS_G5	-	-	141.7	-	-	93.0	176.5	GENROU	ESDC1A	IEESGO
6802	TAS_G6	115.0	115.0	146.5	48.4	66.6	96.1	182.4	GENROU	ESDC1A	IEESGO
6803	TAS_G7	123.0	123.0	155.9	48.9	67.1	102.3	194.1	GENROU	ESDC1A	IEESGO
6804	TAS_G8	123.0	123.0	155.9	53.6	73.7	102.3	194.1	GENROU	ESDC1A	IEESGO
6901	TAS_G10G	250.0	250.0	250.0	107.3	147.7	143.1	294.1	GENROU	IEEET1	GAST
6902	TAS_G10S	120.0	120.0	120.0	53.4	73.6	74.4	141.2	GENROU	IEEET1	IEESGO
7501	YUK_G1	80.0	80.0	100.0	36.0	0.0	90.1	235.3	GENROU	ESDC1A	IEESGO
8000	SYRDARYA	13.0	13.0	15.0	4.2	5.4	4.4	17.6	GENROU	IEEET1	IEESGO
8101	SD_G10	238.0	256.0	210.6	43.7	109.5	103.6	382.4	GENROU	IEEET1	IEESGO
8102	SD_G11	238.0	257.0	210.6	43.7	109.6	103.6	382.4	GENROU	IEEET1	IEESGO
8103	SD_G12	-	257.0	194.4	-	55.0	103.6	352.9	GENROU	IEEET1	IEESGO

Source: JICA Study Team

Table 7.1.2-3 Generator Data (1/2)

Bus		PG [MW]			QG [Mvar]			Base [MVA]	Type		
No.	Name	Case1	Case2	Case3	Case1	Case2	Case3		Generator	Exciter	Governor
8104	SD_G13	-	-	194.4	-	-	103.6	352.9	GENROU	IEEET1	IEESGO
8201	TKG NO.1_G	255.0	255.0	301.1	70.3	85.8	99.6	375.0	GENROU	IEEET1	GAST
8202	TKG NO.1_S	150.0	150.0	150.0	70.3	85.8	99.6	187.5	GENROU	IEEET1	IEESGO
8203	TKG NO.2_G	255.0	255.0	301.1	70.3	85.8	99.6	375.0	GENROU	IEEET1	GAST
8204	TKG NO.2_S	150.0	150.0	150.0	70.3	85.8	99.6	187.8	GENROU	IEEET1	IEESGO
8301	CHI_G1	208.0	246.0	100.0	20.4	45.5	66.6	235.3	GENSAL	ESDC1A	IEESGO
8401	CHA_G1	631.0	617.0	643.6	20.3	61.8	21.9	941.2	GENSAL	ESDC1A	IEESGO
8601	TAS_G1	134.0	134.0	75.0	57.7	68.0	31.0	176.5	GENROU	IEEET1	IEESGO
8602	TAS_G2	133.0	133.0	75.0	57.6	67.9	31.0	176.5	GENROU	IEEET1	IEESGO
8603	TAS_G3	133.0	133.0	-	57.6	67.9	-	176.5	GENROU	IEEET1	IEESGO

Source: JICA Study Team

[Generator model]
The typical generator model which is called “GENROU” in PSS/E application has been used for cylindrical-rotor machines such as steam turbine generators and gas turbine generators. “GENSAL” model, which is also a typical one, has been used for salient-pole machines such as hydro generators. The table below specifies parameters of the two types of generator models.

Table 7.1.2-4 Generator Data for Transient Stability Analysis

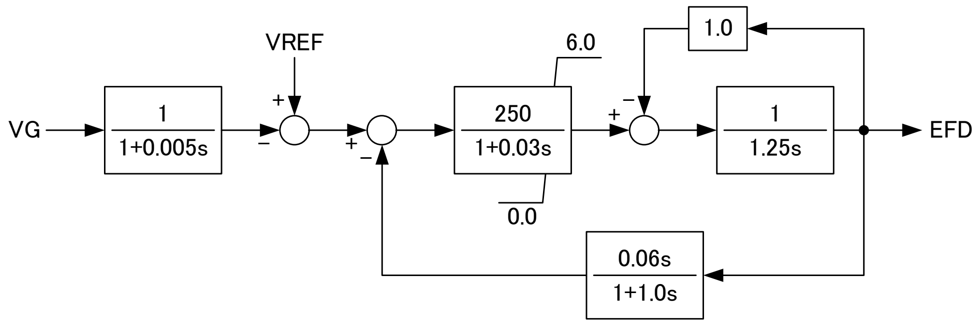
Type	GENROU	GENSAL
Tdo’ [sec]	6.5	5.25
Tdo” [sec]	0.035	0.03
Tqo’ [sec]	1.25	-
Tqo” [sec]	0.035	0.05
H [sec]	4.0 or 5.0(*)	5.0
D [pu]	0	0
Xd [pu]	1.55	0.99
Xq [pu]	1.55	0.66
Xd’ [pu]	0.28	0.35
Xq’ [pu]	0.65	-
Xd” (=Xq”) [pu]	0.19	0.25
Xl [pu]	0.15	0.15
S(1.0)	0.07	0.07
S(1.2)	0.18	0.18

(*) The inertia “H” of the gas turbine of TKG No.1&2_G and TAS_G10G were set to 5.0 seconds, the others were set to 4.0 seconds.

Source: JICA Study Team

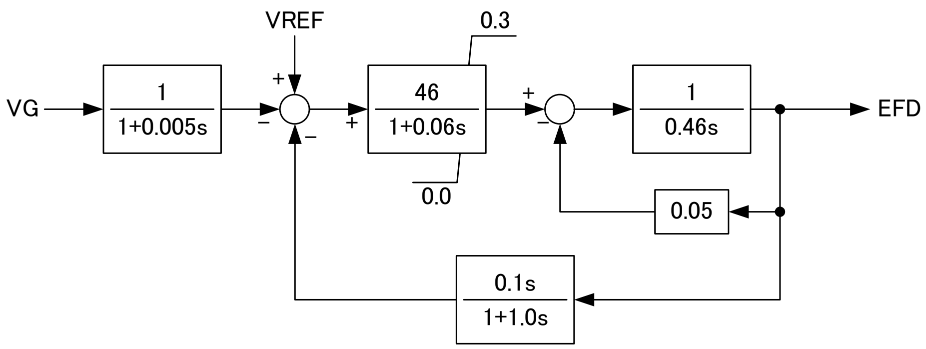
The sets of parameters noted above, which are typical ones, are necessary for the transient stability analysis. The parameter values in “pu” or “per-unit” on the table are given on the machine bases.

[Exciter Model]
"IEEET1" and "ESDC1A" were used as typical AC and DC exciter models respectively. The block diagrams in the following figures show the parameters of those models.



Source: JICA team

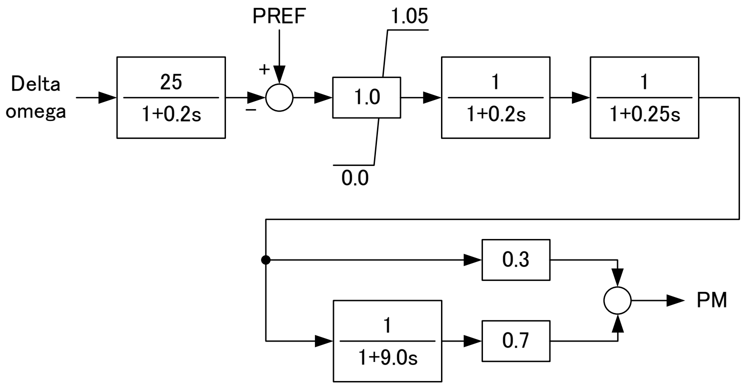
Fig. 7.1.2-2 Block Diagram of Exciter (IEEET1)



Source: JICA Study Team

Fig. 7.1.2-3 Block Diagram of Exciter (ESDC1A)

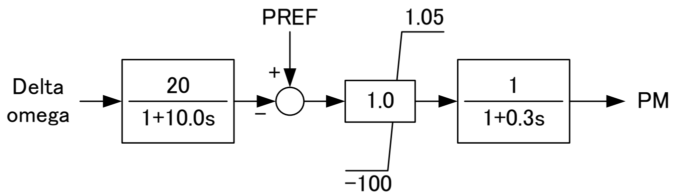
[Governor Model]
"IEESGO" was used as a typical governor model for thermal and hydro generators, and "GAST" was for gas turbine generators. The block diagram in the following figure shows the parameters of the IEESGO model for thermal generators.



Source: JICA Study Team

Fig. 7.1.2-4 Block Diagram of Governor (IEESGO for TPP)

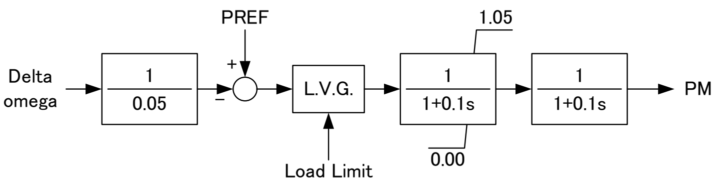
The block diagram in the following figure shows the parameters of the IEESGO model for hydro generators.



Source: JICA Study Team

Fig. 7.1.2-5 Block Diagram of Governor (IEESGO for HPP)

The block diagram in the following figure shows the parameters of the GAST model for gas turbine generators.



Source: JICA Study Team

Fig. 7.1.2-6 Block Diagram (GAST for GT)

- Load input data
  The table below shows bus names and corresponding load in the PSS/E data set.

Table 7.1.2-5 Load Data

Bus		Voltage	PG [MW]			QG [Mvar]		
No.	Name	[kV]	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
100	N-Angren	500	25.0	45.0	52.0	25.0	21.0	52.0
400	N-Angren	220	-	-	44.0	-	-	44.0
700	Angren	220	62.0	122.0	180.0	32.0	65.0	100.0
700	Angren	220	-	-	46.0	-	-	46.0
900	Obi-Khayot	220	135.0	125.0	104.0	65.0	75.0	12.0
1000	Sardor	220	255.0	240.0	180.0	47.0	92.0	67.0
1900	Khakan	220	195.0	144.0	245.0	78.0	76.0	158.0
2000	Sokin	220	230.0	185.0	190.0	110.0	103.0	95.0
2300	Fergana	110	218.0	208.0	220.0	91.0	91.0	51.0
2500	Payulgon	220	45.0	50.0	60.0	22.0	23.0	27.0
2800	Uzgarish	110	220.0	162.0	280.0	38.0	87.0	113.0
3100	Syrdarya	500	-	-	53.0	-	-	53.0
3600	Alabel	500	45.0	45.0	105.0	12.0	12.0	12.0
3900	Zhambyl	500	360.0	360.0	210.0	82.0	82.0	161.0
4000	Shymkent	500	230.0	230.0	313.0	110.0	110.0	82.0
4200	Tashk TPS	220	21.0	21.0	232.0	21.0	21.0	139.0
4200	Tashk TPS	220	11.0	11.0	36.0	11.0	11.0	36.0
4200	Tashk TPS	220	-	-	11.0	-	-	11.0
4400	Tashkent	220	23.0	17.0	34.0	6.0	7.4	12.0
5300	Fazilmon	220	28.0	32.0	40.0	5.0	7.0	15.0
5900	To Zhylgu	220	262.0	264.0	190.0	-17.0	25.0	-66.0
6000	Fergana TPS	110	12.0	14.0	14.0	3.0	3.6	6.0
6101	FER_G1	10	-	-	18.0	-	-	18.0
6200	Kyzyl-Ravat	110	185.0	159.0	204.0	74.0	88.0	91.0
6500	Yulduz	110	245.0	158.0	260.0	90.0	45.0	115.0
7000	Keles	220	220.0	250.0	230.0	95.0	108.0	109.0
7300	Ozodlik	220	190.0	220.0	260.0	78.0	90.0	143.0
7400	Ferooz	220	70.0	80.0	85.0	26.0	30.0	31.0
7500	Yuksak	220	196.0	84.0	219.0	90.0	50.0	94.0
7600	Kuylyuk	220	221.0	199.0	285.0	100.0	84.0	122.0
7700	Fayziabad	220	80.0	100.0	110.0	52.0	32.0	71.0
7800	Adolat	220	227.0	168.0	200.0	116.0	100.0	83.0
7900	Ko-Ki-Sai	220	175.0	169.0	175.0	87.0	82.0	87.0
8000	Syrdarya	220	774.0	639.0	670.0	303.0	336.0	265.0
8000	Syrdarya	220	23.0	37.0	39.0	23.0	37.0	39.0
8300	Chirchik	220	63.0	110.0	156.0	27.0	26.0	70.0
8500	Tashk TPS	110	300.0	350.0	310.0	270.0	280.0	188.0
8500	Tashk TPS	110	24.0	24.0	9.0	24.0	24.0	9.0

Source: Uzbekenergo, SAESP

- Branch input data

The table below shows data of transmission lines, which are called branches in PSS/E. The parameter values in pu on the table are given on the 100 MVA system base.

Table 7.1.2-6 Branch Data (1/3)

From Bus		To Bus		Voltage [kV]	ID	R [pu]	X [pu]	B [pu]	Rate [MVA]		
No.	Name	No.	Name						Case 1	Case 2	Case 3
100	N-Angren	3000	Uzbekistan	500	1	0.00165	0.020196	1.493250	2903.4	2115.7	1823.1
100	N-Angren	3100	Syrdarya	500	1	0.00130	0.015912	1.176500	2903.4	2115.7	1823.1
100	N-Angren	4300	Tashkent	500	1	0.00062	0.007626	0.563815	2903.4	2115.7	1823.1
400	N-Angren	700	Angren	220	1	0.00214	0.018440	0.055276	887.8	646.9	557.5
400	N-Angren	700	Angren	220	2	0.00427	0.029355	0.054500	487.7	355.4	306.2
400	N-Angren	7800	Adolat	220	1	0.00149	0.015909	0.048694	975.4	710.8	612.5
400	N-Angren	7800	Adolat	220	2	0.00389	0.026779	0.049716	487.7	355.4	306.2
600	Sugdiyona	3100	Syrdarya	500	1	0.00217	0.026561	1.963850	-	-	-
700	Angren	900	Obi-Khayot	220	1	0.01200	0.082600	0.153353	487.7	355.4	306.2
700	Angren	900	Obi-Khayot	220	2	0.01382	0.077410	0.139259	425.8	310.3	267.4
900	Obi-Khayot	1000	Sardor	220	1	0.01682	0.094163	0.169396	425.8	310.3	267.4
900	Obi-Khayot	4900	Uzgarish	220	1	0.00395	0.027169	0.050441	487.7	355.4	306.2
1000	Sardor	6700	Turakurgan	220	1	0.00354	0.024295	0.054244	487.7	355.4	306.2
1000	Sardor	6700	Turakurgan	220	2	0.00496	0.027788	0.049991	425.8	310.3	267.4
1100	Kyzyl-Ravat	1300	Yulduz	220	1	0.00956	0.053512	0.096267	425.8	310.3	267.4
1100	Kyzyl-Ravat	6700	Turakurgan	220	1	0.00513	0.035146	0.085812	487.7	355.4	306.2
1100	Kyzyl-Ravat	6700	Turakurgan	220	2	0.00737	0.041285	0.074272	425.8	310.3	267.4
1300	Yulduz	1700	Lochin	220	1	0.00495	0.034039	0.063196	487.7	355.4	306.2
1300	Yulduz	1900	Khakan	220	1	0.00222	0.015302	0.028409	487.7	355.4	306.2
1300	Yulduz	6700	Turakurgan	220	1	0.01248	0.085879	0.159441	487.7	355.4	306.2
1300	Yulduz	6700	Turakurgan	220	2	0.01248	0.085879	0.159441	487.7	355.4	306.2
1700	Lochin	1900	Khakan	220	1	0.00295	0.020299	0.037686	487.7	355.4	306.2

Source: Uzbekenergo, SAESP

Table 7.1.2-7 Branch Data (2/3)

From Bus		To Bus		Voltage [kV]	ID	R [pu]	X [pu]	B [pu]	Rate [MVA]		
No.	Name	No.	Name						Case 1	Case 2	Case 3
1700	Lochin	2000	Sokin	220	1	0.00332	0.022875	0.042469	487.7	355.4	306.2
1700	Lochin	2000	Sokin	220	2	0.00331	0.022797	0.042324	487.7	355.4	306.2
1700	Lochin	5300	Fazilmon	220	1	0.02356	0.084698	0.141666	312.3	227.6	196.1
1700	Lochin	5300	Fazilmon	220	2	0.02356	0.084698	0.141666	312.3	227.6	196.1
1800	Lochin	3000	Uzbekistan	500	1	0.00187	0.019669	1.511610	2428.2	1769.4	1524.7
2000	Sokin	2100	Fergana	220	1	0.00260	0.017878	0.033193	487.7	355.4	306.2
2100	Fergana	2500	Payulgon	220	1	0.00193	0.013272	0.024641	487.7	355.4	306.2
2100	Fergana	2600	Uzbekistan	220	1	0.00946	0.065112	0.120885	487.7	355.4	306.2
2300	Fergana	6000	Fergana TPS	110	1	0.01269	0.023802	0.001936	96.8	70.5	60.8
2300	Fergana	6000	Fergana TPS	110	2	0.01269	0.023802	0.001936	96.8	70.5	60.8
2500	Payulgon	2600	Uzbekistan	220	1	0.00897	0.061755	0.114652	487.7	355.4	306.2
2600	Uzbekistan	4900	Uzgarish	220	1	0.00091	0.006246	0.011596	487.7	355.4	306.2
2600	Uzbekistan	4900	Uzgarish	220	2	0.00082	0.005621	0.010436	487.7	355.4	306.2
3000	Uzbekistan	3100	Syrdarya	500	1	0.00188	0.023011	1.701400	2903.4	2115.7	1823.1
3100	Syrdarya	4300	Tashkent	500	1	0.00155	0.018956	1.401574	2903.4	2115.7	1823.1
3500	Toktogul	3600	Alabel	500	1	0.00178	0.016244	1.300175	2428.2	1769.4	1524.7
3600	Alabel	3700	Frunze	500	1	0.00103	0.009424	0.754300	2428.2	1769.4	1524.7
3700	Frunze	3900	Zhambyl	500	1	0.00216	0.026402	1.952085	2903.4	2115.7	1823.1
3900	Zhambyl	4000	Shymkent	500	1	0.00141	0.020290	1.514065	2903.4	2115.7	1823.1
4000	Shymkent	4100	Tashk TPS	500	1	0.00117	0.014272	1.055230	2903.4	2115.7	1823.1
4100	Tashk TPS	4300	Tashkent	500	1	0.00021	0.002534	0.187335	2903.4	2115.7	1823.1
4200	Tashk TPS	4400	Tashkent	220	1	0.00263	0.018113	0.033627	487.7	355.4	306.2
4200	Tashk TPS	5900	To Zhylgu	220	1	0.00091	0.006246	0.011596	-	-	-
4200	Tashk TPS	7000	Keles	220	1	0.00204	0.014053	0.026090	487.7	355.4	306.2
4200	Tashk TPS	7000	Keles	220	2	0.00238	0.016395	0.030439	487.7	355.4	306.2
4200	Tashk TPS	7000	Keles	220	3	0.00369	0.020643	0.037136	425.8	310.3	267.4
4200	Tashk TPS	7000	Keles	220	4	0.00369	0.020643	0.037136	425.8	310.3	267.4

Source: Uzbekenergo, SAESP

Table 7.1.2-8 Branch Data (3/3)

From Bus		To Bus		Voltage [kV]	ID	R [pu]	X [pu]	B [pu]	Rate [MVA]		
No.	Name	No.	Name						Case 1	Case 2	Case 3
4400	Tashkent	7600	Kuylyuk	220	1	0.00296	0.020377	0.037831	487.7	355.4	306.2
4400	Tashkent	7600	Kuylyuk	220	2	0.00293	0.020143	0.037396	487.7	355.4	306.2
4400	Tashkent	7600	Kuylyuk	220	3	0.00293	0.020143	0.037396	487.7	355.4	306.2
4400	Tashkent	8300	Chirchik	220	1	0.00121	0.006749	0.012141	487.7	355.4	306.2
4400	Tashkent	8300	Chirchik	220	2	0.00121	0.006749	0.012141	487.7	355.4	306.2
4400	Tashkent	8300	Chirchik	220	3	0.00113	0.007807	0.014495	425.8	310.3	267.4
4400	Tashkent	8300	Chirchik	220	4	0.00113	0.007807	0.014495	425.8	310.3	267.4
4400	Tashkent	8400	Charvak	220	1	0.00681	0.046843	0.086968	487.7	355.4	306.2
4400	Tashkent	8400	Charvak	220	2	0.00568	0.039114	0.072618	487.7	355.4	306.2
5300	Fazilmon	5800	Andizhan	220	1	0.00111	0.007651	0.014205	487.7	355.4	306.2
7000	Keles	7100	J-1	220	1	0.00128	0.007146	0.012855	425.8	310.3	267.4
7000	Keles	7200	J-2	220	1	0.00128	0.007146	0.012855	425.8	310.3	267.4
7000	Keles	7500	Yuksak	220	1	0.00089	0.005002	0.008998	425.8	310.3	267.4
7100	J-1	7300	Ozodlik	220	1	0.00089	0.005002	0.008998	425.8	310.3	267.4
7100	J-1	7400	Ferooz	220	1	0.00822	0.046049	0.082841	425.8	310.3	267.4
7200	J-2	7300	Ozodlik	220	1	0.00089	0.005002	0.008998	425.8	310.3	267.4
7200	J-2	7400	Ferooz	220	1	0.00964	0.053989	0.097124	425.8	310.3	267.4
7500	Yuksak	7600	Kuylyuk	220	1	0.00144	0.009915	0.018408	487.7	355.4	306.2
7500	Yuksak	7600	Kuylyuk	220	1	0.00144	0.009915	0.018408	487.7	355.4	306.2
7600	Kuylyuk	7700	Fayziabad	220	1	0.00121	0.006749	0.012141	425.8	310.3	267.4
7600	Kuylyuk	7800	Adolat	220	1	0.00715	0.040015	0.071986	425.8	310.3	267.4
7700	Fayziabad	7800	Adolat	220	1	0.00878	0.049146	0.088412	425.8	310.3	267.4
7800	Adolat	7900	Ko-Ki-Sai	220	1	0.00213	0.011909	0.021424	425.8	310.3	267.4
7900	Ko-Ki-Sai	8000	Syrdarya	220	1	0.01397	0.078204	0.140688	425.8	310.3	267.4
8300	Chirchik	8400	Charvak	220	1	0.00506	0.034820	0.064646	487.7	355.4	306.2
8300	Chirchik	8400	Charvak	220	2	0.00624	0.042940	0.079720	487.7	355.4	306.2

Source: Uzbekenergo, SAESP

- Transformer input data

  The table below shows data of transformers. The parameter values in pu on the table are given on the machine bases.

Table 7.1.2-9 Transformer Data (1/3)

From Bus		To Bus		Id	Specified		Rate	Ratio	
No.	Name	No.	Name		R [pu]	X [pu]	[MVA]	Wind 1 [pu]	Wind 2 [pu]
100	N-Angren	201	N-ANG_G1	1	0.00278	0.12497	400.0	1.000	1.000
100	N-Angren	202	N-ANG_G2	1	0.00278	0.12497	400.0	1.000	1.000
100	N-Angren	203	N-ANG_G3	1	0.00278	0.12497	400.0	1.000	1.000
100	N-Angren	400	N-Angren	1	0.00278	0.12497	800.0	1.000	1.000
400	N-Angren	501	N-ANG_G6	1	0.00278	0.12497	400.0	1.000	1.000
400	N-Angren	502	N-ANG_G7	1	0.00278	0.12497	400.0	1.000	1.000
400	N-Angren	503	N-ANG_G8	1	0.00278	0.12497	400.0	1.000	1.000
700	Angren	801	ANG_G1	1	0.00278	0.12497	200.0	1.000	1.000
700	Angren	802	ANG_G2	1	0.00278	0.12497	125.0	1.000	1.000
700	Angren	803	ANG_G3	1	0.00278	0.12497	120.0	1.000	1.000
700	Angren	804	ANG_G4	1	0.00278	0.12497	125.0	1.000	1.000
700	Angren	805	ANG_G5	1	0.00278	0.12497	120.0	1.000	1.000
1100	Kyzyl-Ravat	6200	Kyzyl-Ravat	1	0.00278	0.12497	200.0	1.000	1.000
1100	Kyzyl-Ravat	6200	Kyzyl-Ravat	2	0.00278	0.12497	200.0	1.000	1.000
1300	Yulduz	6500	Yulduz	1	0.00278	0.12497	200.0	1.000	1.000
1300	Yulduz	6500	Yulduz	2	0.00278	0.12497	200.0	1.000	1.000
1700	Lochin	1800	Lochin	1	0.00278	0.12497	100.0	0.900	1.000
1700	Lochin	1800	Lochin	2	0.00278	0.12497	100.0	0.900	1.000
1900	Khakan	1901	KHA_G1	1	0.00278	0.12497	125.0	1.000	1.000
2100	Fergana	2300	Fergana	1	0.00278	0.12497	200.0	1.000	1.000
2100	Fergana	2300	Fergana	2	0.00278	0.12497	125.0	1.000	1.000
2600	Uzbekistan	3000	Uzbekistan	1	0.00278	0.12497	500.0	1.000	1.000
2600	Uzbekistan	3000	Uzbekistan	2	0.00278	0.12497	500.0	1.000	1.000

Source: JICA Study Team

Table 7.1.2-10 Transformer Data (2/3)

From Bus		To Bus		Id	Specified		Rate	Ratio	
No.	Name	No.	Name		R [pu]	X [pu]	[MVA]	Wind 1 [pu]	Wind 2 [pu]
2800	Uzgarish	4900	Uzgarish	1	0.00278	0.12497	200.0	1.050	1.000
2800	Uzgarish	4900	Uzgarish	2	0.00278	0.12497	200.0	1.050	1.000
3100	Syrdarya	3301	SD_G1	1	0.00278	0.12497	400.0	1.000	1.000
3100	Syrdarya	3302	SD_G2	1	0.00278	0.12497	400.0	1.000	1.000
3100	Syrdarya	3303	SD_G3	1	0.00278	0.12497	400.0	1.000	1.000
3100	Syrdarya	3304	SD_G4	1	0.00278	0.12497	400.0	1.000	1.000
3100	Syrdarya	3305	SD_G5	1	0.00278	0.12497	400.0	1.000	1.000
3100	Syrdarya	8000	Syrdarya	1	0.00278	0.12497	500.0	1.000	1.000
3100	Syrdarya	8000	Syrdarya	2	0.00278	0.12497	500.0	1.000	1.000
3500	Toktogul	4801	TOK_G1	1	0.00278	0.12497	400.0	1.000	1.000
3500	Toktogul	4802	TOK_G2	1	0.00278	0.12497	400.0	1.000	1.000
3500	Toktogul	4803	TOK_G3	1	0.00278	0.12497	400.0	1.000	1.000
3500	Toktogul	4804	TOK_G4	1	0.00278	0.12497	400.0	1.000	1.000
4100	Tashk TPS	4200	Tashk TPS	1	0.00278	0.12497	500.0	1.000	1.000
4100	Tashk TPS	4200	Tashk TPS	2	0.00278	0.12497	500.0	1.000	1.000
4200	Tashk TPS	6801	TAS_G5	1	0.00278	0.12497	180.0	1.000	1.000
4200	Tashk TPS	6802	TAS_G6	1	0.00278	0.12497	180.0	1.000	1.000
4200	Tashk TPS	6803	TAS_G7	1	0.00278	0.12497	180.0	1.000	1.000
4200	Tashk TPS	6804	TAS_G8	1	0.00278	0.12497	200.0	1.000	1.000
4200	Tashk TPS	6901	TAS_G10G	1	0.00278	0.12497	400.0	1.000	1.000
4200	Tashk TPS	6902	TAS_G10S	1	0.00278	0.12497	200.0	1.000	1.000
4200	Tashk TPS	8500	Tashk TPS	1	0.00278	0.12497	200.0	1.000	1.000
4200	Tashk TPS	8500	Tashk TPS	2	0.00278	0.12497	200.0	1.000	1.000
4300	Tashkent	4400	Tashkent	1	0.00278	0.12497	200.0	1.000	1.000
4300	Tashkent	4400	Tashkent	2	0.00278	0.12497	200.0	1.000	1.000
5800	Andizhan	5801	ANG_G1	1	0.00278	0.12497	250.0	1.000	1.000

Source: JICA Study Team

Table 7.1.2-11 Transformer Data (3/3)

From Bus		To Bus		Id	Specified		Rate	Ratio	
No.	Name	No.	Name		R [pu]	X [pu]	[MVA]	Wind 1 [pu]	Wind 2 [pu]
6000	Fergana TPS	6101	FER_G1	1	0.00278	0.12497	300.0	1.000	1.000
6700	Turakurgan	8201	TKG NO.1_G	1	0.00278	0.12497	400.0	1.000	1.000
6700	Turakurgan	8202	TKG NO.1_S	1	0.00278	0.12497	200.0	1.000	1.000
6700	Turakurgan	8203	TKG NO.2_G	1	0.00278	0.12497	400.0	1.000	1.000
6700	Turakurgan	8204	TKG NO.2_S	1	0.00278	0.12497	200.0	1.000	1.000
7500	Yuksak	7501	YUK_G1	1	0.00278	0.12497	300.0	1.000	1.000
8000	Syrdarya	8101	SD_G10	1	0.00278	0.12497	400.0	1.000	1.000
8000	Syrdarya	8102	SD_G11	1	0.00278	0.12497	400.0	1.000	1.000
8000	Syrdarya	8103	SD_G12	1	0.00278	0.12497	400.0	1.000	1.000
8000	Syrdarya	8104	SD_G13	1	0.00278	0.12497	400.0	1.000	1.000
8300	Chirchik	8301	CHI_G1	1	0.00278	0.12497	300.0	1.000	1.000
8400	Charvak	8401	CHA_G1	1	0.00278	0.12497	1000.0	1.000	1.000
8500	Tashk TPS	8601	TAS_G1	1	0.00278	0.12497	200.0	1.000	1.000
8500	Tashk TPS	8602	TAS_G2	1	0.00278	0.12497	200.0	1.000	1.000
8500	Tashk TPS	8603	TAS_G3	1	0.00278	0.12497	200.0	1.000	1.000

Source: JICA Study Team

7.1.3 Power flow analysis

(1) Criteria of power flow

The table below shows criteria of the power flow in Uzbekenergo.

Table 7.1.3-1 Power Flow Criteria

Item	Planning stage	Operating stage
Voltage	100%±5%	100%±10%
Overload	100%	100%

Source: Uzbekenergo, SAESP

Allowable ranges of voltage variation are 100 % ±5 % in the planning stage and 100 % ±10 % in the operating stage. In this study, the range in the planning stage was assumed to be the power flow criterion.
The table below shows the change of transmission line current capacity due to ambient temperature variations. In case that 25 degrees C is base ambient temperature, a transmission line current capacity is 1.29 times at -5 degrees C, 0.94 times at 30 degrees C, and 0.81 times at 40 degrees C, respectively.

Table 7.1.3-2 Change of Transmission Line Current Capacity

Ambient Temperature [degree C]	**-5**	0	5	10	15	20	25	**30**	35	**40**
Factor	**1.29**	1.24	1.20	1.15	1.11	1.05	1.00	**0.94**	0.88	**0.81**

Source: Uzbekenergo, SAESP

The table below shows allowable capacity of each conductor under each ambient temperature of -5, 25, 30 and 40 degree C. Unit of the values in this table is “MVA”.

Table 7.1.3-3 Allowable Capacity of Conductor

Size [mm^2]	Voltage [kV]	Capacity [MVA]			
		Temperature [degree C]			
		-5	25	30	40
120	110	92.2	71.4	67.2	57.9
	220	193.6	150.0	141.0	121.5
	500	439.9	341.0	320.5	276.2
240	110	148.7	115.3	108.4	93.4
	220	312.3	242.1	227.5	196.1
	500	709.7	550.1	517.1	445.6
300	110	167.1	129.6	121.8	104.9
	220	351.0	272.1	255.7	220.4
	500	797.7	618.3	581.2	500.9
400	110	202.8	157.2	147.8	127.3
	220	425.8	330.1	310.3	267.4
	500	967.8	750.2	705.2	607.7
500	110	232.3	180.0	169.2	145.8
	220	487.7	378.1	355.4	306.3
	500	1108.5	859.3	807.8	696.0

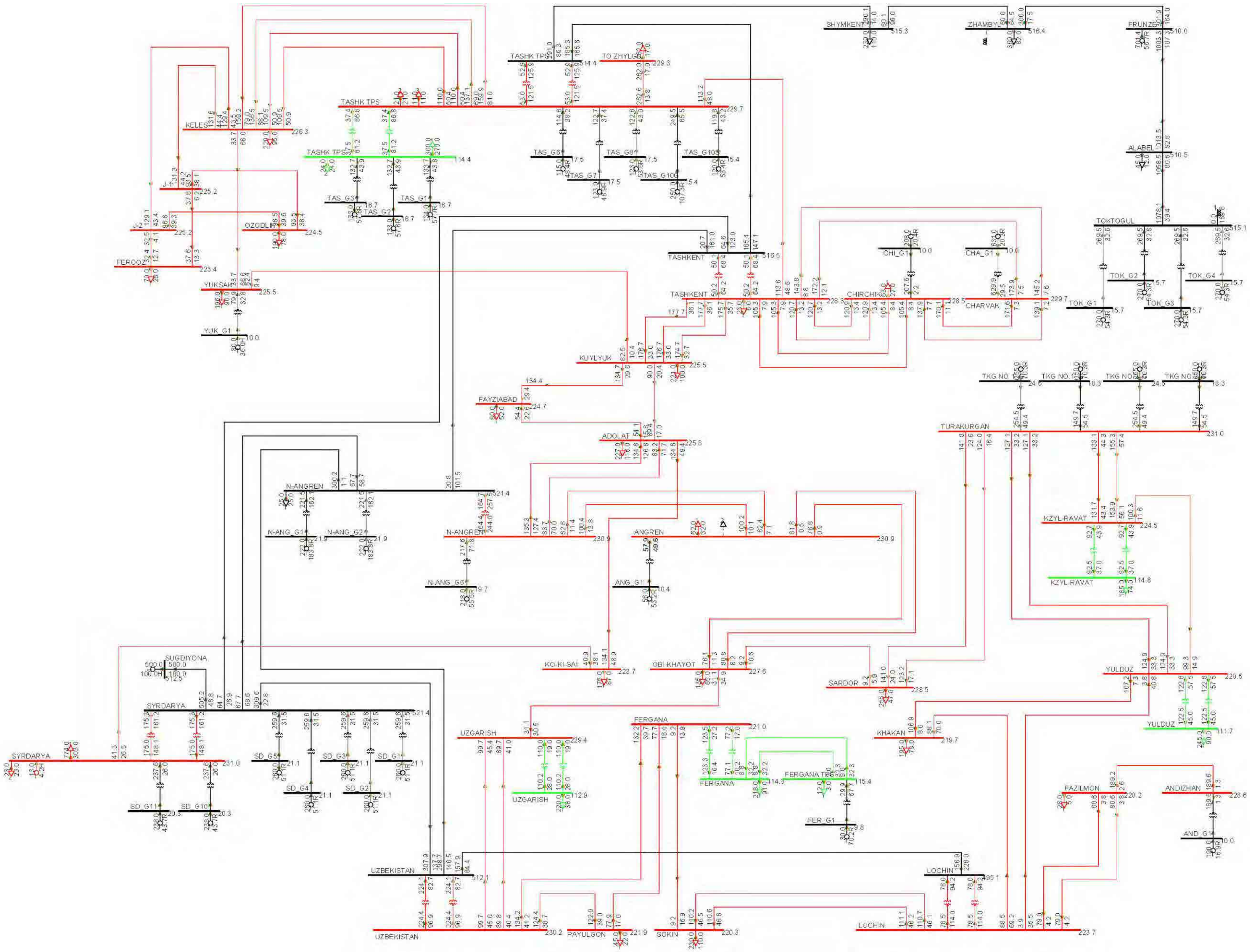
Source: Uzbekenergo, SAESP

(2) Calculation results

Each power flow analysis result is shown below.

(2-1) Case 1

The analysis was conducted under the condition of peak demand at 21:00 of summer in 2019. The power flow calculation result under normal condition is shown in the figure below.



Source: JICA Study Team

Fig. 7.1.3-1 Power Flow Calculation Result Under Peak Demand Condition at 21:00 of Summer in 2019 (Normal Condition)

Power flow calculation results under normal conditions and N-1 conditions are shown in the table below.

Table 7.1.3-4 Power Flow Calculation Result Under Peak Demand Condition at 21:00 of Summer in 2019

Case No.	N-1 Transmission Line	Under Voltage (Lower than 95 %)			Over Voltage (Higher than 105 %)			Maximum Flow (vs. Rate)			
		Node	Base [kV]	Value [%]	Node	Base [kV]	Value [%]	From node	To node	Base [kV]	Value [%]
Normal Condition											
1-1	None	None	-	-	None	-	-	Toktogul	Alabel	500	59.2
N-1 Condition											
1-2	Yulduz – Turakurgan	None	-	-	None	-	-	Toktogul	Alabel	500	59.2
1-3	Sardor – Turakurgan	None	-	-	None	-	-	Sardor	Turakurgan	220	81.5
1-4	Obi-Khayot – Sardor	None	-	-	None	-	-	Toktogul	Alabel	500	59.2
1-5	Angren – Obi-Khayot	None	-	-	None	-	-	Toktogul	Alabel	500	59.2
1-6	Kyzyl-Ravat – Turakurgan	None	-	-	None	-	-	Kyzyl-Ravat	Turakurgan	220	83.6
1-7	Kyzyl-Ravat – Yulduz	None	-	-	None	-	-	Toktogul	Alabel	500	59.2
1-8	Yulduz – Khakan	None	-	-	None	-	-	Lochin	Khakan	220	62.6
1-9	Yulduz – Lochin	None	-	-	None	-	-	Toktogul	Alabel	500	59.2
1-10	Lochin – Khakan	None	-	-	None	-	-	Yulduz	Khakan	220	63.6

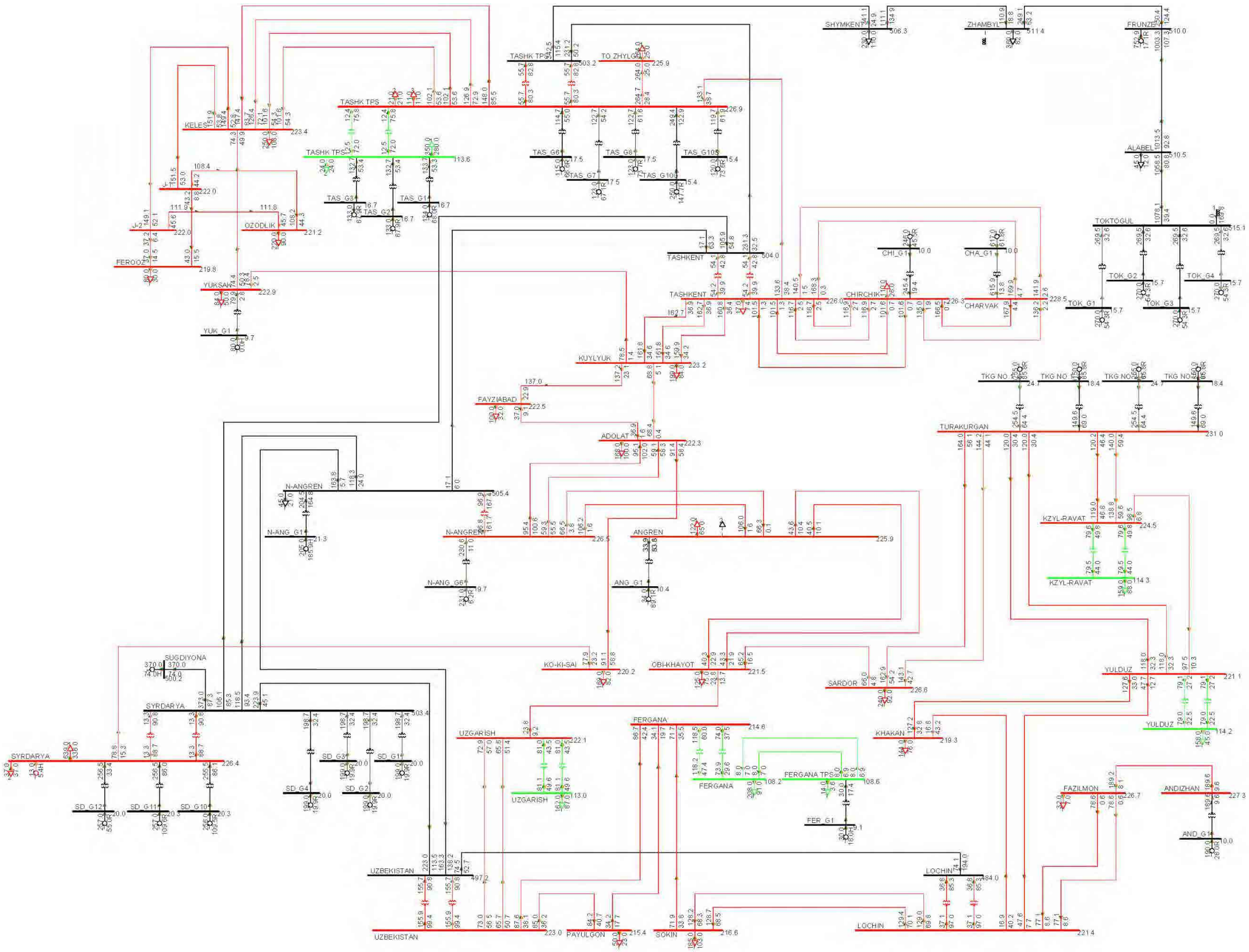
Source: JICA Study Team

[Normal condition]
All bus voltages were within the tolerance from 95 % to 105 % of the rated voltage. No overload on the transmission line occurred.

[N-1 condition]
Similar to normal condition, all transmission line power flows were within 100 % of the rated capacity.

(2-2) Case 2

The analysis was conducted under the maximum temperature condition at 11:00 of summer in 2019.
The power flow calculation result under normal condition is shown in the figure below.



Source: JICA Study Team

Fig. 7.1.3-2 Power Flow Calculation Result Under the Maximum Temperature Condition at 11:00 of Summer in 2019 (Normal Condition)

Power flow calculation results under normal conditions and N-1 conditions are shown in the table below.

Table 7.1.3-5 Power Flow Calculation Result Under Maximum Temperature Condition at 11:00 of Summer in 2019

Case No.	N-1 Transmission Line	Under Voltage (Lower than 95 %)			Over Voltage (Higher than 105 %)			Maximum Flow (vs. Rate)			
		Node	Base [kV]	Value [%]	Node	Base [kV]	Value [%]	From node	To node	Base [kV]	Value [%]
Normal Condition											
2-1	None	None	-	-	None	-	-	Toktogul	Alabel	500	68.7
N-1 Condition											
2-2	Yulduz – Turakurgan	None	-	-	None	-	-	Toktogul	Alabel	500	68.7
2-3	Sardor – Turakurgan	None	-	-	None	-	-	Sardor	Turakurgan	220	**114.7**
2-4	Obi-Khayot – Sardor	None	-	-	None	-	-	Toktogul	Alabel	500	68.7
2-5	Angren – Obi-Khayot	None	-	-	None	-	-	Toktogul	Alabel	500	68.7
2-6	Kyzyl-Ravat – Turakurgan	None	-	-	None	-	-	Kyzyl-Ravat	Turakurgan	220	89.4
2-7	Kyzyl-Ravat – Yulduz	None	-	-	None	-	-	Toktogul	Alabel	500	68.7
2-8	Yulduz – Khakan	None	-	-	None	-	-	Toktogul	Alabel	500	68.7
2-9	Yulduz – Lochin	None	-	-	None	-	-	Toktogul	Alabel	500	68.7
2-10	Lochin – Khakan	None	-	-	None	-	-	Toktogul	Alabel	500	68.7

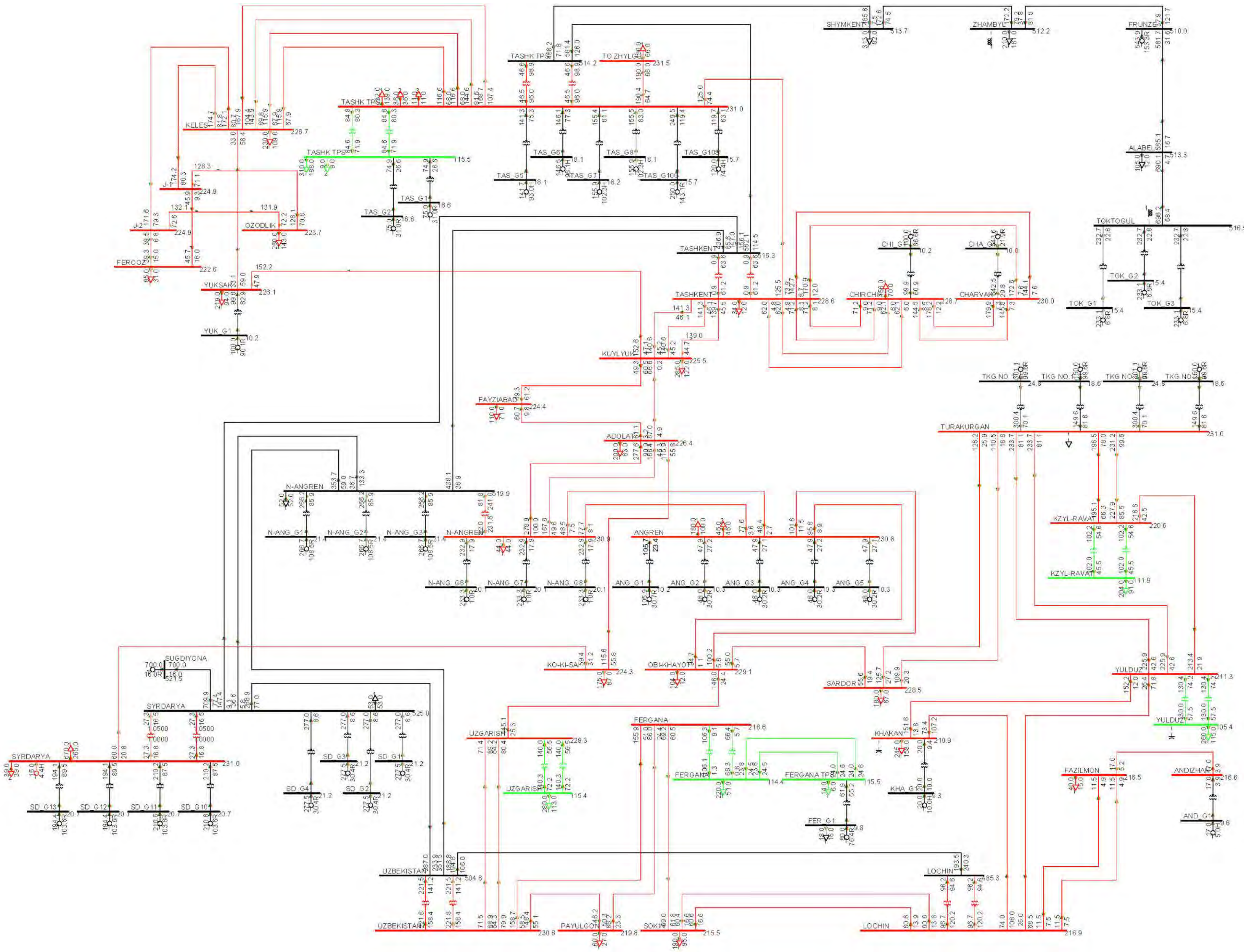
Source: JICA Study Team

[Normal condition]
All bus voltages were within the tolerance from 95 % to 105 % of the rated voltage. No overload on transmission line occurred.

[N-1 condition]
Similar to the normal condition, no bus voltage exceeded the tolerance of the rated voltage. In case 2-3 however, transmission lines overload occurred.

(2-3) Case 3

The analysis was conducted under the condition of peak demand at 21:00 of winter in2020.
A power flow calculation result under normal condition is shown in the figure 3.



Source: JICA Study Team

Fig. 7.1.3-2 Power Flow Calculation Result Under Peak Demand Condition at 21:00 of Winter in 2020 (Normal Condition)

Power flow calculation results under normal condition and N-1 conditions are shown in the table below.

Table 7.1.3-6 Power Flow Calculation Result Under Peak Demand Condition at 21:00 of Winter in 2020

Case No.	N-1 Transmission Line	Under Voltage (Lower than 95 %)			Over Voltage (Higher than 105 %)			Maximum Flow (vs. Rate)			
		Node	Base [kV]	Value [%]	Node	Base [kV]	Value [%]	From node	To node	Base [kV]	Value [%]
Normal Condition											
3-1	None	None	-	-	None	-	-	Keles	J-1	220	46.1
N-1 Condition											
3-2	Yulduz – Turakurgan	Khakan Yulduz	220	**93.7** **94.4**	None	-	-	Kyzyl-Ravat	Yulduz	220	56.5
3-3	Sardor – Turakurgan	None	-	-	None	-	-	Sardor	Turakurgan	220	46.8
3-4	Obi-Khayot – Sardor	None	-	-	None	-	-	Keles	J-1	220	46.1
3-5	Angren – Obi-Khayot	None	-	-	None	-	-	Keles	J-1	220	46.1
3-6	Kyzyl-Ravat – Turakurgan	None	-	-	None	-	-	Kyzyl-Ravat	Turakurgan	220	77.5
3-7	Kyzyl-Ravat – Yulduz	Khakan	220	**94.4**	None	-	-	Yulduz	Turakurgan	220	51.3
3-8	Yulduz – Khakan	Khakan	220	**93.3**	None	-	-	Lochin	Khakan	220	62.0
3-9	Yulduz – Lochin	None	-	-	None	-	-	Keles	J-1	220	46.1
3-10	Lochin – Khakan	Khakan	220	**92.6**	None	-	-	Yulduz	Khakan	220	62.4

Source: JICA Study Team

[Normal condition]
All bus voltages were within the tolerance from 95 % to 105 % of the rated voltage. No overload on transmission line occurred.

[N-1 condition]
All transmission line power flows were within 100 % of the rated capacity.
In Case 3-2, bus voltage of Khakan S/S and Yulduz S/S were lower than 95 % of the rated voltage. And bus voltage of Khakan S/S was lower than 95 % of the rated voltage in Case 3-7, Case 3-8 and Case 3-10. However, all bus voltages were more than over 90 % of the rated voltage, and the bus voltages other than the above were greater than 95% of the rated voltage.

(3) Countermeasure

Countermeasures for each case are shown below.

(3-1) Countermeasures for case 2

The countermeasures to eliminate the transmission line overload (in Case 2-3) are as follows;

1. Reduce generator output
2. Open transmission line
3. Replace transmission line conductor

(3-1-1) Reduce generator output
Table 7.1.3-7 shows the change of power flow caused by reduction of power generator output of Turakurgan Thermal Power Station (TPS).
When the output of Turakurgan TPS is reduced from 810 MW to 690 MW, the transmission line power flow is reduced to within 100 % of the rated capacity. Of course, overload does not occur in the other transmission line. All bus voltages are within the tolerance from 95 % to 105 % of the rated voltage.

Table 7.1.3-7 Change of Power Flow Caused by Reducing Generator Output

Case No.	Item (Countermeasure 3-1-1)	Value	
		Before	After
2-3	Generator Output (Turakurgan TPS)	810 MW	690 MW
	Transmission Line Power Flow Value (From Sardor S/S to Turakurgan TPS)	**114.7 %**	99.9 %

Source: JICA Study Team

(3-1-2) Open transmission line
Table 7.1.3-8 shows the change of power flow caused by opening transmission line.
When the transmission line (From Obi-Khayot S/S to Sardor S/S) is opened, the transmission line overload is solved. Like a countermeasures described in item 3-1-1, overload does not occur in the other transmission line. And all bus voltages are within the tolerance from 95 % to 105 % of the rated voltage.

Table 7.1.3-8 Change of Power Flow Caused by Opening Transmission Line

Case No.	Item (Countermeasure 3-1-2)	Value	
		Before	After
2-3	Transmission Line Operation State (From Obi-Khayot S/S to Sardor S/S)	Close	Open
	Transmission Line Power Flow Value (From Sardor S/S to Turakurgan TPS)	**114.7 %**	99.7 %

Source: JICA Study Team

(3-1-3) Replace transmission wire
Table 7.1.3-9 shows the change caused by replacing the transmission wire.
According to interviews with SAESP, the existing towers that are located between Sardor S/S

and Turakurgan TPS can keep suspending the size of transmission wire up to 500 mm^2 without tower modification.
When power flow is calculated by changing line size from 400 mm^2 to 500 mm^2, the rate of power flow is reduced from about 115 % to about 102 %. Practically, there is no problem about this value because the operation time is relatively short such as 2 or 3 hours.

Table 7.1.3-9 Change of Power Flow Caused by Replacing Transmission Wire

Case No.	Item (Countermeasure 3-1-3)	Value	
		Before	After
2-3	Transmission Wire Size (From Sardor S/S to Turakurgan TPS)	400mm^2	500mm^2
	Transmission Line Power Flow Value (From Sardor S/S to Turakurgan TPS)	**114.7 %**	**101.6** %

Source: JICA Study Team

In order to prevent an overloading completely, it is recommended adoption of the GAP type transmission line.

(3-2) Countermeasures for case 3

The countermeasures to raise voltage (in Case 3-2, Case 3-7, Case 3-8 and Case 3-10) are as follows;

1. Increase generator terminal voltage
2. Install capacitor at substation

(3-2-1) Increase generator terminal voltage
Table 7.1.3-10 shows the change caused by increasing bus voltage of generator.
According to the grid code of Uzbekistan, it is allowed to operate up to 110 % of the rated voltage at generator end buses in the 220 kV systems.
In each case with this countermeasure, when the power plant operating voltage is 107.8 % of the rated voltage at the 220 kV bus side, the lowest voltage is greater than 95 % of the rated voltage.

Table 7.1.3-10 Change of Bus Voltage Caused by Increasing Generator Terminal Voltage

Case No.	Bus Voltage (Countermeasure 3-2-1)	Value	
		Before	After
All Cases	Turakurgan TPS (High Voltage Side)	105.0 %	107.8 %
3-2	Khakan	**93.7 %**	95.7 %
	Yulduz	**94.4 %**	96.7 %
3-7	Khakan	**94.4 %**	96.4 %
3-8	Khakan	**93.3 %**	95.0 %
3-10	Khakan	**92.6 %**	95.3 %

Source: JICA Study Team

The bus voltage of Turakurgan TPS and Sardor S/S are more than 105 % of the rated voltage, but there is no bus that voltage reaches 110 % of the rated voltage.

(3-2-2) Install capacitor at substation
In the previous calculation cases, the lowest voltage bus was appeared in Khakan S/S. Therefore, calculation was carried out by adding a capacitor bank of 60 MVA to Khakan S/S. Table 7.1.3-11 shows the change of bus voltage caused by the installation.

Table 7.1.3-11 Change of Bus Voltage Caused by Installing Capacitor to S/S

Case No.	Item (Countermeasure 3-2-2)	Value	
		Before	After
All Cases	The Rate of Capacitor (At Khakan S/S)	None	60 MVA
3-2	Khakan	**93.7 %**	95.8 %
	Yulduz	**94.4 %**	96.0 %
3-7	Khakan	**94.4 %**	96.6 %
3-8	Khakan	**93.3 %**	96.6 %
3-10	Khakan	**92.6 %**	95.1 %

Source: JICA Study Team

Regarding to this countermeasure, all bus voltages were within the tolerance from 95 % to 105 % of the rated voltage.

(4) Conclusion of power flow analysis

In the case of normal condition, the problem of over and / or under voltage and overload did not occur in each case. On the other hand, some problems were observed in the cases under N-1 conditions.
The problem of overload occurred at the high temperature time in the summer season, and the problem of voltage drop occurred at the peak demand in the winter season.
Overload occurred in the transmission line between Sardor S/S and Turakurgan TPS, and voltage drop occurred at Khakan S/S and Yulduz S/S.

In the summer season, the current capacity of transmission line is reduced with the increase of ambient temperature. Power demand of the Fergana region is the maximum at night time, but Turakurgan TPS output still remains constant. Load demand is reduced during day time, and power flow to the west is increased. Hence overload occurs in the transmission line coupled with the reduction of transmission rate capacity due to the temperature rise.

When Uzbekistan system is divided from Kyrgyzstan system without the interconnection, Turakurgan TPS is only power plant to supply reactive power to the Fergana region. Therefore, it is difficult to keep the voltage of the buses that exist far away from this power plant.

If these problems are occurred, it is possible to solve them with the following system operation;

- Transmission line open (from Obi-Khayot S/S to Sardor S/S)
- Increase of generator terminal voltage (Turakurgan TPS)

However, these methods are nothing more than a temporary way. The power flow control of transmission lines such as opening of a transmission line is not a fundamental solution as a countermeasure to eliminate overload of equipment. To increase the generator terminal voltage is not also a fundamental solution since it gives very little effect to keep bus voltages within the tolerance range if the substations are far away from the power plant. Since power demand in Namangan Province is expected to increase in future, it is necessary to repair the old equipment and install new equipment including capacitor banks.

From the results of this analysis, we recommend replacing the transmission line to increase its capacity and installing the capacitor bank to maintain normal voltage in future.
However, these countermeasures should be done with careful consideration of the power system planning, such as construction of new 500 kV transmission lines, which will be scheduled in future.

7.1.4 Fault current analysis

(1) Criteria of fault current
The maximum fault current in each voltage level is not determined, but the maximum fault current at each substation bus is given in Uzbekenergo.

Specific premises are shown below;

- Bus voltage before the fault: 1.0pu at all buses
- Transformer tap: Center tap
- Source reactance of generator: Sub-transient (Xd")
- Fault type and location: Three phase short circuit at each bus in the Grid
- Fault current value to be assessed: Root-mean-square value of the fault current

(2) Calculation results
Fault current calculation results in each case are shown in the table below.

Table 7.1.4-1 Fault Current Calculation Result

Bus		Fault Current [kA]			Allowable Fault Current [kA]
Name	Rated Voltage [kV]	Case 1	Case 2	Case 3	
Obi-Khayot	220	10.3	10.2	10.8	31.5
Sardor	220	9.4	9.4	9.5	15.7
Kyzyl-Ravat	220	8.2	8.3	8.3	25.0
Yulduz	220	9.5	9.5	9.7	15.7
Lochin	220	10.4	10.3	10.0	31.5
Lochin	500	4.5	4.4	4.5	20.0
Khakan	220	8.2	8.1	8.6	25.0
Turakurgan	220	**14.1**	**14.2**	**14.3**	-

Source: JICA Study Team

(3) Conclusion of fault current analysis
From the result, fault currents at all substations were within the allowable levels, thus there was no problem regarding fault current. Since the fault current at TKG 1&2 is 14.3 kA as shown in the table, circuit breakers with current breaking capability of 31.5kA should be suitable considering future generation expansions and the present maximum allowable fault current level of the other substations.

7.1.5 Dynamic stability analysis

(1) Specific premises
Specific premises are shown below;

- Fault type: Three phase short circuit
- Fault clearance time: 100 msec after the fault occurring.
- Switching sequences: 3LG - O
  A reclosing sequence was not assumed to be included in the simulations as a more severe condition.
- Load characteristics: Active powers were treated as constant current loads, and reactive powers were treated as constant impedance loads during dynamic stability simulations.
- Fault location: Fault locations were assumed to be transmission lines around TKG 1&2. The transmission lines and corresponding fault locations are shown in the following table

Table 7.1.5-1 shows the fault location and transmission lines to be opened in order to remove a fault.

Table 7.1.5-1 Fault Locations in the Dynamic Stability Analysis

No.	Transmission Line		Fault Location
	From Node	To Node	
1	Sardor	Turakurgan	Turakurgan
2	Yulduz	Turakurgan	Turakurgan
3	Kyzyl-Ravat	Turakurgan	Turakurgan
4	Kyzyl-Ravat	Yulduz	Kyzyl-Ravat
5	Sardor	Obi-Khayot	Sardor
6	Yulduz	Khakan	Yulduz
7	Yulduz	Lochin	Yulduz

Source: JICA Study Team

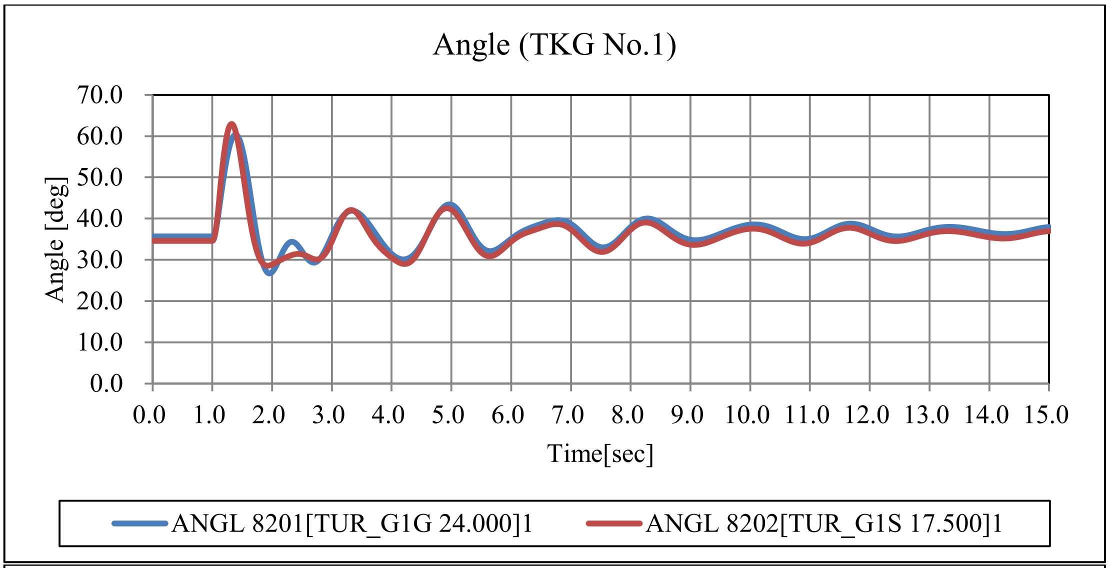
(2) Calculation Results
Dynamic stability analysis results are shown in the table below.

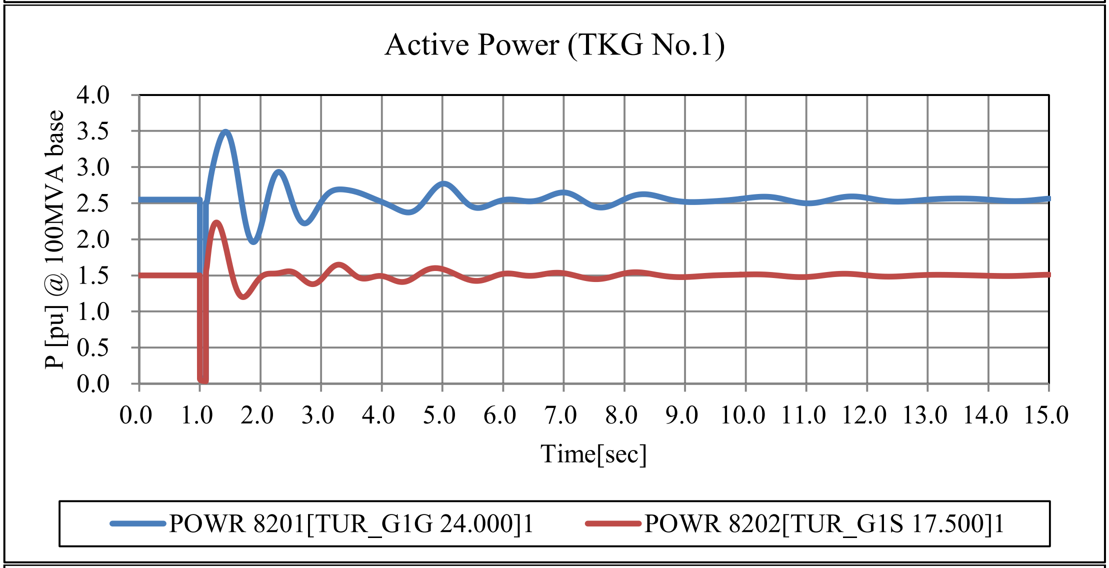
Table 7.1.5-2 Dynamic Stability Analysis Results

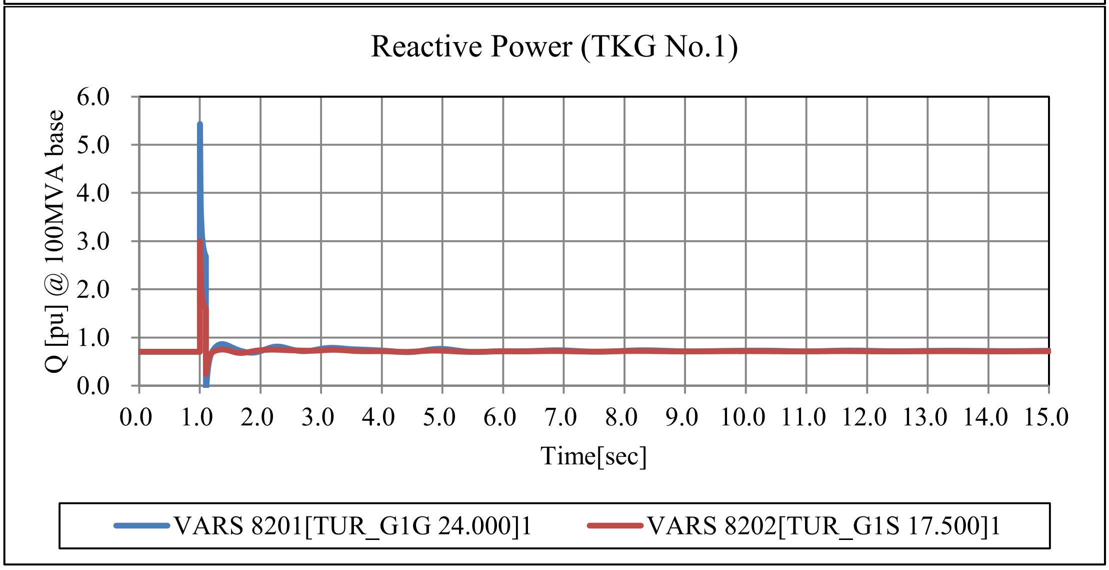
No.	Case 1	Case 2	Case 3
1	STABLE	STABLE	STABLE
2			
3			
4			
5			
6			
7			

Source: JICA Study Team

The figures below show a calculated result of Case 1-1 as an example.

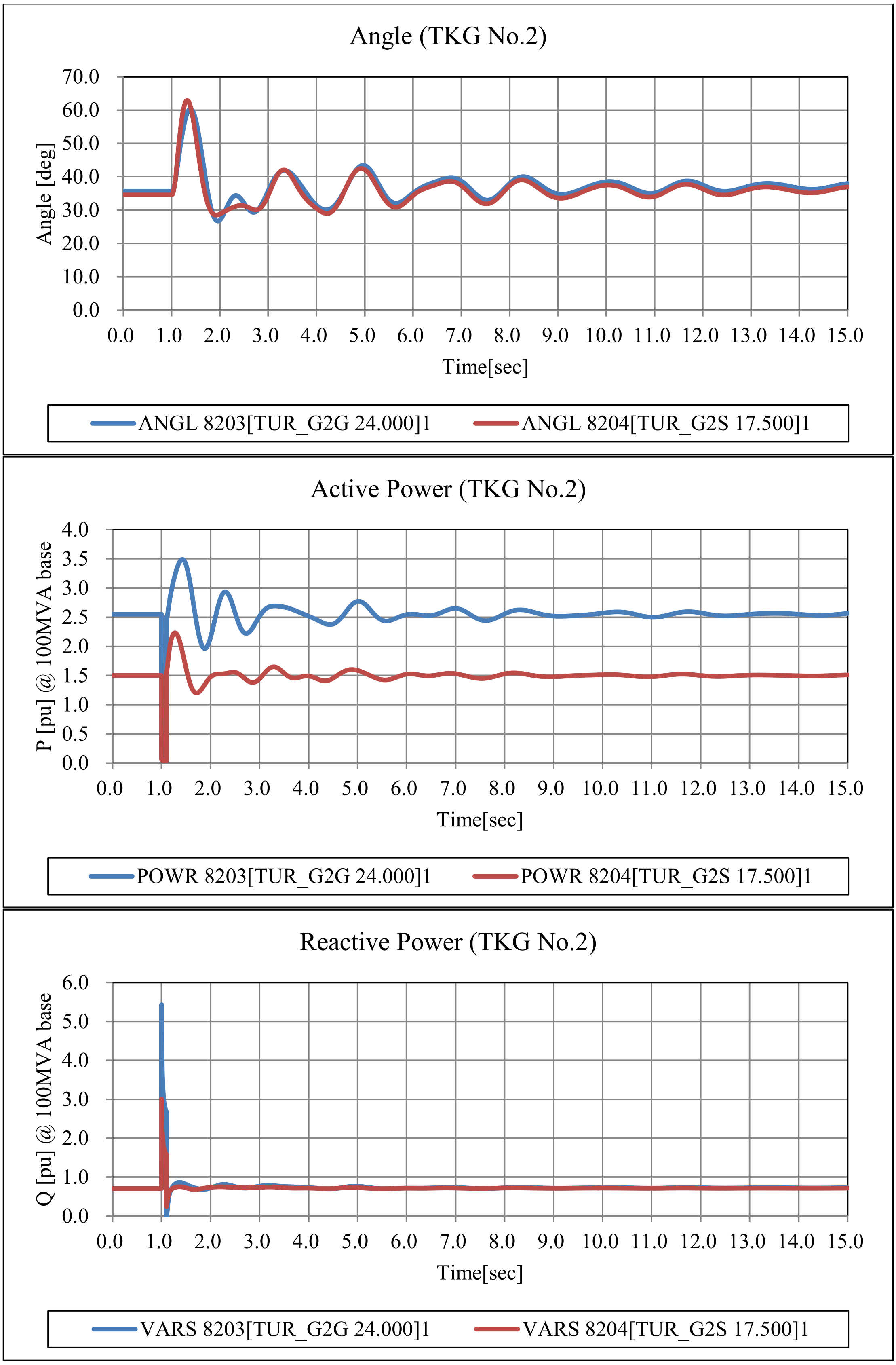






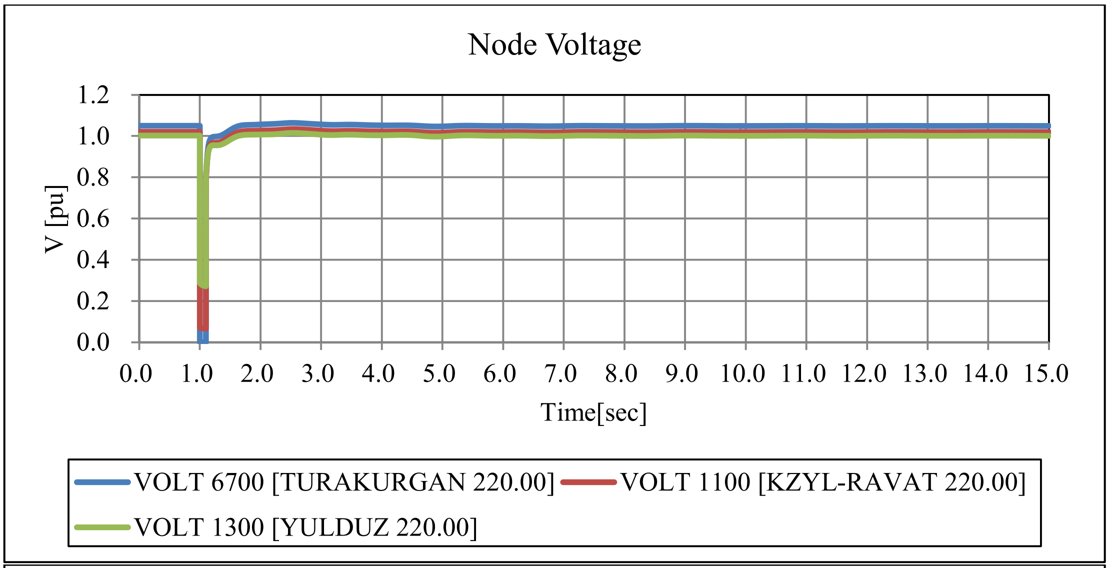
Source: JICA Study Team

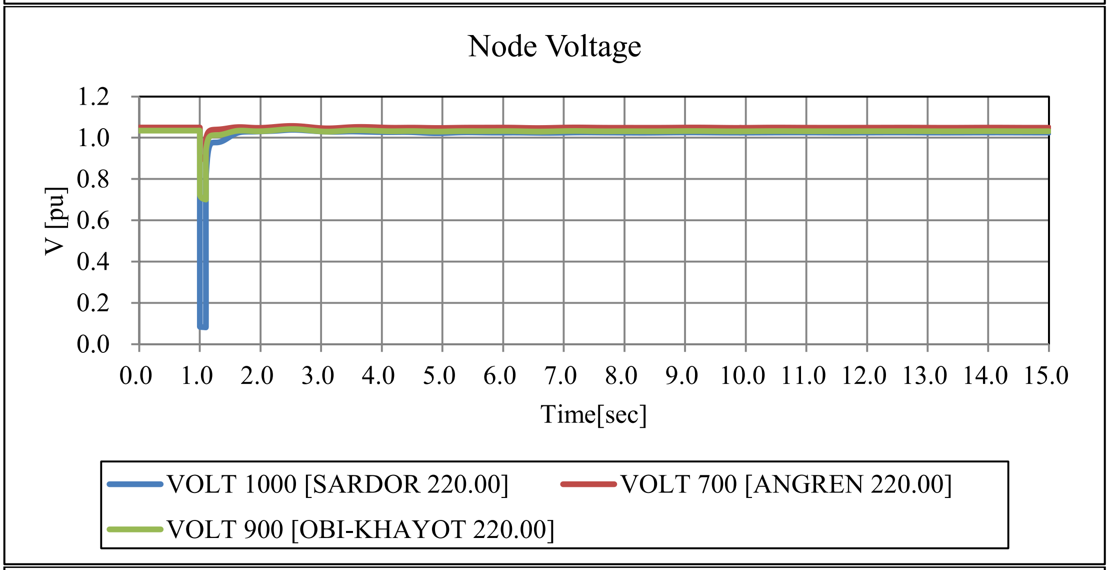
Fig. 7.1.5-1 Result of Case 1-1 (1/3)

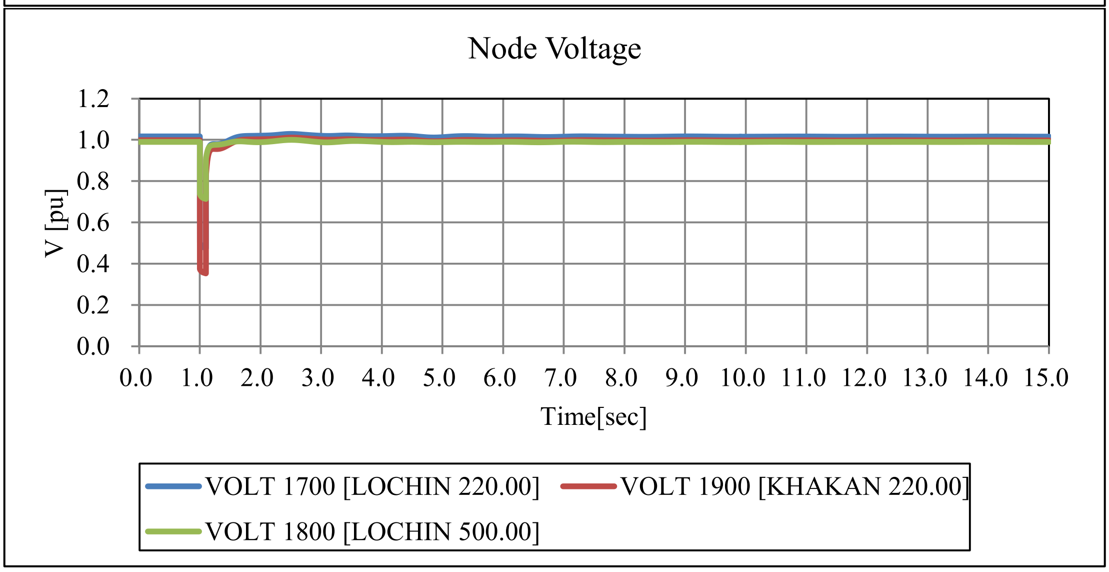


Source: JICA Study Team

Fig. 7.1.5-2 Result of Case 1-1 (2/3)







Source: JICA Study Team

Fig. 7.1.5-3 Result of Case 1-1 (3/3)

(3) Conclusion of dynamic stability analysis

The power system is shown to be stable any fault around TKG 1&2 if the fault is cleared in 100 msec.

It is recommended installing PSS (Power System Stabilizer) in order to improve more stability of generator.

7.1.6 Conclusion

The study on the interconnection for TKG No.1&2 has been conducted to verify the expected impacts to the grid in terms of reliability and stability.

From power flow analysis, in the case of normal condition, the problem of over and / or under voltage and overload did not occur in every case. On the other hand, some problems were observed on N-1 conditions.

It is not difficult to solve these problems by operating power system as a temporary way. However, these methods should not be permanent measures since expected power demand growth in Namangan Province will worsen the voltage problem in future.

For solving these problems, we recommend replacing transmission lines between Sardor S/S and Turakurgan TPS, and installing a sufficient capacitor bank to Khakan S/S.

However, these countermeasures should be done with careful consideration of the power system planning which will be scheduled in future.

From fault current analysis and dynamic stability analysis, there will be no significant problems caused by connecting TKG No.1&2 in Turakurgan area.

7.2 Grid Connection Plan

7.2.1 Outline of Grid Connection plan for Transmission Lines in the project

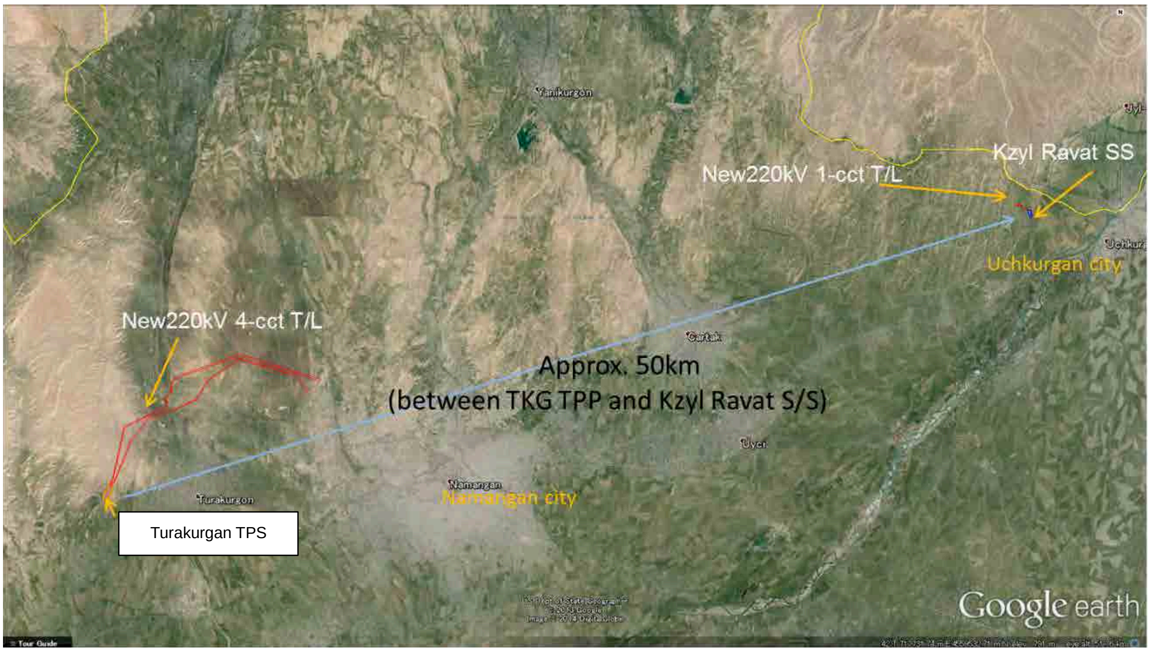
Two main the grid connection plans for transmission lines (hereafter: T/L) for in the project are shown in Table 7.2.1-1.
The first connection plan is the construction of the 220kV 4-circuits T/L (hereafter: the 4-cct T/L) which connects to the existing power grid to transmit the electric power generated in TKG TPS. The second one is 220kV 1-circuit T/L (hereafter: the 1-cct T/L) between Kyzl Ravat Substation (hereafter: SS) and the existing power grid in order to change power system structure for the construction of TKG TPS.

Table 7.2.1-1 New T/L for This Project

Route	Voltage [kV]	Number of Circuits [cct.]	Section	Length [km]
Turakurgan TPS	220	4	Turakurgan TPS – 220kV Existing line at the north-east of Namangan city	Approx. 15km
Kzyl Ravat S/S (Approx. 50km from TKG TPS)		1	Kzyl Ravat S/S – 220kV Existing line at the east of Uchkurgan city	Approx. 0.8km

Source: Uzbekenergo

The location of each T/L is shown Figure 7.2.1-1. The 4-cct T/L is connected from TKG TPS to the existing lines which are located at the north-west of Namangan city. The 1-cct T/L adjacent to Kyzl Ravat SS is located at west of Uchkurgan city and apart approx. 50km from TKG TPS.



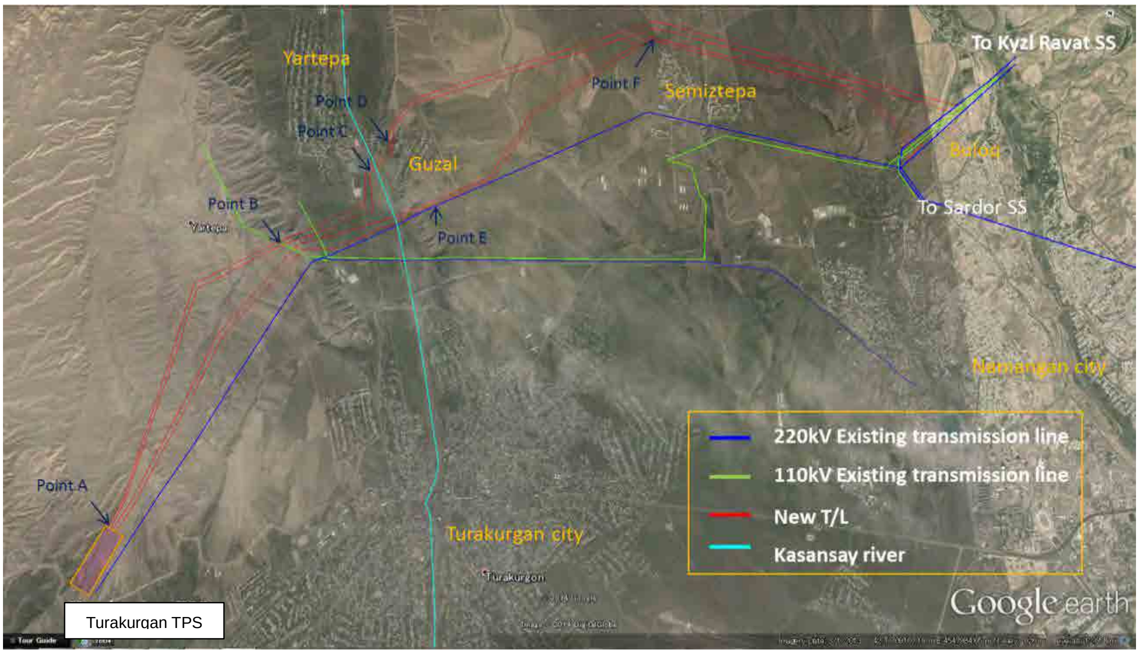
Source JICA Study Team

Figure 7.2.1-1 Construction Site of 220kV New T/L

7.2.2 Route Selection of Transmission line

The details for each T/L are described as followings.
The route of T/L was designed by SREDAENEVEGOSETPOJECT (hereafter: SAESP) which is a subsidiary of Uzbekenergo. Therefore, JICA Study Team checked T/L route designed by SAESP.

(1) The 4-cct T/L Connected to the Existing Power Grid from TKG TPS
As shown in Figure 7.2.2-1, the 4-cct T/L was designed using 2 routes (hereafter: The north route, The south route) at each 2 circuits T/L combined out of 4circuits T/L.



Source JICA Study Team

Figure 7.2.2-1 220kV New T/Ls around Turakurgan P/S

1) The North Route near TKG TPS
As shown in Figure 7.2.2-1, the north route starts from TKG TPS and runs along 220kV existing T/L ,and it crosses two of the 110kV existing T/L and Kasansay river with a width of approx. 250m, running between Yartepa settlement and Guzal settlement. Finally, it runs along the north of Semiztepa settlement connects to 220kV existing T/L (Sardor - Kzyl Ravat line and Sardor – Crystal line) to the north-west of Namangan city. Each point survived was surveyed by the JICA Study team is shown in Figure 7.2.2-2 to Figure 7.2.2-5.

Figure7.2.2-2 Planned the land for TKG TPS
(Point A)

Figure 7.2.2-3 Crossing Existing Line
(Point B)

Figure 7.2.3-4 Crossing Kasansay River
(Point C)

Figure 7.2.2-5 Guzal Settlement
(Point D)

2) The South Route near TKG TPS
As shown in Figure 7.2.2-1, the south route runs much like the north route before crossing the Kasansy river. After crossing the Kasansay river, of which width is approx.150m, it runs south of the Guzal settlement and along the 220kV existing T/L. Finally, it runs between the Guzal settlement and Semtepa settlement, and along the north route, and connects to a 220kV existing T/L, the same as the north route. The location for each point surveyed by the JICA Study team is shown in Figure 7.2.2- 6 to Figure 7.2.2-7.

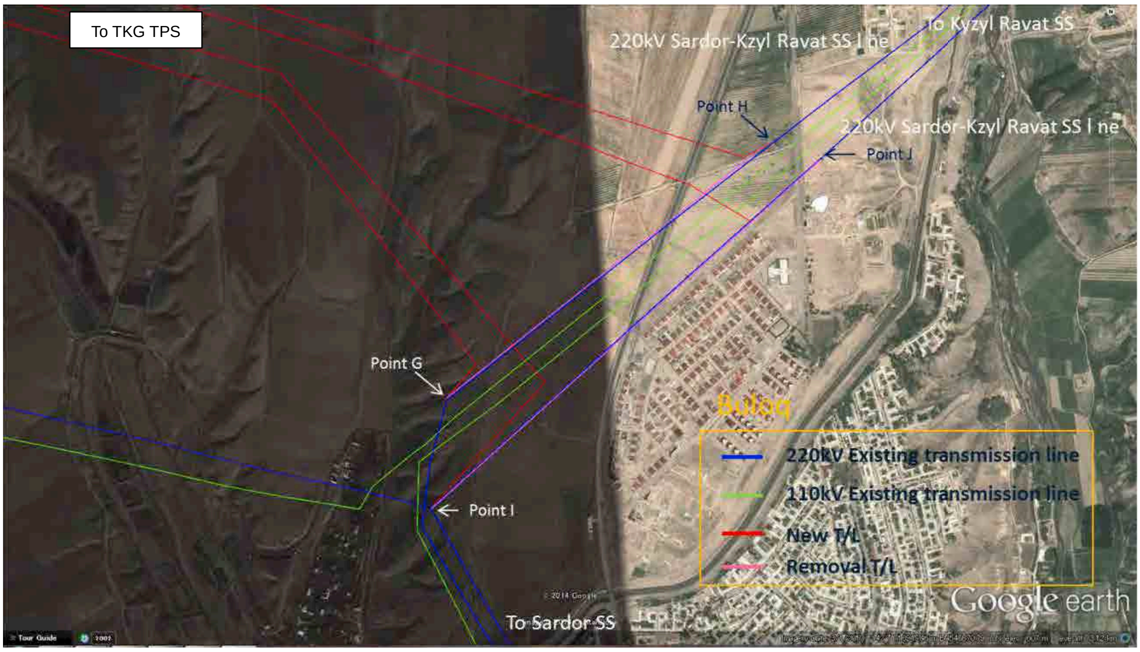
Figure 7.2.2-6 The South of Guzal Settelment

Figure7.2.2-7 Angle point at the North of

(Point E) Semiztepa Settelment (Point F)

3) Connection Point of The 4-cct T/L to Existing T/L

As shown in Figure 7.2.2-8, the 4-cct T/L crosses two lines of 110kV existing T/L immediately before the connection point at 4-cct T/L to 220kV existing T/L (Sardor – Kzyl Ravat line and Sardor – Crystal line). Therefore, the new towers for the 4-cct T/L have to be installed in immediate proximity to live-lines such as 110kV existing T/Ls and 220kV T/Ls in order to connect to existing lines. A photograph for each connection point is shown in Figure 7.2.2- 9 to Figure 7.2.2-12.



Source JICA Study Team

Fig 7.2.2-8 Connection Point to the 220kV Existing T/Ls

Figure 7.2.2-9 Connection point A (Point G)

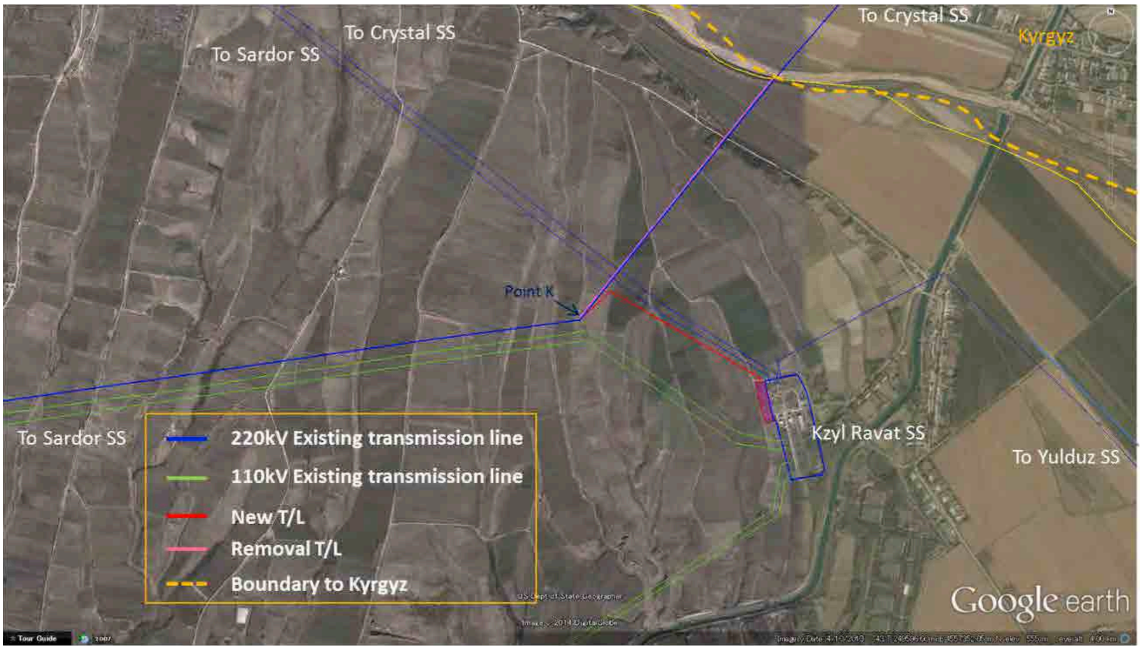
Figure7.2.2-10 Connection point B (Point H)

Figure 7.2.2-11 Connection point C (Point I)

Figure 7.2.2-12 Connection point D (Point J)

(2) The 1-cct T/L immediately near Kzyl Ravat SS

In order to change the structure of the power grid, the 1-cct T/L is connected from Kzyl Ravat SS to 220kV existing T/L (Sardor – Crystal line) as shown in Figure 7.2.2-13. The span length between the connection points and the boundary to Kygstan (line colored by Pink) is removed at the same time. A photograph of each point surveyed by JICA Study Team is shown in Figure 7.2.2-14 to Figure 7.2.2-15.



Source JICA Study Team

Figure 7.2.2-13 New transmission lines immediately near Kzyl Ravat SS

Figure 7.2.2-14 Connection point
from Kyzl Ravat SS

Figure 7.2.2-15 connection tower
(Point K)

(3) The Survey Contents and the Survey Results for the Route Selection

1) Confirmation concept for Route Selection

According to interviews with SAESP, their concepts for route selection are following:

- Design T/L as shortly and straightly as possible taking economic efficiency into account
- Design T/L to minimize crossing points for 220kV and 110kV existing T/L
- Take into account that the Right of way (hereafter ROW) is 25m for both sides from the center of the tower
- The JICA Study Team confirmed that the route designed by SAESP covered the basic concepts for the route selection and they selected the shortest and most economical T/L.

2) Conducting the Site survey

The JICA Study Team conducted the site survey for aforementioned 2 T/Ls on January and February 2014. The team confirmed the route was designed by SAESP with regard to the circumstances under T/L, such as settlements, rivers, roads, the crossing points to existing T/L and etc., angle towers as the followings shows.

a) The 4-cct T/L

- The land under this line is mainly a field there are no objects of interference under this T/L.
- Though this T/L runs nearby a part of settlements or through settlements, enough ROW is secured for each settlement.
- The width of Kasansay river is approx. 150m to 250m. Therefore, it is not necessary to design special towers.
- According to SAESP, there are no large pipe lines around this T/L.
- It is necessary to secure enough clearance for the 220kV and 110kV existing T/Ls which this T/L crosses.
- Since this T/L has to connect to two T/Ls such as “Sardor – Kzyl Ravat line” and “Sardor – Crystal line”, it is necessary to thoroughly arrange for the outage of each T/L with the section of the power system operation.
- Since there are the existing 110kV and 220kV T/Ls in immediate proximity toi the connection point of the existing power grid, it is necessary to thoroughly take safety precautions for charged conductors for the existing T/L.

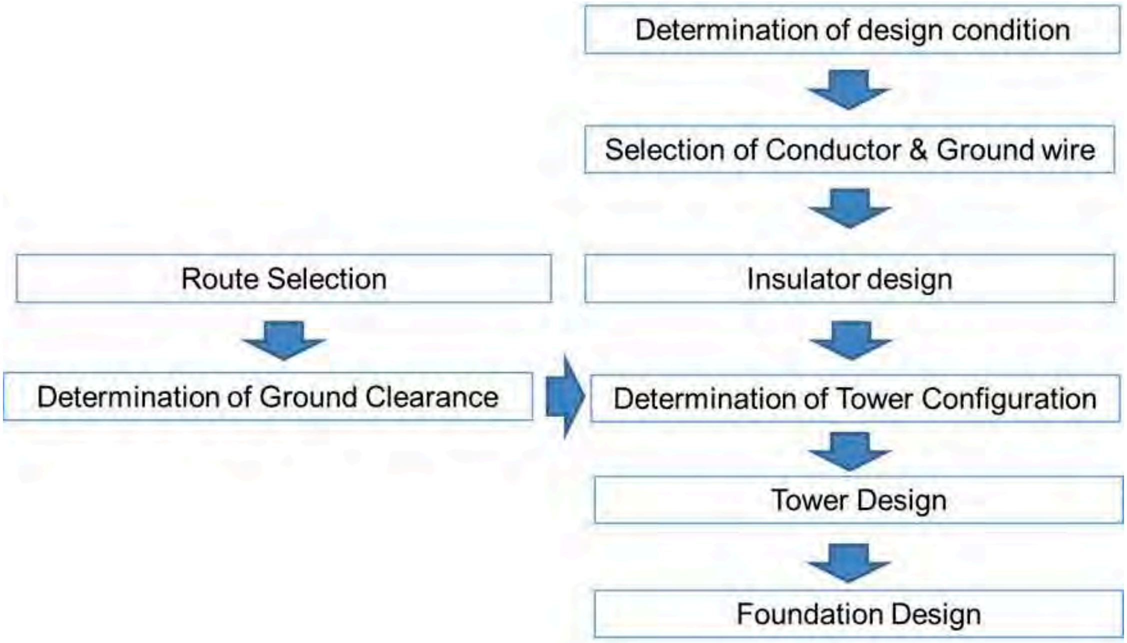
b) The 1-cct T/L around Kzyl Ravat SS

- The area under this T/L is mainly fields, and there are no houses or large rivers under this T/L. Therefore, there are no problems for this route selection.
- Like 4-cct T/L, since there is an existing 220kV T/L in immediate proximity to the connection point to the existing power grid, it is necessary to take safety precautions for the charged conductors of the existing T/Ls.

7.2.3 Transmission Line Design

(1) Design Procedures

For the the design of new the transmission lines between Turakurgan TPS and the existing transmission lines at the north of 10km from Namagan city, both adhere to the Rules of Electrical Installation (PUE) and Gsudarstvennyy Standart (GOST). Design of the transmission line is carried out as shown in Figure 7.2.3-1. The condition of the 4-cct T/L near TKG TPS is as same as those of the 1-cct T/L unless stated otherwise.



Source JICA Study Team

Figure 7.2.3-1 Design Flow of the T/L

(2) Design Conditions

1) Ambient temperature

Table 7.2.3-1 Ambient Temperature

Type	Temperature[degree]
Maximum temperature	45
Minimum	-30
Annual mean air temperature	15
Temperature in case of glazed frost	-5

Source: Uzbekenergo

2) Wind velocity

- Maximum wind velocity 29 m/s (500Pa)at the height of 15m
- Predominant wind direction

3) Wind pressure

- Tower: 500 Pa
- Conductor: 500 Pa
- Ground wire: 500 Pa

4) Glazed frost condition
- Thickness: 10mm (Icing Level II)
- Density: 0.9g/cm^3

5) Conductors Load Conditions
Conductors load conditions are shown in Table 7.2.3-2.

Table 7.2.3-2 Conductors Load Design Conditions

Case	Temperature [℃]	Wind Pressure			Glazed Frost	Remarks
		Max. (500 Pa)	Still	Special		
1	45	-	○	-	-	Maximum temperature
2	-30	-	○	-	-	Minimum temperature
3	15	-	○	-	-	Annual mean temperature
4	-5	-	○	-	○*	
5	-5	○	-	-	-	
6	-5	-	-	0.25 x P_{max}	○*	
7-1	-15	-	-	60 Pa	-	Working time
7-2	**70	-	○	-	-	Maximum operation temperature of conductors

*Thickness 10mm, Density of Ice: 0.9 g/cm^3
**Conductor temperature
Source: Uzbekenergo and SAESP

6) Pollution Level
Medium (IEC (International Electrotechnical Commission) standard)

7) Other conditions
Other conditions are shown in Table 7.2.3-3

Table 7.2.3-3 Other Conditions for T/L Design

Conditions	The 4-cct T/Ls	The 1-cct T/L
Maximum rainfall [mm]	200 – 350	250
Maximum snow depth [mm]	200	390
Depth of soil freezing [mm]	400	400
Maximum humidity [%]	100	100
Isokeraunic level (IKL) [days]	15 – 25	22

Source: Uzbekenergo

8) Safety Factors (Permissible Tension)
a) Conductors and Ground Wires
The permissible tension of conductors and cables for overhead line (more than 1kV) in PUE, the permissible tensions of conductors, are shown in Table 7.2.3-4. Therefore, the tension in the most severe conditions was assumed to be 45% of ultimate tensile strength of conductors and ground wires.

Table 7.2.3-4 Permissible Tension of Conductors

Condition	Permissible Tension (% Ultimate Tensile Strength)	
	Conductor	Ground wire
Maximum load at the minimum air temperature (-30 ℃) stringent (most severe) conditions	45	50
Maximum load at the annual mean temperature (15℃)	30	35

Source: PUE

b) Insulators and Insulator Strings
Based on Table 7.2.3-4, the permissible tension for the most severe condition was assumed to be 45% of Rated Ultimate Strength (RUS) of insulator.

c) Towers
- 1.5 to yield strength of material under normal condition (= stringent condition)
- 1.1 to yield strength of under broken-wire condition (= normal condition + one ground wire or one phase conductor breakage)

d) Foundations
- 2.0 under normal condition
- 1.5 under broken-wire condition

(3) Conductors and Ground Wire Design

1) Technical characteristics of Conductor and Ground Wire

The system power system proved that a single conductor of ACSR (Aluminum Cable Steel Reinforced) 500mm^2 for conductor is appropriate for the the Project. Therefore, ACSR 500mm^2 and ACSR 400mm^2 for conducto and OPGW mm^2 for ground wires were applied as same as the existing line. The technical characteristics for the conductor and ground wires are shown in Table 7.2.3-5.
Regarding conductors, ACSR/AS(Aluminum-clad steel), witha core covered with aluminum steel, is applied in this report, though ACSR, with a galvanized steel core, is usually applied as normal conductors in Uzbekistan because ACSR/AS has a long life span for corrosion resistance with the core covered with aluminum.
Like conductors, regarding ground wire, AC type covered with aluminum is applied in this report.
According to Uzbekenergo, OPGW is not applied to the relay carrier system of 220kV T/L, so OPGW is not scheduled to be used to 220kV T/L. Therefore, OPGW is not studied in this report.
The technical characteristics are shown in Table 7.2.3-5.

Table 7.2.3-5 Technical Characteristics of Conductors and Ground wires

Type	Conductor		Ground wire
	ACSR/AS 400mm^2	ACSR/AC 500mm^2	AS 70mm^2
Component of stranded wires	AL 26/4.37 AC 7/3.4	AL 54/3.4 AC 7/3.4	AC7/3.5
Total area of aluminum wires [mm^2]	390.0	490.2	-
Total area of conductor [mm^2]	453.55	553.75	67.5
Overall diameter [mm]	27.7	30.6	10.5
Weight [kg/km]	1,492	1,771	426.5
Ultimate tensile strength [kN]	131.7	148.4	77.3
Modulus of elasticity [N/mm^2]	74,800	72,500	149,000
Coefficient of linear expansion x 10^{-6}/℃]	20.3	20.3	12.9
DC resistance at 20℃[Ω/km]	0.0700	0.0565	1.12
Number of conductors per phase	1	1	-
Number of fiber cables	-	-	-

Source: JICA Study Team

2) Maximum Working Tension and Every Day Stress
The standard span length was assumed to be 400m. The maximum working tension and the EDS of both the conductor and the ground wires satisfy the determined safety factors as shown in Table 7.2.3-4.

3) Sags and Tensions of the Ground wires
The sags of ground wires under EDS condition must be below 80% of the conductors' sag at the standard span length for avoiding a reverse flashover from the ground wires to conductors and direct lightning stroke to the conductors. The tension of the ground wires are determined to satisfy the safe clearance of conductors and ground wires in the mid-span.

4) Standard Span Length
The standard span length between towers: 400m (assumed by JICA Study Team)

5) Right of Way (ROW)
ROW is set as 25m from the center of Tower to each side perpendicular to direction of conductors.

6) Ground Clearance
The most severe state for the ground clearance of conductors will occur when the conductor's temperature rises to 70 degrees under still air conditions. As for this project, the minimum height of the conductors above ground provided by Uzbekenergo is shown in Table 7.2.3-7.

Table 7.2.3-7 Minimum Height of Conductor above Ground

Classification	Height[m]
Plain (not access to)	7
Populated area	8
Crossing roads	15

(4) Detemination of Insulator Design

1) Insulator type and size

Based on the GOSS, Insulator unit applied to these T/Ls is standard type porcelain or toughened glass insulator with ball and socket, complying with IEC60305. The 70kN type insulator is applied for suspension towers and 120kN type insulator is applied for the tension (angle) towers. The technical characteristics of the insulators are shown in Table 7.2.3-8.

Table7.2.3-8 Technical Characteristics of Insulator

Type	U70BS	U120B
Rated Ultimate Strength [kN]	70	120
Nominal diameter [mm]	255	255
Nominal spacing [mm]	146	146
Nominal Creepage Distance	295	295

Source: IEC 60305

2) Number of Insulator per String

According to SAESP, the number of insulators for 220kV T/L is usually16–18 units. Based on IEC, the number of insulators is determined by the contamination level ” Medium ”, which is 17 units, and the number designed for the lighting impulse withstand voltage (LIWV) and arcing horn is 18 units. Therefore, the JICA Study Team adapts 18 units as maximum insulator units in this report. However, it is necessary to study in design stage details in consideration of the actual contamination levels at the site.

3) Insulator Strings (Span Length: 400m)

Insulator fittings also have to support the same strength as the insulators as shown in Table 7.2.3-9.

Table 7.2.3-9 Tension Insulator Assmembly

Conductor	Tower type	Maximum Tension	Insulator type	Permissible Strength
ACSR/AS 400mm^2	Tension	52kN (Single)	Double strings of 240kN (120kN x 2)	4.6 >2.7
	Suspension	13.7kN	Single strings 80kN x 1	5.2>2.7
ACSR/AS 500mm^2	Tension	59kN (Single)	Double strings of 240kN (120kN x 2)	4.1 >2.7
	Suspension	14.7kN	Single strings 80kN x 1	4.7 >2.7

Source: JICA Study Team

(5) Determination of Tower Configuration

1) Clearance Design

According to PUE, the values of clearance diagram are described as shown in Table7.2.3-10.

Table 7.2.3-10 Swinging Angle and Insulation Clearance

	Normal	Abnormal
Wind Velocity [m/s]	10m/s	29m/s
Swinging angle of suspension strings	10 deg.	50 deg.
Swinging angle of tension strings (jumper)	10 deg.	50 deg.
Value of clearance diagram [mm]*	1,800	550

Source: JICA Study Team
Source* PUE

2) Tower Configurations

The towers shall normally be of the following two standard types as shown in Table 7.2.3-11.

Table 7.2.3-11 Tower types and Applied Conditions

Type	Position of Use	Angle of Deviation or Entry	String Type
SS	Straight line	0 - 5	Suspension
TT	Angle or Terminal	0 - 60	Tension

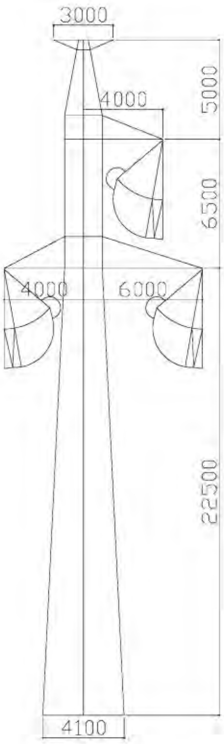
Source: JICA Study Team

The weight of Tower calculated by the JICA Study Team is shown in Table 7.2.3-12.

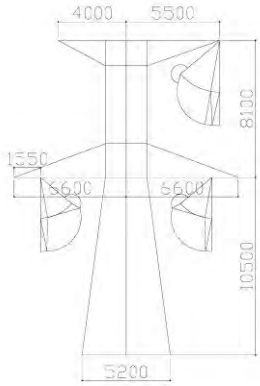
Table 7.2.3-12 Caluculated Weight of Towers

Tower Extension	SS[ton]	TT[ton]
0	6.6	6.0
+5	-	7.6
+9	-	9.6
+14	-	12.7

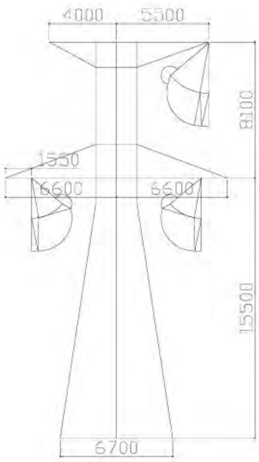
Source: JICA Study Team



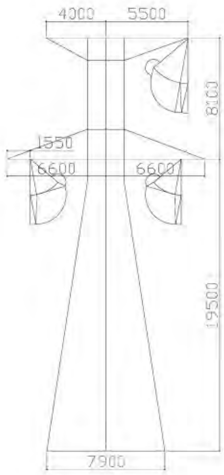
Source: JICA Study Team
Figure 7.2.3-2 Type "SS" Tower



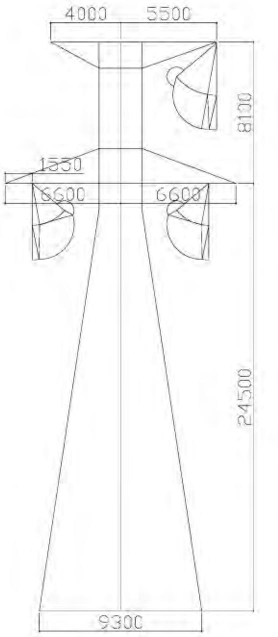
Source: JICA Study Team
Figure 7.2.3-3. Type "TT" Tower +0



Source: JICA Study Team
Figure 7.2.3-4 Type "TT" Tower +5



Source: JICA Study Team
Figure 7.2.3-5 Type "TT" Tower +9



Source: JICA Study Team

Figure 7.2.3-6 Type “TT” Tower +14

3) Tower Design

Based on the consideration of minimum ground clearance and the

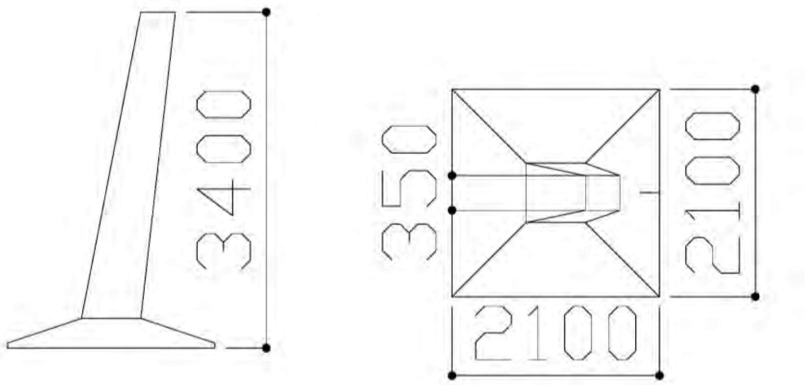
Based on GOST, “NC220 - 5T”as the suspension towers are applied, Y220-3HC3+0, +5, +9, +14 as tension towers applied. Assumed foundation Loads of each tower type is shown in Table 7.3.3-13.

Table 7.2.3-13 Assumed Foundation Loads

Type	Leg Extension [m]	Compressive Load [kN]	Tensile Load [kN]
SS	0	350	310
TT	0	390	330
	+4	420	350
	+9	450	380
	+14	490	400

Source: JICA Study Team

(6) Foundation Design
According to SAESP, they did not have a sufficient amount of geology characteristics data, but they surmised the geology characteristics of this project are stable based on the data of a similar project. It is therefore necessary to check for and conduct boring as well as create a detailed design in order to confirm the geology characteristics prior to the construction of the T/Ls.and to determine the type of foundations based on the aforementioned data.



Source SAESP

Figure 7.2.4-7 A example of Pad and Chimney Type Foundation

7.2.4 Construction Schedule

(1) Whole Schedule for T/L Construction
The construction for T/L is shown in Table 7.2.4-1.

Table 7.2.4-1 Construction schedule for T/L

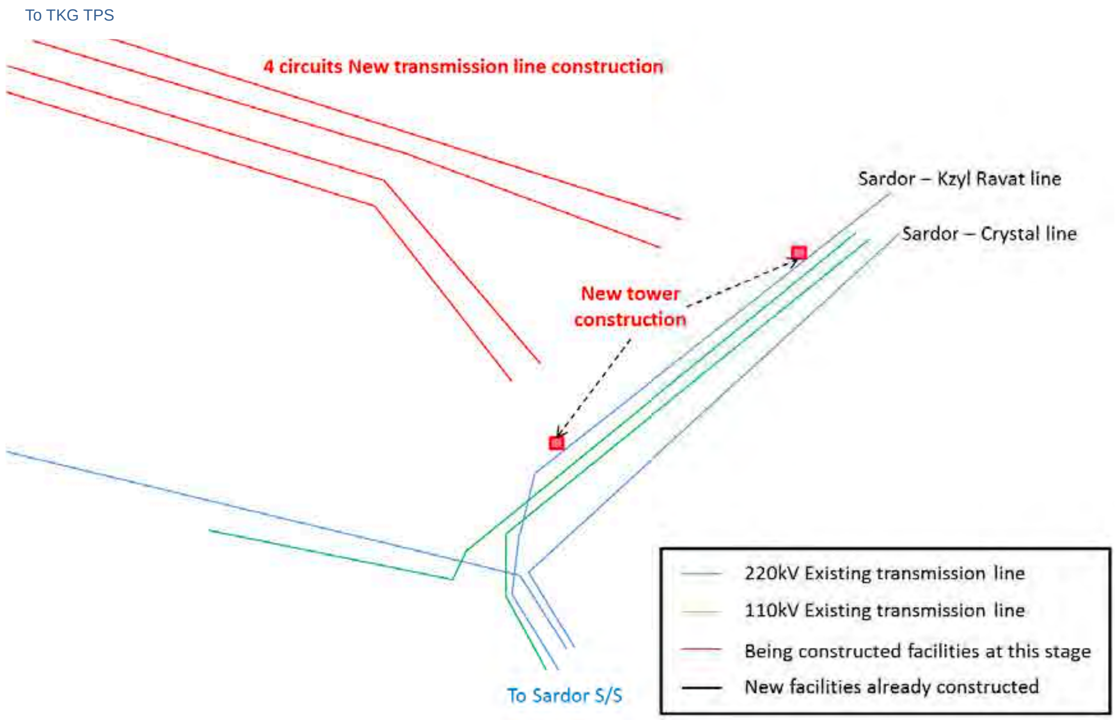
No.	Item	2014												2015												2016	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	Prepareing documents	■	■	■																							
2	Placing orders for equipment				■	■	■	■	■																		
3	Construction work								■	■	■	■	■	■	■												
4	Ereciton work										■	■	■	■	■	■	■	■	■								
5	Commissioning work																			■	■	■	■	■	■		
6	Guarantee test																									■	■

Source: Uzbekenergo

(2) Plan of Connection to the Existing Line

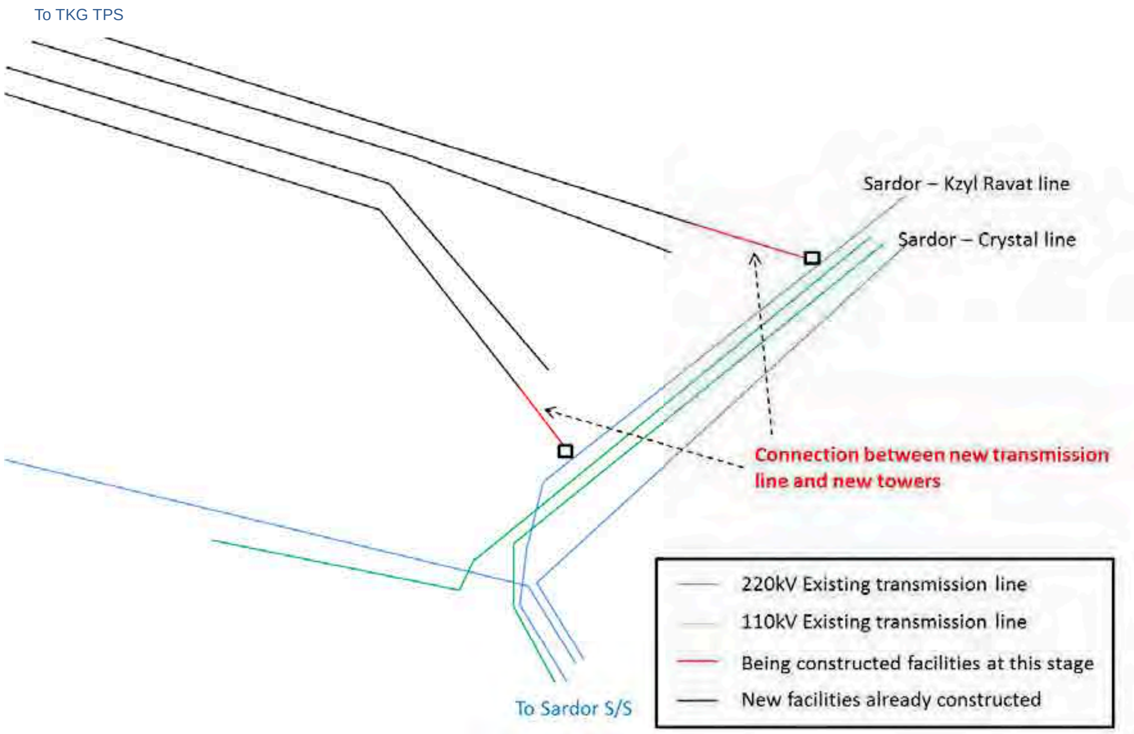
1) Procedure to connect the 4-cct T/L to the Existing Power Grid

The procedures to connect the 4-cct T/L are shown in Figure 7.2.4-2 to 7.2.4-6.



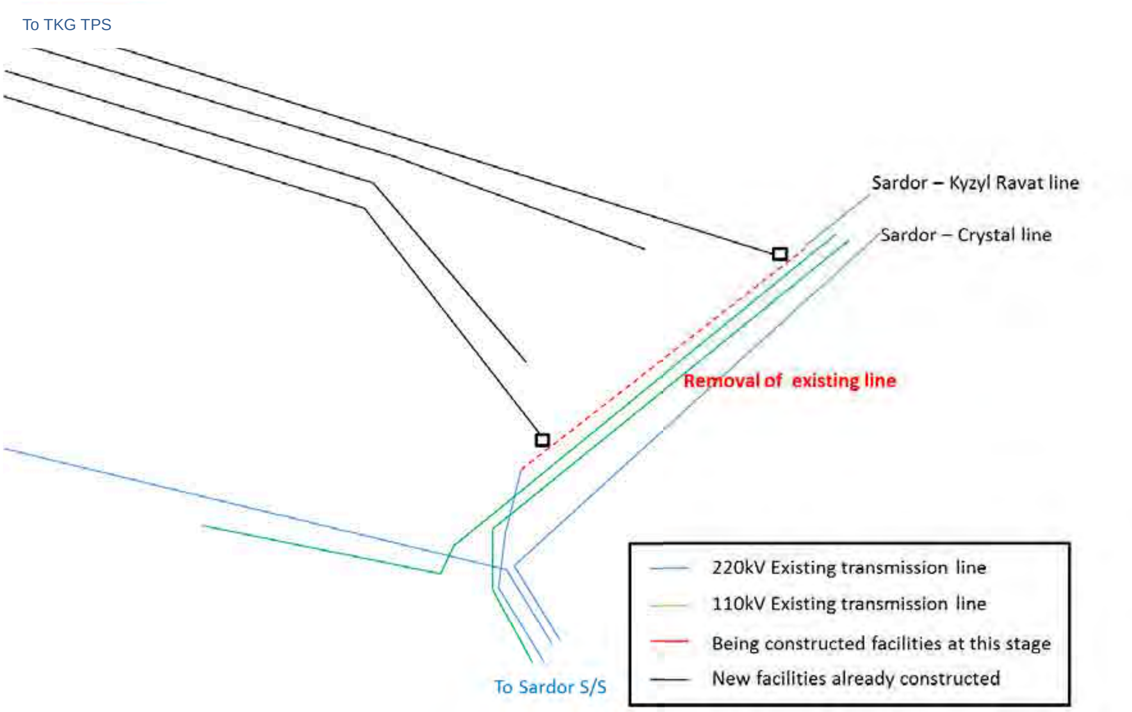
Source: JICA Study Team

Figure 7.2.4-1 The 4-cct T/L Connection Procedure to the Existing Power Grid (1)



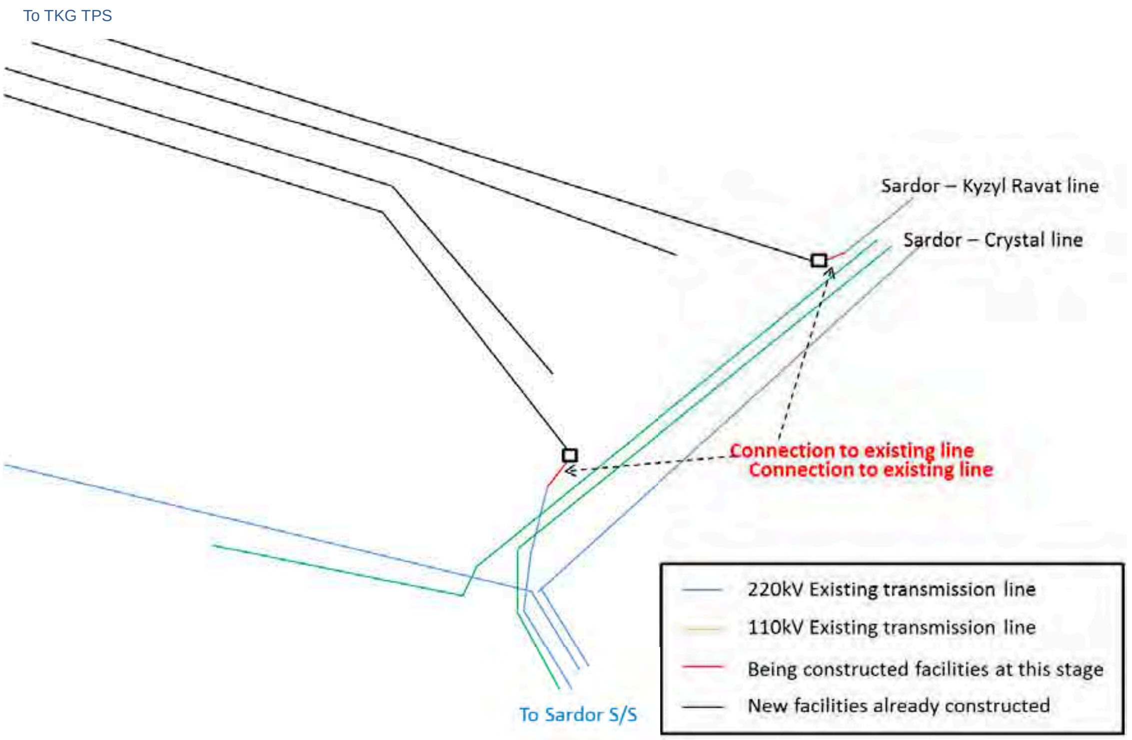
Source: JICA Study Team

Figure 7.2.4-2 The 4-cct T/L Connection Procedure to the Existing Power Grid (2)



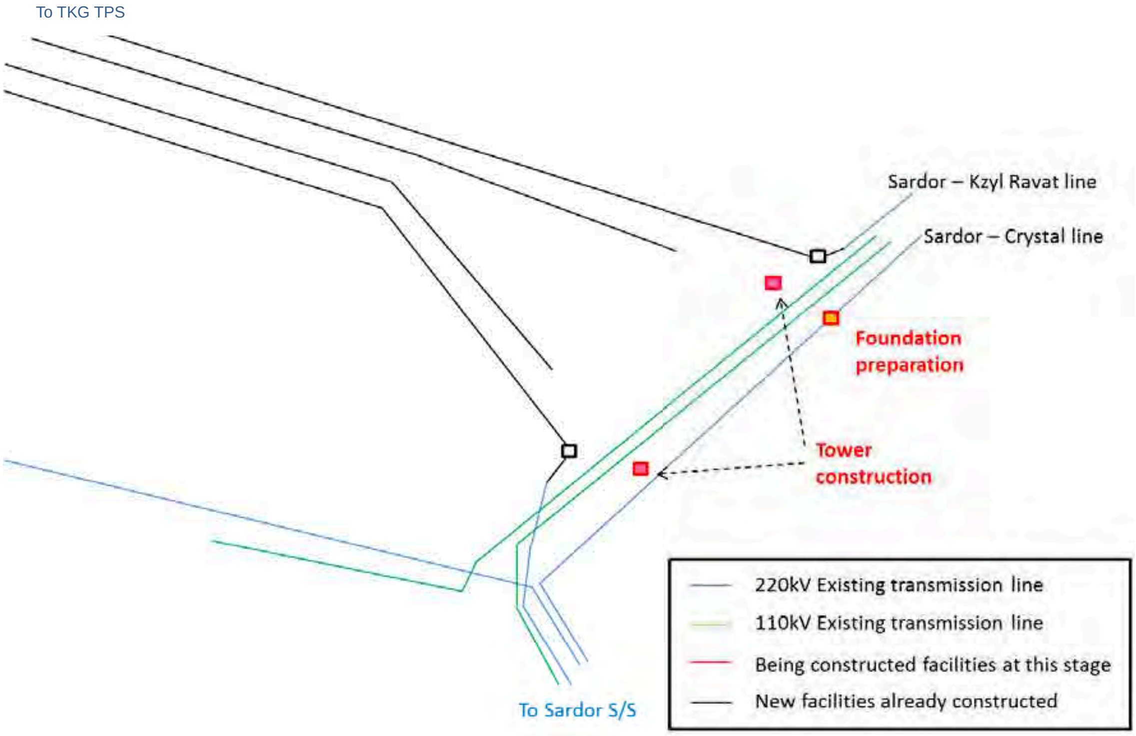
Source: JICA Study Team

Figure 7.2.4-3 The 4-cct T/L Connection procedure to the Existing Power Grid (3)



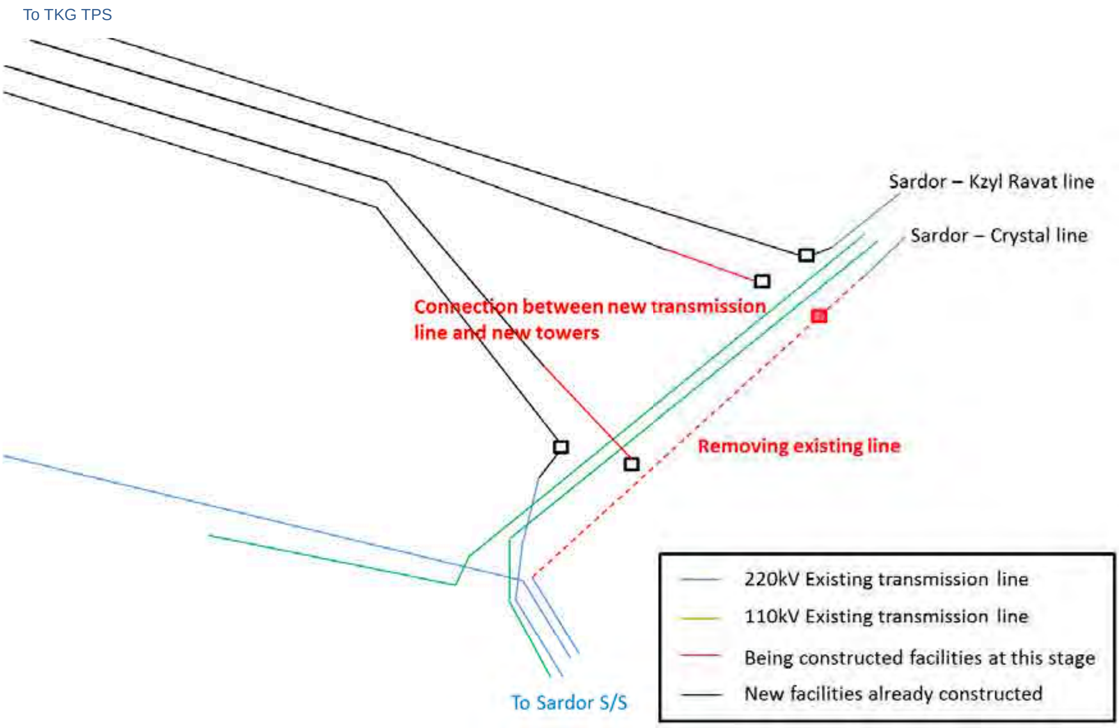
Source: JICA Study Team

Figure 7.2.4-4 The 4-cct T/L Connection Procedure to the Existing Power Grid (4)



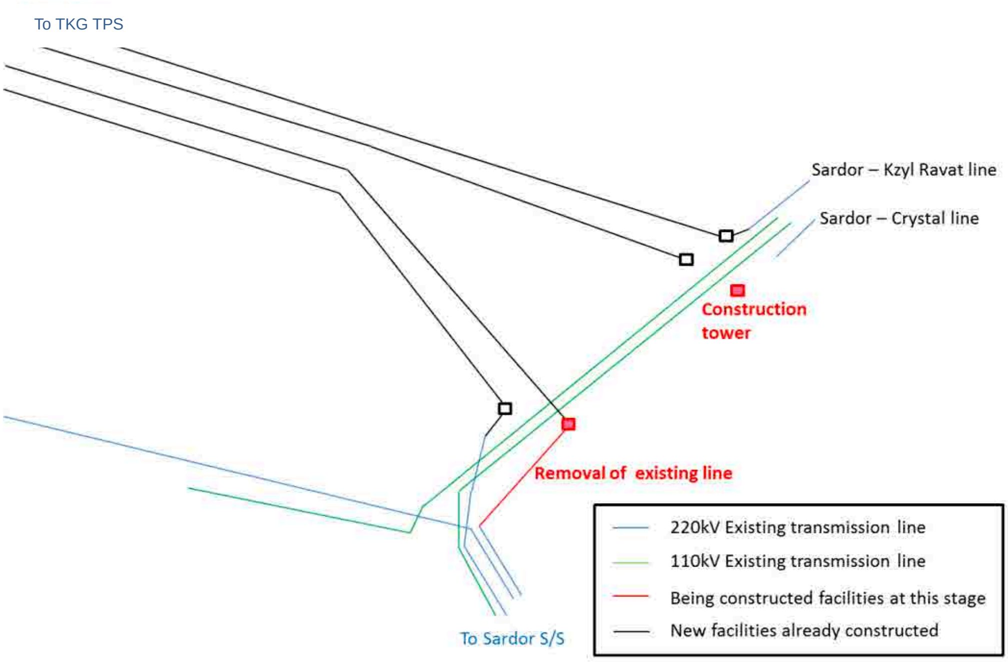
Source: JICA Study Team

Figure 7.2.4-5 The 4-cct T/L Connection Procedure to the Existing Power Grid (5)



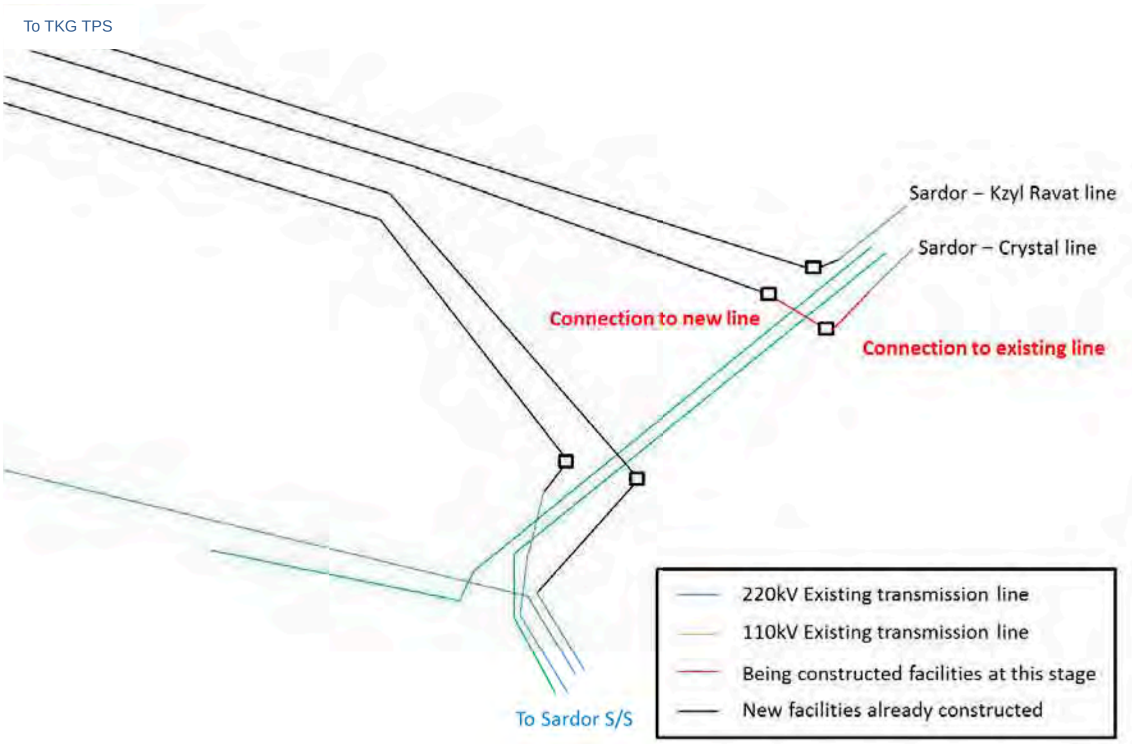
Source: JICA Study Team

Figure 7.2.4-6 The 4-cct T/L Connection Procedure to the Existing Power Grid (6)



Source: JICA Study Team

Figure 7.2.4-7 The 4-cct T/L Connection Procedure to the Existing Power Grid (7)

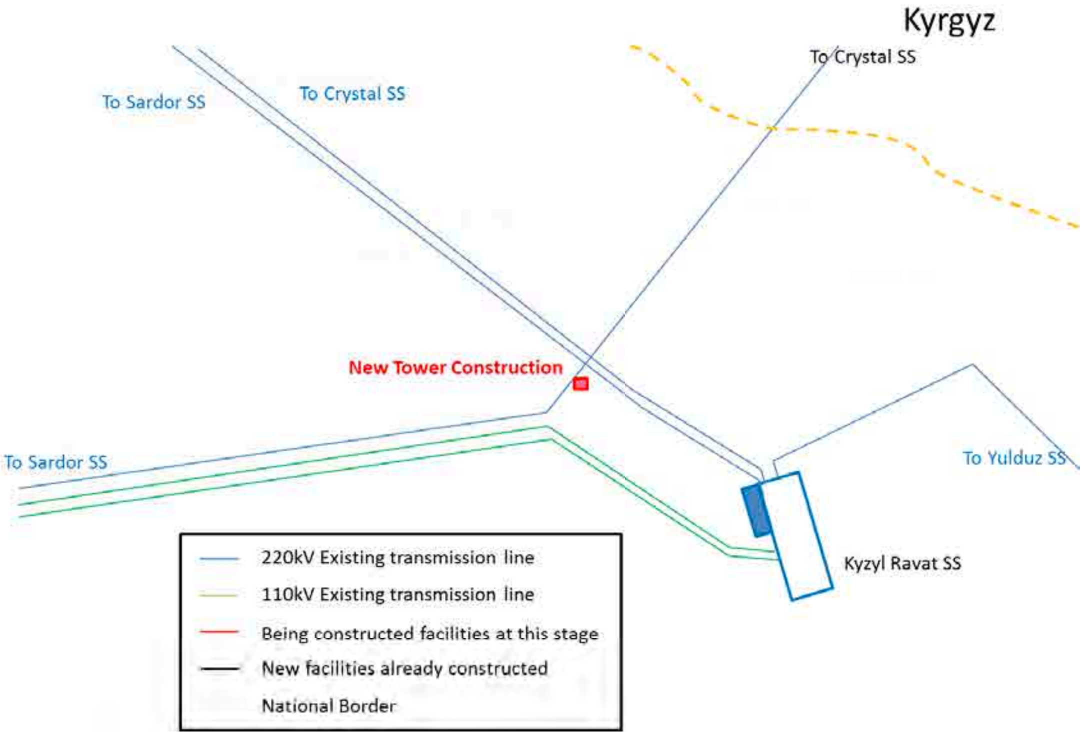


Source: JICA Study Team

Figure 7.2.4-8 The 4-cct T/L Connection Procedure to the Existing Power grid (8)

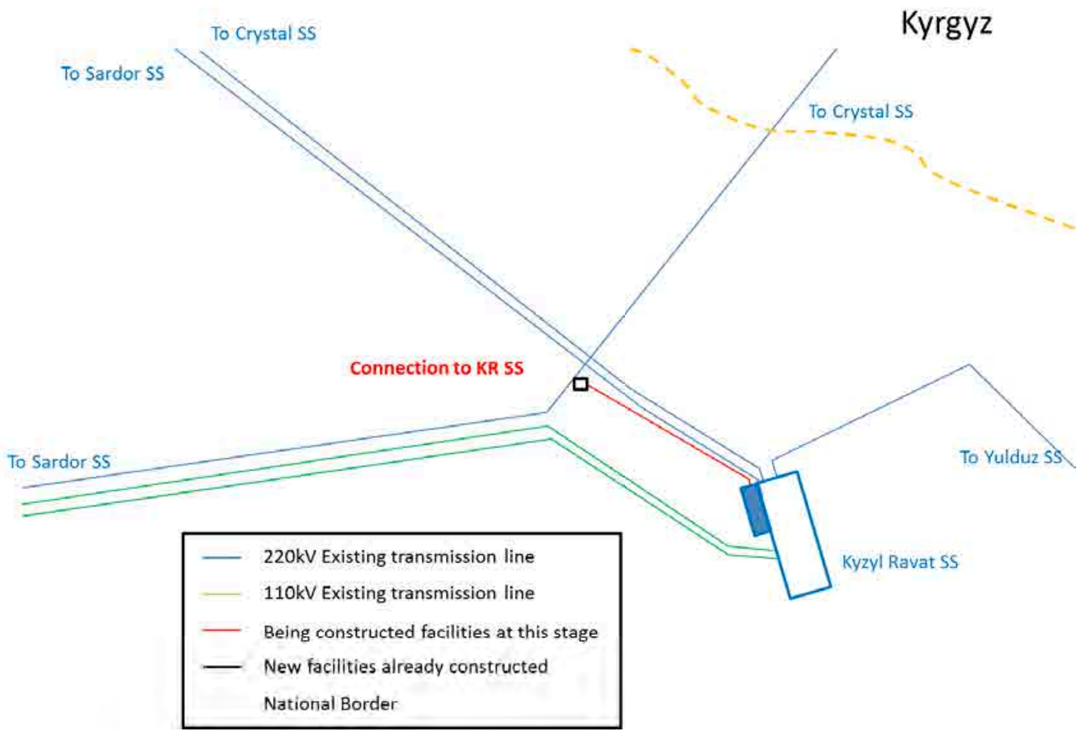
2) Procedure to Connect the 1-cct T/L around Kyzl Ravat SS to the Existing Power Grid

The procedures to connect the 1-cct T/L are shown in Figure 7.2.4-7 to 7.2.4-9.



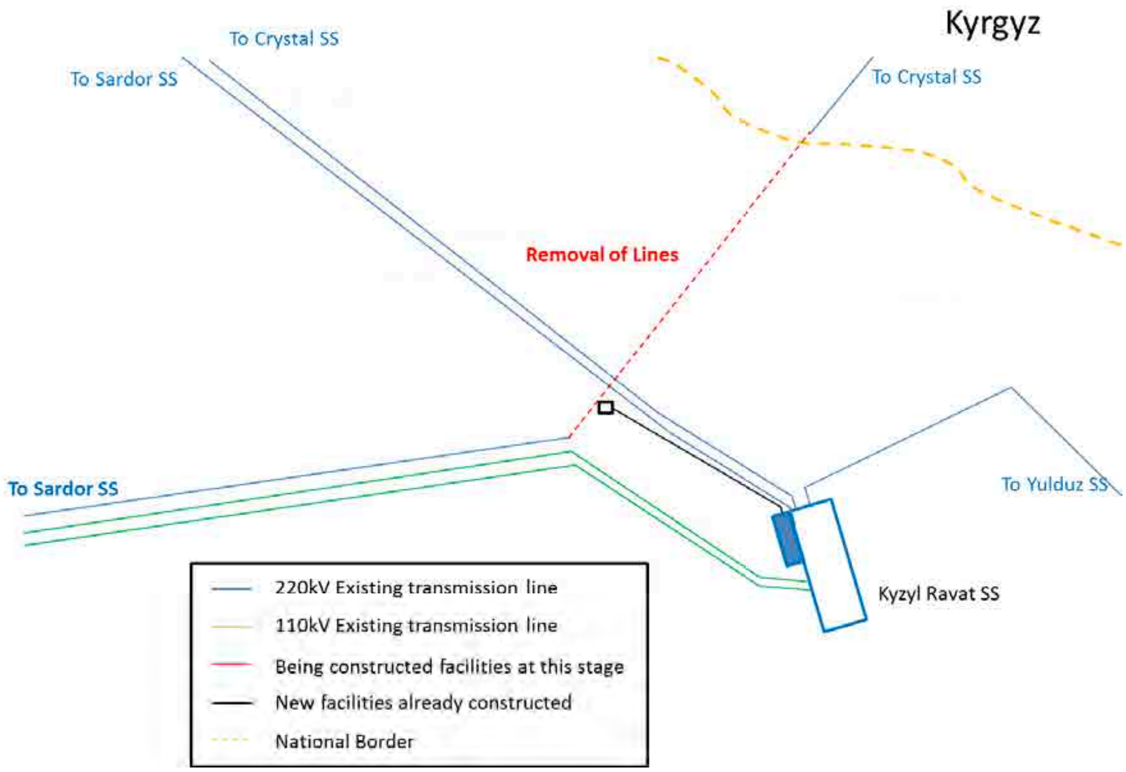
Source: JICA Study Team

Figure 7.2.4-9 The 1-cct T/L Connection Procedure to the Existing Power Grid (1)



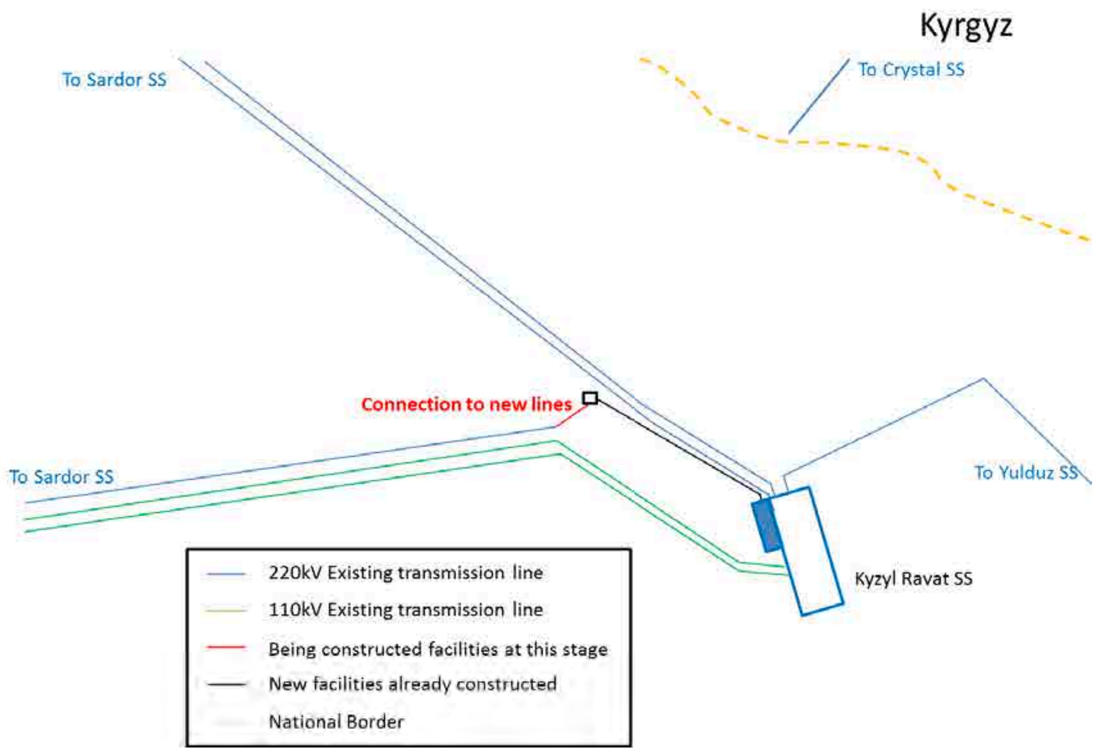
Source: JICA Study Team

Figure 7.2.4-10 The 1-cct T/L Connection Procedure to the Existing Power Grid (2)



Source: JICA Study Team

Figure 7.2.4-11 The 1-cct T/L Connection Procedure to the Existing Power Grid (3)



Source: JICA Study Team

Figure 7.2.4-12 The 1-cct T/L Connection Procedure to the Existing Power Grid (4)

7.2.5 Construction cost for T/L

(1) Total Construction Cost for T/L

The total construction cost for transmission lines is 15.71 million USD.

(2) Cost Eestimation of T/L

Based on an interview with SAESP and ETQ (Elektrtamoqquilish), the construction cost of transmission line for this project was estimated to be 16 million USD as shown in Table 7.2.5-1

*Premium rate: This project involves complicated construction, such as the a connection to the existing transmission lines over the 110kV transmission lines in consideration of N–1 criteria. In this case, based on past experiences of construction performed in Japan, the premium rate to all construction costs is assumed to be 15%.

Table 7.2.5-1 Construction cost of T/L

Item	Construction Length [km]	Unit Cost [MUSD/km]	FC [MSD]	LC [MSD]	Total Cost [MUSD]
New line	59.4	0.23	9.29	4.37	13.66
Premium rate	-	-	-	-	2.05
Total	-	-	-	-	15.71

Source: JICA Study team

7.3 Modification on Existing Substation

In order to transmit power properly from TKG, Kyzyl Ravat substation & Sardor substation will be required to be rebuilt. In this section, the design for the reconstruction plan is described. All reconstruction must be performed in accordance with "Rules of electrical installations Uzbekistan version"(hereinafter PUE) and "Reference book Russian version".

7.3.1 Reconstruction designs for Kyzyl Ravat Substation

(1) Summary
220kV transmission lines (Single circuit) will be connected from TKG to Kyzyl Ravat substation. In order to secure the transmission capacity in Kyzyl Ravat substation, the following reconstructions will be required.

- Reconstruction of 220kV Switch Yard
- Replacement of the existing 2 Transformers from 125MVA to 200MVA each
- Replacement of 110kV Switch Yard Equipment
- Replacement of Protection Relays

1) Reconstruction of 220kV Switchyard
According to "PUE", 220kV switchyard scheme must be changed from Figure7.3.1 to the scheme of "two bus systems with a bypass" as Figure 7.3.2. The objects to be rebuilt for this study are indicated in the red letters & lines.

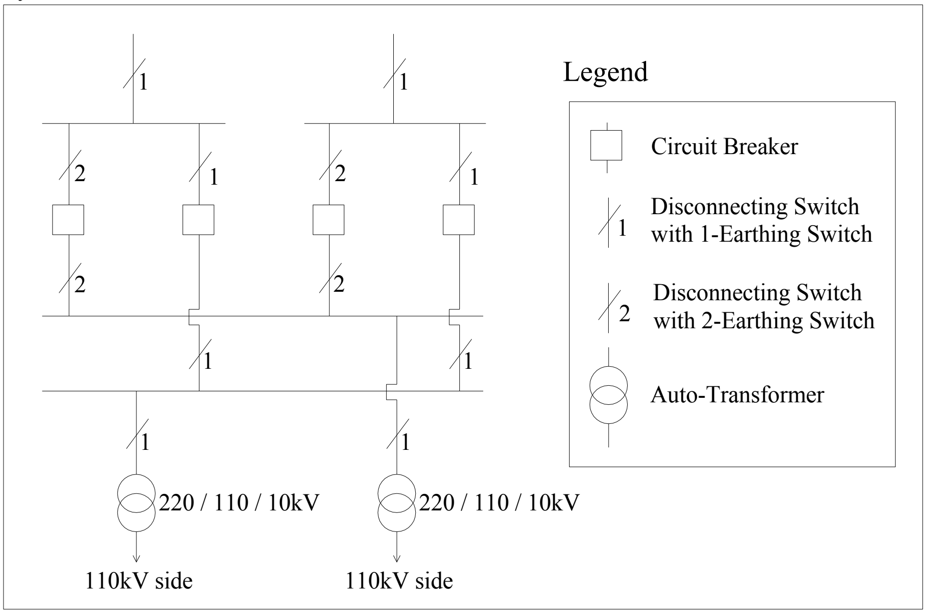
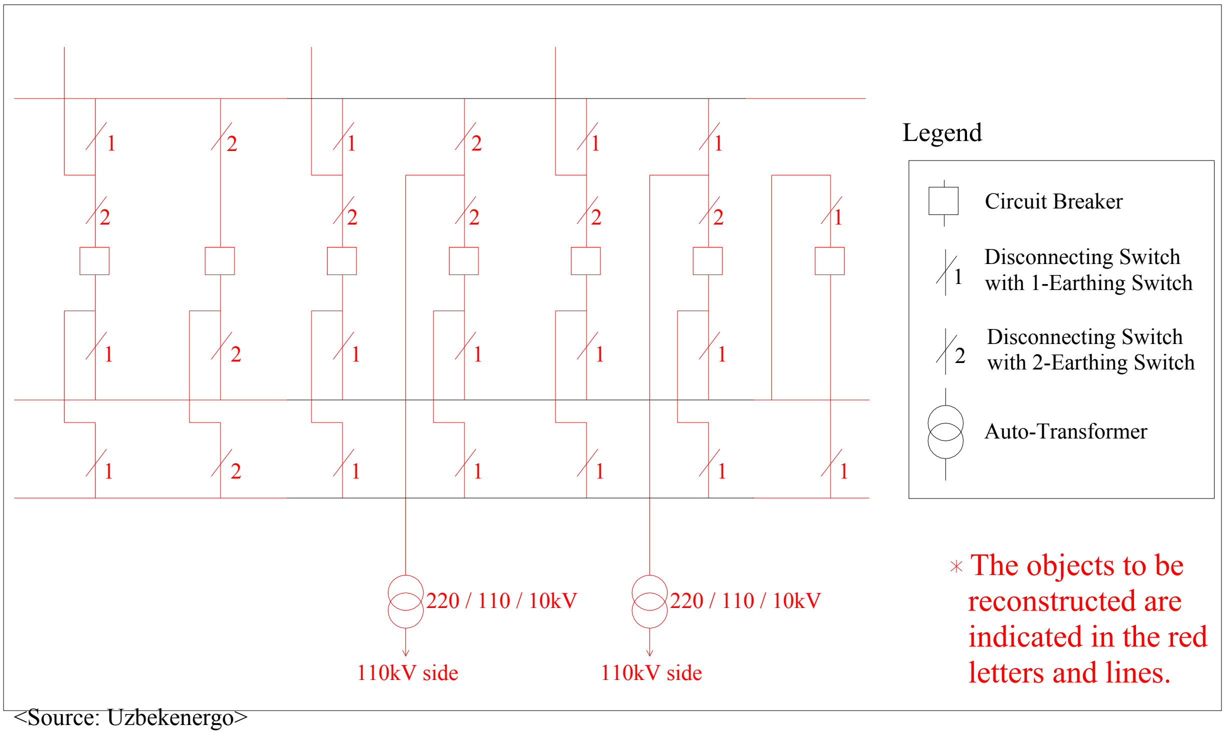


Figure 7.3.1 220kV part in Single-line Diagram of Kyzyl Ravat substation (Before reconstruction)



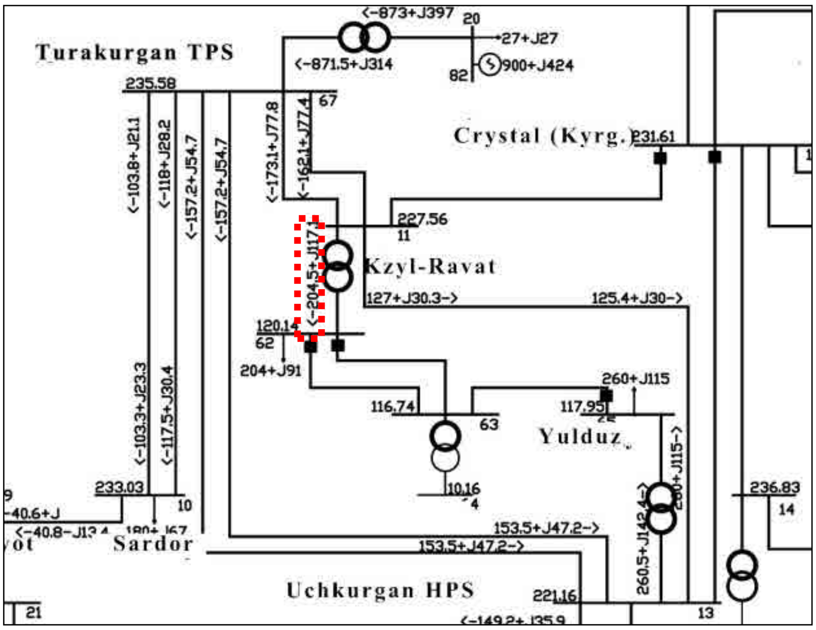
<Source: Uzbekenergo>

Figure 7.3.2 220kV part in Single-line Diagram of Kyzyl Ravat substation (After reconstruction)

Two bypass bays and bus-tie bays will be newly installed for the reconstruction. Additionally, the existing 220kV equipment, such as circuit breakers and disconnecting switches, have to be replaced to deal with the increasing of transmission capacity. As an example, the rated short-circuit current for 220kV circuit breaker will be upgraded from 25kA to 40kA.

2) Upgrading of the two existing transformers from 125MVA to 200MVA.

The transmission capacity in Kyzyl Ravat substation is expected to be 204 MVA after operating TKG No.1&2 in 2017 as shown in Figure 7.3.3. However, given the N-1 consideration, the capacity of the existing transformers (2*125MVA) will not be able to satisfy future capacity requirements. Hence, it is necessary to upgrade each transformer to 200MVA.

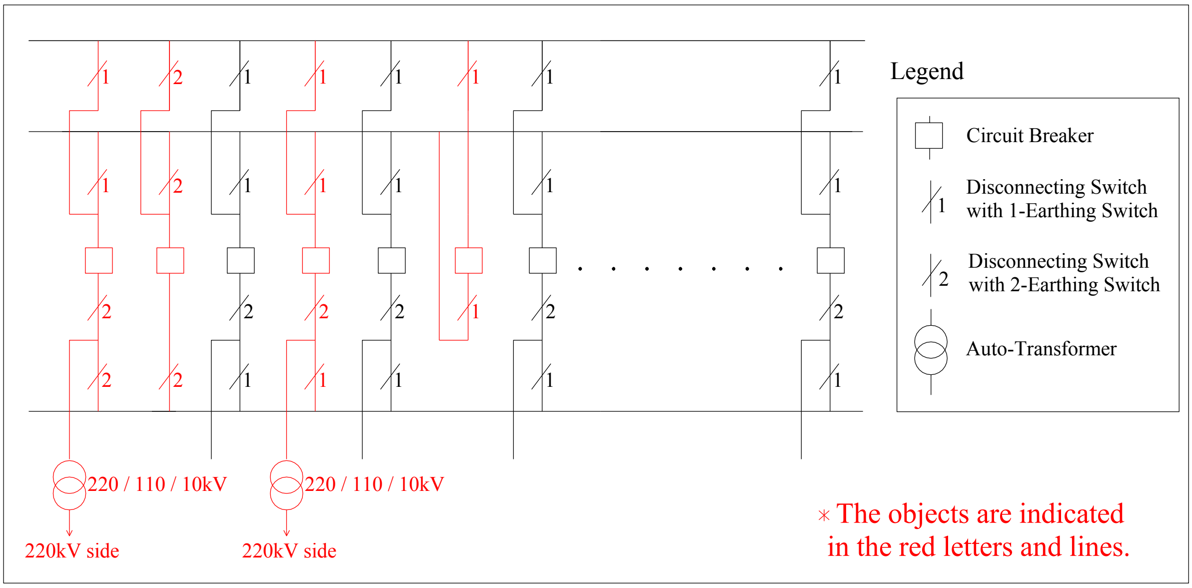


Source : Uzbekenergo

Figure 7.3.3 Power flow plan in 2017 (Close-up of Kyzyl Ravat substation)

3) Replacement of 110kV Switchyard Equipment

According to “PUE”, changing 110kV switchyard scheme isn’t necessary. However, the existing 110kV equipment, such as the bypass bay and the bus-tie bay, need to be replaced with new ones with larger transmission capacities in order to guarantee transmission capacity after TKG operation start. Meanwhile, the other switchgears for transmission lines can satisfy the transmission capacity requirements after the start of TKG operation, thus their replacementwon’t be necessary.



Source : Uzbekenergo

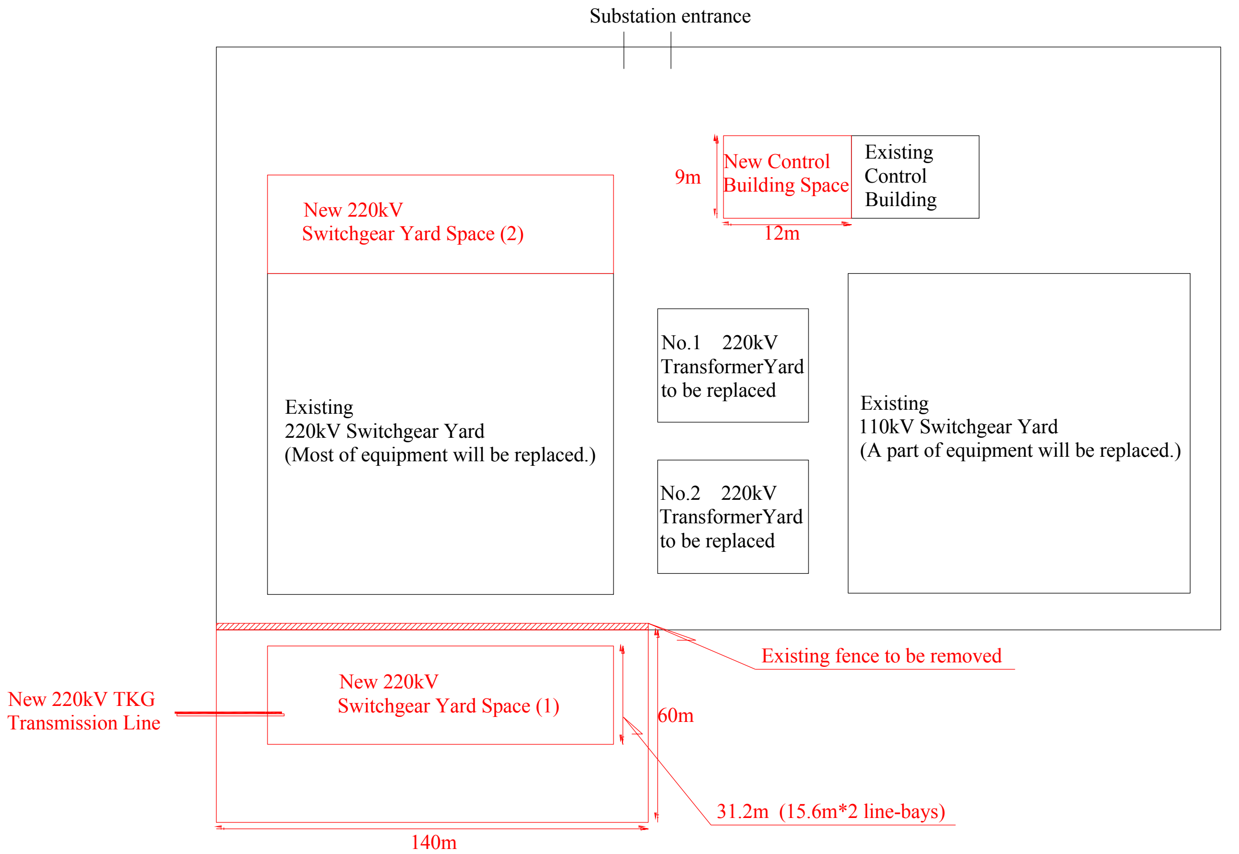
Figure 7.3.4 110kV part of Single-line Diagram for Kyzyl Ravat substation

(4) Replacement of Protection Relays

In addition to the aforementioned reconstruction, replacement of the communication systems and protection relays for the transformers, transmission lines and busbars will be necessary. However, the existing control building doesn't have the vacant space for new equipment. Hence, new control building will be constructed adjacent to the existing, and new panels will be installed in the new one.

(2) Equipment layout

The layout plan of Kyzyl Ravat substation is shown in Figure 7.3.5. The existingKyzyl Ravat substation is not sufficient to carry out all reconstruction. Hence, the expansion of 220kV switchgear yard by relocating the existing fence is necessary. The expansion dimension is planned with 60m x 140m. The owner of this area is Uzbekenergo.
It is planned to install a new bypass bay, a 220kV line-bay for TKG and bus-tie bay in the expansion area. Based on "PUE", the spread of 15.6m is necessary to install a line-bay of 220kV switchgear with accessories, such as lighting and fire fighting system. Hence, the expansion area has enough space to install 2 line-bays, as Figure 7.3.5 demonstrates.
Meanwhile, the other equipment is planned to be installed within the current premise.



Source : Uzbekenergo

Figure7.3.5 The equipment layout of Kyzyl Ravat Substation

(a) New 220kV Switchgear Yard Space (1)

(b) New 220kV Switchgear Yard Space (2)

(c) The existing transformer

(d) The existing 220kV Switchgear Yard

(e) The existing 110kV Switchgear Yard

(f) New Control Building Space

Source : Uzbekenergo

Figure7.3.6 Pictures in Kyzyl Ravat Substation

(3) Specifications of the main facilities

Based on Uzbekenergo, the specifications of main equipment for the reconstruction are determined as follows.

1) 220kV Transformer

Two existing transformers should be replaced to guaranteesufficient capacity for TKG operation. The new ones are Auto-transformers with On-Load-Tap-Changer. The other specifications are as follows.

[Transformer]

➢ Rated voltage	230/121/11 kV
➢ Cooling type	OFAF (Oil Forced Air Forced)
➢ Lightning Impulse Withstand Voltage	HVside 750kV
	MVside 480kV
	LVside 90kV

2) 220kV Switchgear

220kV switchgear scheme should be changed to the scheme of "two bus systems with a bypass". The specifications of the main equipment for reconstruction are as follows.

[Circuit Breaker]

Insulator of the new circuit breaker is SF6 gas. The other specifications are as follows.

➢ Rated voltage	220 kV
➢ Rated current	2000 A
➢ Rated short-circuit current	40 kA
➢ Lightning Impulse Withstand Voltage	1050 kV

[Disconnecting Switch]

➢ Rated voltage	220 kV
➢ Rated current	2000 A
➢ Lightning Impulse Withstand Voltage	1050 kV

[Current Transformer]

➢ Rated voltage	220 kV
➢ Rated current	2000 A
➢ Lightning Impulse Withstand Voltage	1050 kV

[Voltage Transformer]

➢ Rated voltage	220 kV
➢ Lightning Impulse Withstand Voltage	1050 kV

[Lightning Arrester]

➢ Rated voltage	198 kV
➢ Rated discharge current	10 kA
➢ Lightning Impulse Withstand Voltage	1050 kV

[Protection Method for Transformer]

- Differential protection

[Protection Method for Transmission Line]

- Directional Carrier-current protection
- Distance Protection (Three-stage)
- Zero current directional protection (Four-stage)

[Protection Method for Busbar]

- Differential current protection (Main & Reserved)

[Communication Method for Protection Relay]

- Power Line Communication by High Frequency Wire

3) 110kV Switchgear

The specifications of the main equipment for the reconstruction of 110kV Switchyard are as follows.

[Circuit Breaker]

Insulator of the new circuit breaker is SF6 gas. The other specifications are as follows.

- Rated voltage 110 kV
- Rated current 2000 A
- Rated short-circuit current 25 kA
- Lightning Impulse Withstand Voltage 520 kV

[Disconnecting Switch]

- Rated voltage 110 kV
- Rated current 2000 A
- Lightning Impulse Withstand Voltage 520 kV

[Current Transformer]

- Rated voltage 110 kV
- Rated current 2000 A
- Lightning Impulse Withstand Voltage 520 kV

[Voltage Transformer]

- Rated voltage 110 kV
- Lightning Impulse Withstand Voltage 520 kV

[Lightning Arrester]

- Rated voltage 110 kV
- Rated discharge current 25 kA
- Lightning Impulse Withstand Voltage 520 kV

(4) Cost estimation

In this section, total cost estimation for reconstruction of Kyzyl Ravat S/S is described. Total cost is estimated based on the following assumptions.

- All equipment will be procured from abroad, and the price is estimated in US dollars for CIF price.
- The procurement costs for spare parts and tools is estimated to account for 5% of total equipment cost.
- The transportation cost is estimated to account for 5% of total equipment cost with spare parts.
- The costs for civil and erection works is estimated to account for 35% of total equipment cost with spare parts.
- The removal costs for the existing equipment iestimated to account for 35% of total

equipment cost with spare parts.

- Costs for works such as facility designs, documentation etc by a contractor would be estimated as Miscellaneous cost. It is estimated to account for 10% of the total costs.

Table 7.3.1 Construction cost

Items	Foreign Currency [MUSD]	Local Currency [MUSD]	Total [MUSD]
Equipment	6.798		6.798
Spare part	0.340		0.340
Transportation		0.357	0.357
Civil and Erection		2.498	2.498
Removal cost		2.498	2.498
Miscellaneous cost	0.714	0.535	1.249
Total	7.852	5.889	**13.740**

Source : JICA Study Team

Table7.3.2 Cost Estimation [Kyzyl Ravat Substation]

No.	Items	Quantity	Unit cost [MUSD]	Total Cost [MUSD]
1	**220kV Transformer & Switch Yard bay**			**5.5122**
1.1	220/110/10kV 200MVA Transformer (3-Phase)	2 sets	1.400	2.800
1.2	Circuit Breaker (Gas insulated)(3-Phase)	7 sets	0.066	0.462
1.3	Disconnecting Switch with 1-earthing switch (3-Phase)	17 sets	0.016	0.272
1.4	Disconnecting Switch with 2-earthing switch (3-Phase)	11 sets	0.0162	0.1782
1.5	Lightning Arrester	4 sets	0.0025	0.01
1.6	Current Transformer	14 sets	0.01	0.14
1.7	Voltage Transformer	3 sets	0.01	0.03
1.8	Busbar Structure conductor, fitting	7 sets	0.038	0.266
1.9	Set of Structures for Switch bay	7 sets	0.086	0.602
1.10	Set of Over Connections for Switch bay	7 sets	0.068	0.476
1.11	Grounding Wire	3 sets	0.092	0.276
2	**110kV Switch Yard bay**			**0.3627**
2.1	Circuit Breaker (Gas insulated) (3-Phase)	4 sets	0.045	0.18
2.2	Disconnecting Switch with 1-earthing switch (3-Phase)	7 sets	0.0105	0.0735
2.3	Disconnecting Switch with 2-earthing switch (3-Phase)	6 sets	0.0107	0.0642
2.4	Lightning Arrester	4 sets	0.0015	0.006
2.5	Current Transformer	6 sets	0.0065	0.039
3	**10kV Station service equipment**			**0.0284**
3.1	Station Service Transformer	1 set	0.025	0.025
3.2	Current Transformer	2 sets	0.0012	0.0024
3.3	Lightning Arrester	2 sets	0.0005	0.001

No.	Items	Quantity	CIF [MUSD]	Total Cost [MUSD]
4	**Control Panel, Relay Panel for 220kV equipment**			**0.484**
4.1	Substation Control Building	1 set	0.08	0.08
4.2	Protection Relay for Transformer	2 sets	0.08	0.16
4.3	Protection Relay for Transmission Line	3 sets	0.039	0.117
4.4	Protection Relay for Busbar	3 sets	0.039	0.117
4.5	Control cables		0.01	0.01
5	**DC Equipment**			
	Battery, DC distribution Panel		0.08	0.08
6	**AC Equipment**			
	Service Switchboard		0.08	0.08
7	**Communication and SCADA**			
	Extension of function		0.25	0.25

Source : JICA Study Team

7.3.2 Reconstruction designs for Sardor Substation

(1) Summary

According to changing the grid connection by operating TKG No.1&2, transmission lines between TKG and Sardor substation will be connected. However, because the existing relay and communication system in Sardor substation wouldn't match with the planned specifications of new relay and communication in TKG side, the existing systems should be replaced.

The existing control building has a vacant space for installing the new systems, hence, new control building isn't necessary. For reference, pictures of the existing control building are shown in Figure 7.3.7.

Source : JICA Study Team

Figure 7.3.7 The existing control building in Sardor substation

(2) Specifications of the main facilities

[Protection Method for Transmission Line]

- Directional Carrier-current protection
- Distance Protection (Three-stage)
- Zero current directional protection (Four-stage)

[Communication Method for Protection Relay]

- Power Line Communication by High Frequency Wire

(3) Cost estimation

In this section, total cost estimation for reconstruction of Sardor substation is described. Total cost is estimated based on the following assumptions.

- All equipment will be procured from abroad, and the price is estimated in US dollars for CIF price.
- The procurement costs for spare parts and tools is estimated to account fort 5% of total equipment cost.
- The transportation costs is estimated to account for 5% of total equipment cost with spare parts.
- The costs for civil and erection works is estimated to account for 35% of total equipment cost with spare parts.
- The removal costs for the existing equipment is estimated to account for 35% of total equipment cost with spare parts.
- Costs for works such as facility designs, documentation etc by a contractor is estimated as Miscellaneous cost. It would be estimated to account for 10% of the total costs.

Table 7.3.3 Construction cost

Items	Foreign Currency [MUSD]	Local Currency [MUSD]	Total [MUSD]
Equipment	0.143		0.143
Spare part	0.007		0.007
Transportation		0.008	0.008
Civil and Erection		0.053	0.053
Removal cost		0.053	0.053
Miscellaneous cost	0.015	0.011	0.026
Total	0.165	0.124	**0.289**

Source : JICA Study Team

Table7.3.4 Cost Estimation [Sardor Substation]

No.	Items	Quantity	CIF [MUSD]	Total Cost [MUSD]
1	**Control Panel, Relay Panel for 220kV equipment**			
1.1	Protection Relay for Transmission Line	2 sets	0.039	0.078
1.2	Control cables	1 set	0.005	0.005
2	**Communication and SCADA**			
	Extension of function		0.060	0.060

Source : Uzbekenergo

Chapter 8. Environmental and Social Considerations

The study of environmental social considerations is being conducted while keeping the following point in mind.

Regarding the introduction of technology for the project, it is important for project proponents to consider the most practicable technology and technology of lower environmental load taking into account economic situation in Uzbekistan.

The adequacy of this project will be verified through the following by JICA survey team.

- The review of EIA report, LARAP, and relative documents created by project proponents.
- The verification about appropriateness of background of this project though a site survey, interview from project proponent s, etc..
- Qualitative or quantitative reassessment to ensure compliance with the laws and regulations of Uzbekistan concerning natural, social, and environmental aspects, consistency of JICA and IFC/WB Guidelines.

If there are any issues to be improved, project proponents will discuss the issues at hand and propose a solution with the cooperation of the JICA survey team.

As a result, it is important that this project progress in a positive direction.

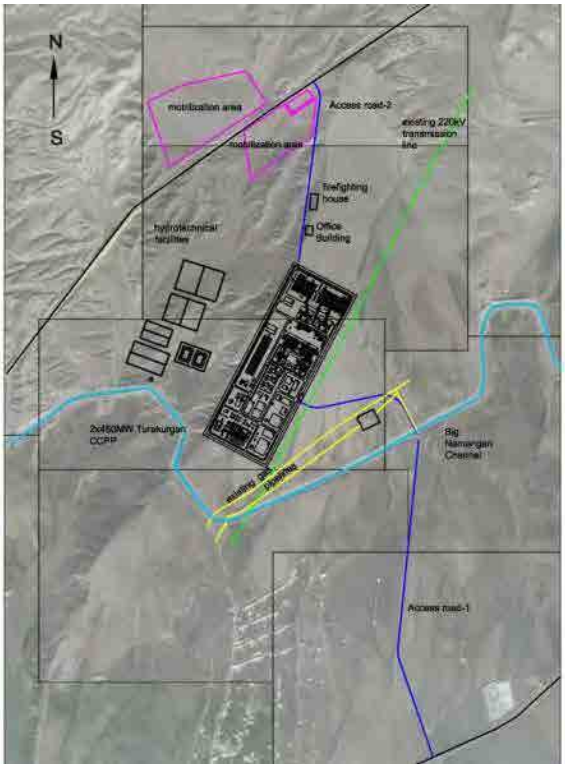
8.1 Project Summary

The overview of the project is summarized.

8.1.1 Summary of JICA-financed portion

(1) TKG TPS

TKG TPS construction plan relates to the construction of a TPS (900MW capacity) with high heat efficiency using natural gas for fuel in Turakurgan district. The main facilities include gas combined cycle generator units(450MW×2), a switch yard, a procumbent system for natural gas, a water treatment system, and a gas pipeline (500ｍ×1).



Source: The project proponent document

Figure 8.1.1-1 Proposed power station site

(2) Transmission line(220kV transmission line (approximately 20km×4 lines)) and Kyzyl Ravat substation

The four 220kV transmission lines with a length of approximately 20km will be installed from TKG TPS to connect the existing transmission line which is nearby the Sardor substation, located in northwest of Namangan region. These proposed transmission line routes pass through the Kasansay and Turakurgan districts and are charged with of 220 kV Crystal circuit – Sardor at Kyzyl Ravat substation in Uychi district of Namangan region (Figure 8.1.1-2).

The number of towers for the propsed transmision line route is shown in Table8.1.1-1.

The project includes a plan to expand the Kyzyl Ravat substation (approximately 1ha) (Figure 8.1.1-3).

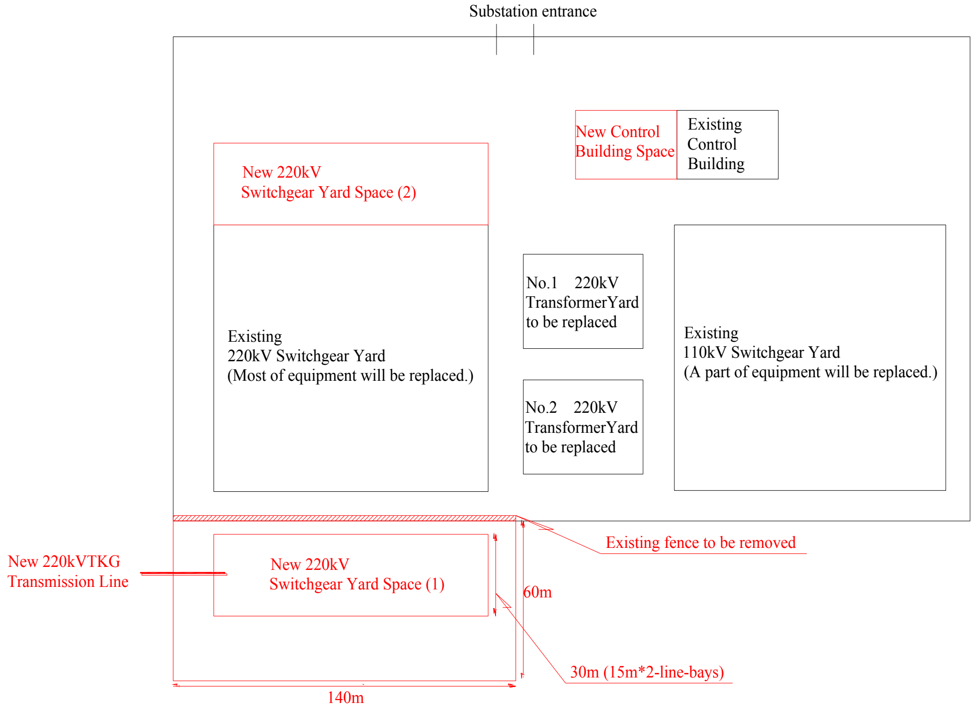
Source: The project proponent document

Figure 8.1.1-2 220kV transmission line (220kV transmission line (20km×4 lines))

Table 8.1.1-1 Number of tower about the proposed transmission line route

Name of Route	Total Length	Transmission Tower		Notes
		Total Number	Angle Tower	
TL 220 KV "Kyzyl Ravat" SS - "Sardor" SS on TKG TPS	15.1km	63	13	Kasansay district 7.3 km Turakurgan district 7.8 km
TL 220 KV "Crystal"SS - "Sardor" SS on TKG TPS	15.0km	63	13	Kasansay district 7.2 km Turakurgan district 7.8km
TL 220 kV "Crystal" SS - "Sardor" SS with TKG TPS	14.5km	57	12	Kasansay a district 7.0 km Turakurgan district 7.5km
TL 220 kV "Kyzyl-Rawat" SS - "Sardor" SS with TKG TPS	14.0 km	57	12	Kasansay a district6.5 km Turakurgan district 7.5km
TL 220 kV "Sardor-Crystal" on Kyzyl-Ravat	0.7 km	3	3	Uychi district

Source: The project proponent document



Location of Kyzyl Ravat SS

Source: The project proponent document

Figure 8.1.1-3Redeveloped Kyzyl Ravat SS

8.1.2 Summary of the Associated Facilities

There are some associated facilities, such as a potable water service pipe, a fire-fighting facility and the residential housing for staff.

These facilities are categorized as associated project described in the JICA Environmental Guidelines (2010 April). Therefore, The EIA reports about these facilities are reviewed by JICA survey Team.

Table 8.1.2-1 Summary of the associated facilities of the project

Facility	Status
Potable water pipe	1.The project relates to the construction of a new TPS, and construction of a potable water pipe is not necessary if the project does not exist. 2.Without the construction of the potable water pipe, the operation of the TPS as well as the feasibility of the project will be encumbered.
Fire-fighting facility	1.The project relates to the construction of a new TPS and construction of fire-fighting facility is not necessary if the project does not exist. 2.Without the construction of the management facility/ fire-fighting facility, the operation of the TPS is not possible, nor is the feasibility of the project.
Access roads	1.The project relates to the construction of a new TPS, and construction of access roads is not necessary if the project does not exist. 2.Without the construction of the access roads, the TPS operation of will be seriously encumbered, and the feasibility of the project will be lost.
Residential housing for power station staff	1.The project relates to the construction of a new TPS, and the construction of residential housing for power station staff is not necessary if the project does not exist. 2.Without the construction of the residential housing for power station staff, the well-being of the staff in charge of TPS operations cannot be, and the feasibility of the project will be seriously disturbed.

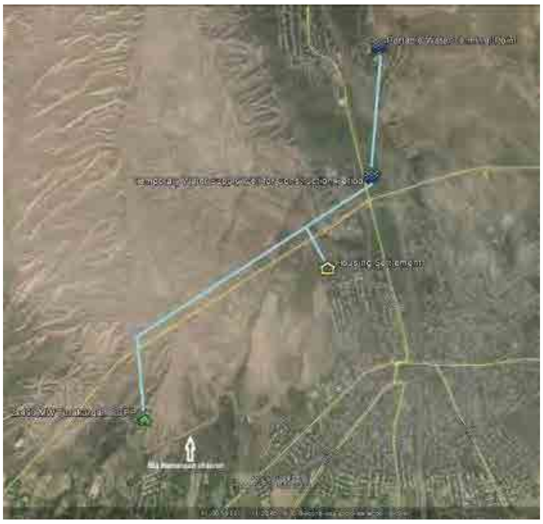
Outline of the associated facilities are as below.

(1) Potable water service pipe

Potable water will be supplied from the potable water intake point to the worker's camp and TPS through a pipeline. The amount of water used for this project is 160m^3 per day. Water is pumping from the existing artesian well at the rate of 160m^3/h (3,840 m^3/ day) per well. The artesian well has a depth of 130m according to the status of the aquifer in this area.

The pipeline is 100mm radius with a total length of 6,500m consisting of 2,700m and 3,800m long pipelines.

The pipeline will be installed mainly along the road and underground of the residential area (0.6-0.7m deep), avoiding the agricultural field.

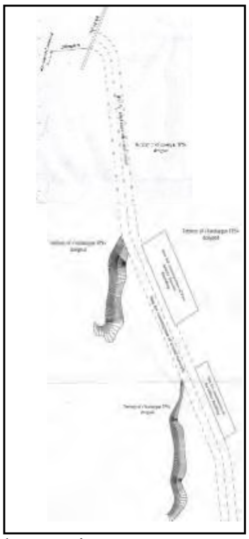


Source: The project proponent document

Figure 8.1.2-1 Water intake point and potable water pipeline

(2) Fire-fighting facility

The fire-fighting facility is a two-story building located to the north of the project site as shown in Figure 8-1.2-2. The building consists of a watching room, a conference room, etc. 45 staff (shift work: 15 staff at a time) will work in this facility.



Source: The project proponent document

Figure 8.1.2-2 Fire-fighting facility.

(3) Access roads

TPS site will be accessed from the surrounding road via two access roads which will be constructed to the north and south of the site. Land acquisition for the access road is included in the project land acquisition. The access roads will be 7m wide and 1km and 1.4km long respectively and paved with asphalt (Figure 8.1.1-1, portrayed as the blue line).

(4) Residential housing for power station staff

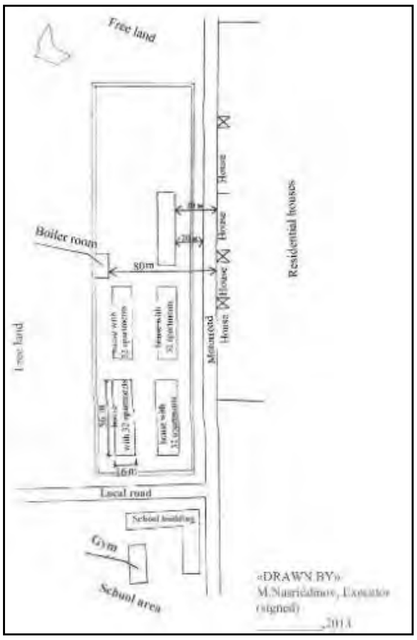
The residential housing for power station staff will be constructed in Sayram Rural Community in Turakurgan district , Bakht Makhalla 4km north-east of the project site

The houses will consist of 5 buildings of four-story (160 households, 320 people), each measuring 15m×56m and 3.3m height for each story, accommodating 32 households (each unit is equipped with a kitchen, a bathroom a rest room. 24 units consist of 2 rooms, 8 units consists of 3 rooms).

The houses will be constructed on the land of 2.0ha owned by Bakht Fayzli Tongi, an agricultural company based in Bakht Makhalla.

The housing land will consist of the residential housing (4,480m^2), road(3,200m^2), and the green space(12,320m^2)

The domestic wastewater of 5 buildings drains the sewer system of Turakurgan city through underground reinforced-concrete pipes.



Source: The project proponent document

Figure 8.1.2-3 Layout of the residential housing for the power station staff

8.2 Environmental and social status

The general outline of the environmental status of the project area based on an EIA report (Preliminary report of the environmental impact assessment of project) and the results of survey are described as follows.

8.2.1 Air quality

Table 8.2.1-1 is described air quality of Namangan region.

The governmental authority is measuring the air pollutant concentration in three locations (Nearby high ways, traffic road, and nearby residential area) in the Namangan region. The three locations are located about 10 km from the project site shown in Figure8.2.1-1.

The project proponent and the governmental authority have never measured the air pollutant concentration in the project site and the surrounding area.

There is no large emission source in the project site and the surrounding area, so it is assumed that air pollutant concentration in the project site is lower than the value measured in three locations.

In this study, air quality of the project site is considered as air quality of Namangan region in the viewpoint of safety assessment.

The nitrogen dioxide (NO_2) concentration is 0.03mg/m^3 at the average level, and 0.06mg/m^3 at the maximum level. These values are lower than the maximum permissible concentration (MPC).

The pollutant concentration is diluted with due to changes in atmospheric conditions, such as the wind direction, the concentration value over a long period of time, such as the average annual value, is lower than the value over shorter period of time, like a 24-hour value, 30-minute value or 10-minute value Likewise, the ambient air quality standard is also lower for the concentration value over longer period of time.

Compared to the 1-hour value regulated by IFC/WB EHS Guidelines shown in Table 8.2.1-1, the 1-hour value of IFC/WB EHS Guidelines is higher than the 30-minute value. Therefore, if 30-minute value of nitrogen dioxide (NO_2) concentration is complied, 1-hour value in the IFC/WB EHS Guidelines are met.

The sulfur dioxide (SO_2) concentration is 0.003 mg/m^3, which is well below the MPC. Moreover, this value also complies with the IFC/WB EHS Guideline.

Table 8.2.1-1Air quality in Namangan region in 2012

Unit: mg/m^3

Pollutant	Sampling location in Namangan	Current value			Uzbekistan Maximum permissible concentration(MPC)			IFC/WB EHS Guideline
		Average (30 min value)	MAX (30 min value)	Sampling number	30 min value	Dairy average	Working environment	
NO_2	Nearby High way	0.03	0.06	918	0.085	0.06	5.0	0.2(1hour) 0.04(1year)
	Nearby road	0.03	0.05	918				
	Nearby residential area	0.03	0.06	918				
SO_2	Nearby High way	0.003	0.006	918	0.5	0.20	10.0	0.5(10min) 0.125(24hours)
	Nearby road	0.003	0.006	918				
	Residential area	0.003	0.006	918				
CO	Nearby High way	1.5	4	918	5.0	4.0	20.0	-
	Nearby road	1.5	4	918				
	Nearby residential area	1.5	4	918				
Dust	Nearby High way	0.08	0.3	621	0.15	0.1	-	0.15(24hours) 0.07(1year)
	Nearby road	0.07	0.3	918				
	Nearby residential area	0.08	0.3	918				

Source: Review of air pollution and pollutants emissions in cities of Uzbekistan for 2013 (Hydrometeorology Center of the Cabinet of Ministry of Republic of Uzbekistan Monitoring agency of air, water surface and soil pollution)

Figure 8.2.1-1Measurement location

8.2.2 Water quality

Grand Channel Namangan (hereinafter referred to as GCN) is an artificial irrigation channel made of concrete. GCN is connected to the Kasansai River approximately 3km to the east from project site, and water flows in from the Kasansai River (Figure8.2.2-1, 2).

<GCN>

<Kasansai River>

Figure8.2.2-1 GCN and Kasansai River

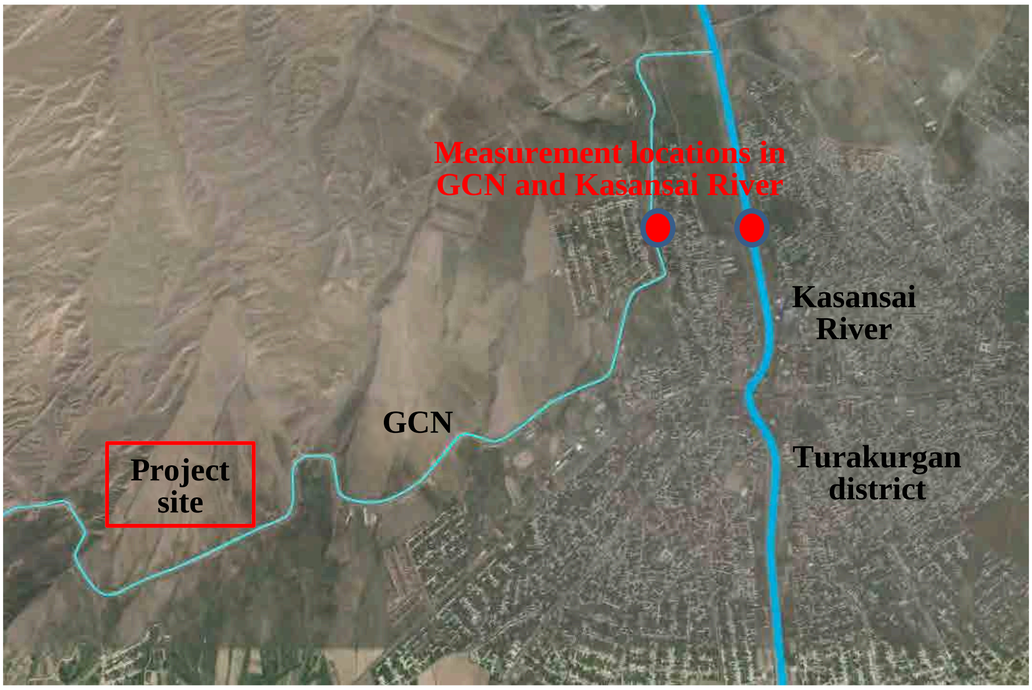


Figure8.2.2-2 GCN and Kasansai River

The chemical composition of water quality of GCN is formed by the natural composition from the Kasansai River.

These streams are subject to little human intervention, with the exception of the impact of agriculture and livestock activities.

Water quality of GCN by chemical analysis in 2013 is shown in Table8.2.2-1 and the measurement locations are shown in Figure8.2.2-2.

According to the survey results, the values of Oil and Grease, Ammonium, sulfate, copper are high compared to the maximum permissible concentration (MPC).

According to the project proponent answer, the above- mentioned higher value is the property of the water quality of this region.

Table 8.2.2-1 Comparison of water quality in GCN and the environmental standard

Item	Unit	Current value		Maximum permissible concentration (MPC)
		March to September 2013*	22 May 2014	
pH	-	8	8	6.5-8.5
DO	mg/L	13.8	10.5	Summer: more than 4.0 Winter: more than 6.0
BOD	mg/L	N/A	1.7	3
SS	mg/L	0.19	5.0	30
Oil and Grease	mg/L	N/A	0.28	0.05
Ammonium	mg/L	1.52	1.51	0.08
nitrites	mg/L	0.05	0.035	0.08
nitrates	mg/L	3.1	1.77	40
sulfates	mg/L	144	134	100
phenol	mg/L	N/A	0.00	0.01
chloride	mg/L	40	20	300
calcium	mg/L	3.2	3.0	180
sodium	mg/L	47.3	16.2	120
potassium	mg/L	47.3		50
phosphate	mg/L	N/A	0.00	0.01
Fe	mg/L	0.3	0.04	0.5
Cu	mg/L	0.017	0.01	0.001
Zn	mg/L	N/A	0.00	0.01
Cr	mg/L	N/A	0.00	0.5
Pb	mg/L	N/A	0.00	0.03
Cd	mg/L	－	0.00	0.001
Hg	mg/L	－	0.000**	0.0005
As	mg/L	－	0.00**	0.005
Mg	mg/L	－	1.7**	－

Source: EIA report and the project proponent document

*The project proponent measured water quality at 1km upstream from the project site.
Each value in the table is the maximum value measured from March to September 2013.
**The results that supplemental analysis was conducted by the project proponent are described.

8.2.3 Noise and vibration

(1) Noise

Noise measurements were conducted from 13 March to 14 March 2014 on the project site and at the closest residential area shown in Figure8.2.3-1.

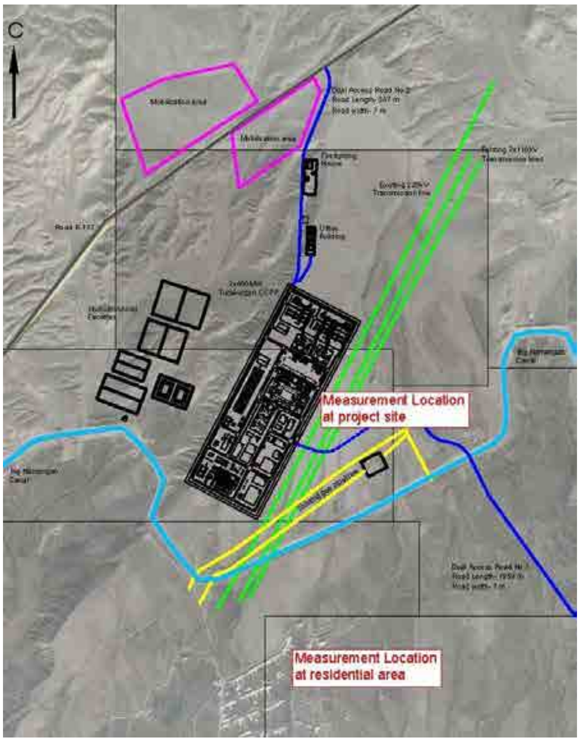


Figure8.2.3-1 Measurement location

Noise levels in the closest residential area, located approximately 1km away, (The edge of the existing residential settlement) from the project site is 38 - 52dB, which satisfies the Uzbekistan environmental standard and IFC/WB EHS Guidelines.

Table 8.2.3-1 Noise level in the project site and the nearest residential area

Unit: dB

Item		OA	31.5Hz	63 Hz	125 Hz	25 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Within the boundaries of the station											
Time zone	8-9	44	41	38	35	34	32	28	26	24	23
	13-14	46	43	39	36	35	33	31	30	26	24
	18-19	41	37	35	32	30	28	27	26	22	21
	1-2	40	35	33	32	31	29	28	26	24	22
1 km from the construction zone a residential village											
Time zone	9-10	52	48	45	43	41	40	38	36	32	30
	14-15	50	46	44	43	40	38	36	34	31	28
	19-20	41	36	33	32	31	30	28	26	24	22
	2-3	38	34	32	30	28	26	25	23	22	20

Source: The project proponent document

Note: Uzbekistan environmental standard and IFC/WB EHS Guidelines

Unit: dB

Item	Ecological standard of the Republic of Uzbekistan		International standards IFC/WBEHS Guidelines (2007)	
	Daytime 7-23	Nighttime 23-7	Daytime	Nighttime
1 km from the construction zone a residential village	55	45	55	45
Within the boundaries of the station	55	45	55	45

Source: EIA report

(2) Vibration

Since there is no facility caused by vibration in the project site and the surrounding area, the survey of vibration around the project site has not been conducted.

8.2.4 Natural environment

(1) Geography and geology

The project site is located in the northeastern part of the Fergana Valley, at the foot of the southern slope of the Chatkalsk ridge. The Fergana Valley surrounded on the north, east and south by mountains, and the Fergana Valley has a length of 370 km and a width of 200 km.

The project site is located on the sloping plain, and has slightly hilly areas. Vertical elevation between the northern and southern areas is 35-89 m.

The project site is located on the alluvial fan of the river, so the alluvial deposit consists of coarse-grained soils with more than 50 m from the surface. Surface layers of from 0.2 to 2.2 m overlain the deposit layer by fine-grained, sandy-loam.

(2) Analysis of earthquake

According to Republic of Uzbekistan KMK 2.01.03-96 "Construction in seismic regions", the project site is categorized as 8 scale of intensity on the Richter scale.

Table 8.2.4-1 Seismic Intensity of Namangan region

Region	Seismic Intensity		
	7	8	9
Namangan	50	100	-

Source: EIA report

(3) Meteorology

The project site is located in the Fergana Valley. Due to the geological formation of the valley, the climate is different from the climate of the surrounding areas. Air mass including moisture and coldness is carried by the higher mountains of Tien Shan and Pamir-Alai surrounding the Fergana Valley.

(g) Ambient temperature and precipitation

It is especially evident the periodic change in the daily wind directions. In addition, precipitation is falling in the foothills and mountains of western Tien-Shan.

Atmospheric circulation is created by the geological formation that caused the development of mountain-valley.

The annual average temperature in Namangan is 15.2 ºC, with the lowest temperature being -15.8ºC in December, and the highest temperature being 42.5ºC in June, according to data obtained from 2003 to 2012.

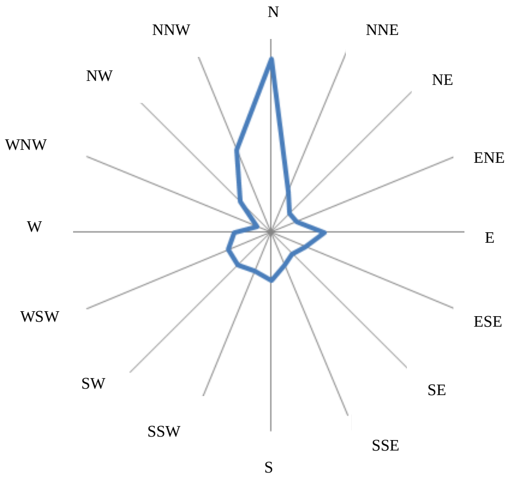
There is rainfall in the Fergana valley throughout the year, the average annual precipitation is 207.32 mm, and torrential rainfalls occur from May to September.

In the summer season, the frequency of heavy rainfall increases to 63-72% compared to other seasons. It often snows in the winter season, with 1-10 cm of snowfall.

(h) Wind direction/wind speed

As shown in Figure 8.2.4-1, the wind direction around the project site is mainly northern wind (21.8%) and the north-north-west (11.15%).

The average wind speed is 2.0m/s. As frequency by wind speed range, 2-3m/s is 59.5%, 0-1m/s is 33.6%, in addition exceeding 8m/s is rare (0.04%).



Source: EIA report

Figure 8.2.4-1 Wind rose

(4) Hydrology

GCN is artificial irrigation channel (made of concrete). GCN is connected to theKasansai River approximately 3km to the east, and water flows in from the Kasansai River.

A water reservoir (Kasan-sai reservoir (the territory of Uzbekistan); Figure 8.2.4-2) in the Kasansai River is located 40km upstream from the GCN connection point.

This reservoir is controlled by Norin Syrdarya Irrigation system basin Management Company, which is a subsidiary of Ministry of Agriculture and Irrigation.

Administrative organization has decided that water for the project is supplied from this reservoir

Flow condition about Kasansai River and GCN is shown in Table8.2.4-2.

The measurement locations are shown in Figure8.2.2-1, 2.

Since network of irrigation channel is construed in this area, GCN is flowed in water of Kasansai River, Naryn River, and other irrigation channels.

EIA report states that the monthly average of maximum water temperature of GCN is 15 ºC. However, according to survey result by JICA survey team, water temperature of GCN ranges 10 ºC to 30 ºC and yearly average temperature is 15 ºC.

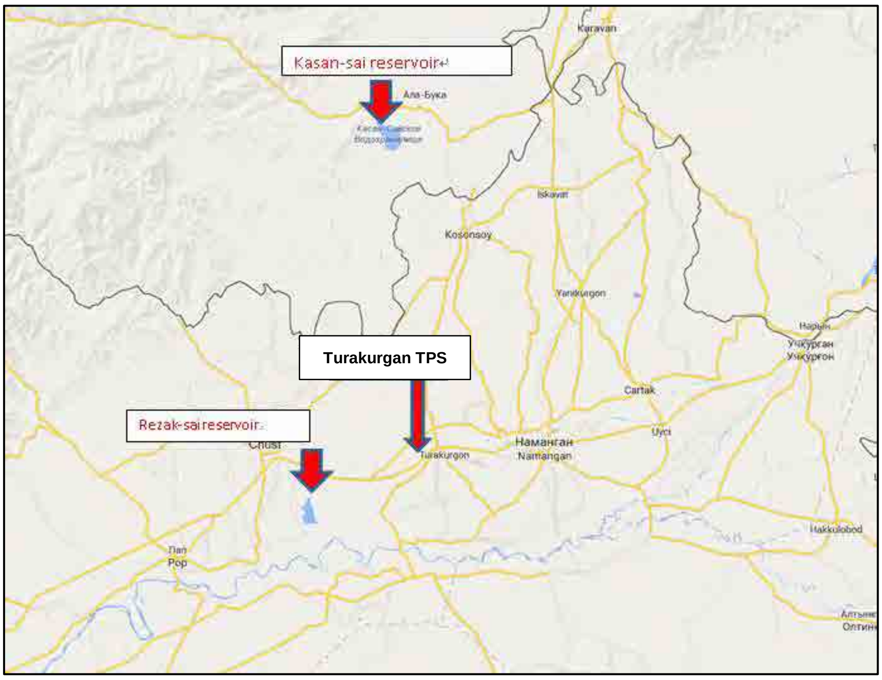


Figure 8.2.4-2 The location of the reservoir

Table8.2.4-2Current Status of Kasansai River and GCN

Item	Kasansai River	GCN
Current Volume		
Average water volume	N/A	6.62 m^3/s
Maximum water volume	300 m^3/s	10.1 m^3/s
Minimum water volume	0.5-1.0 m^3/s	3.15 m^3/s
Current speed		
Average current speed	2.5 m/s	0.5 m/s
Maximum current speed	5.0 m/s	0.6 m/s
Minimum current speed	1.0 m/s	0.4 m/s

Source: The project proponent document

(5) Flora and Fauna

The project proponent conducted the survey about flora and fauna in 2013. The survey results for the flora and fauna was collected based on the interview from local inhabitants and the official survey results from the Namangan environmental service.

The survey results from the Namangan environmental service was also composed based on interviews from local inhabitants and visual observations.

The results are is as follows.

(a) Flora

The project site does not contain any natural forests and protected zones, and the project site and surrounding area are composed of cultivated land, pastureland, and unusable land.

Ephemerid-ephemeral desert, Herbaceous species sedge, Bonfires, Malcolm, trigonelly, astragalus, prickly grasses, cousin canal thorn(yantak), azhreka, Mamyk and semi-dry thistle have been observed and identified in the Namangan region.

Precious species designated by IUCN (International Union for Conservation of Nature and Natural Resources) and Uzbekistan Red Data Book have not been observed in the project site.

(b) Fauna

Terrestrial animals and aquatic organisms are shown in Table8.2.4-3

The Central Asian tortoise, categorized as a vulnerable species (VU) by IUCN list and Uzbekistan Red Data Book, inhabits the Namangan region.

However, the Central Asian tortoise dwells in the clay and sandy areas southwest 50km away from the project site in Namangan region. A Land characteristic of the project site is composed of gravel and rocky structures. Therefore, Central Asian tortoise cannot inhabit this this area.

Also, some amphibians, reptiles, birds and mammals categorized as a Least Concern (LC) by the IUCN list and Uzbekistan Red Data Book inhabit the Namangan region.

However, precious species designated by IUCN list and Uzbekistan Red Data Book have not been observed on the project site.

Regarding aquatic organisms, since the GCN is an artificial irrigation channel, the habitat environment of GCN for aquatic organisms is poor. Moreover, the a small number of Mariinka, belonging to the Schizathorax genus, inhabit the water,, but the number of aquatic organisms is small.

Table8.2.4-3 Fauna List

No	Local name	Scientific name	Red Book of Uzbekistan	IUCN
Fish species occurring in the river piece Kasansay and GCN				
1	Turkestan cheschuychataya fish	Gobio gobio Kessler	LC	–
2	Black fish (Mariinsky Theatre)	Schizothorax intermedius	LC	–
3	Red fin	Scardinius erythrophatalmus	LC	–
4	Mariinka	Schizothorax	LC	–
Amphibia				
1	Marsh Frog	Rana ridibunda	LC	LC
2	Green Frog	Bufo viridis	LC	LC
Reptiles (Sudralib yuruvchilar)				
1	Bullet snake (yk Ilon)	Psammophis lineolatus	LC	–
2	water snake	Natrix tessellate	LC	LC
3	Kaltakesak	Eremais velox	LC	–
4	Racerunner (Cnemidophorus),	Trapelus sanguinolentus	LC	–
5	Central Asian tortoise	Testudo (Agrionemys) horsfieldii	VU	VU
Birds				
1	Dove	Columba livia	LC	LC
2	Sufiturgay	Galerida cristata	LC	LC
3	Sassik popishak	Upada epops	LC	–
4	Olakanot kizilishton	Dendrocopos leucopterus	LC	LC
5	Kaldirgoch	Hirundo daurica	LC	LC
6	Zargaldok	Oriolus oriolus	LC	LC
7	Chugurchuk	Sturnus vulgaris	LC	LC
8	Mynah	Acridotheres tristis	LC	LC
9	Gung hag	Corvus frugilegus	LC	LC
10	Bark hag	Corvus corone	LC	LC
11	Chumchuk	Passer domesticus	LC	LC
12	Mucić	Streptopelia senegalensis	LC	LC
13	Zagizgon	Pica pica	LC	LC
14	Barn Swallow	Hirundo rustica	LC	LC
15	Red-rumped Swallow	Hirundo daurica, Cecropis daurica	LC	LC
16	Black swift	Apus apus	LC	–
17	Magpie	Acridotheres tristis	LC	LC
Mammals				
1	Tub hedgehog	Hemiechinus auritus	LC	LC
2	Small netopir	Pipistrellus pipistrellus	LC	–
3	Kum tovushkoni	Lepus capensis	–	–
4	Kichi kushoek	Allactaga elater	LC	LC
5	Hare	Jepus	LC	–
6	Fox	Vulpes vulpes	LC	LC
7	Wolf	Canus lupus	LC	–
8	Mouse	Apodemus agrarius	LC	–
9	Mole voles	Ellobius talpinus	LC	–
10	Pipistrelle	Pipistrellus	LC	LC
11	Tamarisk gerbils	Meriones tamariscinus Pallas	LC	–
12	Big-eared hedgehog	Hemiechinus auritus	LC	–
13	Hare	Lepus tolai	LC	–
14	Central Asian fox	Vulpes vulpes	LC	–

Source: The project proponent document and EIA report

8.2.5 Social environment

(1) Land use

The project site is located 4km west of the Turakurgan district and 11km west of Namangan City.

The site area is approximately 77.6ha. The project site is composed of cultivated land, pastureland, and unusable land.

There are the existing gas pipelines, 220kV transmission lines, and an artificial irrigation channel nearby the project site. Moreover, Route117 is located 1km north of the project site , and Route112 is located 2km south . The nearest residential area is located approximately 1km south of the project site.

(2) Socioeconomic conditions

Fergana Valley is an important area of Uzbekistan. This area occupies 4.3% of the country's land. However, 27.2% of Uzbekistan population lives in this area.

In this area, there are various companies such as chemical, textile, automobile, petroleum, and agricultural fertilizer companies, etc., , and these companies have their own various networks.

Electricity demand in this area is increasing. Additionally, an in important issue is the guarantee of electricity supply and demand balance. The objective of this project is to fulfill aforementioned mission.

The project site for TKG TPS is located in Holmatov KFY (Community name) of Turakurgan district. Outline of socioeconomic conditions of this area is shown in the Table 8.2.5-1(1).

The proposed four 220kV transmission line routes will be installed from TKG TPS to the connection point nearby the Sardor substation.These routes pass through the Kasansay and Turakurgan districts and Uychi district located Kyzyl Ravat substation in Namangan region.

Outline of socioeconomic conditions of this area is also shown in the Table 8.2.5-1(2).

Figure 8.2.5-1(1) Outline of social condition

Item		Administrative region (Holmatov KFY (village Schohidon Nurly Dyer))	Turakurgan District
A. Population & demography			
1	Population	26,390	199,450
2	Population density	N/A	717
3	Age group		
	0 – 16	N/A	65,408
	16 – 60	N/A	114,041
	60 –	N/A	18,995
4	Sex		
	Male	13,165	100,283
	Female	13,225	99,167
5	Religion	Muslims	Muslims
6	Ethnic group	99% uzbek.1% other	99% of the Uzbek. 1% other
7	Birth rate	21.8per thousand	22.2per thousand
8	Mortality rate	4.2per thousand	4.2per thousand
B. Industry			
1	Value of production by industry	N/A	N/A
2	Number of employees by industry (Occupation)	54 (Category of business)	3,455(Category of business)
C. Infrastructure			
1	Current situation of Water supply	61.5%	67.2%
2	Electricity	100%	100%
3	Gas supply	72.3%	73.5%
4	public transport service	Private transport	Private transport
5	Number of medical service	4 rural health units(clinic)	1 hospital, 23 rural health units(clinic)
6	Fire and enforcement services	8 police boxs	3 fire stations, 1 police station, 72police boxs
D. Sanitation			
1	Hygiene and sanitation condition,	Good	Well, meet SanPin № 0246-08
2	Public health care	100%	100%
3	Nutrition	100%	100%
4	Sewerage or other sanitary waste Disposal system	N/A	Central swage system
E. Education			
1	Number of schools	10	69
2	Literacy Rate（Education level）	100%	100%

Note: Definition of Public Health Care; It is possible for local residents to use public medical care by the local system of State Medical Institution.
Definition of Nutrition; It is possible for local residents (population) to consume the sufficient quantities of food of appropriate quality supplied through domestic production or imports.

Source: The project proponent document and EIA report

Figure 8.2.5-1(2) Outline of social condition

Item		Kasansay district	Uychi district	Namangan region
A. Population & demography				
1	Population	185,169	207,944	2,512,557
2	Population density	375	671	338
3	Age group			
	0 – 16	N/A	N/A	790,107
	16 – 60	N/A	N/A	1,540,833
	60 –	N/A	N/A	127,797
4	Sex			
	Male	94061	104165	1,270,304
	Female	91108	104165	1,242,253
5	Religion	Muslims	Muslims	Muslims
6	Ethnic group	41% uzbek.59% other	97% uzbek.3% other	88% uzbek.12% other
7	Birth rate	18.2 per thousand	20.3 per thousand	18.8 per thousand
8	Mortality rate	5.0 per thousand	4.8 per thousand	4.6 per thousand
B. Industry				
1	Value of production by industry	N/A	N/A	823,367 Million SUM
2	Number of employees by industry (Occupation)	3,298	3,728	43,273
C. Infrastructure				
1	Current situation of Water supply	81.9%	65.1%	77.0%
2	Electricity	100%	100%	100%
3	Gas supply	96.5%	90.1%	83.8%
4	public transport service	Private transport	Private transport	Private transport
5	Number of medical service	1 hospitals, 23 rural health units(clinic)	3 hospitals, 20 rural health units(clinic)	536hospitals,244 rural health units(clinic)
6	Fire and enforcement services	N/A	N/A	N/A
D. Sanitation				
1	Hygiene and sanitation condition,	N/A	N/A	N/A
2	Public health care	N/A	N/A	N/A
3	Nutrition	N/A	N/A	N/A
4	Sewerage or other sanitary waste Disposal system	N/A	N/A	N/A
E. Education				
1	Number of schools	55	48	690
2	Education level	100%	100%	100%
3	Literacy Rate	100%	100%	100%

Source: The project proponent document and EIA report

8.3 Environmental Impact Assessment and other legal systems

8.3.1 Environmental Administration and related legal systems*

(1) Environmental Administration

(a) Administrative boundary

The following governmental agencies play primary a role regarding the Environmental Administration in the Republic of Uzbekistan.

- The President: Act as a decision maker of major environmental issues and also as a leader to promote international cooperation on environmental conservation.
- The Diet: Clarifying environmental conservation policies, making decisions in the Diet, acting as a liaison with the State Nature Conservancy council, establishing sanctuary and disaster area, developing legal systems.
- The Cabinet: Implementing environmental conservation policy, making decisions and supervising operations on environmental conservation plans, and allocating natural resources.

(b) Implementing Agencies

Based on the above role-sharing, the implementing body actually managing environmental issues is the State Committee for Nature Protection "Goskomprirody", which was established in 1989 in the Cabinet office and reports to the Diet. Furthermore, regarding local organization of the State Committee for Nature Protection, the local Committee for Nature Protection exists in each province and in major cities. State and local Committee for Nature Protection implements and manages environmental conservation.

The primary responsibilities held by the State Committee for Nature Protection are as follows.

- Legal surveillance regarding environmental conservation
- Promotion on environmental conservation plan
- Guidance on environmental tests implemented by the state
- Approval of environmental standards
- Issue and nullification of license for emission/storage of pollutant and industrial waste
- Implementation of environmental measurement
- System for international cooperation on environmental issues

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* Republic of Uzbekistan Preparatory Survey on Tashkent Heat Supply Power Plant Modernization Project Final Report,2009

Other than the State Committee for Nature Protection environmental management is conducted by Ministry of Health, Ministry of Agricultural Water Utilization under the scope of each jurisdiction respectively. Also, State Land Use Committee, State Forestry Committee, Uzbek Hydro meteorological Institution "Uzgidromet"are obliged to conduct environmental conservation. Monitoring on air /water quality in the general environment is actually measured by Uzbek Hydro meteorological Institution "Uzgidromet" under State Nature Conservatory Committee.

(2) System of legal restriction on the environment

Laws regarding nature conservation, utilization of natural resources, environmental conservation are composed of act, presidential decree, legislative decree, and enactment. The legal system regarding environmental conservation is composed not only from the aspect of pollution abatement, but also from the aspects of laws regarding ecological conservation of land, water, wildlife and plants.

Followings are the Basic Laws and the established years.

- The Law of the Republic of Uzbekistan "On Nature Protection" (9 December 1992 ref, 754-XII)
- The Law of the Republic of Uzbekistan "On Water and Water Use" (6 May 1993, ref. 837-XII)
- The Law of the Republic of Uzbekistan "On Ambient Air Protection" (27 December 1996, ref. 353-I)
- The Law of the Republic of Uzbekistan "On Fauna Use and Protection" (26 December 1997, ref. 545-I)
- The Law of the Republic of Uzbekistan "On Flora Use and Protection" (26 December 1997, ref. 543-I)
- Land Code of the Republic of Uzbekistan (30 April 1998, ref. 599-I)
- The Law of the Republic of Uzbekistan "On Forest" (15 April 1999, ref. 770-I)
- The Law of the Republic of Uzbekistan "On Protection of Population and Areas from Emergency Conditions of Natural and Technogenic Character" (20 August 1999, ref. 824-I)
- The Law of the Republic of Uzbekistan "On Environmental Audit" (25 May 2000, ref. 73-II)
- The Law of the Republic of Uzbekistan "On Radiation Safety" (31 August 2000, ref. 120-II)
- he Law of the Republic of Uzbekistan "On Protection of Agricultural Plants from

Pests, Diseases and Agrestals" (31 August 2000, ref. 116-II)

- The Law of the Republic of Uzbekistan "On Solid Waste Disposal" (5 April 2002, ref. 362-II)
- The Law of the Republic of Uzbekistan "On Subsoil" (new edition), (13 December 2002, ref. 444-II)
- The Law of the Republic of Uzbekistan "On Preserved Natural Territories" (3 December 2004, ref. 710-II)

The above are basic laws, and there are a number of decrees and regulations which deal with specific restrictions.

8.3.2 The EIA in Uzbekistan

(1) The procedure for EIA

In Uzbekistan, the implementation of business activities having a potential environmental and human impact such as a power station project and Environmental impact assessment (EIA) should be implemented according to the Law on Nature Preservation (enacted in December 9, 1992).

Regarding the specific procedures, according to the Resolution of the Cabinet of Ministers no. 491 on Adoption of the Environment Impact Assessment Regulations in the Republic of Uzbekistan (enacted December 31, 2001, hereinafter referred to as “Regulations No.491).

The activity is classified into four categories (category I to IV) according to the degree of potential impact.

TPS with generation capacity of 300MW or higher is classified to category I, 100MW to 300MW into category II, and smaller than 100MW as category III, according to “Regulations No.491)

For business activities in categories I to III, submission of a detailed Environmental impact assessment (EIA) is required according to “Regulations No.491”, Environmental Impact Assessment should be submitted to the State Committee for Nature Protection for approval prior to the business activity having potential environmental and human impact.

In case of transmission line project, If transmission lines traversing several districts is planned or if transmission lines traverse protected/vulnerable areas, the project proponent must prepare an EIA report and submit it to the State Committee for Nature Protection for approval prior to project commencement.

Outline about difference of EIA procedure by Category is shown in Table 8.3.2-1.

Table 8.3.2-1 Difference of EIA procedure

Item	Category I	Category II	Category III	Category IV
Preparation of predesign and design documentation	EIA report	EIA report	EIA report	Statement of environmental impact
Examining Authority	State Committee	State Committee	State Committee	Regional authority
Fee for request for examination of application	Minimal 70 people salaries	Minimal 50 people salaries	Minimal 25 people salaries	Minimal 3 people salaries
Period of environmental examination	30 days (Compositive projects: no more than 2 month)	30 days (Compositive projects: no more than 2 month)	20 days	10 days

(2) Implementation of EIA report

As determined in Section 10 of the Regulations No.491, 3 steps of EIA procedure is as follows: the preliminary assessment in the planning phase, the review of the assessment, and the establishment of the final environmental standard prior to the start of the facility operation.

【Planning phase】

i. Preparation of the draft EIA report

The draft EIA report should be prepared in the planning phase of the project and submitted to the State Committee for Nature Protection.

ii. Reflection of the EIA review

Following the review of the draft EIA, additional survey, on-site investigation, special analysis, or model simulation is conducted as necessary to determine the appropriate environmental protection measures before being reviewed by the State Committee for Nature Protection for approval.

The draft environmental impact assessment report shall be reviewed within 30 days from the day of submission.

As for this project, the draft EIA report was approved by the State Committee for Nature Protection on 10 July 2013.

【Pre-operation phase】

Statement of Environmental Consequences (Final EIA report) should be prepared and submitted the State Committee for Nature Protection prior to the commercial operation of the project facility.

The project proponent should acquire the appraisal (letter of positive conclusion) from the State Committee for Nature Protection through the review of parameter collected during commissioning operation period.

This procedure is almost the same as the procedure for application approval during the pre-operation phase in Japan.

(3) Public consultation

In Uzbekistan, a public meeting within the scope of EIA procedure is not specifically regulated in the Regulations No.491

The Regulations No.491 Chapter 11 specifies that the results of the public consultations shall be described as necessary in the EIA report.

Consequently, for the power generation project in Uzbekistan, a public meeting is generally held by the power generation company as part of the environmental impact assessment in case of the project being located in an urban area such as Tashkent.

The meeting is planned and conducted by the project proponent. The procedure consists of five steps:

Step 1, Notifying people involved of the meeting

Step 2, The preparation of the abstract of the EIA, distribution to the people involved, and the EIA report being made available to public inspection;

Step 3, Holding the meeting with local residents;

Step 4, Collection and analysis of the opinions of local residents through a questionnaire; and

Step 5, Reporting the results of the meeting to relevant organizations.

The meeting schedule should be widely notified using newspaper, TV and relevant websites and so on.

The EIA abstract is made in Uzbek and Russian and is distributed to the relevant people. It is made available to the public within the power station and the local community. The EIA explanation meeting is an opportunity of direct session with local residents and should be open to as many local residents as possible.

The meeting should consist of a general explanation of the project, including the advantages of having a new facility, potential environmental impacts from the project proponent, and a Q&A session. Afterwards, a questionnaire is distributed to collect the views of the local residents and ensure their understanding of the project's concept.

The result of the meetings is reported to relevant organizations through the summary report of the meetings published by the project proponent, and is publicized through the mass media.

The summary report is described the responses of questions from local residents by the project proponent. If local residents have any complains, they have any chances to claim to relevant organizations. Arrangement of between local residents and project proponent will be conducted by relevant organizations.

The opinions received from the local residents will be reflected in the final Statement of Environmental Consequences as described above.

8.3.3 The gap with JICA Environmental Guidelines (April 2010)

The content of the Statement of Environmental Consequences is stipulated in Chapter 11 of the Environmental Impact Assessment Regulations No.491 (the Resolution of the Cabinet of Ministers no. 491 (enacted December 31, 2001)).

The procedure in regards to EIA in Uzbekistan is very simple: it can be compared to the content of the EIA report for this project (including the actual description) with the requirements of the World Bank OP 4.01 Annex B and JICA Guideline on Environmental and Social Consideration (Table 8.3.3-1).

It is required to prepare for an abbreviated RAP, an environmental management plan and a monitoring plan for both the construction and operation phase.

Table 8.3.3-1 Comparison between JICA Guideline, World Bank (OP 4.01) and the EIA content in this project

Content	JICA Guideline on Environmental and Social Consideration	World Bank (OP4.01, Annex B)	The Environmental Impact Assessment Regulations (the Resolution of the Cabinet of Ministers no. 491 (enacted December 31, 2001))	Contents of the EIA in this project	Gap between JICA Guideline and the EIA	Correspondence of this Survey Mission
Executive Summary	This concisely discusses significant findings and recommended actions.	Concisely discusses significant findings and recommended actions.	No regulations.	Description of Chapter 9. The ecological control list; The important results and outline of the activities are described in accordance with Check-list by JICA environmental guidelines a conclusion.	There is no gap.	
Policy, legal, and administrative framework	This is the framework within which the EIA report is to be carried out.	Discusses the policy, legal, and administrative framework within which the EA is carried out. Explains the environmental requirements of any co-financiers. Identifies relevant international environmental agreements to which the country is a party.	No regulations.	Description of the purpose of the preparation of the EIA report as introduction.	There is no gap.	

Content	JICA Guideline on Environmental and Social Consideration	World Bank (OP4.01, Annex B)	The Environmental Impact Assessment Regulations (the Resolution of the Cabinet of Ministers no. 491 (enacted December 31, 2001))	Contents of the EIA in this project	Gap between JICA Guideline and the EIA	Correspondence of this Survey Mission
Project Description	This describes the proposed project and its geographic, ecological, social and temporal context, including any off-site investments that may be required (e.g. dedicated pipelines, access roads, power stations, water supply, housing, or raw material and product storage facilities). It also indicates the need for any resettlement or social development plan. It normally includes a map showing the project site and the area affected by the project.	Concisely describes the proposed project and its geographic, ecological, social, and temporal context, including any offsite investments that may be required (e.g., dedicated pipelines, access roads, power stations, water supply, housing, and raw material and product storage facilities).Indicates the need for any resettlement plan or indigenous peoples development plan. Normally includes a map showing the project site and the project's area of influence.	-Equipment, materials and resources, technology used. Analysis of the fuel for environmental assessment. -The current status of the residential area, farmland, transmission line, life infrastructure.		There is a gap _ No description of the proposed project included for auxiliary projects	Confirmation of the proposed project included for auxiliary projects. Confirmation of scope of EIA regarding any projects
				Description of Chapter 10.Resettlement Plan (Remarks) The Project "Construction of New TPS with Total Capacity of 900MW Consisting oh Two 450MW CCGT units in Turakurgan District, Namangan Province" Land Allocation and Resettlement Action Plan ("220kV Transmission Lines 4x20km" is included)	_ No description of Land acquisition/resettlement regarding auxiliary projects.	Monitoring of compensation progress.. Review of Land acquisition and resettlement plan and Survey of involuntary resettlement status
Baseline Data	This assesses the dimensions of the study area and describes relevant physical, biological, and socio-economic	Assesses the dimensions of the study area and describes relevant physical, biological, and socioeconomic	-Environmental analysis of the environmental status, population, land development before the	Description of Chapter 1.Ecological Condition.	There is no gap.	

Content	JICA Guideline on Environmental and Social Consideration	World Bank (OP4.01, Annex B)	The Environmental Impact Assessment Regulations (the Resolution of the Cabinet of Ministers no. 491 (enacted December 31, 2001))	Contents of the EIA in this project	Gap between JICA Guideline and the EIA	Correspondence of this Survey Mission
	conditions, including all changes anticipated to occur before the project commences. Additionally, it takes into account current and proposed development activities within the project area but not directly connected to the project. Data should be relevant to decisions about project site, design, operation, or mitigation measures, and it is necessary to indicate the accuracy, reliability, and sources of the data.	conditions, including any changes anticipated before the project commences. Also takes into account current and proposed development activities within the project area but not directly connected to the project. Data should be relevant to decisions about project location, design, operation, or mitigatory measures. The section indicates the accuracy, reliability, and sources of the data.	Project installation.			
Environmental Impacts	This predicts and assesses the project's likely positive and negative impacts in quantitative terms, to the extent possible. It identifies mitigation measures and any negative environmental impacts that cannot be mitigated, and explores opportunities for environmental enhancement. It identifies and estimates the extent and quality of available data, essential data gaps and uncertainties associated with predictions, and it specifies topics that do not require	Predicts and assesses the project's likely positive and negative impacts, in quantitative terms to the extent possible. Identifies mitigation measures and any residual negative impacts that cannot be mitigated. Explores opportunities for environmental enhancement. Identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions, and specifies topics that do not require further attention.	-Technical countermeasures to mitigate and prevent negative environmental impact. -Situation analysis of negative impact in the emergency case, assessment of preventive measures. -Prediction of environmental change after project installation.	Description of _ Chapter 1.Ecological Condition _ Chapter 2. The environmental impact assessment and other legal system _ Chapter 3. Results of preliminary review _ Chapter 6. Plan of measures taken for environmental protection	There is a gap. No description about EIA in construction phase	Consideration of EIA in construction /operation phase, if necessary

Content	JICA Guideline on Environmental and Social Consideration	World Bank (OP4.01, Annex B)	The Environmental Impact Assessment Regulations (the Resolution of the Cabinet of Ministers no. 491 (enacted December 31, 2001))	Contents of the EIA in this project	Gap between JICA Guideline and the EIA	Correspondence of this Survey Mission
	further attention.					
Analysis of Alternatives	This systematically compares feasible alternatives to the proposed project site, technology, design, and operation including the “without project” situation in terms of the following: the potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. For each of the alternatives, it quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. It also states the basis for selecting the particular proposed project design, and offers justification for recommended emission levels and approaches to pollution prevention and abatement.	Systematically compares feasible alternatives to the proposed project site, technology, design, and operation--including the "without project" situation--in terms of their potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. For each of the alternatives, quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. States the basis for selecting the particular project design proposed and justifies recommended emission levels and approaches to pollution prevention and abatement.	The analysis of the alternatives for the project plan and technical decisions regarding natural protection, in view of the latest technologies.	Description of Chapter 5. Comparison of alternative, including the “Zero” option	There is a gap. No description about alternatives to the project site	Confirmation of details
Environmental Management Plan	This describes mitigation, monitoring, and institutional measures to be taken during construction and operation in	Covers mitigation measures, monitoring, and institutional strengthening; see outline in OP 4.01, Annex C.	The construction plan including the environmental impact of the equipment,	Description of _ Chapter 6. Plan of measures taken for environmental	There is no gap.	Confirmation of details

Content	JICA Guideline on Environmental and Social Consideration	World Bank (OP4.01, Annex B)	The Environmental Impact Assessment Regulations (the Resolution of the Cabinet of Ministers no. 491 (enacted December 31, 2001))	Contents of the EIA in this project	Gap between JICA Guideline and the EIA	Correspondence of this Survey Mission
	order to eliminate adverse impacts, offset them, or reduce them to acceptable levels.		technologies, materials used in construction and mitigation measures.	protection as environmental management plan during construction phase _ Chapter 7. The action plan for the protection of the environment during the operational phase _ Chapter 8. The monitoring plan of the environment		
Public Consultation	This includes a record of consultation meetings (date, venue, participants, procedures, opinions of major local stakeholders and responses to them, and other items), including consultations for obtaining the informed views of the affected people, local NGOs, and regulatory agencies.	N/A (It is stated in Appendix)	As necessary	・Implementation of the public consultation is described in the Annex. ・Minutes on Public hearing dated on 24 June, 14 December, 2013	There is no gap.	
Appendixes	N/A	(i) List of EA report preparers --individuals and organizations. (ii) References --written materials both published and unpublished, used in	No regulations.	Implementation of the public consultation is described in the Annex. Contents of Annex are the following: Annex1. Record of	No requirement in JICA Guidelines.	Preparation, if necessary

Content	JICA Guideline on Environmental and Social Consideration	World Bank (OP4.01, Annex B)	The Environmental Impact Assessment Regulations (the Resolution of the Cabinet of Ministers no. 491 (enacted December 31, 2001))	Contents of the EIA in this project	Gap between JICA Guideline and the EIA	Correspondence of this Survey Mission
		study preparation. (iii) Record of interagency and consultation meetings, including consultations for obtaining the informed views of the affected people and local nongovernmental organizations(NGOs).The record specifies any means other than consultations (e.g., surveys) that were used to obtain the views of affected groups and local NGOs. (iv) Tables presenting the relevant data referred to or summarized in the main text. (v) List of associated reports (e.g., resettlement plan or indigenous peoples development plan).		public hearings Annex2.Receipt of payment for advertising on local TV channel Annex3.Printed announcements for hearing Annex4. Signature and names of hearing participants		

8.3.4 Standards related to this project

As a major environmental regulation in Uzbekistan, standard value / regulations for air, water and noise is described.

8.3.4.1 Atmosphere

(1) Environmental standard

In the Republic of Uzbekistan, maximum permissible concentration (MPC) for protecting human health is established for the general/working area.

Table 8.3.4-1 indicates MPC and classes of danger of main pollutants generated by TPS emissions.

30min MPC value for NO_2 in Uzbekistan is very strict, lower than half of the one hour average value of IFC/WB General EHS Guidelines and EU environmental standard.

30min MPC value for SO_2 is similar to 10min value of IFC/WB EHS Guideline.

Table 8.3.4-1 Standard and Danger Class of Main Pollutants Formed by TPS

Pollutant	Maximum permissible concentration (MPC) (mg/m^3)			Danger Class＊	IFC/WB EHS Guidelines (2007) (mg/m^3)	EU environmental standard (mg/m^3)
	30min	Daily average	Working area			
Nitrogen dioxide (NO_2)	0.085	0.06	5.0	2	0.2(1hour average) 0.04(yearly average)	0.2(1hour average) 0.04(yearly average)
Nitrogen oxide (NO)	0.6	0.25	-	3	—	—
Sulfur dioxide (SO_2)	0.5	0.2	10.0	3	0.5(10min) 0.125(daily average)	0.35(1hour average) 0.125(daily average) 0.02(yearly average)
Carbon oxide (CO)	5.0	4.0	20.0	4	—	—
Suspended particles (Dust)	0.15	0.1	-	3	0.15(daily average) 0.07(yearly average)	0.05(daily average) 0.04(yearly average)

Note: ＊Class of danger is categorized as follows according to the Russian standard

1. Pollutant of extreme danger
2. Pollutant of high danger
3. Pollutant of medium danger
4. Pollutant of low danger

Source: Sanitary norms, rules and hygiene normative documents of the Republic of Uzbekistan. SanPiN No. 0015-94.

(2) Emission standard

In the Republic of Uzbekistan, the pollutant in the exhaust gas emitted from TPS is not regulated by concentration standard of pollutant in the exhaust gas established by fuel type and generation scale, like it is in the IFC/WB EHS Guidelines.

Instead, ground concentration of air pollutant discharged from each stack is regulated.

MPC values, namely the concentration of air pollutant discharged (Table 8.3.4-1), are multiplied by each area /danger factor shown in Table 8.3.4-2. As a result, the standard values of maximum ground concentration are calculated and it should not exceed the concentration standard value (Table 8.3.4-3).

Concentration of air pollutants discharged from each stack is estimated by the OND-86 calculation model. This model is regulated by technical manual, "Inspection on inventory making pollutant source and pollutant emissions limitation setting on atmosphere (Ministry of Justice 1553 on 3 June 2006)"

This makes it possible to increase permissible emission by lowering ground concentrations and designing a higher stack, for example, for the same scale and type of emission source.

This emission control policy by diffusion is similar to the emission control policy for SOx in Japan (K value regulation).

Table 8.3.4-2 Territorial Rates for Assessment on Pollutants, Being discharged into Atmosphere

Territorial location	Limits in MPC depending on the class of hazard of discharged pollutants			
	1	2	3	4
Provinces: Tashkent, Fergana, Andizhan, Namangan Cities: Navoi, Samarkand, Bukhara	0.17	0.20	0.25	0.33
Provinces: Bukhara, Djizak, Kashkadaria, Navoi, Samarkand, Syrdaria	0.20	0.25	0.33	0.50
The Republic of Karakalpakstan, the Khorezm province	0.25	0.33	0.50	1.00

Source:"Instruction on Inventory of Pollution Sources and Rating the Pollutant Emission into Ambient Air for Enterprises of the Republic of Uzbekistan"(the Ministry of Justice ref. 1533.3 January 2006)

The project area corresponds to Turakurgan district in Namangan region.

Standard value for maximum ground concentration of emission from each stack of TKG No1&2 calculated by territorial rate was shown in Table 8.3.4-3.

According to EIA report (p6), the maximum ground concentration of NO_2 emitted from TKG1&2 is 11.1μg/m^3 (0.13MPC).

There is no regulation concerning pollutant concentration in exhaust gas in Uzbekistan. In this project, NOx concentration will comply with the Russian standard (GOST 29328-92) shown in the Table 8.3.4-4. This standard value is equivalent to the guideline value for TPS stipulated in IFC/WB EHS Guideline.

Table 8.3.4-3 Standard value of main pollutants and maximum ground concentration (30min value)

Pollutant	MPC (mg/m^3)	Territorial rate	Standard value of maximum ground concentration(mg/m^3)	Danger Class
Nitrogen dioxide	0.085	0.20	0.017	2
Nitrogen oxide	0.6	0.25	0.15	3
Sulphur dioxide	0.5	0.25	0.125	3
Carbon oxide	5.0	0.33	1.65	4
Soot	0.15	0.25	0.0375	3

Source: "Instruction on Inventory of Pollution Sources and Rating the Pollutant Emission into Ambient Air for Enterprises of the Republic of Uzbekistan"(the Ministry of Justice ref. 1533.3 January 2006)

Table 8.3.4-4 Emission standard for exhaust gas

Pollutant	GOST 29328-92	IFC/WB EHS Guidelines for Thermal power station (2008)
Nitrogen oxides (NOx)	51mg/Nm^3 (25ppm)	51mg/Nm^3 (25ppm)

Source: The document obtained at the survey.

(3) Designation of SPZ (Sanitary Protect Zone)

When TPS is built in Uzbekistan, SPZ is designated by regulation of "Sanitary Norms and rules of air pollutant at residential area (SPN No.0246-08)". Residents are forbidden to live in a SPZ. In case of gas-fired power station, SPZ is established 500m away from the TPS boundary .

8.3.4.2 Water quality

(1) Environmental standard

The water quality standard for drinking water and other water usage facilities at water withdrawal stations as an environmental standard in Republic of Uzbekistan is shown in Table 8.3.4-5.

Drinking water supply value determines what potable water system is used. Therefore, for example Bacillus coli are completely removed before supply for drinking water.

According to value of Bacillus coli for drinking water supply, this value corresponds to The Class 2 water standard for drinking water in Japan.

The value of non-drinking water (recreation) is stricter than the value of water supply. Because non-drinking water value (recreation) is the main purpose for water of swimming pools, it is the water in a pool could be ingested or drank directly.

The latest version of the rules to protect water bodies SanPin Uzbekistan N 0172-04 "Sanitary requirements for surface waters in the territory of the Republic of Uzbekistan "instead of SanPiN № 0056-98 (Only the numerical values changed).

Table 8.3.4-5 Environmental Standard for drinking water and water usage

Pollutant and such	Drinking water supply	Non-drinking water (recreation)
Suspended matters	Suspended matters content shall not increase on:	
	0.25 mg/L	0.75 mg/L
	For ponds that contain more than 30 mg/L of mineral substances during low water an increase of the content of suspended matters is allowed within 5%	
	Clouds with rate of sedimentation more than 0.4 mm/s for flowing pond and more than 0.2 mm/s for reservoirs are prohibited for discharge	
Floatable impurities (substances)	Floating films, spots of mineral oils and accumulations of other impurities shall not be detected on the surface of a pond	
Smell	Water shall not obtain alien smells with intensity of not more than 1 mark (point) detected:	
	Immediately or at further chlorination (other treatment)	Immediately
Coloration	Shall not be detected in the column:	
	20cm	10cm
Temperature	Summer temperature of water as a consequence of discharge of wastewater shall not increase more than 3°C comparing to the average temperature of the hottest month of a year for the last 10 years.	
Hydrogen ion index (pH)	Shall not exceed 6.5-8.5	
Mineral content	Shall not exceed 1,000 mg/L of dry residue, including: Chlorides – 350 mg/l ;Sulphates – 500 mg/l	
Dissolved oxygen	Shall not be less than 4 mg/L at any period of the year in a sample taken before 12:00 a.m.	
Biochemical oxygen demand	Should not exceed at 20°C:	
	3.0 mgO_2/L	6.0 mgO_2/L
Chemical oxygen demand	Should not exceed at 20°C:	
	15.0 mgO_2/L	30.0 mgO_2/L
Substances liable to	Shall not contain any	

Pollutant and such	Drinking water supply	Non-drinking water (recreation)
cause infection		
Bacillus coli	Not more than 10,000 in 1L (1,000 in 100ml) (not distributed for decentralized water source)	Not more than 5,000 in L (500 in 100ml)
Colyfag (in plaque forming units)	Not more than 100 in 1L (not distributed for decentralized water source)	Not more than 100 in L
Teleorganic eggs of worms, cysts of Bacillus coli	Shall not contain in 1 L	
Chemical substances	Shall not contain in concentrations exceeding MPC	

Source: Rules for protection of surface water from contamination by discharge water.(SanPIN No.0056-98)
Sanitary requirements for surface waters in the territory of the Republic of Uzbekistan (SanPin Uzbekistan N 0172-04)

GCN is the artificial irrigation canal, and water from the GCN is taken from Kasansai River etc. As for this project, water from the GCN is used for the cooling system, processed water with the exception to potable water. MPC applied for GCN in accordance with regulation, which is shown in Table 8.3.4-6.

Potable water will be procured through water pipeline.

Table 8.3.4-6 Water quality standard (MPC) for GCN

Item	Unit	Maximum permissible concentration (MPC)
pH	-	6.5-8.5
DO	mg/L	Summer: more than 4.0 Winter: more than 6.0
BOD	mg/L	3
SS	mg/L	30
Oil and Grease	mg/L	0.05
Ammonium	mg/L	0.08
nitrites	mg/L	0.08
nitrates	mg/L	40
sulfates	mg/L	100
phenol	mg/L	0.01
chloride	mg/L	300
calcium	mg/L	180
sodium	mg/L	120
potassium	mg/L	50
phosphate	mg/L	0.01
Fe	mg/L	0.5
Cu	mg/L	0.001
Zn	mg/L	0.01
Cr	mg/L	0.5
Pb	mg/L	0.03

Source: EIA report and the project proponent document

(2) Effluent standard

Effluent from TKG TPS must be treated in a way so as to meet the water quality standard for water usage shown in Table8.3.4-6, in consideration the environmental impact.

The effluent standard applied to the outlets is shown in Table 8.3.4-7.Temperature of thermal effluent is not regulated. According to EIA report, the temperature rise by thermal effluent is estimated to be less than 1ºC at downstream of the outlet.

Table 8.3.4-7 The effluent standard for TKG TPS

items	Unit	Standard	IFC/WB EHS Guidelines
pH	-	6.5-8.5	6.5-8.9
SS	mg/L	500	50
DO	mg/L	-	-
Oil and Grease	mg/L	0.1	10
Nitrites	mg/L	3.3	-
Nitrates	mg/L	45	-
Sulfates	mg/L	500	-
Chloride	mg/L	350	-
Calcium	mg/L	487	-
Sodium	mg/L	170	-
Potassium	mg/L	-	-
Phosphate	mg/L	2.5	-
Fe	mg/L	5.0	1.0
Magnesium	mg/L	170	-
Residual chlorine	mg/L	-	0.2
Chrome trivalent Chrome hexavalent	mg/L	0.5 / 0.1	0.5
Copper	mg/L	1.0	0.5
Zinc	mg/L	1.0	0.5
Lead	mg/L	0.1	0.5
Cadmium	mg/L	0.1	0.5
Mercury	mg/L	0.01	0.005
Arsenic	mg/L	0.1	0.5

Source: EIA repot p.42 and the document obtained at the field survey.
Rules for protection of surface water from contamination by discharge water(SanPIN No.0056-98).

8.3.4.3 Noise and vibration

The Noise standard established by the environmental standard for residential area is shown in Table 8.3.4-8. It shall not exceed 45dB during night and 55dB during daytime.

Noise standard equals the value of IFC/WB EHS Guidelines.

Table 8.3.4-8 Environmental standard for noise (residential area)

Category	Standard in Uzbekistan		IFC EHS Guidelines(2007)	
	Daytime	Nighttime	Daytime	Nighttime
Residential area	55dB(A)	45dB(A)	55dB(A)	45dB(A)

Source :Sanitary norms and rules for the assumption noise for residential, public buildings and residential areas(June 19, 2009 № 0267-09)

In accordance with this standard, noise level requirements in the residential area, as shown in Table 8.3.4-9, are met..

There is also noise standard of SanPIN No.0120-01 as a working environment within industrial area, and noise level shall not exceed 85dB.

There is no environmental standard for vibration levels.

Table 8.3.4-9 Environmental standard for noise
(Adjacent to House, Hospital, Dispensaries, School, and Library)

(dB)

Time zone	OA	31.5Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz
From 7AM to 11PM	55	90	75	66	59	54	50	47	45	43
From11PM to 7AM	45	83	67	57	49	44	40	37	35	33

Source: Sanitary norms and rules for the assumption noise for residential, public buildings and residential areas (June 19, 2009 № 0267-09)

8.3.4.4 Waste

Standards for treatment of waste shall be established for all economical activities, regardless of the types of industry in Republic of Uzbekistan.

Hazardous waste is categorized into 4 classes:

I	Extreme danger
II	High danger
III	Medium danger
IV	Low danger

Source: RD 118,0027714.60-97 Nature protection. Treatment of waste from production and consumption. Terms and definitions. Goskompriroda of Uzbekistan. Tashkent. 1997.

Waste generated in TPS is usually Class III and IV.

The standard value for maximum allowable amount of waste is calculated using the consumed amount of materials used for production to the final process at the current production facilities using the most appropriate manufacturing method.

Every waste material must have the following displayed: the name of the waste material, generation source, physical/chemical characterization and danger level, and production standard.

Maximum allowable storage amount is established for every waste material based on standards such as disposal amount, manufacturing plan for the product, treatment of waste material and usage schedule.

Transportation of waste to disposal site or reuse is delegated to the licensed company. Final disposal is conducted at the licensed disposal facility.

The status of waste during transportation and treatment is assessed through a manifest system[*].

[*] The manifest system is a set of forms, reports, and procedures designed to seamlessly track of the waste from the time it leaves the generator facility where it was produced, until it reaches the off-site waste management facility that will store, treat, or dispose of waste.

8.4 Scoping and TOR of the survey

8.4.1 Result of the review of the EIA report

(1) Air quality

According to EIA report, the predicted concentration of nitrogen dioxide (NO_2) from TKG TPS is less than 0.13 MPC (0.011 mg/m^3).

The concentration of NO_2 near TKG TPS is predicted to be almost the same amount as Namangan city

(2) Water quality

In this project, cooling water for the condenser cooling system of TKG TPS will be taken from GCN. GCN is an artificial irrigation channel. Water temperature of GCN is 10-30℃ and the flow rate is 3.2-10.1m^3/s. Flow rate of GCN tends to be the lowest in summer.

Blowdown water from the cooling tower system will be discharged at 0.126m^3/s at a with the water temperature being 30℃ higher than water intake temperature. The temperature rise of GCN caused by cooling water discharge is calculated around the summer season when the flow rate of GCN is the lowest. This calculation result is assumed to be largely affected by cooling tower water discharge. The estimated water temperature rise at the timing of discharge is +0.6℃.

Potable water for TKG TPS is supplied through the potable water pipeline. General wastewater from TKG TPS is treated by relevant facility, and wastewater is collected in the effluent tank and discharged through the wastewater treatment system.

(3) Waste

Domestic waste, waste oil and hazardous waste will be generated in the construction/operation phase. The project proponent will adhere to relevant regulations and laws.

According to EIA report, treatment/ processing plan of waste materials is shown in table 8.4.1-1.

Table 8.4.1-1 Treatment/ processing plan of waste materials

Waste materials	Treatment/ processing plan	Waste generation (ton/year)
Black metal scrap, Colored scrap metal, Metal shavings of black metal, Waste electrodes	Delivery to repair shops, the processing plant of scrap metal in Namangan city after temporary storage	440
Waste transformer oil, Waste turbine oil	The used oil is temporarily stored the oil tank. The used oil is delivered to the relevant facility for sales as the valuable resource.	30
Used tires	Delivery to the processing company after temporary storage	2
Cotton waste, Oily sand, Oily crushed stone, Oily sludge	Delivery to the processing company for the production of asphalt in Namangan city after temporary storage	40
Liquid mud from the cleaning of turbine oil	Transport to the treatment plants of industrial wastewaters (Oil is burned in the boiler)	2
Used batteries, Sludge from waste water purification unit, The sludge from the pre-treated raw water, Removal of dirt, turbidity of river water, The residue from the chemical treatment of compressors and piping system HRSG, Lime waste, Waste in the processing of salt, Waste from the insulating materials, Debris	Transport to the landfill for industrial materials in Namangan	9,000
Municipal solid waste, clothing material	Transport to the landfill for domestic waste in Namangan city	260
Used paper	Transport to the center of waste paper	3
Food waste	Reuse as animal feed	1

Note: The amount of waste generation by the project was assumed based on the amount of waste generated by Navoi TPS.

Source: EIA report

(4) Noise and vibration

(a) Noise

Noise impact during construction/ operation phase was not predicted by a quantitative method in the EIA report. For assessment of noise impact, similar predicted results are quoted in the EIA report. The estimated noise level at the boundary of the project site is below 54dB.

(b) Vibration

According to EIA report, the estimated vibration level from TKG TPS is less than 50dB.

(5) Protected area

The project site is not located within the protected area, and there is no protected area located around the project site.

(6) Flora and Fauna

The project site is composed cultivated land, pastureland, and unusable land.

According to Flora and Fauna, precious species designated by IUCN and by Uzbekistan Red Data Book have not been observed.

Regarding aquatic organisms, since GCN is an artificial irrigation channel, the habitat environment of GCN for aquatic organisms is poor, moreover, the number of aquatic organisms is small.

(7) Resettlement

The project site is governmental land and involuntary resettlement does not occur. Area of the permanent land-acquisition is 77.6ha.The temporary land-acquisition for construction is 15.0ha.

(8) Environmental management plan (mitigation measures, monitoring plan)

According to EIA report, the project proponent have considered taking measures to mitigate environmental and social issues, as well as a monitoring plan during the construction/operation phase.

8.4.2 Draft Scoping

For draft scoping of the project associated with TPS, transmission lines are described in Table 8.4.2-1, 2 according to JICA Guidelines (April 2010) and based on the EIA report and the results of the first field survey.

Table 8.4.2-1 Draft scoping (Thermal power station)

No.	Item	Assessment				Reasons for assessment
		Construction phase		Operation phase		
		Positive	Negative	Positive	Negative	
【Pollution】						
1	Air pollution	N	B	N	A	Construction phase: Generation of dust by land preparation and other construction work is expected. Generation of air pollutant (SOx, NOx, and others) from operation of heavy machines and trucks is predicted, but the impact will be limited only within the surrounding area. Operation phase: NOx is generated by the operation of TPS.
2	Water pollution	N	B	N	B	Construction phase: Turbid water is generated by dredging work and land preparation work. Concrete waste water and oil-containing wastewater is generated during construction phase, but the impact will be limited only within the surrounding area. Operation phase: Effluent generated by the operation of the plant is discharged into the artificial irrigation channel. Plant effluent and other effluent are treated before discharge. As thermal effluent is low in quantity compared to water flow in the artificial irrigation channel, water temperature rise will be approximately 1oC and the affected water area will be limited to the vicinity of the water outlet.
3	Waste	N	B	N	B	Construction phase: Domestic waste, waste oil and hazardous waste will be generated by the construction work. Operation phase: Domestic waste, waste oil and hazardous waste will be generated.
4	Soil pollution	N	B	N	B	Construction phase: Possibility of soil pollution caused by leakage of lubricant and fuel oil from construction vehicles and machines. Operation phase: Possibility of soil pollution caused by leakage of lubricant and fuel oil from operation of TPS.
5	Noise and vibration	N	B	N	B	Construction phase: Impact of noise and vibration is predicted caused by operation of heavy machines and trucks, but it will be limited only in the surrounding area. Impact by activity of high noise level including piling may extensive, but only temporary. Operation phase：Impact of noise and vibration is predicted caused by operation of the plant, but the nearest residential area is 1km away and the impact will be insignificant.
6	Ground Subsidence	N	N	N	N	Construction/operation phase: no ground water will be taken.
7	Offensive odor	N	B	N	B	Construction phase: In case domestic waste from the workers' room is not appropriately treated, offensive odor of rotten waste may be generated.

No.	Item	Assessment				Reasons for assessment
		Construction phase		Operation phase		
		Positive	Negative	Positive	Negative	
						Operation phase: In case domestic waste was not appropriately treated, offensive odor may be generated.
8	Bottom sediment	N	B	N	B	Construction/operation phase: Discharge of untreated effluent may cause sediment pollution.
【Natural environment】						
1	River water	N	N	N	N	Construction/operation phase: Water used in the plant will be taken from the artificial irrigation channel, and river water will not be taken.
2	Ground water	N	N	N	N	Construction/operation phase: Ground water pumping is not conducted in construction and operation phase.
3	Protected area	N	N	N	N	The project site is not located within the protected area, and there is no protected area located around the project site.
4	Terrestrial ecosystem and precious species	N	C	N	C	Construction/operation phase: The project site is a non-used land with poor vegetation. No precious species of flora/fauna inhabits within the project site. However impact of ecosystem is unclear.
5	Marine ecosystem and precious species	N	N	N	N	Construction/operation phase: The project does not correspond to this section.
6	River ecosystem	N	B	N	B	Construction/operation phase: Very few aquatic organisms are found in the artificial irrigation channel and the river supplying water into the artificial irrigation channel, and adverse effects on the ecosystem will be very limited.
7	Marine condition	N	N	N	N	Construction/operation phase: The project does not correspond to this section.
8	Geographical features	N	N	N	N	Construction/operation phase: The project site is located in the gently-sloped alluvial plain and the geographical features will not be altered.
【Social environment】						
1	Involuntary resettlement Land acquisition	N	B	N	N	Project site is governmental land and involuntary resettlement does not occur. Area of the permanent land-acquisition is 77.6ha,the temporary land-acquisition for construction is 15.0ha.
2	Poor People	N	C	N	C	The existence of poor people around the site will be checked by the survey.
3	Minorities	N	N	N	N	There is no minority group living around the project site.
4	Deterioration of Local Economy such as Losses of Employment and Livelihood Means	B	N	B	N	Construction phase: There is a possibility that local residents will be employed for construction work, and construction material and equipment may be purchased in the local area. Operation phase: New jobs will be created by the operation of TPS.
5	Land Use and Utilization of Local Resources	N	C	N	C	Construction/operation phase: The project site is governmental land and involuntary resettlement does not occur. It is unclear whether land use and utilization of local resources will change.
6	Water use	N	C	N	C	Construction phase: Turbid water may be generated by reclamation of

No.	Item	Assessment				Reasons for assessment
		Construction phase		Operation phase		
		Positive	Negative	Positive	Negative	
						land. The impact on the life and livelihood of the local residents is investigated in this survey. Fishery is not conducted in the irrigation channel or rivers. Operation phase: As for the potential effect of water intake/discharge from TPS, the life and livelihood of the local residents is investigated in the survey. There may be the possibility of the shortage of potable water for local residents.
7	Existing Social Infrastructure and Services	N	B	N	B	Construction phase: Increased number of workers and their family may lead to the need for improvement of infrastructure (houses, medical facility school, waterworks, sewage, and gas pipeline). The commute for power station workers will increase the traffic volume of the surrounding roads. Operation phase: The houses for workers and their family are prepared as part of the project. There may be the need for improvement of infrastructure (houses, medical facility school, waterworks, sewage, and gas pipeline).
8	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	N	C	N	N	The project site is governmental land and involuntary resettlement does not occur. However it will be compensated by land acquisition and the consultation with the decision-making organization of the local residents will be necessary.
9	Misdistribution of Benefits and Loss	N	B	N	B	Construction/operation phase: There may be inequality of employment of the local residents and contract outsourcing which may lead to misdistribution of benefits.
10	Local Conflicts of Interest	N	C	N	C	Local residents will be compensated by land acquisition, and local conflict of interest is anticipated.
11	Cultural heritage	N	N	N	N	Historical, cultural and/or archaeological property and heritage does not exist around the project site.
12	Landscape	N	N	N	N	There is no scenic area around the project site.
13	Gender	N	N	N	N	Construction/operation phase: No specific impact on gender is predicted by the project.
14	Children's Rights	N	N	N	N	Construction/operation phase: No specific impact on children's rights is predicted by the project.
15	Infectious Diseases such as HIV/AIDS	N	B	N	N	Construction phase: A temporary influx of migrant labor during the construction period may increase the risk of sexual transmitted diseases, etc.
16	Labor Environment (Including Work Safety)	N	B	N	B	Construction/operation phase: Labor accident of workers is predicted in construction work. The security agents may constitute security hazard to the local residents.
【Others】						
1	Accidents	N	A	N	A	Construction phase: Possibility of accidents by construction work and operation of construction vehicles Operation phase: Possibility of accidents by operation of the facility and operation of vehicles

No.	Item	Assessment				Reasons for assessment
		Construction phase		Operation phase		
		Positive	Negative	Positive	Negative	
2	Cross-boundary Impact and Climate Change	N	B	N	B	Construction phase: Although CO_2will be produced by construction work, construction period is limited and cross-boundary pollution and impact on .climate change is predicted to be insignificant. Operation phase: $CO_2$is produced by the project operation, but with high-efficiency CCPP, CO_2 generation per kWh is lower than in the conventional power generation system and the cross-boundary pollution and impact on climate change will be very little.

Notes; The categorization criteria is as follows.

A: Significant positive/negative impact is expected.

B: Positive/negative impact is expected to some extent.

C: Extent of positive/negative impact is unknown. (Further examination is needed, and the impact may be clarified as the study progresses.)

N: No impact is expected.

Source: JICA Study Team

Table 8.4.2-2 Draft scoping (Transmission line)

No.	Item	Assessment: Construction phase Positive	Assessment: Construction phase Negative	Assessment: Construction phase Positive	Assessment: Construction phase Negative	Reasons for assessment
【Pollution】						
1	Air quality	N	B	N	N	Construction phase: Generation of dust by land preparation and other construction work is expected, but only temporarily. Generation of air pollutant (SOx, NOx, and others) from operation of heavy machines and trucks is predicted, but the impact will be limited only within the surrounding area. Operation phase: Air pollution is not generated.
2	Water quality	N	C	N	C	Construction/operation phase: The status of the rivers along the transmission line route is not known. In case there is a river, soil runoff may occur from exposed soil such as embankment and cut earth causing water turbidity in the downstream of the river.
3	Waste	N	B	N	N	Construction phase: Unused/spent material will be generated, but the impact will be limited to the area around the construction site. Operation phase: no waste will be generated.
4	Soil pollution	N	N	N	N	Construction phase: There is possibility of soil pollution caused by leakage of lubricant and fuel oil from construction vehicles and machines. However, the impact will be limited to the area around the construction site. Operation phase: No soil pollution will be generated.
5	Noise and vibration	N	B	N	N	Construction phase: Impact of noise and vibration is predicted caused by operation of heavy machines and trucks, but will be limited to the surrounding area. Operation phase: Noise and vibration will not be generated.
6	Ground Subsidence	N	N	N	N	Construction/operation phase: No ground water will be taken.
7	Offensive odor	N	N	N	N	Construction phase: In case domestic waste from the workers' room is not appropriately treated, offensive odor of rotten waste may be generated. Operation phase: Offensive odor will not be generated.
8	Bottom sediment	N	N	N	N	Construction/operation phase: Sediment pollution does not occur.
【Natural environment】						
1	River water	N	N	N	N	Construction/operation phase: There is no use of river water.
2	Ground water	N	N	N	N	Construction/operation phase: No ground water will be taken.
3	Protected area	N	N	N	N	Construction/operation phase: The transmission line route does not pass through the protected area such as national park.
4	Terrestrial ecosystem and precious species	N	C	N	C	Construction/operation phase: The status of flora and fauna along the transmission line route is not specified.
5	Marine ecosystem and precious species	N	N	N	N	Construction/operation phase: The project does not correspond to this section.
6	River ecosystem	N	N	N	N	Construction/operation phase: There is no use of river water.

No.	Item	Assessment				Reasons for assessment
		Construction phase		Construction phase		
		Positive	Negative	Positive	Negative	
7	Marine condition	N	N	N	N	Construction/operation phase: The project does not correspond to this section.
8	Geographical features	N	C	N	C	Construction/operation phase: The status of geographical features along the transmission line route is not specified.
【Social environment】						
1	Involuntary resettlement Land acquisition	N	B	N	N	Construction/operation phase: The transmission line route is established to bypass the residential area and buildings, and involuntary resettlement will not occur. Land that will be permanently used is 13.9ha, 10ha of which is agricultural land including meadow and the other 4ha is uncultivated land. Land that will be temporarily used is 88.3ha (66.0 ha of agricultural land and 22.3ha of uncultivated land).
2	Poor People	N	C	N	N	Construction phase: The survey will check if there are poor people in the vicinity of the site. Construction/operation phase: Checking if there are poor people around the site is not specified, and even if there are, any change in their life or livelihood due to transmission lines is not expected.
3	Minorities	N	C	N	N	Operation phase: Checking if there are minority groups around the site is not specified, and even if there are, any change in their life or livelihood due to transmission lines is not expected.
4	Deterioration of Local Economy such as Losses of Employment and Livelihood Means	B	N	N	N	Construction phase: Positive effects (increased employment opportunity for construction work, equipment purchase locally) are anticipated. Operation phase: Altered land (tower basement) is scattered, and the location can be moved so as to avoid significant change to the local economy.
5	Land Use and Utilization of Local Resources	N	C	N	C	Construction/operation phase: Altered land (tower foundation) is scattered, rather small in area (13.9ha). However it is unclear whether Land Use and Utilization of Local Resources will change due to the proposed transmission line route.
6	Water use	N	C	N	C	Construction/operation phase: The status of the irrigation and domestic water source along the transmission line route is not known. In case there is a water source, soil runoff may occur from exposed soil such as embankment and cut earth causing water turbidity.
7	Existing Social Infrastructure and Services	N	N	N	N	Construction phase: It is predicted that the increase of traffic due to construction activity is very limited and will have little impact on the social infrastructure. Operation phase: We predict there will be no unusual effects on the existing social infrastructure
8	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	N	C	N	N	Before construction phase: The project proponent will compensate residents for land acquisition in accordance with governmental procedure and the consultation with the decision-making organization of the local residents will be necessary. Operation phase: The effect on social institution and local decision-making institution is not anticipated.

No.	Item	Assessment: Construction phase Positive	Assessment: Construction phase Negative	Assessment: Construction phase Positive	Assessment: Construction phase Negative	Reasons for assessment
9	Misdistribution of Benefits and Loss	N	B	N	N	Construction phase: There may be inequality of employment of the local residents and contract outsourcing may lead to misdistribution of benefits. Operation phase: No special effect on misdistribution of benefits and loss is anticipated.
10	Local Conflicts of Interest	N	C	N	C	Construction/operation phase: Local conflicts of interest are not specified.
11	Cultural heritage	N	C	N	N	Construction phase: Existence of historical, cultural and/or archaeological property and heritage around the transmission line construction site is not specified. Operation phase: Historical, cultural and/or archaeological property and heritage will not be affected.
12	Landscape	N	N	N	N	Construction/operation phase: There is no scenic area to be taken care of within 50km of the project site, and adverse effects on landscape is not anticipated.
13	Gender	N	N	N	N	Construction/operation phase: No specific impact on gender is predicted by the project..
14	Children's Rights	N	N	N	N	Construction phase: Construction work of transmission line will be carried out mainly using heavy machines, and simple tasks for child labor will be very limited. Consequently, child labor is not anticipated. Operation phase: No specific impact on children's rights is predicted by the project.
15	Infectious Diseases such as HIV/AIDS	N	B	N	N	Construction phase: A temporary influx of workers during the construction period may increase the risk of sexual transmitted diseases, etc. Operation phase: No unusual change regarding infectious diseases is anticipated.
16	Labor Environment (Including Work Safety)	N	B	N	B	Construction phase: High possibility of accidents by construction work . Operation phase: Accidents such as electric shock and falling may occur during maintenance work.
17	Electromagnetic field	N	N	N	B	Operation phase: Adverse health effects due to the electromagnetic is predicted.
【Others】						
1	Accident	N	A	N	A	Construction/operation phase: There is a risk of transmission tower falling due to soil runoff caused by floods.
2	Cross-boundary Impact and Climate Change	N	N	N	N	Construction/operation phase: The transmission line route does not cross the boundary. CO_2 generation does not occur.

Notes; The categorization criteria is as follows.
A: Significant positive/negative impact is expected.
B: Positive/negative impact is expected to some extent.
C: Extent of positive/negative impact is unknown. (Further examination is needed, and the impact may be clarified as the study progresses.)
N: No impact is expected.

Source: JICA Study Team

8.4.3 Term of reference for the survey

Regarding the environmental items that may be affected, information on the current status, impact prediction and mitigation measures are acquired from the EIA report and other documents provided by the project proponent.

The acquired information is analyzed and considered for certain environmental items as necessary based on the aforementioned scoping result. The term of reference is shown in Table 8.4.3-1, 2.

Confirmation of the baseline data: The collection of the current information regarding environmental impact prediction.

_ Natural environment: the existing data on meteorology, ambient air quality, water quality, flora and fauna shall be collected and organized. Referring to relevant authorities is conducted as needed.

_ Social environment: the existing data on social environment (land use, land/marine traffic, fishery, sanitation, population status, education, social infrastructure, occupation, and income), scenic area, cultural heritage, and minority groups shall be collected and organized. Referring to relevant authorities is conducted as needed.

Prediction and assessment of environmental impact: Regarding the items confirmed at the scoping, the qualitative and quantitative prediction and assessment of the impact during construction and operation phase shall be conducted as necessary.

Stakeholder meeting: An opportunity to consult with the local residents shall be established to promote understanding of the EIA. Comments and opinions are collected and the response thereto shall be compiled. The stakeholder meeting shall be held twice, once during the scoping stage and again at the completion of the draft EIA report.

Confirmation of land acquisition and resettlement plan: The land acquisition of TPS site has already been completed. The land for other associated facilities and transmission lines, if already acquired, shall be confirmed to ensure compliance with JICA Guidelines, including the acquisition process. In the case significant discrepancies with JICA Guidelines are found, an action plan shall be established to resolve the discrepancy to the furthest degree possible, and the plan shall be submitted to relevant authorities under the condition that the project implementation is subject to implementation of the plan.

Table 8.4.3-1 Survey items, survey method, assessment and mitigation measures (Thermal power station)

Environmental items	Survey item	Survey method	Assessment and mitigation measure	Considerations
Air pollution	-Environmental standard -Meteorological data -Current air quality	-Confirmation of air quality standard and gas emission standard -Confirmation of meteorological data (temperature, humidity, wind direction/speed, etc) -Confirmation of the measurement result of air pollutant in the ambient air	-Air pollution mitigation measures should be taken during construction phase. -Gas emission standards should be satisfied in operation phase. -Diffusion simulation of air pollutant in exhaust gas is conducted during operation phase to confirm compliance to the environmental standard.	-The diffusion simulation has been conducted and mitigation measures have been developed by the project proponent. The data analysis and additional prediction assessment shall be conducted as necessary.
Water pollution/bottom sediment	-Relevant environmental standard -Current flow status -Current water quality	-Confirmation of water quality standard and effluent standard -Confirmation of the measurement result of the current flow status -Confirmation of the measurement result of river water quality	-Water pollution mitigation measure should be taken during construction phase. -Diffusion simulation of thermal effluent is conducted during operation phase to confirm compliance to the environmental standard. -Effluent from TPS shall be treated at the treatment facility to satisfy the effluent standard in operation phase.	-The prediction assessment has been conducted and mitigation measures have been developed by the project proponent. The data analysis and additional prediction assessment shall be conducted as necessary.
Waste/Offensive odor	-Relevant standards	-Confirmation of the standard concerning waste treatment	-Understanding waste generated in construction and operation phase, promoting the reuse or treating and disposing of appropriately.	-The mitigation measures have been developed by the project proponent. The data analysis and additional mitigation measure shall be considered as necessary.
Soil pollution	N/A	N/A	- Oil pollution mitigation measure should be taken during construction and operation phase.	-The mitigation measures have been developed by the project proponent. The data analysis and additional mitigation measure shall be considered as necessary.
Noise and vibration	-Relevant environmental standards -Current status of	-Confirmation of noise standard -Confirmation of the measurement result	-Noise and vibration mitigation measure should be taken during construction and	-The impact prediction has been conducted and mitigation measures have been developed by the

Environmental items	Survey item	Survey method	Assessment and mitigation measure	Considerations
	noise and vibration	of noise and vibration	operation phase. -Noise prediction is conducted to confirm compliance to the environmental standard.	project proponent. The data analysis and additional prediction assessment shall be conducted as necessary.
Terrestrial ecosystem and precious species	-Habitat status of terrestrial flora, mammals, birds, reptilians, amphibians, etc.	- Confirmation of the existing document information.	- The mitigation measure for flora and fauna should be taken during construction and operation phase.	- In case precious species are found inhabiting within the project site, transplantation and other mitigation measures shall be developed.
River ecosystem	-Habitat status of fish etc.	- Confirmation of the existing document information.	-The mitigation measure for fish should be taken during construction and operation phase.	-The data analysis and additional prediction assessment shall be conducted as necessary.
Involuntary resettlement	-Current status of livelihood in the area.	-Collection of information on the status of livelihood	-The mitigation measure for the change of livelihood	-Development of mitigation measures as necessary.
Poor people	-Existence of poor people	-Examination of the existing document. -Hearing of the relevant organizations, field survey.	-The mitigation measure for poor people	-In case poor people live in the area, the impact of the project is confirmed and mitigation measure will be taken as necessary.
Local Economy such as Losses of Employment and Livelihood Means	-Current status of job and livelihood in the area. -Local economic development plan.	-Collection of data concerning employment and livelihood of the local area.	- Promote employment of the local residents.	N/A
Land Use and Utilization of Local Resources	-Current status of land use and utilization of local resources.	-Collection of data concerning land use and utilization of local resources	-The mitigation measures for the land use will be taken.	-Development of mitigation measures as necessary.
Water use	-Current status of industrial activity and ship navigation.	-Collection of information on water use (no fishery is conducted).	-Water turbidity mitigation measure should be taken during construction phase. -Understanding the area of impact of thermal effluent, and confirming the water use in the area. -Consideration of water intake and discharge method. -Domestic waste water and other waste water discharge shall comply with the effluent standard.	-The impact prediction has been conducted and mitigation measures have been developed by the project proponent. The data analysis and additional prediction assessment shall be conducted as necessary.

Environmental items	Survey item	Survey method	Assessment and mitigation measure	Considerations
Existing Social Infrastructure and Services	-Current status of land use. -Current status of roads -Current status of infrastructure facilities	-Collection of road status information. -Collection of infrastructure facility data. -Confirmation of development plan of local economy.	-Development of construction worker's lodgment and infrastructure for operation phase. -Development of traffic accident mitigation measures.	-The mitigation measures have been developed by the project proponent. The data analysis and additional prediction assessment shall be conducted as necessary.
Social Institutions such as Social Infrastructure and Local Decision-making Institutions	-Current status of social infrastructure and local decision-making	-Collection of information on compensation skim	-Development of compensation skim	-Development of mitigation measures as necessary.
Misdistribution of Benefits and Loss	-Current status of employment and livelihood of the area -Confirmation of development plan of local economy.	-Collection of information on the status of local employment and livelihood	-Development of fair employment criteria.	-Development of mitigation measures as necessary.
Local Conflicts of Interest	-Current status of livelihood in the area	-Collection of information on the status of livelihood	-The mitigation measure for local conflicts	-Development of mitigation measures as necessary.
Infectious Diseases such as HIV/AIDS	N/A	N/A	-Development of labor safety plan	-The mitigation measures have been developed by the project proponent. The data analysis and additional prediction assessment shall be conducted as necessary.
Labor Environment (Including Work Safety)	N/A	N/A		
Accidents	N/A	N/A	-Development of labor accident mitigation measures for construction and operation phase.	-The mitigation measures have been developed by the project proponent. The data analysis and additional prediction assessment shall be conducted as necessary.
Cross-boundary Impact and Climate Change	-Estimation of CO_2 generation in this project	-Estimate CO_2 generation from fuel consumption.	-Development of CO_2 generation reduction measures for construction phase. -Manage appropriate operation management and understand CO_2 generation amount during operation phase.	-Collection of necessary data and understanding of CO_2 generation.

Source: JICA Study Team

Table 8.4.3-2 Survey items, survey method, assessment and mitigation measures (Transmission line)

Environmental items	Survey item	Survey method	Assessment and mitigation measure	Considerations
Air pollution	N/A	N/A	-Construction phase: Air pollution mitigation measures should be taken.	- The mitigation measures will be examined in the EIA report and additional measures will be taken as necessary.
Water pollution	N/A	N/A	-Construction phase: Water pollution mitigation measures should be taken. -Operation phase: soil runoff prevention measures will be taken.	-The mitigation measures will be examined in the EIA report and additional measures will be taken as necessary.
Waste	-Relevant standard	-Confirmation of the standard concerning waste handling.	-Construction phase: understanding the types and quantity of waste and developing appropriate treatment and disposal method.	- Treatment and disposal measures will be examined in the EIA report and additional measures will be taken as necessary.
Noise and vibration	-Relevant environmental standard	-Confirmation of noise standard	-Construction phase: Noise and vibration mitigation measure should be taken.	- The mitigation measures will be examined in the EIA report and additional measures will be taken as necessary.
Terrestrial ecosystem and precious species	- Habitat status of terrestrial flora, mammals, birds, reptilians, amphibians, etc.	-Confirmation of the existing document information.	-Construction and operation phase: -Confirmation of existence of precious species. -Mitigation measure for flora and fauna that will potentially be affected should be taken.	- Existence of precious species will be examined in the EIA report and additional mitigation measures for flora and fauna will be taken as necessary.
Geographical features	- Geology	-Collection of geological information	-Construction and operation phase: Soil-runoff mitigation measures will be taken.	-The mitigation measures will be examined in the EIA report and additional measures will be taken as necessary.
Involuntary resettlement	-Current status of livelihood.	-Collection of information on the status of livelihood	-The mitigation measures for livelihood will be taken.	-Examination of compensation plan (LARAP) and development of additional mitigation measure as necessary.
Poor people	-Existence of poor people	-Examination of the existing document. -Hearing of the relevant organizations, and field survey.	-Confirm if poor people live in the area, and if there is, assess the impact on them and develop livelihood support program.	-In the case poor people live in the area, the impact of the project is confirmed and livelihood support measures will be taken as necessary.

Environmental items	Survey item	Survey method	Assessment and mitigation measure	Considerations
Minorities	-Existence of minorities	-Examination of the existing document. -Hearing of the relevant organizations, field survey.	-Confirm if minority groups in the area, and if so, assess the impact on them and develop livelihood support program.	-In case minority people live in the area, the impact of the project is confirmed and livelihood support measures will be taken as necessary.
Local Economy such as Losses of Employment and Livelihood Means	-Review of the compensation plan	-Collection of data concerning employment and livelihood of the local area.	-Construction phase: Promote employment of the local residents.	-Examination of compensation plan (LARAP) and development of additional mitigation measures as necessary.
Land Use and Utilization of Local Resources	-Current status of land use and utilization of local resources.	-Collection of data concerning land use and utilization of local resources	-The mitigation measures for the land use will be taken.	-Development of mitigation measures as necessary.
Water use	- The current status of irrigation and domestic watercourse.	- Collection of data concerning water use.	-Construction and operation phase: Soil-runoff mitigation measures will be taken.	- The mitigation measures will be examined in the EIA report and additional measures will be taken as necessary.
Social Institutions such as Social Infrastructure and Local Decision-making Institutions	-Current status of social infrastructure and local decision-making	-Collection of information on compensation skim	-Development of compensation skim	-Development of mitigation measures as necessary.
Misdistribution of Benefits and Loss	-Current status of employment and livelihood of the area -Confirmation of development plan of local economy.	-Collection of information on the status of local employment and livelihood	-Development of fair employment criteria.	-Development of mitigation measures as necessary.
Local Conflicts of Interest	-Current status of livelihood in the area	-Collection of information on the status of livelihood	-The mitigation measure for local conflicts	-Development of mitigation measures as necessary.
Cultural heritage	-Historical, cultural and/or archaeological property and heritage.	-Collection of data concerning historical, cultural and/or archaeological property and heritage	-Construction phase: In case there is a risk of the project impact on historical, cultural and/or archaeological property and heritage, protection measure shall be taken.	-The mitigation measures will be examined in the EIA report and additional measures will be taken as necessary.
Infectious Diseases such as HIV/AIDS	N/A	N/A	-Development of a labor safety plan	- The mitigation measures developed by the project proponent shall be considered and additional mitigation measures shall be taken as necessary.
Labor Environment (Including Work	N/A	N/A		

Environmental items	Survey item	Survey method	Assessment and mitigation measure	Considerations
Safety)				
Electromagnetic field	N/A	N/A	-The prediction of electromagnetic field shall be conducted in operation phase.	-The transmission line route shall avoid the residential area as much as possible.
Accidents	N/A	N/A	-Accident prevention measures shall be taken in both software aspect (safety training, education) and hardware aspects (provision of safety gear, etc).	-The mitigation measures developed by the project proponent shall be considered and additional mitigation measures shall be taken as necessary.

Source: JICA Study Team

8.5 The results of the survey

In order to predict the impact of concerned environmental items caused by the project, a quantitative prediction and re-assessment were conducted

8.5.1 Re assessment of the prediction

(1) Air pollution

Table 8.5.1-1details the emission gas data from TKG TPS specified in the results of the review.

Used gas fuel for TKG TPS contained almost no sulfur (0.005g/m^{3}as H_2S) in the results of the review.

Table 8.5.1-1 Emission gas data from TKG TPS

Items	Unit	TKG NO.1&2	
		TKG NO.1	TKG NO.2
Emission volume (wet)	m^3/s	761.6	761.6
Exhaust gas temperature	°C	98	98
Exhaust gas speed	m/s	26.9	26.9
Stack height	m	90	90
NO_2.emission	g/s	34.5	34.5

Note: Concentration of pollutants is actual base in the exhaust gas.
SO_2 emission is estimated 0.6g/s and the amount is one hundredth of NO_2.emission.

According to EIA report, the predicted concentration of nitrogen dioxide (NO_2) is no more than 0.13MPC (11μg/m^3) near TKG TPS as well as residential area in Turakurgan district. The predicted result is a good indicator.

However, according to the impact caused by NO_2, the prediction was conducted using the Gaussian diffusion model based on the emission gas data. This model is frequently used in USA and Japan etc.

Using the following Gaussian diffusion model, 30-min value estimation was conducted according to the time scale in conformity to the ambient air quality standards of Uzbekistan.

$$C(R) = \frac{Q}{2\pi\ \sigma_y \sigma_z u} \exp\left(\frac{y^2}{2\pi\ \sigma_y^2}\right)\left(\exp\left\{-\frac{(z-He)^2}{2\sigma_z^{\ 2}}\right\} + \exp\left\{-\frac{(z+He)^2}{2\sigma_z^{\ 2}}\right\}\right)$$

[Symbol]

C: Aboveground concentration at a leeward distance R (m)
Q_p: Emission volume
σ_y: Parameter in the horizontal direction (m)

σ_z: Parameter in the vertical direction (m)
Converting 3-min value to 30-min value using the formula below
$\sigma_y = \sigma_{y1} \times (30/3)^{0.2}$ (σ_{y1} ;Pasquill-Gifford)
σ_z: Parameter in the vertical direction (m)(Pasquill-Gifford)
u: Wind speed (m/s)
Calculating the wind speed at the stack outlet level, using the measurement ground-level wind speed (10m) and the elements described below.
$U_2 = U_1 (Z_2/Z_1)^P$
U_1: wind speed at measurement height level (m/s),
U_2: wind speed at the stack outlet level (m/s),
Z_1: measurement height level(10m)
Z_2: Stack height (m)
P: Coefficient of stability
R: Horizontal distance between smoke source and calculated point (m)
Z: Aboveground height
He: Effective stack height (m)
$He = H + \Delta H$
H: Actual stack height (m)
ΔH: Elevation height (m)

The concentration of NO_2 discharged from the stack having reached the ground by dispersion heavily depends on the diffusion parameter for each of the wind speed and atmospheric stability, as shown in the aforementioned calculation formula.

The wind around the project site primarily comes from the north as shown in Figure 8.2.4-1. Average wind speed is 2.0m/s.

As for conditions of the vicinity of TKG TPS, the nearest residential area and orchards are located approximately 1km away from TKG TPS to the south on the lee of northerly wind. Additionally, the vicinity of Kasansai River is dotted with a comparatively large amount of orchards, to the east from TKG TPS. However, the frequency western winds is low.

As a result, air pollutant dispersion is calculated based on northerly winds.

Calculation is simulated under the conditions shown below, based on the stability and wind speed indicated in the atmospheric stability classification of Pasquill.

Table 8.5.1-2 Setting conditions for stability and wind speed

Stability		Wind speed conditions at ground level (m/s)
Unstable	B	1.0, 2.0, 3.0, 4.0
Neutral	C	1.0, 2.0, 3.0, 4.0
	D	1.0, 2.0, 3.0, 4.0, 6.0, 8.0,10.0,15.0

Table 8.5.1-3Pasquill stability categories

Wind speed at ground level U (m/s)	Daytime				Nighttime (rate of solar radiation = 0)
	Rate of solar radiation Q (unit 0.01 kWm^{-2})				
	60 < Q	30 – 59	15 – 29	1 - 14	
U < 2.0	A	A-B	B	D	F
2.0 - 2.9	A-B	B	C	D	E
3.0 - 3.9	B	B-C	C	D	D
4.0 - 5.9	C	C-D	D	D	D
6.0 < U	C	D	D	D	D

Note: This category shows the stability of the atmosphere proposed by Pasquill. Each category means as below.
Category A: Strongly unstable, Category B: Moderately unstable, Category C: Slightly unstable
Category D: Neutral, Category E: Slightly stable, Category F: Moderately stable

The stack outlet is located at high elevation, so that atmospheric stability at the stack outlet becomes “Neutral” compared to the instability of atmosphere at ground level.

For instance, stability B at ground level is set to be stability C at the stack outlet level, and wind speed condition at outlet level is set to be between 1.0m/s and 4.0m/s, accounting for wind speed conditions of Stability B with conservative point of view.

The prediction was conducted for all the cases of stability and wind speeds described above.

Prediction results are shown in Table 8.5.1-4. The prediction concentration by TKG TPS is estimated to be 1.5-18.7$\mu g/m^3$.

As for the results, the maximum concentration added background concentration at ground level is estimated 61.5-78.7$\mu g/m^3$ (Contribution ratio: 2.4-23.8%).

Therefore, the predicted concentration is complies with the Environmental standard of Uzbekistan as well as the IFC/WB EHS Guidelines.

Table 8.5.1-4 Prediction of the maximum ground concentration (30 min value)

Items	Atmospheric conditions (stability)	Wind speed (m/s)	Maximum concentration at ground-level (μg/m^3)	Distance of maximum concentration (km)	Current maximum concentration* (μg/m^3)	Prediction Concentration** (μg/m^3)	Environmental standard (MPC) of Uzbekistan (μg/m^3)	IFC/WB EHS Guidelines (2007)
NO_2	B	1.0	18.3	2.4	60	61.5 – 78.7	85	200(1-hour value)
		2.0	18.7	1.7				
		3.0	18.1	1.2				
		4.0	17.6	0.9				
	C	1.0	12.9	6.1				
		2.0	14.0	3.7				
		3.0	14.0	2.9				
		4.0	13.6	2.1				
	D	1.0	1.5	50.1				
		2.0	2.1	24.0				
		3.0	2.7	16.1				
		4.0	2.9	12.4				
		6.0	3.1	9.7				
		8.0	3.1	8.0				
		10.0	3.0	7.1				
		15.0	2.8	5.8				

* Measurement result of Namangan city
**Prediction concentration is maximum concentration at ground-level added current concentration

Note; Supplemental explanation

SO_2 emission is one hundredth of NO_2.emission. Maximum concentration at ground-level is proportional to the emission volume in accordance with Gaussian diffusion model. Therefore, SO_2 maximum concentration is also one hundredth of that of NO_2. The impact caused by SO_2 is insignificant.

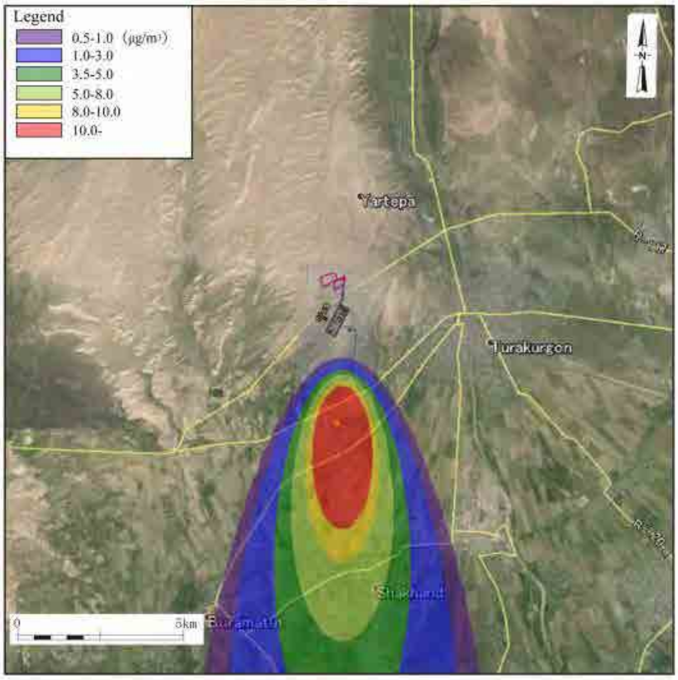


Figure 8.5.1-1 Ground level concentration of NO_2., Stability: B, Wind; N, 1m/s

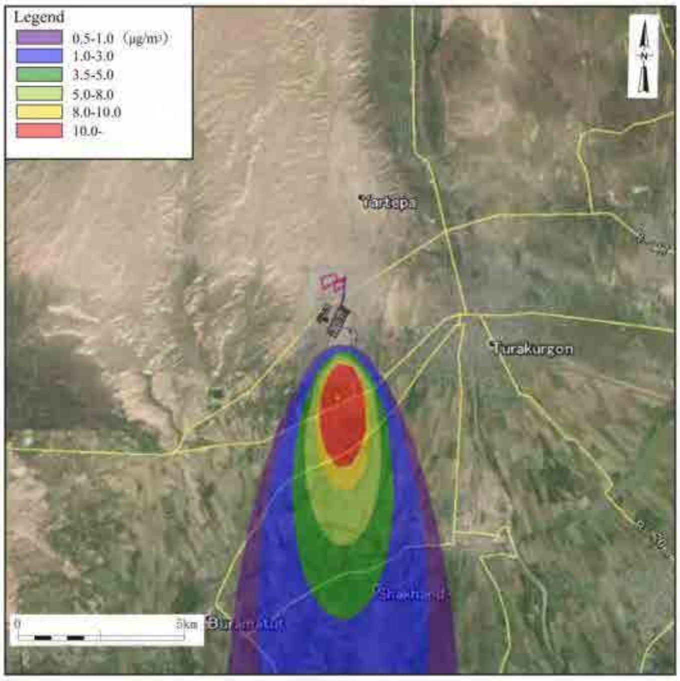


Figure 8.5.1-2 Ground level concentration of NO_2, Stability: B, Wind; N, 2m/s

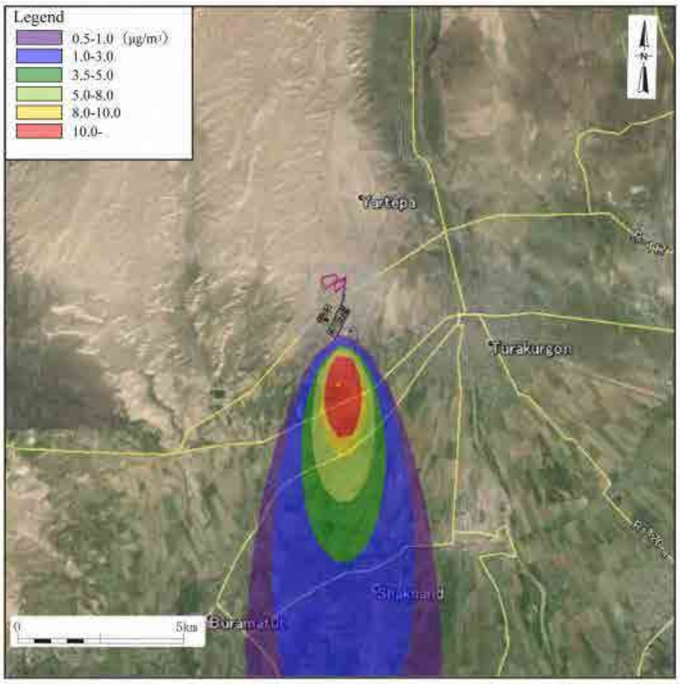


Figure 8.5.1-3 Ground level concentration of NO_2, Stability: B, Wind; N, 3m/s

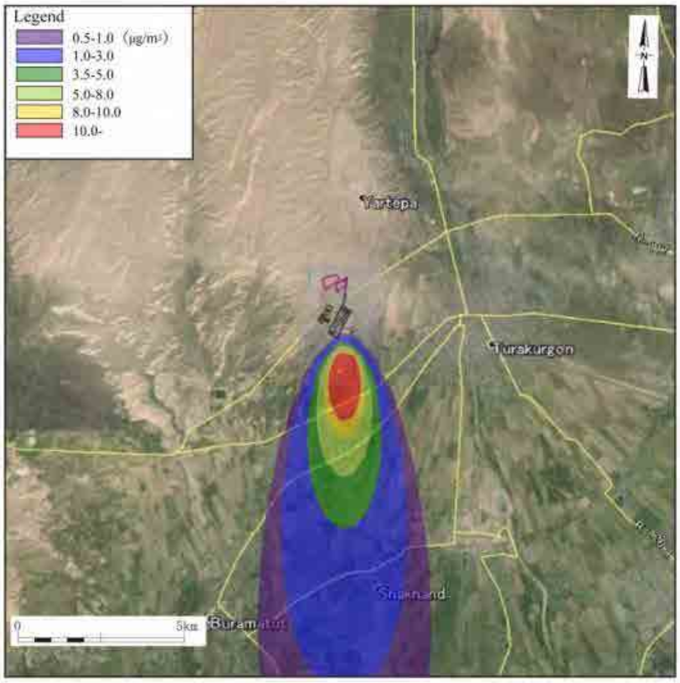


Figure 8.5.1-4 Ground level concentration of NO_2, Stability: B, Wind; N, 4m/s

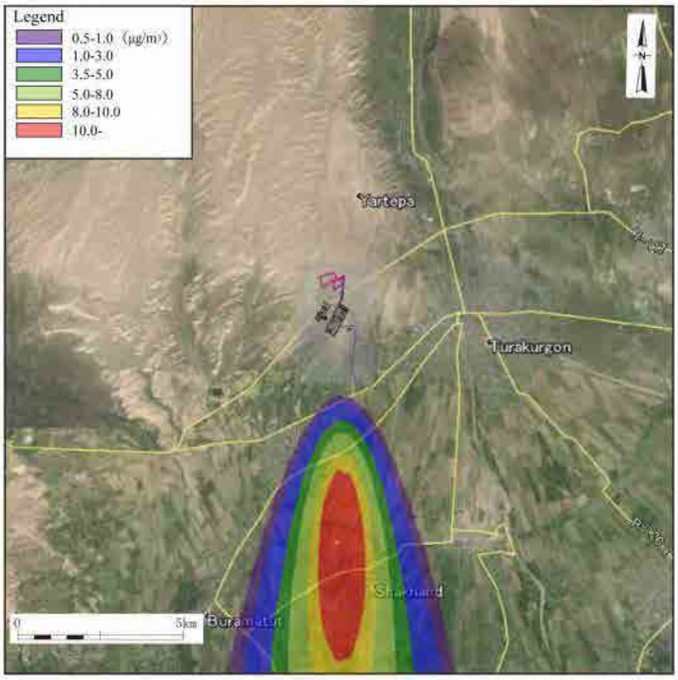


Figure 8.5.1-5 Ground level concentration of NO_2, Stability: C, Wind; N, 1m/s

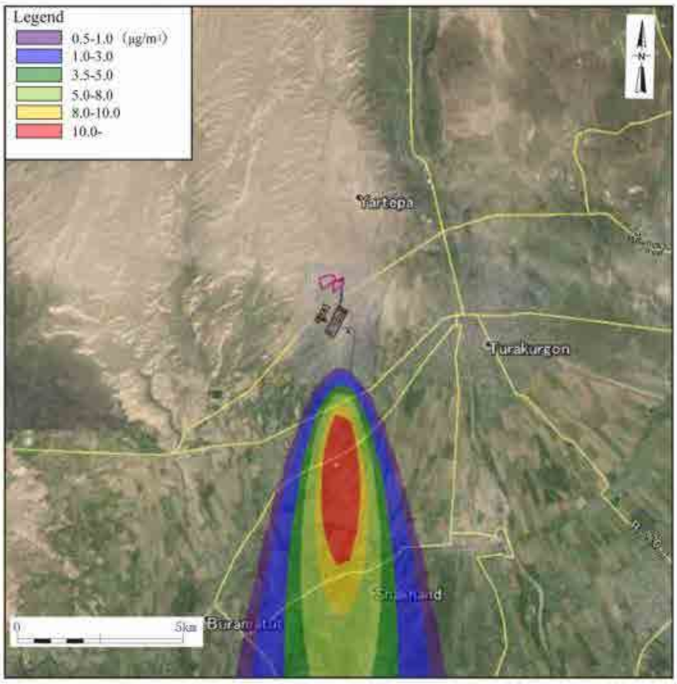


Figure 8.5.1-6 Ground level concentration of NO_2, Stability: C, Wind; N, 2m/s

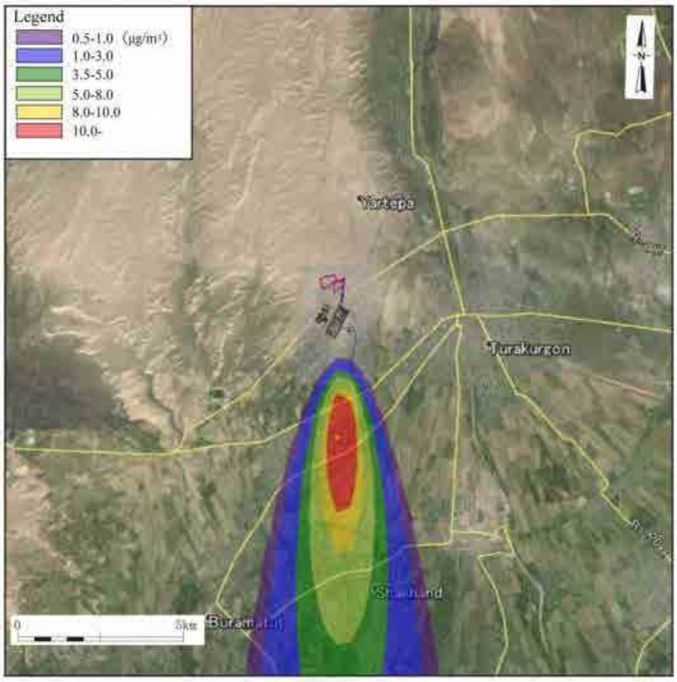


Figure 8.5.1-7 Ground level concentration of NO_2, Stability: C, Wind; N, 3m/s

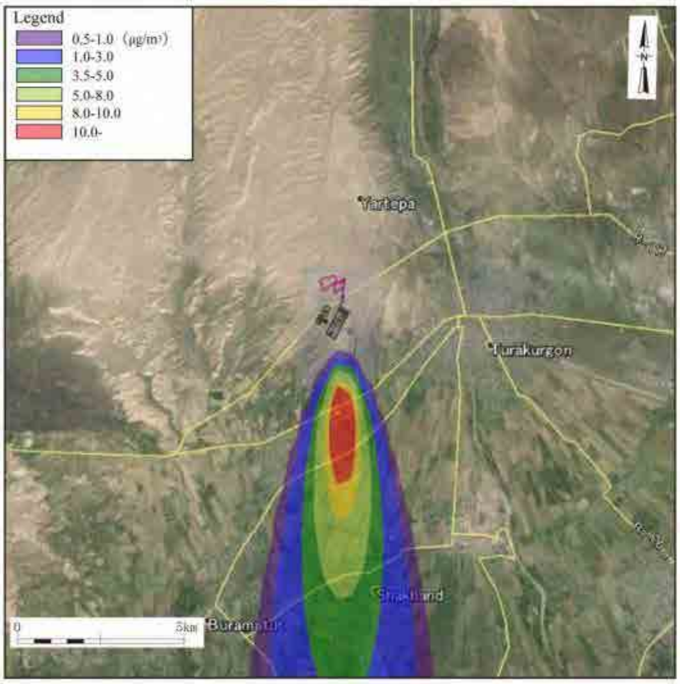


Figure 8.5.1-8 Ground level concentration of NO_2, Stability: C, Wind; N, 4m/s

(2) Water quality

(a) Water use

(i) Cooling water

1m^3/s of water is to be taken from GCN as cooling water for the condenser cooling system of TKG TPS.

GCN is an artificial irrigation channel made of concrete. Water temperature of GCN is 10-30℃ (average temperature 15℃) and the flow rate is 3.2-10.1m^3/s (average flow rate 6.6 m^3/s). Flow rate of GCN tends to be lowest in summer.

GCN takes in river water from rivers including Kasansai River located 3km east and Naryn River (Figure 8.5.1-9).

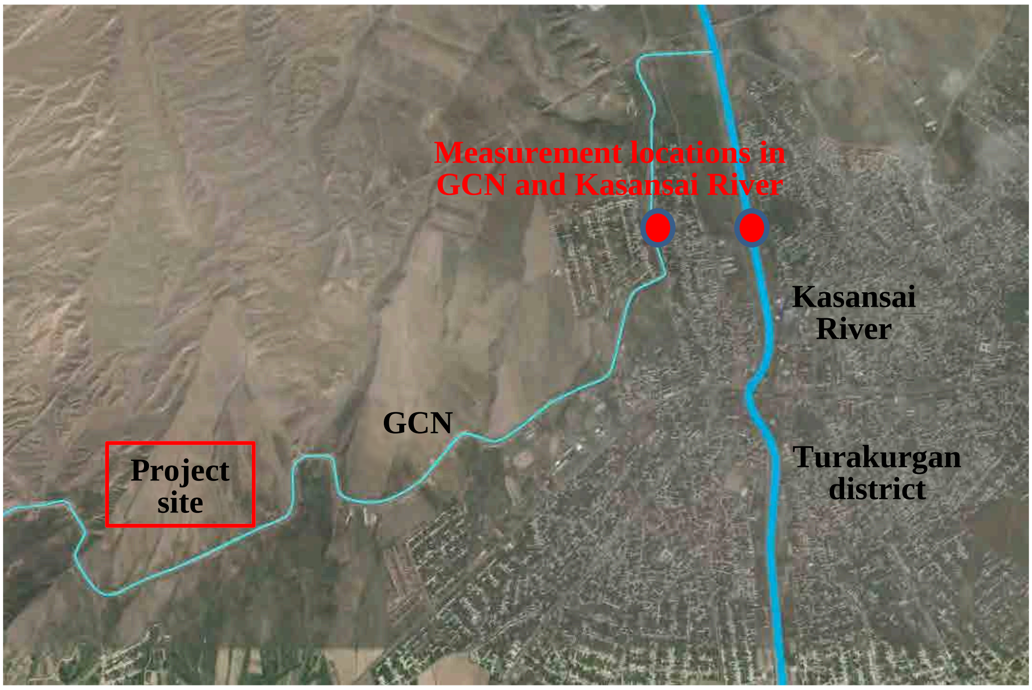


Figure 8.5.1-9 GCN and Kasansai River

The increased amount of water intake for TKG TPS will be supplied by discharging the equivalent amount of water from the basin (Kasan-sai reservoir located 40km upstream of GCN connection point).

Kasan-sai reservoir is controlled by Norin Syrdarya Irrigation System Basin Management Company which is a subsidiary organization of Ministry of Agriculture and Irrigation, and the increase of discharge from the basin has already been determined.

Table 8.5.1-5 describes the status of Kasansai River and GCN.

Table 8.5.1-5 Status of Kasansai River and GCN

Item	Kasansai River	GCN
Current Volume		
Average water volume	N/A	6.62 m^3/s
Maximum water volume	300 m^3/s	10.1 m^3/s
Minimum water volume	0.5-1.0 m^3/s	3.15 m^3/s
Current speed		
Average current speed	2.5 m/s	0.5 m/s
Maximum current speed	5.0 m/s	0.6 m/s
Minimum current speed	1.0 m/s	0.4 m/s
Supply conditions		
Available flow rate	N/A	Max. 1800 m^3/h
	N/A	Min. No record
	N/A	Avg. No record
Temperature	N/A	10～30 °C Average 15°C

Note; The measurement locations are shown in Figure8.5.1-9.

(ii) Potable water

Potable water consumed in TKG TPS is supplied through the potable water pipeline at a rate of 160m^3/day. The potable water pipeline, 6,500m long in total and 100mm in pipe diameter, is embedded at the depth of 0.6-0.7m principally along the road (Figure 8.5.1-10).

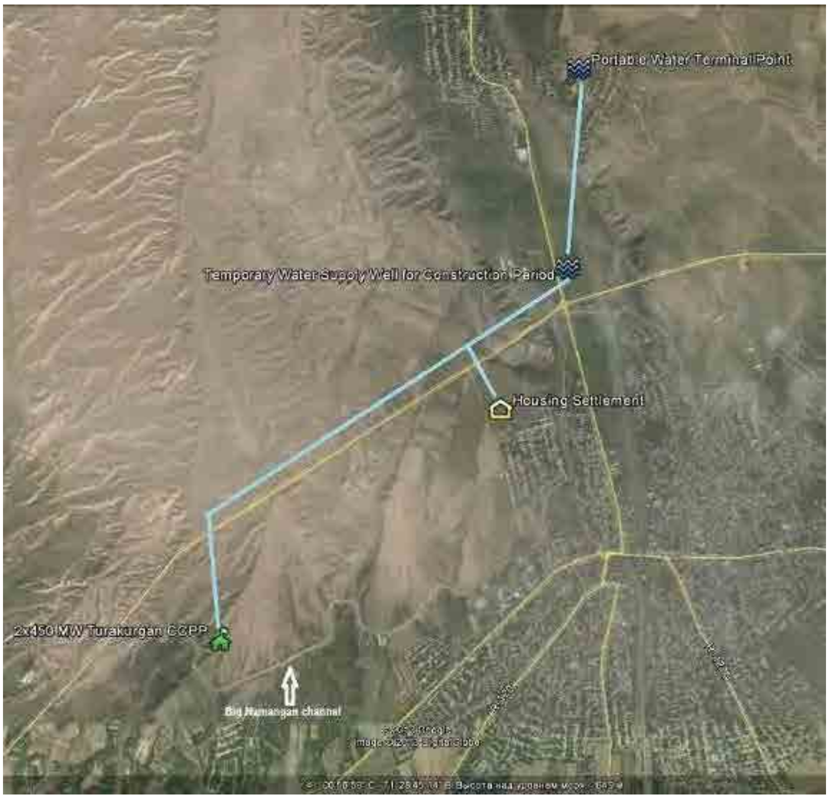


Figure 8.5.1-10 Potable water pipeline route

(b) Water discharge

(i) Blowdown water (water temperature)

Blowdown water from the cooling tower system will be discharged at $0.14m^3/s$ at the water temperature 15℃ higher than water intake temperature.

The temperature rise of GCN, caused by cooling water discharge, is calculated for summer the season when the flow rate of GCN, which is assumed to be largely affected by cooling tower water discharge, is the lowest.

The estimated water temperature rise at the timing of discharge is +0.6℃, as shown below*.

$$\{3.15m^3/s \times 30℃ + 0.14m^3/s \times (30℃ + 15℃)\} / (3.15m^3/s + 0.14m^3/s) = 30.6℃ \quad \ldots①$$

$$30.6℃ - 30℃ = +0.6℃ \ldots\ldots②$$

The discharged water flows through three gateways situated downstream of the discharge point of TKG TPS into Rezak-sai reservoir located 22km downstream (Figure 8.2.4-2). Therefore, temperature rise by blowdown water is insignificant.

(ii) Blowdown effluent (water quality)

Water quality of GCN is shown in Table 8.2.2-1. The chemical substances in blowdown effluent will be condensed by the cooling tower system. According to a rough calculation, the chemical substances will be condensed up to 2.4 times (Intake amount is $0.33m^3/s$, evaporation amount is $0.19m^3/s$ and discharge amount $0.14\ m^3/s$).

The water quality of blowdown effluent has to comply with SanPin No.0056-96, Tashkent, 1996(Sanitary rules and norms of surface waters from pollution), which regulates permissible concentration amounts. As for Table 8.5.1-6, water quality of blowdown water will be complied with the standards of Uzbekistan (Table 8.5.1-7).

In addition, newly chemical substances caused by this project will be not created.

*Supplemental explanation

In case of average flow rate of GCN and average water temperature , the estimated water temperature rise is +0.3℃.

$$\{6.62m^3/s \times 15℃ + 0.14m^3/s \times (15℃ + 15℃)\} / (6.62m^3/s + 0.14m^3/s) = 15.3℃ \quad \ldots①$$

$$15.3℃ - 15℃ = +0.3℃ \ldots\ldots②$$

Table 8.5.1-6 Chemical substances condensed in blowdown water

Item	Unit	Current values of GCN		Chemical substances condensed by cooling system*	Standard of Uzbekistan	IFC/WB EHS Guidelines
		March to September 2013*	22 May 2014			
pH	-	8	8	6.5-8.5**	6.5-8.5	6.5-9.0
SS	mg/L	0.19	N/A	0.46	500	50
DO	mg/L	13.8	10.5	0**	-	-
Oil and Grease	mg/L	N/A	0.28	0.00***	0.1	10
Nitrites	mg/L	0.05	0.035	0.1	3.3	-
Nitrates	mg/L	3.1	1.77	7.4	45	-
Sulfates	mg/L	144	134	345.6	500	-
Chloride	mg/L	40	20	96.0	350	-
Calcium	mg/L	3.2	3.0	7.7	487	-
Sodium	mg/L	47.3	16.2	113.5	170	-
Potassium	mg/L	47.3		113.5	-	-
Phosphate	mg/L	N/A	0.00	0.00	2.5	-
Fe	mg/L	0.3	0.04	0.72	5.0	1.0
Magnesium	mg/L	N/A	0.00	0.00	170	-
Residual chlorine	mg/L	N/A	N/A	0**	-	0.2
Chrome trivalent Chrome hexavalent	mg/L	N/A	0.00	0.00	0.5 / 0.1	0.5
Copper	mg/L	0.017	0.01	0.048	1.0	0.5
Zinc	mg/L	N/A	0.00	0.00	1.0	0.5
Lead	mg/L	N/A	0.00	0.00	0.1	0.5
Cadmium	mg/L	N/A	0.00	0.00	0.1	0.5
Mercury	mg/L	N/A	0.000	0.000	0.01	0.005
Arsenic	mg/L	N/A	0.00	0.00	0.1	0.5

*The concentration of chemical substances condensed is estimated, based on the bigger current values.
** Since DO, Residual chlorine are separated by evaporation. These substances will almost not remain in blowdown water. The value of pH will depend on the change of water quality caused by the chemical substances condensed or the change of composition. However, the value of pH will be not estimated many difference.
*** Oil including water drawn from GCN is separated by oil separator at intake point for pre-treatment ,if required.

Source: EIA report, The Project proponent document

(iii) General wastewater discharge

Water of GCN is drawn 72m^3/h to the process of TPS. This used water is recycled and reused in the process. Water of 72m^3/h means supplement water for a reduction caused by vaporization at the boiler etc.

General wastewater from TKG TPS is neutralized using CCDI (Comprehensive cleaning of the industrial discharge), with sludge collected within the project site, and water is collected in the effluent tank and discharged through the wastewater treatment system.

TKG TPS will be equipped with the wastewater treatment system and a rainwater pit to collect oily water as to comply with the regulations in the Uzbekistan and IFC/WB EHS Guidelines (Table 8.5.1-6).

(3) Noise and vibration

(a) Noise

Noise impact during construction/ operation phase was not predicted using a quantitative method in the EIA report. According to the response of project proponent, noise impact was predicted based on the consideration of Navoi TPS (450MW) as the similar project (Each generator scale of TKG TPS is 450MW).

This survey mission was reassess the environmental impact based on the conditions of machinery, vehicle and equipment generated noise in Navoi TPS project.

The nearest residential area is located approximately 1km from TKG TPS to the south.

(i)Construction phase

Using noise level data caused by operation of construction equipment, the predicted noise level is estimated by the following theoretical formula based on "ISO9613 Acoustic Attenuation of sound during propagation outdoors"

$$L_{PA} = L_{WA} - 20\log_{10} r - 8 - A_{\gamma} - A_E$$

[Symbol]

L_{PA}: Noise level at the estimation point (dB)
L_{WA}: A-characteristic correction power level at noise source (dB)
r: Distance from noise source to estimation point
A_{γ}: Amount of attenuation by partition wall (dB)
A_E: Amount of attenuation by air suction (dB)

Noise generated by major construction machinery for the Navoi TPS project is shown in Table 8.5.1-7. The following machines are assumed to be operating simultaneously. In actual practice, excavation and pile driving work are performed sequentially according to the work schedule, so simultaneous operation of all following machines is not frequent.

Table 8.5.1-7 Noise level of major construction machinery

Machine type	Scale	Noise source level (dB)	Number of machines
Truck crane	50t	116	4
Dump truck	11t	113	4
Back hoe	$0.6m^3$	110	2
Bulldozer	11t	99	1
Hydraulic hammer	4.5t	95	2
Concrete pumping car	65～$85m^3/h$	113	2
Concrete mixer	4.5 m^3	105	4
Air compressor	10.5～11.0^3/min	105	5

Figure 8.5.1-11 shows noise level distribution during the operation of the construction machinery.

The Attained noise level resulting from the operation of the construction machinery is approximately 60-70dB at the boundary of the site, and below approximately 53 dB at a residential area 1km from the boundary.

Predicted noise level at residential area is 53-55 dB in daytime, which meets daytime environmental standards in the Uzbekistan and IFC/WB guidelines but exceeds the nighttime standard of 45dB (Table 8.5.1-8).

However, construction work will only be conducted during daytime. Moreover, the schedule management will be performed to ensure leveling of the amount of construction work wherever possible, and the state-of-the-art low-noise equipment will be introduced. Thus, efforts will be made to minimize the noise impact.

Table 8.5.1-8 Predicted noise level at residential area during construction period

Time zone	Background at residensial area (dB)	Attained noise level caused by facilities (dB)	Predicted Noise level (dB)	Environmental standards for Uzbekistan and IFC/WB guidelines
Day time (7-23)	41-52	<53	53-55	55

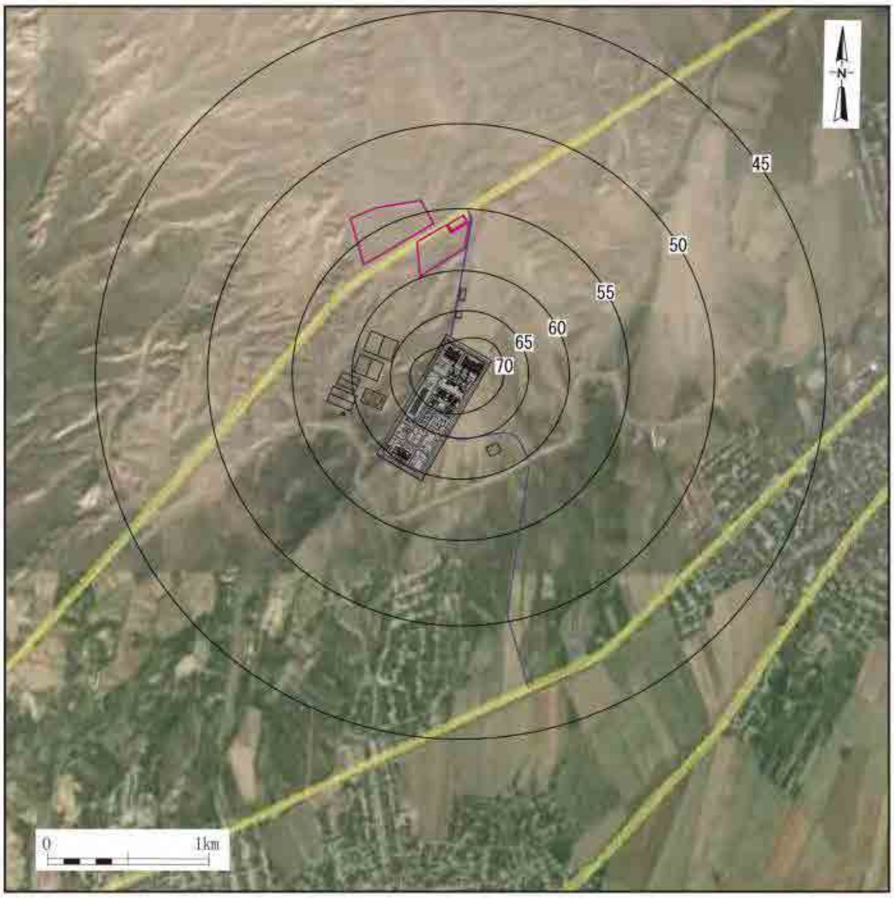


Figure 8.5.1-11 Distribution of noise levels during construction phase

(ii) Operation phase

The major facilities generating noise is shown in Table 8.5.1-9. The major sources of noise come from the turbine, pumps, air compressors, and cooling tower.

Noise levels were simulated in accordance with the same theoretical formula while in the construction phase. Likewise, the prediction area boundary is set to an approximate 1km radius of TKG TPS.

Table 8.5.1-9 Noise level of plant facility (Each Unit)

Machine type	Noise source level(dB)	Octave band (Hz)							
		63	125	250	500	1000	2000	4000	8000
HRSG	75.0	73.7	51.3	59.3	57.4	59.8	62.5	66.2	47.6
Water supply pump	91.6	71.0	77.0	87.0	88.0	80.0	79.0	78.0	73.0
Cooling tower fan	85.0	68.0	70.0	78.0	78.0	80.0	75.0	75.0	70.0
Stack	80.4	76.4	76.7	70.5	68.2	60.8	53.5	52.1	55.9
Circulation water pump	98.9	85.0	85.0	88.0	91.0	94.0	92.0	89.0	86.0
Gas turbine	80.3	52.2	63.5	69.0	69.5	74.2	76.0	73.3	55.3
Steam turbine	80.0	48.0	52.2	72.0	73.1	75.1	74.8	62.2	49.5
Gas compressor	99.3	75.5	85.5	91.5	92.5	94.5	92.5	85.5	76.5
Condensate pump	90.4	49.2	63.0	72.4	80.8	86.0	85.8	81.7	73.9

Note:

1. Noise source level is calculated from A-characteristic correction power level at 1m from noise source.
2. Calculation under the condition that gas turbine and steam turbine are equipped with a cover.

Figure 8.5.1-12 shows the distribution of noise levels from TKG TPS.

The Attained noise level caused by facilities is approximately 55-70dB at the boundary of the site, and below approximately 44 dB at residential area of 1km away from the boundary.

Predicted Noise level at residential area is 46-53 dB in daytime, and 45 dB in nighttime, which meets the daytime/nighttime environmental standards for Uzbekistan and IFC/WB guidelines (Table 8.5.1-10).

Furthermore, further mitigation measures such as " using low-noise type equipment", "planting trees on the boundary of the site", and "installation of soundproof wall" will be considered for several facilities located on southern side of the site, such as water supply pump, circulation water pump and gas compressor , if necessary.

Table 8.5.1-10 Predicted noise level at residential area

Time zone	Background at residensial area (dB)	Attained noise level caused by facilities (dB)	Predicted Noise level (dB)	Environmental standards for Uzbekistan and IFC/WB guidelines
Day time (7-23)	41-52	44	46-53	55
Night time (23-7)	38		45	45

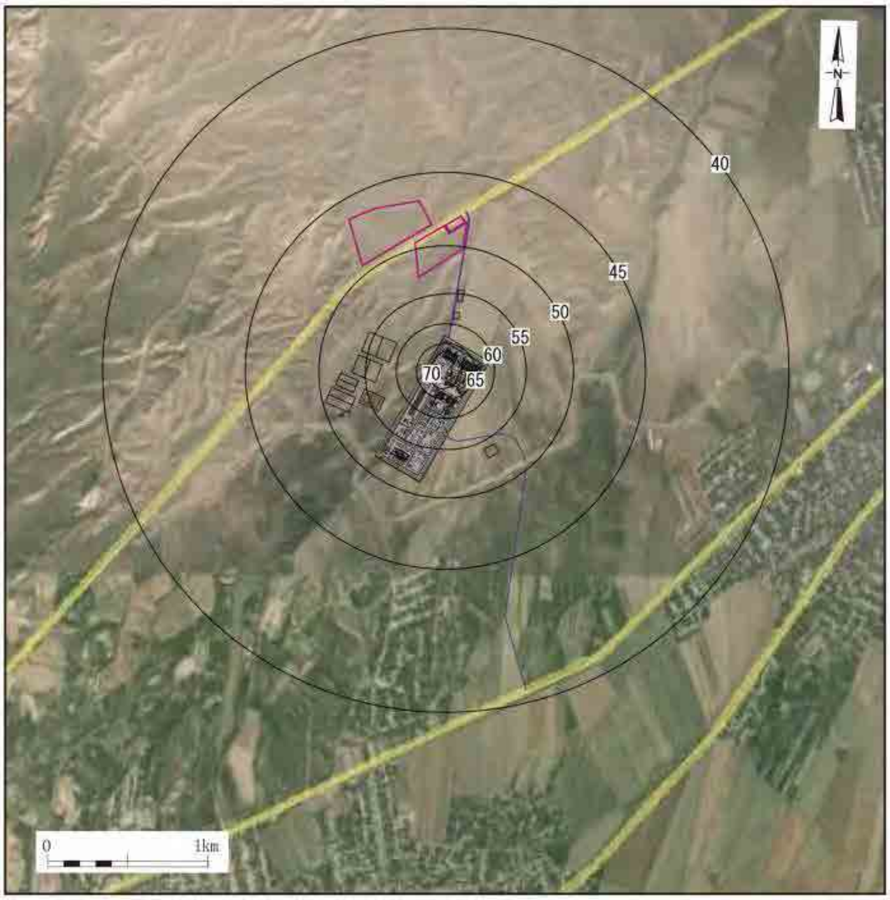


Figure 8.5.1-12 Distribution of noise levels during operation phase

(c) Vibration

Vibration impact during construction/ operation phase was not predicted in EIA report.

The nearest residential area is located approximately 1km to the south from TKG TPS. This survey mission was reassess environmental impact based on the conditions of vibrations generated by machinery, vehicle and equipment in Navoi TPS project, as the similar project.

(i) Construction phase

The major construction machinery generated vibration is shown in Table 8.5.1-9. The major construction machinery used in construction work includes a dump truck, bulldozer and back hoe for excavation, a hydraulic hammer used for pile driving, a truck crane for transportation of the equipment and material, and a mixer for producing concrete.

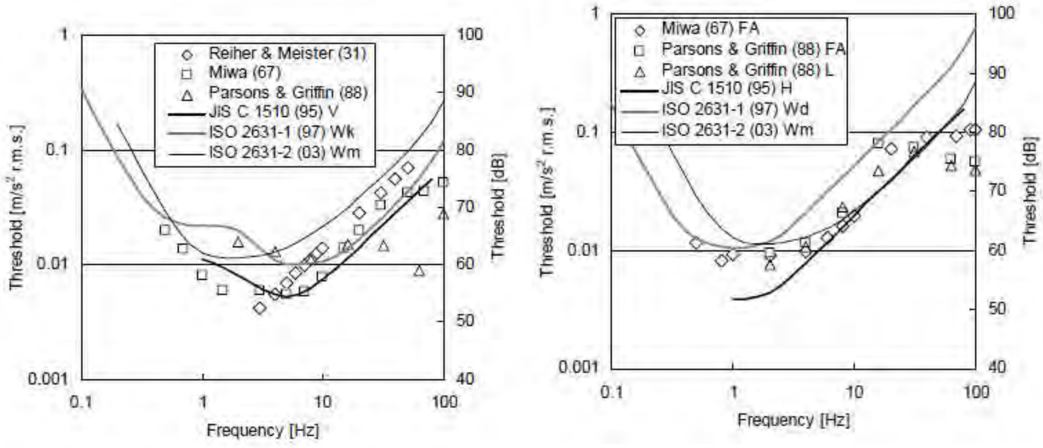
Table 8.5.1-9 Vibration level of construction power station machinery

Machine type	Scale	Vibration level by distance(dB)			
		5m	100m	200m	300m
Truck crane (hydraulic)	50t	69	47	36	25
Dump truck	11t	69	47	36	25
Back hoe	$0.6m^3$	80	59	47	37
Bulldozer	11t	75	64	53	42
Hydraulic hammer	4.5t	80	59	47	37

Table 8.5.1-10 shows the distribution of vibration levels at a distance from sources. The vibration level is below approximately 40dB at 300m. The residential area located approximately 1km from TKG TPS site

In case more than 55dB is produced, as based on Figure 8.5.1-13, evaluation for vibrations should be considered.

Therefore, vibration impact caused by project is insignificant.



(The case of vertical vibration)   (The case of horizontal vibration)

Figure8.5.1-13 Study of evaluation of vibratory sensation

Source: Yasunao Matsumoto, Evaluation of vibratory with respect to human response, Japan Society of Civil Engineers, 2005

(ii) Operation phase

The major facilities which generate vibration are shown in Table 8.5.1-11. The major sources of vibration includes turbine, pumps, and compressors. Machinery which generate large amounts vibration in TPS are installed on strong foundations, and vibration levels attenuates with distance.

Vibration level at the residential area located approximately 1km from TKG TPS site is less than 30dB, as shown in Table 8.5.1-10.

In addition, residents are forbidden to live within SPZ established 500m away from the TPS boundary.

Therefore, vibration impact caused by project is insignificant as well as construction phase.

Table 8.5.1-10 Vibration level of plant facility (Each Unit)

Machine type	Vibration level by distance(dB)		
	1m	100m	300m
Circulation water pump	67	38	16
Gas turbine	80	51	29
Steam turbine	74	45	23
Gas compressor	58	29	2

8.5.2 Environmental assessment

The environmental impact assessment according to the results of the survey is described in Table 8.5.2-1, 2. Chapter 8.12 is referred for more details as the environmental checklist.

Table 8.5.2-1 The result of environmental assessment (Thermal power station)

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Constructi on period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
【Pollution】										
1	Air pollution	N	B	N	A	N	B	N	B	Construction phase: Generation of dust by land preparation and other construction work is expected. Generation of air pollutant (SOx, NOx, and others) from operation of heavy machines and trucks is predicted, but the impact will be limited only within the surrounding area. Operation phase: Natural gas is used and very little SO_2 and dust is generated from the gas turbine, but NOx is emitted. The maximum concentration at ground level was complied with Environmental standard of Uzbekistan as well as IFC/WB EHS Guidelines.
2	Water pollution	N	B	N	B	N	B	N	B	Construction phase: Turbid water is generated by dredging work and land preparation work, but the impact will be limited only within the surrounding area. The concrete wastewater and oil-containing wastewater are generated during construction phase. The wastewater is collected in a specially designed pond and transported by special vehicles to the treatment facility in Namangan city. The domestic wastewater is collected in a tank and transported by special vehicles to the treatment facility in Namangan city. Operation phase: Effluent generated by the operation of the plant is discharged into the artificial irrigation channel. Plant effluent and other effluent are treated before discharge. As thermal effluent is small in quantity compared to water flow in the artificial

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Construction period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
										irrigation channel, water temperature rise will be less than 1°C and the affected water area will be limited to the vicinity of the water outlet. Domestic wastewater generated by the project will be discharged into the public sewage line.
3	Waste	N	B	N	B	N	B	N	B	Construction phase: Domestic waste, waste oil and hazardous waste will be generated by the construction work. However, project proponent will arrange for the development of a waste management program. Operation phase: Domestic waste, waste oil and hazardous waste will be generated. However, project proponent will arrange for the development of a waste management program.
4	Soil pollution	N	B	N	B	N	B	N	B	Construction phase: There is the possibility of soil pollution caused by leakage of lubricant and fuel oil from construction vehicles and machines. Operation phase: There is the possibility of soil pollution caused by leakage of lubricant and fuel oil from operation of TPS.
5	Noise and vibration	N	B	N	B	N	B	N	B	Construction phase: Impact of noise and vibration is predicted caused by operation of heavy machines and trucks, but it will be limited only in the surrounding area. Impact by activity of high noise level including piling may extensive, but construction activity is during daytime and temporary. Noise standard for daytime will be complied. In addition, it is not carried out construction work during nighttime. Therefore, noise is not created by night work. Operation phase : Impact of noise and vibration is predicted caused by operation of the plant, but the nearest residential area is 1km away and the impact will be insignificant. Noise standard will be complied.
6	Ground Subsidence	N	N	N	N	N	N	N	N	Construction/operation phase: no ground water will be taken.

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Construction period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
7	Offensive odor	N	B	N	B	N	B	N	B	Construction phase: In case domestic waste from the workers' camp is not appropriately treated, offensive odor of rotten waste may be generated. Operation phase: In case domestic waste was not appropriately treated, offensive odor may be generated.
8	Bottom sediment	N	B	N	B	N	B	N	B	Construction/operation phase: Discharge of untreated effluent may cause sediment pollution.
【Natural environment】										
1	River water	N	N	N	N	N	N	N	N	Construction/operation phase: Water used in the plant will be taken from the artificial irrigation channel, and river water will not be taken.
2	Ground water	N	N	N	N	N	N	N	N	Construction/operation phase: Ground water pumping is not conducted in construction and operation phase.
3	Protected area	N	N	N	N	N	N	N	N	The project site is not located within the protected area, and there is no protected area within 50km.
4	Terrestrial ecosystem and precious species	N	C	N	C	N	N	N	N	Construction/operation phase: The project site is composed cultivated land, pastureland, and unusable land with poor vegetation. No precious species of flora/fauna inhabit the project site. Impact of terrestrial ecosystem is estimated to be insignificant.
5	Marine ecosystem and precious species	N	N	N	N	N	N	N	N	Construction/operation phase: The project does not correspond to this section.
6	River ecosystem	N	B	N	B	N	N	N	N	Construction/operation phase: The increased amount of water intake for TPS will be supplied by discharging the equivalent amount of water from the upstream water basin. As result, the adverse impact on aquatic organism will be very limited. Very little aquatic organism is found in the artificial irrigation channel and the river supplying water into the artificial irrigation channel, and the adverse impact on the ecosystem will be very limited.
7	Marine condition	N	N	N	N	N	N	N	N	Construction/operation phase: The project does not correspond to this section.

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Construction period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
8	Geographical features	N	N	N	N	N	N	N	N	Construction/operation phase: The project site is located in the gently- sloped alluvial plain and the geographical features will not be altered.
【Social environment】										
1	Involuntary resettlement Land acquisition	N	B	N	N	N	N	N	N	Project site is governmental land and involuntary resettlement does not occur. The compensation for land acquisition will be conducted in accordance with law s and regulations.
2	Poor People	N	C	N	C	N	N	N	N	All citizens are guaranteed human rights and minimum income by law and regulation. There are no poor people defined by World bank around the project site. Reference: 1) There is no official term as “Poverty Threshold” in Uzbekistan. However, the rate of minimum wage per month (96 105 soum ; US$ 41.72(US$1.4/day (Exchange rate11.06.2014))* is officially established. *The name of Law is Decree President of the Republic of Uzbekistan About increasing the salaries, pensions, stipends and allowances (Legislative Assembly of the Republic of Uzbekistan, 2013, № 49, p. 631) This rate is more than US$1.25 a day as the poverty rate defined by World bank. 2) All citizens are guaranteed Citizenship, Personal Rights and Freedoms, Political Rights, Economic and Social Rights, and Guarantees of Human Rights and Freedoms by “Constitution of the Republic of Uzbekistan”.
3	Minorities	N	N	N	N	N	N	N	N	There are no minority groups living around the project site.
4	Deterioration of Local Economy such as Losses of Employment and Livelihood Means	B	N	B	N	B	N	B	N	Construction phase: There is a possibility that local residents are employed for construction work and construction material and equipment are purchased from the local area. Operation phase: New jobs will be created by the operation of TPS.
5	Land Use and Utilization of Local	N	C	N	C	N	N	N	N	Construction/operation phase: Project site is on governmental land and involuntary resettlement does not

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Construction period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
	Resources									occur. Because of the project site that composed cultivated land, pastureland, and unusable land, land use and utilization of local resources are hardly disturbed by the project.
6	Water use	N	C	N	C	N	N	N	N	Construction phase: The project site is composed cultivated land, pastureland, and unusable land. GCN is the artificial irrigation channel, and fishery is not conducted. In addition, fishery is not conducted in Kasansai river. Local residents near the project site are not using GCN as waterworks. Therefore, water use is hardly disturbed by the project. Operation phase: The increased amount of water intake for TPS will be supplied by discharging the equivalent amount of water from the upstream water basin. Therefore, water use is hardly disturbed by the project. As for potable water for TPS and the residential housing for power station staff (The amount of water is 160m^3/day), the project proponent places water pipeline newly. Since artesian well as water source has sufficient supply capacity (3,840m^3/day/well), there is no shortage of drinking water for local residents.
7	Existing Social Infrastructure and Services	N	B	N	B	N	B	N	B	Construction phase: Increased number of workers and their family may lead to the need for improvement of infrastructure (houses, medical facility school, waterworks, sewage, and gas pipeline).Commuting of workers will increase the traffic volume of the surrounding roads. Operation phase: The houses for workers (300 people for maintenance) and their family are prepared as part of the project. There may be the need for improvement of infrastructure (houses, medical facility school, waterworks, sewage, and gas

No.	Items	Assessment at the scoping: Construction period: Positive	Assessment at the scoping: Construction period: Negative	Assessment at the scoping: Operation period: Positive	Assessment at the scoping: Operation period: Negative	Assessment based survey results: Construction period: Positive	Assessment based survey results: Construction period: Negative	Assessment based survey results: Operation period: Positive	Assessment based survey results: Operation period: Negative	Reason for assessment
										pipeline). The project proponent plans to lay water pipeline and gas pipeline. As for fuel for TKG TPS, since natural gas will be distributed through the dedicated pipeline by UZBEKNEFTGAZ(Company name), the demand by local residents will be hardly disturbed. In addition, since water source has sufficient supply capacity, there is no shortage of drinking water for local residents.
8	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	N	C	N	N	N	B	N	N	Project site is governmental land and involuntary resettlement does not occur. However, local residents will be compensated for land acquisition, and the consultation with the decision-making organization of the local residents will be necessary.
9	Misdistribution of Benefits and Loss	N	B	N	B	N	B	N	B	Construction/operation phase: There may be inequality of employment of the local residents and contract outsourcing that leads to misdistribution of benefits.
10	Local Conflicts of Interest	N	C	N	C	N	B	N	B	Local residents will be compensated by land acquisition, and local conflicts of interest are anticipated.
11	Cultural heritage	N	C	N	N	N	N	N	N	Historical, cultural and/or archaeological property and heritage does not exist around the project site.
12	Landscape	N	N	N	N	N	N	N	N	There is no scenic area around the project site.
13	Gender	N	N	N	N	N	N	N	N	Construction/operation phase: No specific impact on gender is predicted by the project.
14	Children's Rights	N	N	N	N	N	N	N	N	Construction/operation phase: No specific impact on children's rights is predicted by the project.
15	Infectious Diseases such as HIV/AIDS	N	B	N	N	N	B	N	N	Construction phase: A temporary influx of migrant labor during the construction period may increase the risk of sexual transmitted diseases, etc. Project proponent will develop a safety and sanitation management plan and implement regular medical checkups.
16	Labor	N	B	N	B	N	B	N	B	Construction/operation phase: Labor

No.	Items	Assessment at the scoping: Construction period: Positive	Assessment at the scoping: Construction period: Negative	Assessment at the scoping: Operation period: Positive	Assessment at the scoping: Operation period: Negative	Assessment based survey results: Construction period: Positive	Assessment based survey results: Construction period: Negative	Assessment based survey results: Operation period: Positive	Assessment based survey results: Operation period: Negative	Reason for assessment
	Environment (Including Work Safety)									accidents of workers are predicted at work. Project proponent will implement the project in accordance with the labor law. Project proponent will develop the safety and sanitation management plan and implement the regular medical checkup. Project proponent will subcontract a security firm to deploy security guards.
【Others】										
1	Accidents	N	A	N	A	N	A	N	A	Construction phase: There is the possibility of accidents by construction work and operation of construction vehicles. Operation phase: There is the possibility of accidents by operation of the facility and operation of vehicles.
2	Cross-boundary Impact and Climate Change	N	B	N	B	N	B	N	B	Construction phase: Although CO_2 will be produced by construction work, construction period is limited and cross-boundary pollution and impact on climate change is predicted to be insignificant. Operation phase: CO_2 is produced by the project operation, but with high-efficiency CCPP, CO_2 generation per kWh is lower than in the conventional power generation system and the cross-boundary pollution and impact on climate change will be little.

Notes:The categorization criteria are as follows.

A: causes serious impact.

B: causes certain degree of impact.

N: No impact is expected.

Table 8.5.2-2Theresult of environmental assessment (Transmission line)

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Constructi on period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
【Pollution】										
1	Air pollution	N	B	N	N	N	B	N	N	Construction phase: generation of dust by land preparation and other construction work is expected, but only temporarily. Generation of air pollutant (SOx, NOx, and others) from operation of heavy machines and trucks is predicted, but the impact will be limited only within the surrounding area. Operation phase: Air pollution is not generated.
2	Water pollution	N	C	N	C	N	B	N	N	Construction phase: In case there is a river, soil runoff may occur from exposed soil such as embankment and cut earth causing water turbidity in the downstream of the river. Operation phase: Tower foundation implementation will be conducted as a measure to prevent soil runoff, such as the foundation which placed concrete.
3	Waste	N	B	N	N	N	B	N	N	Construction phase: Unused/spent material will be generated, but the impact will be limited only in the surrounding construction site. The earth and sand will be generated by excavation work However, this earth and sand will be backfill in the construction site or be sold to local residents through local government. Operation phase: No waste will be generated.
4	Soil pollution	N	N	N	N	N	N	N	N	Construction phase: There is the possibility of soil pollution caused by leakage of lubricant and fuel oil from construction vehicles and machines. However, the impact will be limited only in the surrounding construction site. Operation phase: No soil pollution will be generated.
5	Noise and vibration	N	B	N	N	N	B	N	N	Construction phase: Impact of noise and vibration caused by operation of heavy machines and trucks is predicted. However, the impact will be limited only in the surrounding construction site. In addition, construction activity is during the

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Construction period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
										daytime and will be temporary. Operation phase: noise and vibration will not be generated.
6	Ground Subsidence	N	N	N	N	N	N	N	N	Construction/operation phase: no ground water will be taken.
7	Offensive odor	N	N	N	N	N	N	N	N	Construction phase: In case domestic waste from the workers camp is not appropriately treated, offensive odors from rotten waste may be produced. However, due to the comparatively small scale of construction, the impact of offensive odors is estimated to be insignificant. Operation phase: Offensive odor will not be produced.
8	Bottom sediment	N	N	N	N	N	N	N	N	Construction/operation phase: Sediment pollution will not occur.
【Natural environment】										
1	River water	N	N	N	N	N	N	N	N	Construction/operation phase: there is no use of river water.
2	Ground water	N	N	N	N	N	N	N	N	Construction/operation phase: no ground water will be taken.
3	Protected area	N	N	N	N	N	N	N	N	Construction/operation phase: The proposed transmission line route does not pass through the protected area such as national park.
4	Terrestrial ecosystem and precious species	N	C	N	C	N	N	N	N	Construction/operation phase: Proposed sites for tower foundations and transmission line routes are almost all on cultivated land. In addition, the tower foundation is approximately 20m x 20m per tower. The impact of terrestrial ecosystem and precious species is estimated to be insignificant.
5	Marine ecosystem and precious species	N	N	N	N	N	N	N	N	Construction/operation phase: The project does not correspond to this section.
6	River ecosystem	N	N	N	N	N	N	N	N	Construction/operation phase: There is no use of river water.
7	Marine condition	N	N	N	N	N	N	N	N	Construction/operation phase: The project does not correspond to this section.
8	Geographical features	N	C	N	C	N	A	N	A	Construction/operation phase: Based on survey regarding geographical features, the location of transmission towers have been chosen to be on stable plain land. The altered area for

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Construction period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
										transmission tower is narrow. However, there is the possibility of collapse of a tower caused by sediment runoff etc.
【Social environment】										
1	Involuntary resettlement Land acquisition	N	B	N	N	N	B	N	N	Regarding this project, involuntary resettlement does not occur. The compensation for land acquisition will be conducted in accordance with laws regulations.
2	Poor People	N	C	N	N	N	N	N	N	There are no poor people living around the proposed transmission line route.
3	Minorities	N	C	N	N	N	N	N	N	There are no minority groups living around the proposed transmission line route.
4	Deterioration of Local Economy such as Losses of Employment and Livelihood Means	B	N	N	N	N	N	N	N	Construction work will be conducted after autumn after harvest time finishes. In addition, the construction period of a tower is only lasts a few months. The impact of livelihood of local residents is estimated to be insignificant.
5	Land Use and Utilization of Local Resources	N	C	N	C	N	N	N	N	The proposed transmission line route is almost all on cultivated land. The size the tower foundations are approximately 20m x 20m per tower. Local residents can use the land underneath transmission line after construction period. Therefore, land use and utilization of local resources will be hardly disturbed by the project.
6	Water use	N	C	N	C	N	N	N	N	Construction phase: Local residents are using waterworks. Therefore, water use is hardly disturbed by the project. Operation phase: The impact of water use will not be generated.
7	Existing Social Infrastructure and Services	N	N	N	N	N	N	N	N	Construction phase: Construction period is short term comparatively. Whole period of construction is approximately one year. Therefore, existing social infrastructure and services will be not disturbed by the project. Operation phase: The impact of existing social infrastructure and services will not be generated.
8	Social Institutions	N	C	N	N	N	B	N	N	Local residents will be compensated for land acquisition, and the consultation with the

No.	Items	Assessment at the scoping: Construction period: Positive	Assessment at the scoping: Construction period: Negative	Assessment at the scoping: Operation period: Positive	Assessment at the scoping: Operation period: Negative	Assessment based survey results: Construction period: Positive	Assessment based survey results: Construction period: Negative	Assessment based survey results: Operation period: Positive	Assessment based survey results: Operation period: Negative	Reason for assessment
	such as Social Infrastructure and Local Decision-making Institutions									decision-making organization of the local residents will be necessary.
9	Misdistribution of Benefits and Loss	N	B	N	N	N	B	N	N	Construction phase: There may be inequality of employment of the local residents and contract outsourcing that will lead to misdistribution of benefits.
10	Local Conflicts of Interest	N	C	N	C	N	B	N	N	Local residents will be compensated by land acquisition, and local conflicts of interest are anticipated.
11	Cultural heritage	N	C	N	N	N	N	N	N	The proposed transmission line route is almost the cultivated land. The nearest historical monument is located 16km from the proposed route, and there is not a cultural heritage nearby the proposed route.
12	Landscape	N	N	N	N	N	N	N	N	The proposed transmission line route is almost all on cultivated land, and there is no scenic area close to the proposed route.
13	Gender	N	N	N	N	N	N	N	N	Construction/operation phase: No specific impact on gender is predicted by the project.
14	Children's Rights	N	N	N	N	N	N	N	N	Construction/operation phase: No specific impact on children's rights is predicted by the project.
15	Infectious Diseases such as HIV/AIDS	N	B	N	N	N	B	N	N	Construction phase: A temporary influx of migrant labor during the construction period may increase the risk of sexual transmitted diseases, etc. Project proponent will develop a safety and sanitation management plan and implement regular medical checkups.
16	Labor Environment (Including Work Safety)	N	B	N	B	N	B	N	B	Construction/operation phase: There is the possibility of electric shock, falling accident. Labor accidents of workers are predicted at work. Project proponent will implement the project in accordance with the labor law. Project proponent will develop the safety and sanitation management plan and implement regular medical checkups. Project proponent will subcontract a security firm to deploy security guards.

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Construction period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
17	Electromagnetic field (EMF)	N	N	N	B	N	N	N	N	Operation phase: In case of 220kV transmission, the height of transmission line must be kept higher than 7m from the ground based on regulations in "Rules of Electrical Installation". In addition, building the structure from the transmission line center within 25m on both sides is forbidden. Project proponent designs the transmission line route to avoid traversing residential areas. Therefore, the impact of EMF is estimated to be insignificant.
【Others】										
1	Accidents	N	A	N	A	N	A	N	A	Construction/operation phase: There is the possibility of collapse of a tower caused by sediment runoff etc.
2	Cross-boundary Impact and Climate Change	N	N	N	N	N	N	N	N	The transmission line route does not cross the national border. Construction phase :CO_2 will be produced by construction work. However, construction period will be for a short period and the number of equipment and machinery for construction work is comparatively small. Operation phase: CO_2 generation does not occur during operation.

Notes: The categorization criteria are as follows.
A: causes serious impact.
B: causes certain degree of impact.
N: No impact is expected.

8.6 Consideration of alternatives

8.6.1 Zero-option

Namangan region accounts for 4.3% of the land area and 27.2% of Uzbekistan's population of. It is a place of activity for 85 major companies, 84 joint-ventures, and 22,000 small businesses.

Namangan region is expecting appearance of various new businesses such as energy, chemistry, textile, automobile, and fertilizer companies. However, fragility of the power supply system and old facilities which is causing planned outages is ongoing issue.

The project concerns the renovation of old facilities as well as the reinforcement of the power supply system described above. The aging Tashkent Power Plant (150MW×12units), which has been in operation since 1962, is to be sequentially decommissioned.

The project will contribute to the economic growth for 10 million people living in Fergana Valley. Currently, Kazakistan depends on importing electricity from its neighboring country (Kirghiz)。

In fact, the existing facilities and import of electricity cannot cover the increase of electricity consumption in Uzbekistan in the future and in view of the efficient use of the national resource, the zero-option is hardly a conceivable alternative (Table 8.6.1-1).

Table 8.6.1-1 Consideration about zero option

Item	Project implementation	Zero-option
Technical aspect	Construction of access road, gas pipeline, water pipeline, management facility, residential housing is needed.	N/A
Economic aspect	For all construction cost, contribution to the economic growth of Uzbekistan is expected, as well as the improvement of the local economy through employment of local residents, utilization of local resource and equipment.	No construction costs will be required. The issue of electric shortages will not be resolved. No improvement of employment of the local residents, and no contribution to the local economy.
Environmental-social consideration aspect	In order to reduce air pollution, appropriate mitigation measures are required. The existing old facilities stop and smaller amount of CO_2 will be generated by the operation of combined cycle power station.	The existing old facilities will continue to operate.

Source: JICA Study Team

8.6.2 Consideration of alternative project sites

Initially, Government had considered the study of candidate sites for TPS. Thereafter, project proponent has mainly considered about TPS sites. As results, the proposed site was determined in Turakurgan district.

Five alternative sites including the project site are as follows.

1. Turakurgan disitrict (This project site)
2. An exisiting site will be used after shutdown of Ferghana combined heat power station
3. A new site at a distant 1km from Ferghana combined with a heat power station
4. A new site at a distant 2km from Pap ward in Gurumsaray village
5. A new site in Jizzakh region

Our conclusions upon considering the above options are described in Table 8.6.2-1.Figure 8.6.2-1, which shows the location of candidate site.

The proposed project site is considered the most favorable alternative when considering infrastructure requirements such as a fuel and water supply system, access to transportation of materials and equipment, and cost efficiency.

Table 8.6.2-1 Consideration about site selection

Site NO. (Shown in Figure 8.6.2-1)	1	2	3	4	5
Name of candidate sites	Turakurgan disitrict (This project site)	An exisiting site will be used after shutdown of Ferghana combined heat power station	A new site at a distant 1km from Ferghana combined heat power station	A new site at a distant 2km from Pap ward in Gurumsaray village	A new site in Jizzakh region
Geographical features	○	---	---	---	X
Infrastructure	○	X	X	---	X
- Access road	---	---	---	---	X
- Water supply	---	---	---	---	X
- Fuel supply	○	X	X	---	---
- Connection of transmission line	○	X	X	---	---
Land Acquisition/ Resettlement	○	---	---	---	X
Natural environmental aspect(protected area, ecosystem and so on)	○	---	---	X	X
Social environmental aspect (heritage, landscape and so on)	○	---	---	X	X
Economical environmental aspect (construction cost and so on)	○	X	X	X	---
General results (Detailed comments)	Cost - USD 1.0billion Infrastructure- USD 50 million TL length- 80 km Water pipeline- 4 km Gas pipeline- 0.5km Canal- 0.5km Land quality- 28 points*	Cost- USD 1.18billion Infrastructure- USD229 million TL length- 470 km Water pipeline – 4 km Gas pipeline- 17km** Canal- 1.5km Land quality- 40 points	Cost- USD 1.19billion Infrastructure- USD235 million TL length- 470 km Water pipeline- 4 km Gas pipeline- 9.5km Canal- 1.5km Land quality- 52 points	Cost- USD 1.12billion Infrastructure- USD166 million TL length- 139 km Water pipeline- 4 km Gas pipeline- 0.5km Canal- 3km Land quality- 50 points	Cost- USD 1.1billion Infrastructure- USD 90 million TL length- 14 km Water pipeline- 10 km Gas pipeline- 0.5km Canal- 0.5-5km Land quality- 60 points

Remark ○:best, ---: medium, x: lower

* Bonitet index: This index is focused the soil productivity (physical characteristics), and is used for the decision of land value, taxation. This index is 100-point scale, 100points is the highest quality, From 60 to 80 points is assumed "Forest soil", From 30 to 60 points is assumed "incompletely soil" etc.

Reference :For land assessment for agriculture(Ministry of economic development and Trade)
(http://www.innovbusiness.ru/pravo/DocumShow.asp?DocumID=103410&DocumType=13)

** Since the capacity of gas pipeline installed existing site is full, it is necessary to install gas pipeline newly, about 17 km, from main pipe to new site.

Source: JICA Study Team

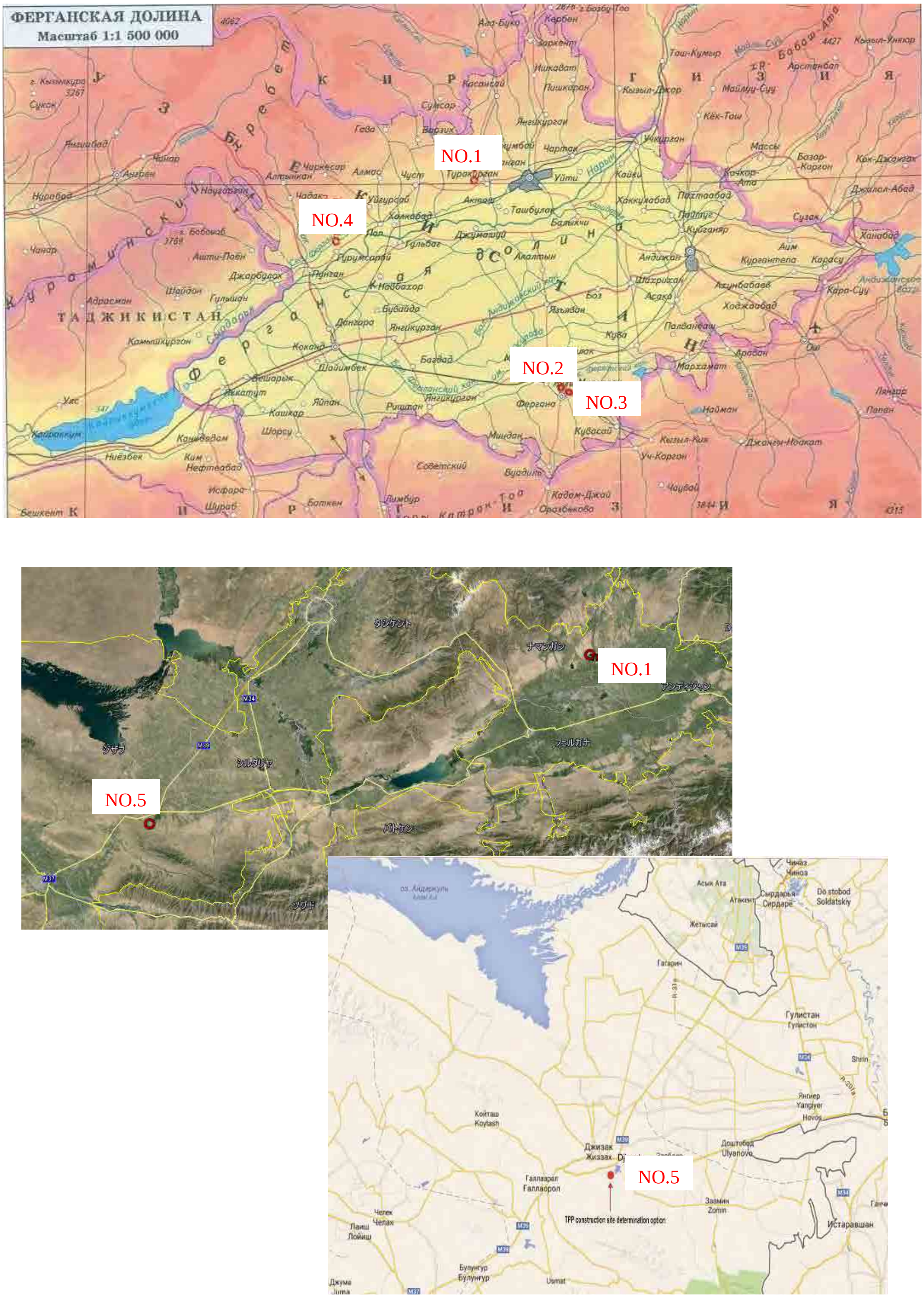


Figure 8.6.2-1 The location of candidate site

8.6.3 Consideration of the power generation method

In the case that natural gas is used for fuel, the existing facility near the project site may be used, which ensures an easy fuel supply and a lower cost for facility construction. Natural gas, which also has advantages from an environmental standpoint, will be adopted for this project.

Table 8.6.3-1 Consideration of fuel for power station

Item	Natural gas	Oil	Coal	Renewable energy
Technical aspect	The existing gas pipeline running near the project site makes fuel supply easy.	Installation of fuel storage and supply facility such as light oil tank is necessary.	Installation of facility for storage and procurement is needed. Ash disposal site should also be constructed.	Renewable energy, though does not consume resources, is low in energy density and vulnerable to restrictions of natural conditions (seasonal changes, wind, etc) and geographic conditions. A backup power station would be needed for the case power is not generated.
Economic aspect	This country has natural gas abundantly. It is economical to use natural gas as fuel for plant. Cost for construction of gas supply facility is low.	High unit price is inevitable. Cost for supply facility construction is also expensive.	Low unit price, high cost for construction of the supply facility. Land acquisition is necessary to install a coal storage site and an ash disposal site.	High facility cost. Power generation of 900MW expected in this project requires a vast area of land (ex.: more than 1,000 ha for solar power generation).
Environmental-social consideration	As fuel used here contains very little ash and sulfur, soot and SOx are not generated.	Dust collector and desulfurization equipment is necessary to treat ash and sulfur in the fuel.	A dust collector shall be installed as fuel contains much ash. A desulfurization system is needed depending on sulfur content. Since large-sized land acquisition is occurred, a significant impact on the local society is predicted.	Air pollutant and CO_2 are not emitted in the process of power generation. CO_2 may be generated depending on the type of backup power station.

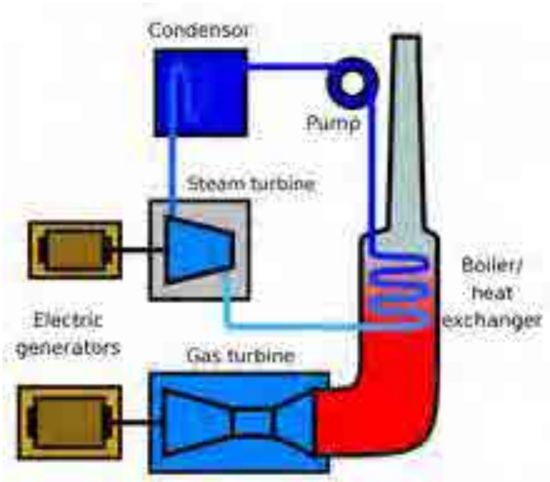
8.6.4 Consideration of the facility

In the case natural gas is used for fuel, combined cycle power generation will be adopted for its high power generation efficiency and advantages in obtaining power sources compared to modifying a conventional power station (Table 8.6.4-1, Figure 8.6.4-1).

There are little heat users around the project site, so the heat supply plant would not be constructed.

Table 8.6.4-1 Consideration of power generation method

Item	Combined cycle thermal power generation	Conventional thermal power generation
Technical aspects	Gas turbine generation is also possible, which makes construction period shorter, while power output is comparatively smaller.	Construction period of conventional thermal power station is longer than that of combined cycle thermal power generation by the number and kind of equipment. Plant cannot be put into operation until the plant is completed.
Economic aspect	Generation efficiency is high and cost per unit generation amount is lower.	Lower generation efficiency and higher cost per unit generation compared to the combined cycle.
Environmental-social consideration	High generation efficiency results in lower CO_2 generation per unit generation amount.	Lower generation efficiency and higher CO_2 emission per unite generation amount compared to the combined cycle.



Source: combined cycle (http://ja.wikipedia.org)

Figure 8.6.4-1Outline of combined cycle generating plant

8.7 Environmental management plan (Mitigation measures)

(1) Implementation system

(a) Construction phase

At the construction phase, the PIU (Project Implementation Unit) of the SJSC Uzbekenergo shall carefully consider the construction activity and encourage the EPC contractor to well understand the necessary mitigation measures and to implement them.

In this regard, an environmental management unit shall be organized prior to the construction activity and an expert environmental management administrator shall be placed.

The unit will discuss and prepare the mitigation measures with supervision consultant and the EPC contractor prior to the construction activity.

During construction activity in which inflow of workers and vehicles is predicted, the PIU with the cooperation of supervisor consultant shall promote the understanding of the surrounding community about the contents and schedule of the construction activity and mitigation measures, collecting the local residents' opinion and correcting the mitigation measures as appropriate.

In order to confirm the implementation of the environmental management and to consider further mitigation measures, the EPC contractor should submit a regular report to the supervision consultant and environmental management unit on the implementation status of the management plan.

PIU shall regularly conduct explanation to the local residents and submit a report to JICA and other relevant organizations about the implementation status of the environmental management, in addition to the environmental monitoring described hereinafter.

Moreover, Grievance Regional Committee shall also function as a grievance organization to understand and address grievances from local residents during construction and operation phase, and conduct appropriate mitigation measures.

Figure8.7-1(1), 2 describes the environmental management and monitoring implementation structure with the reporting flow in construction phase.

Since the operation of transmission lines is included in TKG TPS project, fundamental procedure is the same structure of TKG TPS.

(b) Operation phase

TKG TPS is responsible for organizing an environmental management unit to develop and implement the environmental management plan as a mitigation measures.

TKG TPS shall be placed so that the environmental management plan is appropriately implemented.

TKG TPS shall enhance the understanding of the environmental management plan to the project staff prior to the operation and continue regular education of the staff during operation phase.

The administrator of TKG TPS shall report the contents and implementation status of the environmental management plan and the environmental monitoring plan described below to the director of the plant, with the director taking final responsibility.

The administrator of TKG TPS shall regularly conduct explanation to the relevant organizations and the administrator of the SJSC Uzbekenergo. And the administrator of the SJSC Uzbekenergo submits a report to JICA about the implementation status of the environmental management, in addition to the environmental monitoring described hereinafter.

Figure 8.7-1(2) describes the environmental management and monitoring implementation structure with the reporting flow in operation phase.

Since the management of transmission lines* is conducted by the administrator of TKG TPS, fundamental procedure is the same structure of TKG TPS.

* The maintenance and inspection of transmission line will be conducted by Magistralraya Elecktro Set (Subsidiary of the SJSC Uzbekenergo).

In addition, the project proponent should discuss about environmental management plan with JICA in JICA's appraisal mission.

(2) Mitigation measures

Regarding TPS and the transmission line, major environmental impacts, mitigation measures, responsible organizations, and expenses for each environmental item in construction/ operation phase are listed in Table 8.7-1, 2.

Mitigation measures for transmission line in operation phase are not described in Table 8.7- 2. Achievement of mitigation measures for transmission line means that facility maintenance checks and safety inspections for the transmission line and tower will be conducted regularly in accordance with regulation/law.

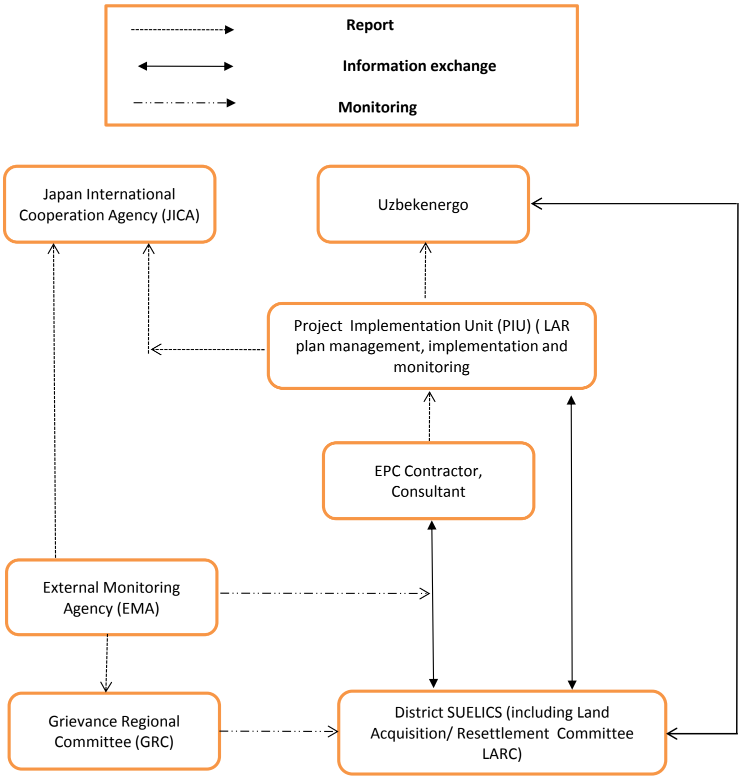


Figure 8.7-1(1) Environmental management and monitoring implementation structure of construction phase for TKG TPS and Transmission line

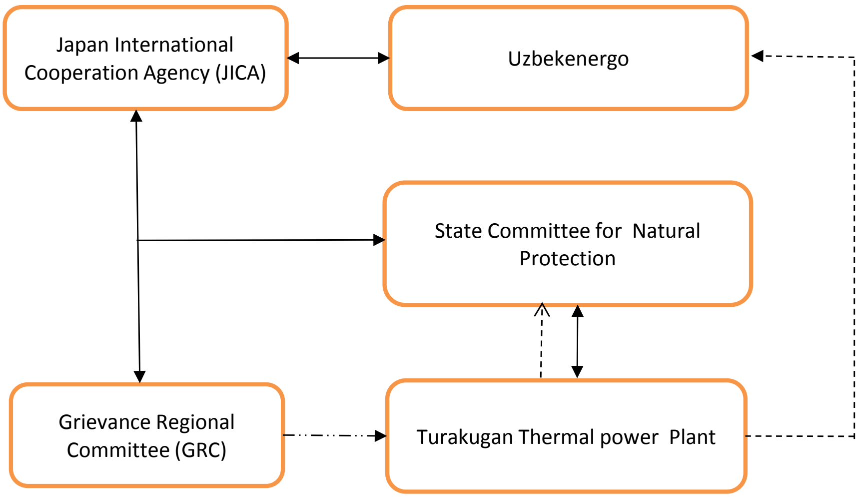


Figure 8.7-1(2) Environmental management and monitoring implementation structure of operation phase for TKG TPS and Transmission line

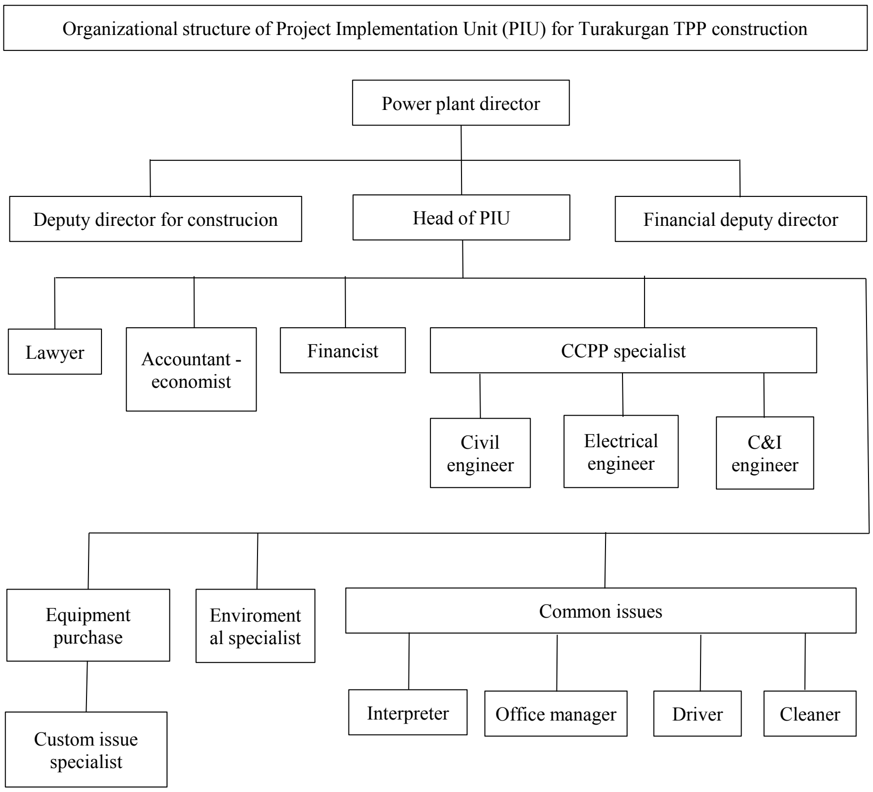


Figure 8.7-2The Structure of PIU

Table 8.7-1 Environmental management plan (Thermal power station)

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
Construction phase					
Air pollution	Temporary emission of air pollutants (SOx, NOx, etc) from heavy machines and vehicles and flying dust may occur	-Periodic checkup and maintenance of vehicles -Shutdown of engine during waiting time -The rear deck of the sand-transport trucks shall be covered -Periodic car wash -Periodic watering of the site and surrounding road in case of strong wind -Monitoring of ambient air in the residential area compared to the standard of Uzbekistan and IFC/WB EHS Guidelines	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Water pollution	Turbid water after rain, domestic wastewater generated by workers is temporarily generated	-Installation of temporary rainwater drainage -Installation of temporary sedimentation pond and oil-separating system -Installation of septic tank and temporary toilet -Monitoring of river water quality compared to the standard of Uzbekistan	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Waste	Domestic waste, waste oil, waste material will be generated	-Development of waste management program including education of workers to encourage reduction and reuse of waste -Prohibition of illegal dumping -Storage of waste oil and chemical materials in a storage site and method to prevent permeation into ground -Separation of waste by waste type, storage in an appropriate storage site and legal disposal in an appropriate disposal site	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Noise and vibration	Temporary noise from the construction machines and vehicles will be generated	-Periodic checkup and maintenance of vehicles -Construction activity and traffic of vehicles is essentially limited to daytime -Use low-noise/vibration type equipment	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor;	Expense is included in EPC contract cost by EPC Contractor.

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
		-Temporary soundproof wall around the project site -Monitoring of Noise level at site boundary and the residential area compared to the standard of Uzbekistan and IFC/WB EHS Guidelines		PIU, Supervisor-consultant	
Terrestrial ecosystem	Air pollution, noise and vibration may be generated during construction	-Implementation of mitigation measures for air pollution, noise and vibration	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
River ecosystem	Water turbidity caused by construction work	-Implementation of mitigation measure for water pollution	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Employment and livelihood	Income gap between the project workers and the local residents may occur	-Priority in employment of local residents, especially project-affected people -Provision of job training for employment	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Local conflict of interest	Inequality among affected people may occur by compensation.	-Supervision of Implementation of LARAP -Construction of relationship between relevant authorities	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Local society	-Influx of workers may generate infectious disease, HIV, conflict with local residents -Influx of workers and their	-Compliance of safety regulations and laws -Development of a safety and sanitation management plan and implementation regular medical checkups -Development of necessary infrastructures for the	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU,	Expense is included in EPC contract cost by EPC Contractor.

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
	family may require establishment of social infrastructure such as medical facility, schools, road, sewage line, etc. -Increase of traffic and damage of the road in the surrounding area.	contractor's mobilization area according to the EPC contract -Slowdown of vehicles in the residential and school area -Traffic of construction vehicles during school commuting hours shall be avoided -Checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake, horn)		Supervisor-consultant	
Labor environment	-There is a risk of workers getting in a labor-related accident. -There is a risk that security agents threaten the security of the local residents.	-Compliance of safety regulations and laws -Development of a safety and sanitation management plan and implementation regular medical checkups -The workers will have a medical examination every year -Construction of a medical facility on the work site with an onsite nurse -Establishment of a cooperative relationship with the local medical facilities	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Accident	-There is the possibility of accidents by construction work and operation of construction vehicles.	-Compliance of safety regulations and laws -Traffic of construction vehicles during school commuting hours shall be avoided -Checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake, horn)	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Global warming	Temporary emission of CO_2 from heavy machines and vehicles	-Rationalization of construction schedule: minimize heavy machine operation and material transportation	Before starting construction activity	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
Operation phase					
Air pollution	Very little SO_2 and dust is generated from the gas turbine, but NOx is emitted	-Use of natural gas -Introduction of low NOx combustion appliances -Use of high stack -Monitoring exhaust gas and ambient air in the residential area compared to the standards of Uzbekistan and IFC/WB EHS Guidelines	Continuously	TKG TPS	Uzbekenergo/ TKG TPS
Water pollution	Cooling tower blowdown and washing wastewater from water demineralizer will be generated	-Installation of water treatment facility -Drain system will be introduced to gather oily rain water -Monitoring of wastewater and river water compared to the standard of Uzbekistan and IFC/WB EHS Guidelines	Continuously	TKG TPS	Uzbekenergo/ TKG TPS
Waste	Waste oil, sludge, domestic Waste will be generated	-Prohibition of illegal dumping -Return waste oil to the suppliers to treat it appropriately -Separation of waste by hazard level, storage in an appropriate sites and legal disposal in an appropriate disposal site -Monitoring of generated waste in the project site and associated facilities	Continuously	TKG TPS	Uzbekenergo/ TKG TPS
Noise and vibration	Noise from cooling tower fan, turbine and pumps is predicted	-Prohibition of construction work during nighttime -Use low-noise equipment -Use of GT enclosure, GT intake silencer, louver for cooling tower, turbine building -Use of low-vibration equipment -Construction of buildings with strong foundation -Regular maintenance of the equipment -Tree-planting and installation of soundproof wall around the project site, if needed -Monitoring of Noise level at site boundary and the residential area compared to the standards of Uzbekistan and IFC/WB EHS Guidelines	Continuously	TKG TPS	Uzbekenergo/ TKG TPS

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
Terretrial ecosystem	Air pollution and noise/vibration resulting from power generation will cause negative effect to terrestrial organisms	-Implementation of mitigation measure for air pollution, noise/vibration	Continuously	TKG TPS	Uzbekenergo/ TKG TPS
River ecosystem	Water turbidity may be caused by power generation activity	-Water pollution mitigation measures shall be conducted	Continuously	TKG TPS	Uzbekenergo/ TKG TPS
Employment and livelihood	Income gap between the project workers and the local residents may occur	-Priority in giving local residents employment opportunities -Provision of job training for employment	Continuously	TKG TPS	Uzbekenergo/ TKG TPS
Local society	-Influx of workers may generate infectious disease, HIV, conflict with local residents. -Influx of workers and their family may require establishment of social infrastructure such as medical facility, schools, road, sewage line, etc. -Increase of traffic and damage of the road in the surrounding area.	-Slowdown of vehicles in the residential and school area -Traffic of vehicles during school commuting hours shall be avoided -Checking traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake, horn)	Continuously	TKG TPS	Uzbekenergo/ TKG TPS
Labor environment	- There is a risk of workers getting in a labor-related accident. -There is a risk that security agents will threaten the security of the local residents	-Compliance of safety laws and regulations and laws -Development of a safety and sanitation management plan and implementation of regular medical checkups -The workers will have a medical examination every year -Establishment of cooperative relationship with the local medical facilities	Continuously	TKG TPS	Uzbekenergo/ TKG TPS

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
Accident	-Fire disaster, serious accident may occur during operation of TKG TPS -There is the possibility of accidents by work	-Development of gas-leakage prevention management plan -Gas-leakage alarm system -Installation of stationary fire prevention system, fire hydrant, fire extinguisher, fire escape exit, fire alarm, fireproof compartment, emergency exit, etc. -Installation of automatic control system - Construction of fire-fighting facility -Compliance of safety regulations and laws -Inspection of equipment -Checking of traffic regulations, driving safety education, checkup of vehicle equipment (brake, horn)	Continuously	TKG TPS	Uzbekenergo/ TKG TPS
Global warming	CO_2 emission caused global warming is generated by operation of TKG TPS	-Adoption of high-efficiency combined cycle power generation system and maintenance of capacity of the facility	Prior to the construction	TKG TPS	Uzbekenergo/ TKG TPS

Table 8.7-2 Environmental management plan (Transmission line)

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
Construction phase					
Air pollution	Temporary emission of air pollutants (SOx, NOx, etc) from heavy machines and vehicles and flying dust may occur	-Periodic checkup and maintenance of vehicles -Shutdown of engine during waiting time -The rear deck of the sand-transport trucks shall be covered -Periodic car wash -Periodic watering of the site and surrounding road in case of strong wind -Monitoring of ambient air in the residential area compared to the standard of Uzbekistan and IFC/WB EHS Guidelines	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Water pollution	Turbid water after rain	- Tower design with consideration of the elevation of tower foundations around the river - Foundation which placed concrete - Installation of temporary rainwater drainage and the connection of existing drainage system	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Waste	Domestic waste, waste oil, waste material will be generated	- Development of waste management program including education of workers to encourage reduction and reuse of waste - Storage of waste oil and chemical materials in a storage site and method to prevent permeation into ground - Prohibition of illegal dumping - Transportation of the drilled soil to storage site for backfill or sale	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Geology and soil	Landslide, collapse of tower will be generated	- Check of the stability of slope /hill -In case of excavation work, the consideration of reinforcement work for slope /hill - Reclamation/ restoration of construction site	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU,	Expense is included in EPC contract cost by EPC Contractor.

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
				Supervisor-consultant	
Noise and vibration	Temporary noise from the construction machines and vehicles will be generated	-Prohibition of construction work during nighttime - Periodic checkup and maintenance of vehicles -Construction activity and traffic of vehicles is essentially limited to daytime -Use low-noise/vibration type equipment -Temporary soundproof wall around the project site -Monitoring of Noise level at site boundary and the residential area compared to the standard of Uzbekistan and IFC/WB EHS Guidelines	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Terrestrial ecosystem	Air pollution, noise and vibration may be generated during construction	-Implementation of mitigation measures for air pollution, noise and vibration -The start of construction from autumn to avoid period of the breeding and feeding -To avoid the use of nesting for birds on towers, the tower will be painted colors that will repel them, along with the installation of a guard. - Collection of plant bulbs/seeds during civil work, putting to practical use during the backfilling	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Local society	-Influx of workers may generate infectious disease, HIV, conflict with local residents -Influx of workers and their family may require establishment of social infrastructure such as medical facility, schools, road, sewage line, etc. -Increase of traffic and damage of the road in the surrounding area	-Compliance of safety regulations and laws -Development of a safety and sanitation management plan and implementation regular medical checkups -Development of necessary infrastructures for the contractor's mobilization area according to the EPC contract -Slowdown of vehicles in the residential and school area -Traffic of construction vehicles during school commuting hours shall be avoided -Checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake,	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
		horn) - The height of transmission line must be secured more than 7m from ground by regulation - To build the structure from the transmission line center to 25 m of both sides is forbidden			
Labor environment	-There is a risk of labor accident of workers -There is a risk that security agents threaten the security of the local residents	-Compliance of safety laws and regulations and laws -Development of safety and sanitation management plan and implementation of regular medical checkup -Construction of a medical facility on the worksite with an onsite nurse -Establishment of a cooperative relationship with the local medical facilities	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Accident	-There is the possibility of accidents by construction work and operation of construction vehicles.	-Compliance of safety regulations and laws -Traffic of construction vehicles during school commuting hours shall be avoided -Checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake, horn)	Continuously	Implementation; EPC Contractor, Ecological consultant Supervisor; PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
Operation phase					
Geology and soil	Landslide, collapse of tower will be generated	- Check of the stability of slope /hill -Facility maintenance checks and safety inspections for towers	Continuously	TKG TPS	Uzbekenergo/ TKG TPS
Labor environment	-There is a risk of labor accident of workers.	-Compliance of safety laws and regulations and laws -Development of safety and sanitation management plan and implementation of regular medical checkup -Establishment of a cooperative relationship with	Continuously	TKG TPS	Uzbekenergo/ TKG TPS

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
		the local medical facilities			
Accident	-Collapse of tower, serious accident may occur. -There is the possibility of accidents by work	-Compliance of safety regulations and laws -Inspection of transmission tower -Checking of traffic regulations, driving safety education, checkup of vehicle equipment (brake, horn)	Continuously	TKG TPS	Uzbekenergo/ TKG TPS

8.8 Environmental monitoring plan

The details of the environmental monitoring plan for TKG TPS, Transmission line during construction and operation phase are shown in Table 8.8-1, 2, and the overview is described below.

Environmental monitoring implementation structure with the reporting flow is shown in Figure 8.7-1 (Previous chapter).

In addition, the project proponent should discuss about environmental monitoring plan with JICA in JICA's appraisal mission.

-TKG TPS-

< Construction phase >

(1) Air quality

NOx(NO, NO_2)and Suspended particles (dust) are used as parameters. The monitoring locations have not been decided yet. Project proponent will decide after completion of a detailed design.

(2) River water quality

TSS, pH, Oil & grease are used as parameters. The monitoring location is the outlet point in GCN.

(3) Noise and Vibration

Noise and Vibration level is to be used as a parameter. The Monitoring locations have not been decided yet. Project proponent will decide after completion of detail design.

(4) Waste

Waste management practice in storage and disposal are used as parameters. The monitoring locations are project site and associated facilities.

(5) Ecosystem

Status of fauna, flora and river organisms are used as parameters. The locations to be monitored are wells, excavation sites and soil storage sites.

(6) Geology and soil

Status of geology and soil (Soundness evaluation including such as the stability of sloop, ground transformation, the leakage of hazard materials) are used as a parameter. The monitoring location is Turakurgan area.

(7) Labor and working conditions

Adherence to laws and regulations is used as parameter. The monitoring location is the construction site.

(8) Accident

Adherence to laws and regulations, the checkup of vehicle equipment are used as parameter. The monitoring location is the construction site and access road.

(9) Grievances

Numbers, contents, and processing results of grievances are used as a parameter.

< Operation phase >

(1) Air quality

NOx (NO, NO_2)is used as a parameter. The Monitoring locations have not been decided yet. Project proponent will decide upon completion of a detailed design.

(2) Exhaust Gas emission

NOx (NO, NO_2) is used as a parameter. The monitoring point is gas ducts.

(3) Wastewater

Chemical substances, TSS, pH, Oil & grease are used as parameters. Measurement parameters shall be based on Uzbekistan regulations and IFC EHS Guidelines for TPS (2008).

The monitoring points are the outlet of the wastewater treatment system for cooling tower blowdown and treatment wastewater.

(4) River water quality

Chemical substances, TSS, pH, Oil & grease are used as parameters. Measurement parameters shall be based on Uzbekistan regulations.

The monitoring locations have not been decided yet. Project proponent will decide after completion of detail design.

(5) Waste

Waste management practice in storage and disposal are used as parameter.

The monitoring location is the disposal (dumping) site.

(6) Noise

Noise level is used as a parameter. The Monitoring locations have not been decided yet. Project proponent will decide upon completion of a detailed design.

(7) Labor and working conditions

Adherence to laws and regulations is used as a parameter. The monitoring location is the construction site.

(8) Accident

Adherence to laws and regulations, the checkup of vehicle equipment, and the soundness of facilities are used as parameter. The monitoring location is TPS site and access road.

(9) Electromagnetic field (EMF)

EMF Intensity is used as a parameter. The monitoring location is the Control room and electrical room.

(10) Grievances

Numbers, contents, and processing results of grievances are used as a parameter.

-Transmission line-

< Construction phase >

Monitoring is conducted for the impacts of construction activity. Monitored items and methods are fundamentally the same as the case for TKG TPS.

< Operation phase >

(1) Geology and soil

Facility maintenance checks and safety inspections for the transmission line and tower will be conducted regularly. These inspection results are the monitored items.

(2) Labor and working conditions

Adherence to laws and regulations is used as a parameter. The monitoring location is the construction site.

(3) Accident

Adherence to laws and regulations, the checkup of vehicle equipment, and the soundness of towers are used as parameter. The monitoring location is the proposed transmission line route and access road.

(4) Grievances

Numbers, contents, and processing results of grievances are used as a parameter.

Table 8.8-1 Items, location, method, frequency, responsibility and expense of the environmental monitoring plan for thermal power station

No.	Item		Method	Location	Frequency	Responsibility	Budget
Construction phase							
1	Air quality	NOx (NO, NO_2), Suspended particles (Dust)	Ambient air quality analyzers	Decision after completion of detail design	Quarterly, Once a week	EPC Contractor, Ecological consultant, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
2	River water quality	pH, TSS, , oil and grease	Sample analysis	Outlet (GNC)	Quarterly	EPC Contractor, Ecological consultant, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
3	Noise and Vibration	Noise level Vibration level	Sound-level meter Vibration meter	Decided after completion of detailed design	Quarterly, Once a week	EPC Contractor, Ecological consultant, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
4	Waste	Waste management practice in storage and disposal	Contract and record	Project site and associated facilities	Continuously	EPC Contractor, Ecological consultant, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
5	Ecosystem	Status of fauna, flora and river organisms	Research	Turakurgan area	Monthly	Ecological consultant, PIU	Management cost for TPS
6	Geology and soil	geology and soil conditions	Control of the groundwater level ,the excavation Inspection	Excavation sites and earth fill	During construction	EPC Contractor, Ecological consultant, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
7	Labor and working conditions	Conformity of laws and regulations	Inspection	Throughout the construction site	Constantly	EPC Contractor, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
8	Accident	_ Conformity of laws and regulations _ Adaptation of design specification	Inspection	Throughout the construction site	Constantly	EPC Contractor, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
9	Grievances	Numbers, contents, and processing results of grievances	Recording	TKG TPS	Daily	PIU,Supervisor-consultant, District Hall	Expense is included in EPC contract cost by EPC Contractor.
Operation phase							
1	Air quality	NOx(NO_2,NO)	Ambient air quality analyzers	Decided after completion of	Quarterly, Once a week	TKG TPS	US$80000(equipment) US$50000(consultant)

No.	Item		Method	Location	Frequency	Responsibility	Budget
				detailed design			
2	Exhaust gas	NOx	Continuous Emission Monitoring System(CEMS)	Gas duct	Continuously	TKG TPS	Expense is included in operation cost.
3	Waste water	Temperature, pH, DO, BOD, SS, Oil and grease, Ammonia, Nitrite, Nitrate, Sulfate, Phenol, Chloride, Ca, Na, K, Phosphate, Fe, Cu, Zn, Cr, Pb	Sample analysis	Outlet of waste treatment facility	Every week	TKG TPS	Expense is included in operation cost.
4	Water quality	Temperature , pH, DO, BOD, SS, Oil and grease, Ammonia, Nitrite, Nitrate, Sulfate, Phenol, Chloride, Ca, Na, K, Phosphate, Fe, Cu, Zn, Cr, Pb	Sample analysis	Decided after completion of detailed design	Quarterly	TKG TPS	Expense is included in operation cost.
5	Noise	Noise level	Sound-level meter	Decided after completion of detailed design	Twice a year	TKG TPS	Expense is included in operation cost.
6	Waste	Waste oil, sludge, domestic waste	Contract and record	The disposal (dumping) site	Twice a year	TKG TPS	Expense is included in operation cost.
7	Labor and working conditions	Conformity of laws and regulations and laws	Inspection	TKG TPS	Constantly	TKG TPS	Expense is included in operation cost.
8	Accident	_ Conformity of laws and regulations _ Adaptation of design specification	Inspection	TKG TPS	Constantly	TKG TPS	Expense is included in operation cost.
9	Electromagnetic field (EMF)	Intensity of EMF	Meter	Control room, electrical room	Monthly	TKG TPS	Expense is included in operation cost.
10	Grievances	Numbers, contents, and processing results of grievances	Record	TKG TPS	Daily	TKG TPS , District Hall	Expense is included in operation cost.

Table 8.8-2 Items, location, method, frequency, responsibility and expense of the environmental monitoring plan for transmission line

No.	Item		Method	Location	Frequency	Responsibility	Budget
Construction phase							
1	Air quality	NOx (NO, NO_2), Suspended particles (Dust)	Ambient air quality analyzers	Throughout the construction site	Constantly	EPC Contractor, Ecological consultant, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
2	Noise and vibration	Noise level Vibration level	Sound-level meter Vibration meter	The boundary of the construction site	Constantly	EPC Contractor, Ecological consultant, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
3	Waste	The type and amount of waste	State on recycling and waste disposal	Throughout the construction site	Constantly	EPC Contractor, Ecological consultant, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
4	Geology and soil	geology and soil conditions	Control of the groundwater level ,the excavation Inspection	Excavation sites and earth fill	During construction	EPC Contractor, Ecological consultant, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
5	Labor and working conditions	Conformity of laws and regulations and laws	Inspection	Throughout the construction site	Constantly	EPC Contractor, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
6	Accident	_ Conformity of laws and regulations _ Adaptation of design specification	Inspection	Throughout the construction site	Constantly	EPC Contractor, PIU, Supervisor-consultant	Expense is included in EPC contract cost by EPC Contractor.
7	Grievances	Numbers, contents, and processing results of grievances	Record	Throughout the construction site	Daily	PIU, Supervisor-consultant, District Hall	Expense is included in EPC contract cost by EPC Contractor.
Operation phase							
1	Geology and soil	Soundness evaluation for towers	Inspection	Throughout transmission line route	Constantly	TKG TPS	Expense is included in operation cost.
2	Labor and	Conformity of laws and	Inspection	Throughout	Constantly	TKG TPS	Expense is included in

No.	Item		Method	Location	Frequency	Responsibility	Budget
	working conditions	regulations and laws		transmission line route			operation cost.
3	Accident	_ Conformity of laws and regulations _ Adaptation of design specification	Inspection	Throughout transmission line route	Constantly	TKG TPS	Expense is included in operation cost.
4	Grievances	Numbers, contents, and processing results of grievances	Record	Throughout transmission line route	Daily	TKG TPS , District Hall	Expense is included in operation cost.

8.9 Stakeholder meeting and others

8.9.1 Public consultation for EIA

Decree of the Cabinet of Ministers No. 491(December 31, 2001) does not stipulate implementing public consultation concerning the construction work in the local area. However, project proponent held a public meeting twice in 2013.

On 24 June 2013, a public consultation was held in Turakurgan, Shirinnlk to give an explanation of the project overview and its environmental social impact and compensation for land acquisition on the local residents.

190 people attended, including an independent ecosystem advisor, government officials, staff of TKG TPS, District Hall, medical staff, and local residents.

On 14 December 2013, another public consultation was held in Turakurgan, Shirinnlk to give an explanation of the project overview, potable water pipeline improvement project, construction material acquisition, payment of compensation, etc. to the local residents.

177 people attended (including 69 females), including government officials, staff of TKG TPS staff, school teachers, and local residents.

The following tables summarize the comments made during the public consultations. Additionally, based on the confirmation of the address list of the participants, the comments concerning the impact of air pollution by construction or the operation of TPS were received by citizens living in the residential area located approximately1km from project site.

Table8.9.1-1 Outline of public consultation on 24 June 2013

Date: 24 June 2013		
Local residents:190 people(94 women)		
Main comments	Affiliation	Answers from the project proponent
Approval of the project	School staff	-
Approval of the project with understanding that environmental impact mitigation measures will be taken	Local companies	-
Questions regarding the worker's camp	Employer	32 residential buildings will be constructed in the land of 25ha in the eastern part of the site, as well as essential infrastructure.
Questions about employment of local residents	Project interests	Although staff are needed in construction and operation phase, the local residents may have limited ability for human resources in the field of electric power system. Employment of local residents will be promoted in other fields.
Concern about gas pressure failure resulting from the connection to the existing gas pipelines	Citizen	Gas will be supplied from the existing Sukh-Namangan1 (Pipe diameter: φ530mm) and Sukh-Namangan2 (Pipe diameter: φ720mm). Gas supply companies, Teploelektroproekt and Uztransagaz, are ready to supply more than twice the current amount of gas supply; therefore, gas pressure failure is not a concern.
Concern regarding a shortage of potable water for local residents during construction and operation phase	Citizen	Uzkommunalhizmat is conducting a cost estimation to change the existing water pipe (Pipe diameter: φ400mm) and is examining the issues to be solved, with the cost support of JICA.
Vegetation within the project site	Citizen	The selection of species of plant and the expenses are under consideration.

Figure 8.9.1-1 Public consultation on 24 June 2013

Table8.9.1-2Outline of public consultation on 14 December 2013

Date : 14 December 2013		
Local residents:177 people(69 women people)		
Main comments	Affiliation	Answers from the project proponent
Employment of young staff.	KFY*	The employment period starts from the fourth quarter of 2013.
Strategy against environmental impact of the project such as exhaust gas and noise.	MFY*	Environmental standards will be satisfied by implementing environmental protection measures.
Detailed explanation of vapor generation process and stopping of electricity supply from the neighboring country	MFY*	Vapor is not used in the District Center of the project, but it is used for the staff's housing. Electricity networks in the neighboring country will not be interrupted.
The difference between other power stations in this area and the power station under construction in Samarkand.	Citizen	Navoi I began operating in 2012, construction of Talimajan Power plant started this year, and Navoi II ,Tashkent, and Takhiatash will follow. The power plant in Samarkand is solar power generation, whereas this project relates to TPS (CCGT).
The generation amount of NOx and other materials and the reason for not selecting solar power generation.	Citizen	1671 tons of NOx will be generated per generation unit of 450MW. Solar power was not selected in view of the installation area, amount of solar radiation, and the status of infrastructure such as pipelines.
Construction site is located near the agricultural farm, with materials placed within the farm area, and even the concrete batcher plant. I want the construction work to be stopped. You should make clear the extent of the power station site. Why do you continue with construction? Does it adversely affect the harvest?	Citizen	The construction site for this project is outside your farm (the area in which you conduct civil work is 1km from the power station site) and therefore the construction work will not be stopped. Please check the extent of the project site. Adverse effect of the construction is not expected.

Note: KFY or MFY means the regional citizen community.


Figure 8.9.1-2 Public consultation on 14 December 2013

8.9.2 Stakeholder meetings

Stakeholder meetings are to be held twice based on JICA Guideline in order to obtain the consent from the residents

The following table summarizes the first stakeholder meetings in accordance with the JICA Guidelines.

The first stakeholder meeting was held on 16 February 2014, and the second stakeholder meeting was held in 27 April 2014.

Table8.9.2-1Outline of stakeholder meeting on 16 February 2014

<table>
<tr><td>Date and Time</td><td>16 February 2014</td></tr>
<tr><td>Language</td><td>Uzbek, English</td></tr>
<tr><td>Participant</td><td>
<table>
<tr><td>Name</td><td>Affiliation</td></tr>
<tr><td>Mullajonov Tukhtaboy</td><td>Director TKG TPS</td></tr>
<tr><td>Alibaev Toshtemir</td><td>Head of PIU</td></tr>
<tr><td>Mamtkarimov Habubullo.</td><td>Deputy governor Namangaskoy area</td></tr>
<tr><td>Sharipov Sharifzoda</td><td>Program Coordinator of the JICA in Central Asia</td></tr>
<tr><td>Kaimov Nosir.</td><td>Hokim Turakurgan district</td></tr>
<tr><td>Ms. Yukako Miyake</td><td>Advisor of the JICA in Central Asia</td></tr>
<tr><td>Hideyuki Okano</td><td>Team Leader of JICA Study Team</td></tr>
<tr><td>Hirata Itagaki</td><td>Sub-Team Leader, Fuel Supply Expert</td></tr>
<tr><td>Eiichi Kato</td><td>Environmental Specialist</td></tr>
<tr><td>Tadashi Nakamura</td><td>Environmental Specialist</td></tr>
<tr><td>Masamichi Shoji</td><td>I&C and Electrical Expert</td></tr>
<tr><td>Toshiyuki Saito</td><td>Transmission Line Expert</td></tr>
<tr><td>Muhamadiev Beaubourg</td><td>TEPSCO manager for Central Asia</td></tr>
<tr><td>Sanin Victoria</td><td>Translator</td></tr>
<tr><td>Khusanov Vahid</td><td>Translator</td></tr>
</table>
Local residents: 229 people(Representatives of schools: 5 people, Residents224 people (Female 80 people))
There was coverage of the Namangan TV.
</td></tr>
<tr><td>Agenda</td><td>The purpose of the meeting
_The role and objectives of the JICA and JICA study team
_Information on the impact on the environment and impact on socio-economic aspects</td></tr>
<tr><td>Remarks</td><td>Questions/comments and answers
<table>
<tr><td>No</td><td>Questions/comments</td><td>Affiliation</td><td>Answers</td></tr>
<tr><td>1</td><td>How about the impact of trees and cattle nearby project site by construction?</td><td>Citizen</td><td>We will verify the impact on flora and fauna through EIA reviews etc.</td></tr>
<tr><td>2</td><td>Thanks to the Government that the latest technology introduced in Namangan region.</td><td>Citizen</td><td>I assure you that TPS will not affect the consumption of gas.
This project will improve energy efficiency, and the gas supply will</td></tr>
</table>
</td></tr>
</table>

		I want to ask whether gas consumption by this project will affect the public?		be guaranteed by the government.	
	3	Is gas reserves sufficient for this project?	RelatedSupplier	According to thelatest information by Government's investment strategy,.gas reserves in Karakalpakstanabound.	
	4	I will not ask any questions. I want to say that I am very happy to support the project and the construction of TPS, because I am sure that it will bring prosperity.	Local trader	-	
	5	Inform us about the supply of electricity in the Fergana Valley?	Citizen	The electricity in the Fergana Valley comes from hydroelectric power station, partly from the energy in the central system of Uzbekistan. Surplus of electricity will be returned to the northern part of Kyrgyzstan through Kazakistan by the operation of this project.	
	6	How many jobs are made by this project?	Citizen	300 people will be hired for the TPS operation . Moreover, new jobs for 250 people for related infrastructure and social services will be generated.	
	7	1) Is there a supply of heating from TPS to public? 2) If this project is classified A in accordance with JICA guidline, should we move to another location?	Citizen	1) There may be the withdrawal of heat for heating during operation of TPS. However, the withdrawal of heat is not available for residents. 2) We willcarry out detailed review, and will report back you after the study is completed in April 2014.	

Figure 8.9.2-1 Stakeholder meeting on 16 February 2014

Table8.9.2-2 Outline of stakeholder meeting on 27 April 2014

Date and Time	27 April 2014
Language	Uzbek
Participant	Name — Affiliation Mullajonov Tukhtaboy — Director TKG TPS Mamtkarimov Habubullo. — Deputy governor Namangaskoy area Hideyuki Okano — Team Leader of JICA Study Team Hirata Itagaki — Sub-Team Leader, Fuel Supply Expert Mitsuaki Shimada — Civil Expert Eiichi Kato — Environmental Specialist Tadashi Nakamura — Environmental Specialist Muhamadiev Beaubourg — TEPSCO manager for Central Asia Local residents: 140 people(Female 40 people) There was coverage of the Namangan TV.
Agenda	The purpose of the meeting _Information on the impact on the environment and impact on socio-economic aspects
Remarks	Questions/comments and answers

No	Questions/comments	Affiliation	Answers
1	Thank you for the support of the Japanese side. In honor of this collaboration, I wrote poems and I read these ones.	Citizen	-
2	We had a unfinished construction site in proposed 220 kV TL route.Our land was appraised by District commission and Evaluation Commission. As a result, I satisfied new allocated land and I have no other questions.	Citizen	I assured you that Uzbekenergo fulfill its obligations.
3	I asked you that gas reservoir is enough or not at the last meeting and I ask you once again. Regarding gas supply for local residents, are there any possibilities of interruption by this project?	Citizen	Uztransgaz issued a guarantee letter that gas is supplied for TKG TPS. We will rise transfer pressure of gas. Therefor, you will not be disrupted your livelihood.
4	I considered the compensation for land losses. I will not require new land. Instead, I plan to work as a specialist in TKG TPS. I hope the to be held monthly meeting for affected poeple and to be broadcasted progress of this	Citizen	Thank you for your advise.

	project.		
5	What is personnel policies of TKG TPS?	Citizen	New job is created and infrastructure and social services are prepared in this region.
6	Inform of the results of your research about the environmental aspect.	Citizen	This project will be introduced the cutting edge of technology. If related regulation/law are met, there are no significant impacts.
7	Are there any impacts of distribution and transmission of electricity by this project?	Citizen	You have nothing to be anxious. Since an electric curent in the residential area is low level, your network will be not affected.

Figure 8.9.2-2 Stakeholder meeting on 16 February 2014

8.10 Land acquisition and compensation

8.10.1 Necessity of land acquisition and resettlement

(1) TKG TPS

In Chapter 8.6.2, five alternative sites, including the project site, were considered. The project sites were selected in view of the infrastructure such as fuel (gas) and water supply and access means for transporting materials and machines. None of the sites contain residential areas, so physical displacement will not occur. Regarding the Bonitet index of the sites indicating land quality, TKG TPS site was the lowest, having low quality land for agriculture. The site is actually a desert with exception of some land around the Ground Channel Namangan（GCN）channel, and consequently, economic loss of the residents is considered lower than other alternative sites.

(2) 220kV transmission line

According to Rules of Electrical Installation, the Right of Way (ROW) of the 220kV transmission line shall be 25m in both sides from immediately beneath the transmission line. In Uzbekistan, no building is allowed within the ROW for safety reasons. The transmission line route was selected to achieve the shortest construction distance of the line, and to avoid residential areas. Consequently, resettlement of the residents living within the ROW of the proposed transmission line route did not happen, but the removal of one incomplete building and three clay fences 1.5m in height shall be conducted（Photo 8.10.1-1）。

Source: Uzbekenergo

Figure 8.10.1-1 Incomplete building and clay fence

(3) Kyzyl-Ravat Substation

In order to the meet the need for the fortification of the substation for the operation of TKG TPS, the existing substation will be expanded in place of constructing a new substation. However, Kyzyl-Ravat Substation, which is to be expanded, needs additional land and a new short-distance transmission line in order to construct an additional facility. The location of the site for the new facility depends on the direction of the transmission line to be connected, and as there is no residence around the Kyzyl-Ravat Substation site, so physical displacement is not foreseen.

8.10.2 Analysis of the legal framework concerning land acquisition and resettlement

(1) Relevant provisions for land acquisitionand resettlement in the Republic of Uzbekistan

There are no laws or legislation in the Republic of Uzbekistan (RU) that specifically address matters related to land acquisition and resettlement. Land acquisition and resettlement is governed by the following laws:

-**The Civil Code:** This Code is enacted by Oily Majlis of the RU No. 257-I of August 29, 1996 and amended according to different laws of Uzbekistan of 1996-2012.

- **The Land Code:** This Code is approved by the Statute of the RU No. 598-I of April 30, 1998and amended according to Division XIX of the Statute of the RU of August 30, 2003, item 41 of the Statute of the RU of December 3, 2004.The amendments regulate issues related to exemption and allotment of lands for non-agricultural purposes and compensation for agricultural production losses.

- **The State Land Cadastre:** This Law is approved by the Statute of the RU No. 666-I of August 28, 1998 and amended according to different laws of the RU of 2002-2004.

- **The State Cadastre:** This Law is approved by the Statute of the RU No. 171-II of December 15, 2000 and amended according to different laws of the RU of 2002-2011.

However, physical displacement will be incurred due to the Project. The Land Code and the following resolution are key legal documents on the Project.

- **Resolution of the Cabinet of Ministers (RCM) No. 146 on "perfection arrangements of procedures related to allotment of land plots for town-planning activities and non-agricultural purposes":** This RCM No. 146 was adopted on May 25, 2011.

- **RCM No. 54 on "measures on radical simplifying the system of granting land for implementation of urban development activities and for other non-agricultural purposes, as well as giving permissions for the construction of facilities":** This RCM No. 54 was adopted on February 25, 2013.

(2) Scope of the RU's right to land acquisition and compensation

According to the Land Code, all land in the republic is state property and permits for use of land are granted and monitored by the State through the district and provincial administrations. National legislation specifies two types of land transfers: (a) for use, lease, or ownership by legal entities dealing with various trades and services for life long inheritable use (with housing), and (b) use or lease by individuals. Because all land ultimately belongs to the RU, it cannot be sold without the buildings on that land. In the case of individual land uses, land can be purchased only with the residence located on that land. A similar provision applies to land used by legal entities (owners of trade or service facilities).

All land occupied by permanent structures required for the project, specifically, transmission lines, wells, cross regulators and outlets, water measuring structures, collectors, and related protection perimeters ("sanitary zones") is allocated by the RU government through the local authorities and will remain the property of the RU government upon completion of the Project. Legislation envisages compensation for damages to land users in full, including lost income, in the following instances:(i) seizure, purchase, or temporary occupation of land; (ii) limitation of the rights of users; and (iii) deterioration of land quality due to the effects of construction works, and servicing and other activities that lead to decreases in the quantity or quality of agricultural products. In the case of acquisition of agricultural lands, in addition to compensation for damages, the legislation envisages compensation for the loss of agricultural production.

The Land Code identifies the following categories of arable land users, who are eligible for compensation for losses and damages in connection with land acquisition:

- **Land owners**: Citizens who were allocated land plots for individual housing construction and/or farming on the basis of lifetime ownership with right of inheritance.
- **Lessees (leaseholders)**: Farmers, who were allocated land plots for agricultural production purposes, on the basis of a long-term lease.
- **Land users**: Users of land plots occupied by tradesmen and services, which are used as private property.
- **Other land users**: All other enterprises, organizations and institutions, which are entitled to use of non-agricultural lands. This is the largest category, which includes enterprises and institutions of all types (private and public). Examples are hospitals, schools, private enterprises, and factories

(3) JICA's Policy on involuntary resettlement

JICA's main principle of involuntary resettlement is finding a way to avoid it if possible by analyzing all actual alternatives. All of the affected peoples (APs) should receive proper compensation and support so that they could improve, or at least restore, their customary way of life and earn incomes at the level existing prior to the realization of the Project. Compensation should be based on the cost of replacement in the maximum fullest extent (Annex).

Table 8.10-2 shows the gaps between the Uzbekistan legal framework for resettlement and JICA's Policy on Involuntary Resettlement, and the correspondence of the Project

Table 8.10.2-1 Comparison of JICA and Uzbekistan policy relating to compensation for land acquisition

No.	JICA guideline	RU's Law	Gap between JICA GL and Uzbekistan Law	Correspondence of the Project
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	No specific policy	Because there is not the policy in RU's regulations, there is a gap.	The project site was selected so as to avoid physical displacement.
2	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	Department of the State Committee of the RU* on Land Resources, Geodesy, Cartography and State Cadastre conducts the estimation of loss of land and production means, and consideration of restoration means of agricultural land and alternative land.	There is no gap.	The project site was selected so as to avoid physical displacement.
3	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	RU law has social policies for all citizens. No specific policy directed to displace persons.	There is no gap.	Compensation will enable affected households to restore their pre-project incomes and standard of living following the implementation of the LARAP
4	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	A State Committee will assess value of agricultural land, loss of crop/tree income, and market value for lands appropriated.	There is no gap.	Affected households are entitled to be compensated at full replacement cost (excluding depreciation) for their lost assets, including temporary losses or impacts.
5	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	Compensation will be paid prior to construction of works.	There is no gap.	Compensation will be fully provided before land can be acquired for civil works or demolition.

No.	JICA guideline	RU's Law	Gap between JICA GL and Uzbekistan Law	Correspondence of the Project
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	No specific policy	Because there is not the policy in RU's regulations, there is a gap.	The project site was selected so as to avoid physical displacement. Therefore, this project is applied.
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	No specific policy	Because there is not the policy in RU's regulations, there is a gap.	Affected households will be consulted with in course of the preparation and implementation of the LARAP.
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	No specific policy	Because there is not the policy in RU's regulations, there is a gap.	Affected households will be fully informed of their compensation option.
9	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	Grievance redress committee includes local community leaders and farmers.	Because representative of affected people is not included in the committee, there is a gap.	Affected households will consulted with in the course of the preparation and implementation of the LARAP
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	Resettlement has a standard mechanism to address grievances.	There is no gap.	Grievance redress mechanism will be established.
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)	Department of the State Committee of the RU* on Land Resources, Geodesy, Cartography and State Cadastre conducts the estimation of loss of land and production means.	There is a gap.	In creating the LARAP, Uzbekenergo interviewed the affected households whose orchards within the project site will all be acquired and confirm their other farmland, the occupation, the income, etc.
12	Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the	All houses/ building/ shops which are registered under Land Code are valued at respective province/ district level People apply for registration for a particular land use.	Because untitled land use is ineligible for compensation, there is a gap.	All affected households will be received compensation regardless of the legal status of the land and land use rights.

No.	JICA guideline	RU's Law	Gap between JICA GL and Uzbekistan Law	Correspondence of the Project
	land they are occupying. (WB OP4.12 Para.15)	Untitled land use is ineligible for compensation.		
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Since land is owned by state, Land Code does not recognize individual ownership of land, but only permits use of land	There is no gap.	Provision of equivalent land is the preferred compensation for lost land, unless the affected household chooses cash compensation.
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	No specific policy, but all citizen's life is covered under RU social policy.	There is no gap.	Tis project is not applied.
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	RU policy relates to compensation only. Living standard improvement applies to all citizens	There is no gap.	Compensation will be provided giving equal consideration to women and men.
16	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	No specific policy	Because there is not the policy in RU's regulations, there is a gap.	LARAP is established in this project.

Notes: "RU" means "Republic of Uzbekistan"

Source: JICA Study Team

(4) Policies on the Project

With regard to the specific land acquisition requirements for the proposed project, the analysis of the socioeconomic conditions and land use in the proposed project area, and an analysis of the legal framework governing land acquisition for public purposes indicates that there are no main inconsistencies between the RU's legal framework and international rules, such as JICA guideline, regarding the acquisition of land from project-affected leasehold farms. However, in the course of project implementation, in the event any unforeseen needs to acquire additional land emerge, and certain categories of land users (for example, those who may be illegally using or occupying land) may be affected. It was agreed that wherever the RU's Laws and international rules are not in full agreement, policies and principles of international rules will be followed.

In order to implement the policy described above, the LARAP was established by taking into consideration of the following principles.

- The project site was selected so as to avoid physical displacement.
- Compensation will enable affected households to restore their pre-project incomes and standard of living following the implementation of the LARAP
- Affected households are entitled to be compensated at full replacement cost (excluding depreciation) for their lost assets, including temporary losses or impacts.
- Compensation will be fully provided before land can be acquired for civil works or demolition.
- Affected households will be consulted with in course of the preparation and implementation of the LARAP.
- Affected households will be fully informed of their compensation option.
- Grievance redress mechanism will be established.
- All affected households will be received compensation regardless of the legal status of the land and land use.
- Provision of equivalent land is the preferred compensation for lost land, unless the affected household chooses cash compensation.
- Compensation will be provided giving equal consideration to women and men.

(5) Cut-off date

In the regulation of RU, the cut-off date is defined as the date in which the district division of the State Committee of the RU on Land Resources, Geodesy, Cartography and State Cadastre signed Certificate of Agreement for land acquisition. However, the cut-off date here in LARAP is the date in which the first public consultation was held: June 24th 2013. On that day, the project outline and its environmental and social impact was explained to the local residents. Therefore, June 24th 2013 is considered the cut-off date for the Project.

8.10.3 Size and area of land acquisition

(1) Size of land acquisition

(a) TKG TPS

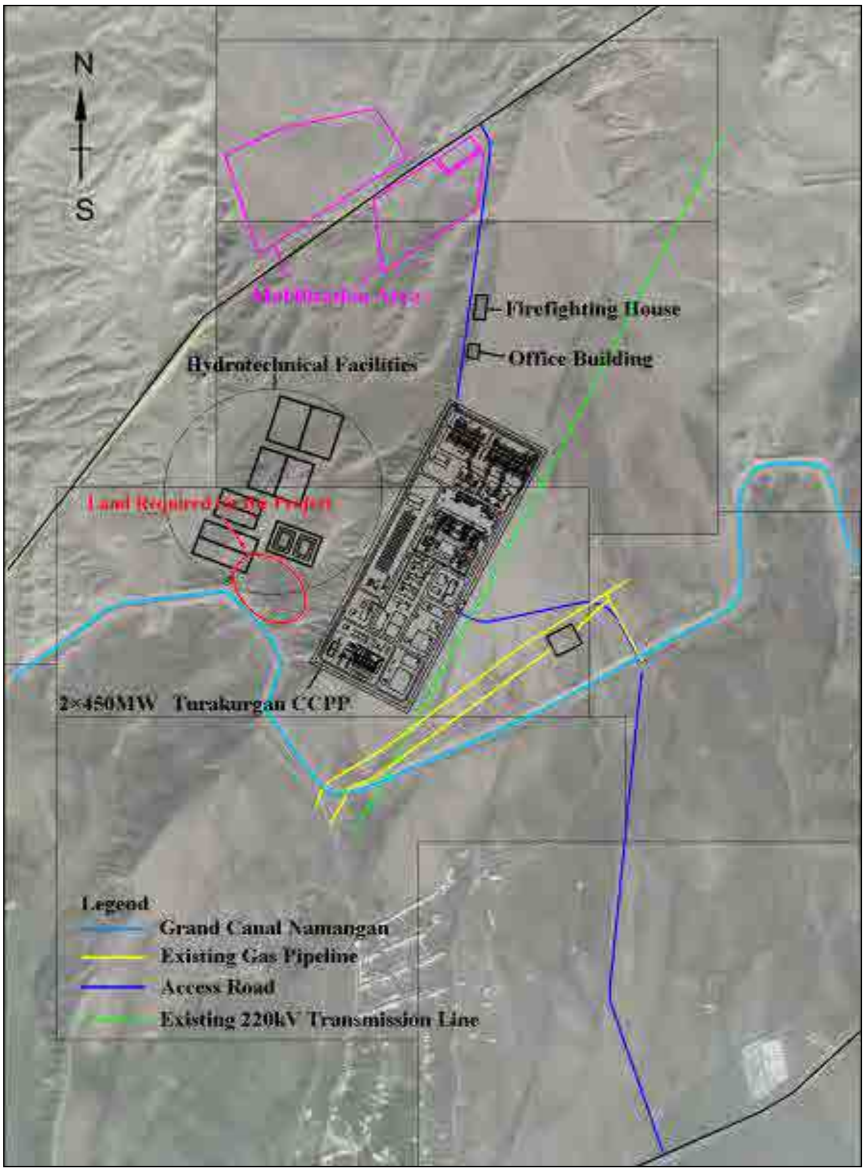
The proposed site of TKG TPS is classified as irrigated land, pastures, and uncultivated land, in terms of land use. The land is uprising from Ground Channel Namangan（GCN） channel toward the TKG TPS site with 20m of difference of elevation, making water in GCN channel unusable and the land is currently a desert as a result. Most of the land is not guaranteed for land use rights, and physical displacement of the residents and economic loss will not occur. 15ha of the land will be temporarily used for mobilization area during construction period is not also guaranteed for land use rights. The orchards located in the water treatment facility site along the GCN channel will be compensated for land acquisition (Table 8.10.3-1, Figure 8.10.3-1).

Table 8.10.3-1 Overview of land acquisition for TKG TPS

Site area	Number of affected households	Area of land acquisition from the affected households	Current land use
86.3 ha	5 households (with land use rights: 1 household) (without land use rights: 4 households)	4.03 ha* (area to be acquired from one household: 0.16 - 2.21ha)	Orchards

Notes: * Orchards within the proposed project site will all be acquired for safety reasons.

Source: LARAP report for the Project
Uzbekenergo



Source; Uzbekenergo

Figure 8.10.3-1 Location of orchard to be acquired for Turakurgan CCCP site

(b) Transmission line/ Substation

(i)New 220kV transmission line

TKG TPS will be connected to Kyzyl-Ravat Substation and Sardor Substation. Four transmission lines (2 line systems: approach line and outlet line) of 220kV will be installed to connect the TKG TPS to the existing transmission line between the two substations (Table 8.10.3-2, Figure 8.10.3-2).

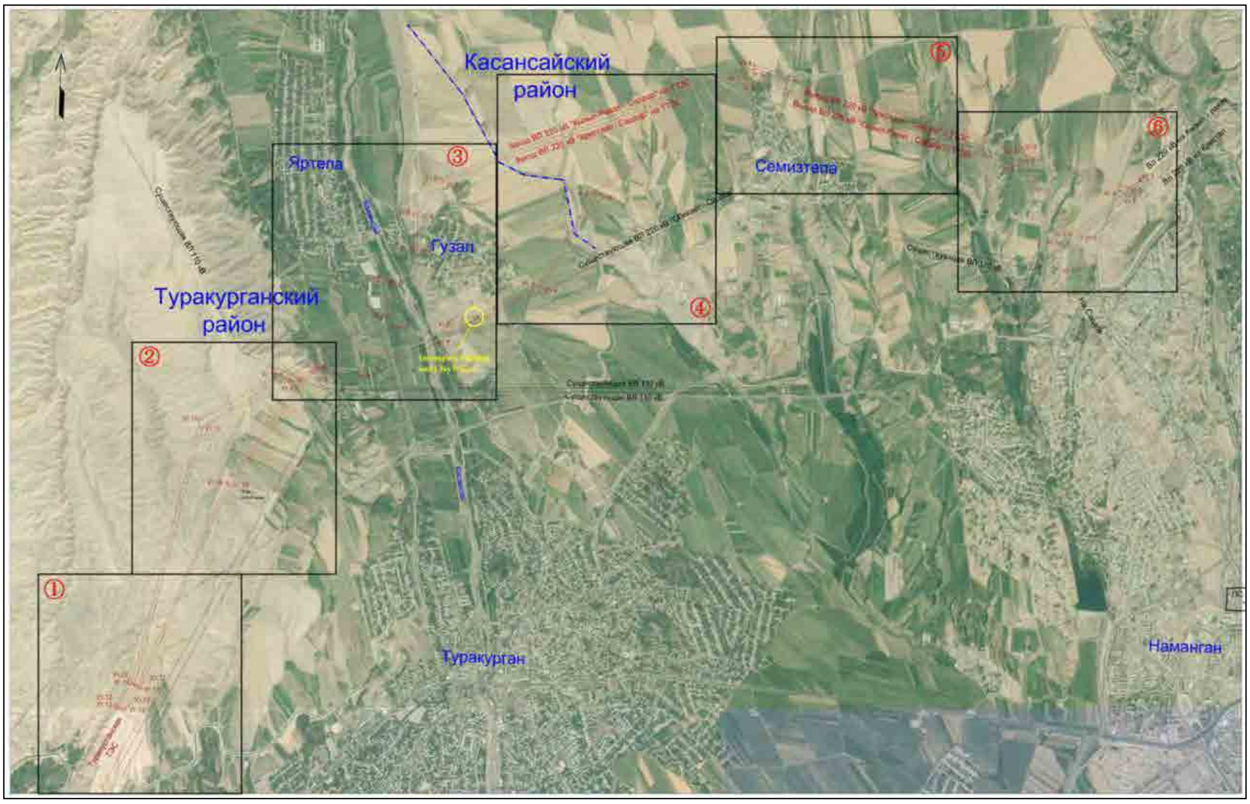
The incomplete building and three clay fences to be cleared are located near outlet line tension tower No.7 (see enlarged figure ③).

Table 8.10.3-2 Total length of the transmission lines

Transmission line	Kasansay District	Turakurgan District	Total (Number of Tower)
Approach line #1	7.3 km	7.8 km	15.1 km (Tension;13, Suspention;50*)
Approach line #2	7.2 km	7.8 km	15.0 km (Tension;13, Suspention;50*)
Outlet line #1	7.0 km	7.5 km	14.5 km (Tension;12, Suspention;45*)
Outlet line #2	6.5 km	7.5 km	14.0 km (Tension;12, Suspention;45*)
Total	28.0 km	30.6 km	58.6 km (Tension;50, Suspention;190*)

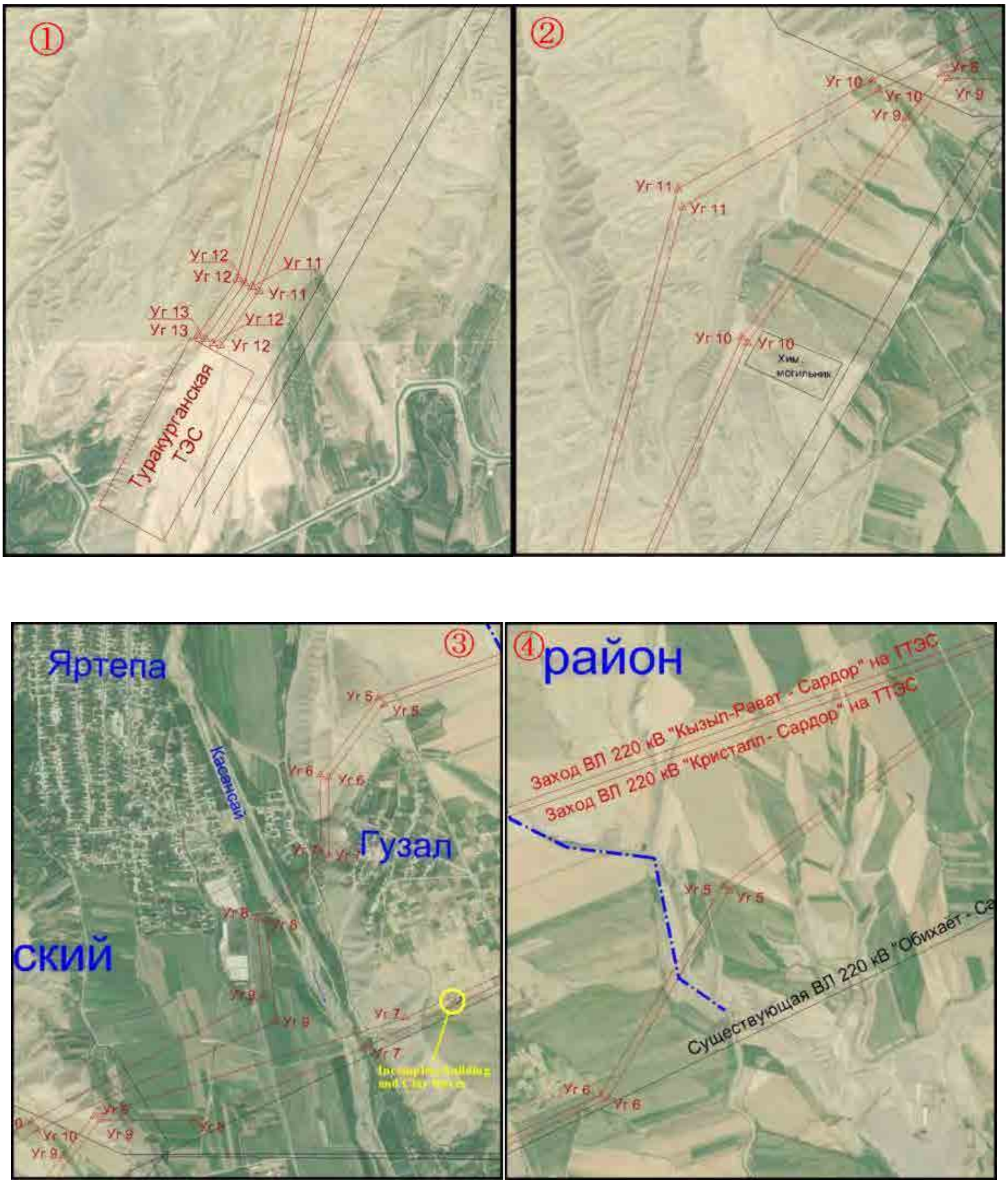
Notes: The location of the suspension towers is not yet determined.

Source: LARAP report for the Project



Source: Uzbekenergo

Figure 8.10.3-2(1) New 220kV transmission line route (whole)



Source: Uzbekenergo

Figure 8.10.3-2 (2) New 220kV transmission line route (magnified view)

Source: Uzbekenergo

Figure 8.10.3-2 (3) New 220kV transmission line route (enlarged view)

Regarding the transmission line construction, the basement of the transmission tower will be permanently used, and the construction area, the road, the material yard etc. will be used temporarily. According to Uzbekenergo, the area designated for permanent use will be 1.563 ha, whereas the area for temporary use has been assessed to amount to 94.34 ha. The location of the tension towers was already determined during the route setting process, whereas suspension towers will be installed at 250m to 300m intervals between the tension towers. The location for the tension towers has yet to have been determined.

Table 8.10.3-3 indicates the status of land acquisition subject for compensation concerning transmission line construction. Households having land use rights include three households planting trees for land conservation purposes at the request of the local government. One place is owned by Kasansay district.

Table 8.10.3-3 Overview of land acquisition for new 220kV transmission line

Size of land required	Approach line	Outlet line	Total
Turakurgan District			
Permanent use	0.012 ha	0.386 ha	0.398 ha
Temporary use	0.105 ha	14.534 ha	14.639 ha
Kasansay District			
Permanent use	0.290 ha	0.104 ha	0.394 ha
Temporary use	16.169 ha	4.238 ha	20.407 ha
Total			
Permanent use	0.302 ha	0.490 ha	0.792 ha
Temporary use	16.274 ha	18.772 ha	35.046 ha
Number of affected household & agricultural companies	**Approach line**	**Outlet line**	**Total**
Turakurgan District			
with land use rights	16	18	34
without land use rights	1	3	4
Owned by district	0	0	0
Kasansay District			
with land use rights	13	4	17
without land use rights	1	7	8
Owned by district	1	0	1
Total			
with land use rights	29	22	51
without land use rights	2	10	12
Owned by district	1	0	1

Source: LARAP report for the Project

(ii) Kyzyl-Ravat Substation

Kyzyl-Ravat Substation located in Uychin District, Namangan Province, will be expanded to be connected to TKG TPS. A land area of approximately 140m×60m and three basements of the new short-distance transmission line will be acquired out of Kyzyl-Ravat Substation site (Figure 8.10.3-3, Figure 8.10.3-4, Table 8.10.3-4).

Source: JICA Study Team

Figure 8.10.3-3 Location of Kyzyl-Ravat Substation

Source: Uzbekenergo

Figure 8.10.3-4 Location of Kyzyl-Ravat Substation (magnified view)

Table 8.10.3-4 Overview of land acquisition for expanding Kyzyl-Ravat Substation

Site area	Number of affected households	Area of land acquisition from the affected households	Current land use
0.838 ha	1 household and district administration (with land use rights: 1 households) (without land use rights: N/A) (owned by district)	0.838 ha* (area to be acquired from one household: 0.038ha)	Orchard

Notes: * 1.309 ~~1.3~~ha of additional land will be temporarily used for construction activity.
Source: LARAP report for the Project
Uzbekenergo

(2) Inventory of loss

Table 8.10.3-5 shows the loss for land, structures and trees.

Table 8.10.3-5 Loss of land, structures and tree on JICA-financed portion

Status	Affected items	Compensation amounts			
		TKG TPS	220 kV Transmission line	Kyzyl-Ravat Substation	Total
Legally	Land (ha) Permanent loss Temporary loss	 0.7 N/A	 0.792 35.046	 0.038 1.3	 1.53 36.346
	Annual crops (kg) (Cotton, Wheat)	N/A	To be determined	N/A	To be determined
	Permanent crops (Trees, Number of trees)	60	2,741	10	2,881
	Structures	N/A	1 (incomplete building) 3 (Clay fences)	N/A	1 (incomplete building) 3 (Clay fences)
Illegally	Land (ha) Permanent loss Temporary loss	 3.33 N/A	 N/A N/A	 N/A N/A	 3.33 N/A
	Annual crops (kg) (Cotton, Wheat)	N/A	To be determined	N/A	To be determined
	Permanent crops (Trees, Number of trees)	357	528	N/A	885
	Structures	N/A	N/A	N/A	N/A
Owned by district	Land (ha) Permanent loss Temporary loss	 N/A N/A	 N/A N/A	 0.8 N/A	 0.8 N/A
	Annual crops (kg) (Cotton, Wheat)	N/A	N/A	N/A	To be determined
	Permanent crops (Trees, Number of trees)	N/A	23	70	93
	Structures	N/A	N/A	N/A	N/A

Source: LARAP report for the Project

8.10.4 Requirement of compensation for lost assets

(1) Compensation policy

The compensation policy concerning land acquisition is as follows.

- Compensation for the loss of assets is conducted on the basis of full compensation at replacement cost, regardless of the legal status land and land-use rights.
- The level of income and life before the project implementation shall be secured based on LARAP
- Both loss of land-use rights and means of agricultural production are compensated based on RCM No.54 (February 25, 2013).
- The loss of land use right is compensated with provision of alternative land, or with money in case the affected households wish compensation by money. The district administration is responsible for arranging alternative land. The affected household is able to choose the alternative land among the candidate land provided by the district administration.

Compensation payment for means of agricultural production is calculated by the following method.

(a) Annual crops

(i)Calculation of compensation payment for permanent acquisition of land

Agricultural producers receive the money equivalent to the gross annual income earned from the crops of the relevant plot. Gross annual income is calculated from the current price of crops based on the average production in the previous three years and crop acreage (current price of respective crop is multiplied by crop acreage, and then multiplied by the average production in the previous three years). The calculation is conducted for respective crop, and the results are added to obtain gross annual income.

(ii) Calculation of compensation payment for temporary acquisition of land

The compensation for the temporary acquisition of land for the first year is calculated similarly to the permanent acquisition (current price of respective crop is multiplied by crop acreage, and then multiplied by the average production). In case temporary acquisition is extended several years, agricultural producers receive the compensation payment equivalent to the net annual income from the current price of all the crops un-harvested on their relevant plot in the next and the following years. Net income is calculated by subtracting gross expenditures for crop production from the gross annual income. The calculation is conducted for respective crop, and the results are added to obtain gross annual income.

Annual crops are not raised in TKG TPS site and Kyzyl-Ravat Substation site, and are not seen being grown at the survey on the proposed route of the 220kV transmission line carried out on January of 2014. The survey will be conducted again after the final design of the transmission line route is determined. Consequently, the possibility of loss of annual crops is limited only to the route of the 220kV transmission line. The land for tower bases of the transmission line is subject for permanent acquisition, but the area is very small (10m x 10m per tower), and growing annual crops will not be impossible on all of the relevant site.

The following data are necessary for calculating compensation payment for land of permanent/temporary acquisition. The compensation in this project is calculated based on the price in 2010 - 2012 of annual crops provided from the Regional Statistics Department.

- Detail of crop acreage
- Current market price of crops
- Average production in the last three years
- Gross expenditures for crop production per yield

Agricultural producers are entitled to receive consultation concerning the calculation of the compensation payment described above.

(b) Permanent crops

(i) Calculation of compensation payment for permanent acquisition of land

Agricultural producers receive the money equivalent to the gross annual income earned from all the crops of the relevant orchard. The income from one orchard tree is calculated based on the average yield per tree in the previous three years, the current market price of crops, and the number of trees. The calculation is conducted for respective tree species. The average of the gross annual income in the last three years is obtained.

In addition to this, the lost profits expected from all the orchard trees until the end of fruiting period are compensated. The compensation for the lost profits per one orchard tree is calculated by multiplying the net annual income of the last year at the current market price by the remaining fruiting period of the relevant tree. The remaining fruiting period is calculated by subtracting the tree age at the time of calculation from the maximum age of fruiting.

The following data are necessary for calculating the compensation payment for the land of permanent acquisition where perennial crops are grown

- Number of trees
- Average yield per tree in the last three years

- Current market price
- Ages of tree
- Maximum age of fruiting

In case the agricultural producers receive an alternative land having virtually equivalent value, they are compensated for lost income for one year and land development expenses for a new orchard. The compensation includes the cost for planting saplings (price of saplings, transport cost, cost for planting) and lost profits of orchard trees for the period up to the age of fruiting.

(ii) Calculation of compensation payment for temporary acquisition of land

The agricultural producers receive compensation for restitution expense of orchards. The compensation includes the cost for planting saplings and lost profits of orchard trees for the period up to the age of fruiting.

In case the agricultural producers receive a new land, they are compensated for land development expenses for a new orchard.

The following data are necessary for respective tree species to calculate compensation

- Number of trees
- Cost for planting saplings per tree
- Current net annual income obtained from one orchard tree
- Age at first fruiting

(2) Entitlement matrix

Table 8.10.4-1 shows ”Type of loss”, ”Entitled persons”, and ”Detail of compensation” of the affected households by construction of JICA-financed portion (TKG TPS, 220kV Transmission line, and Kyzyl-Ravat Substation).

Table 8.10.4-1(1) Entitlement matrix (TKG TPS)

No	Type of Loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation and Assistance Package)	Responsible Organizations
1.	Loss of orchard and trees (Permanent loss)	Legally leaseholder (1 household)	- Land as compensation for land with a plot of equal cost and productivity	Turakurgan district Administration
			- Gross income from all the trees on the orchard - Loss of profit which could be gained from all the trees throughout the remaining years of the product bearing period.	Uzbekenergo
		Farmer who has not certificate of land use rights (4 households)	- Gross income from all the trees on the orchard - Loss of profit which could be gained from all the trees throughout the remaining years of the product bearing period.	Uzbekenergo

Source: JICA Study Team

Table 8.10.4-2(2) Entitlement matrix (New 220kV transmission line)

No	Type of Loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation and Assistance Package)	Responsible Organizations
1.	Loss of agricultural land occupied by annual crops* (cotton, wheat) (Permanent loss)	Legally leaseholder	- Land as compensation for land with a plot of equal cost and productivity	Turakurgan and Kasansay district Administrations
			- Gross income from all the crops on the agricultural land	Uzbekenergo
2.	Loss of agricultural land occupied by annual crops* (cotton, wheat) (Temporary loss)	Legally leaseholder	- Project proponent pays monetary compensation for period of usage in accordance with local commercial rental rate - Gross income from all the crops on the agricultural land	Uzbekenergo
3.	Loss of annual crops* (cotton, wheat)	Farmer who has not certificate of land use rights	- Gross income from all the crops on the agricultural land	Uzbekenergo
4.	Loss of orchard and trees (Permanent loss)	Legally leaseholder (25 households & 3 agricultural companies)**	- Land as compensation for land with a plot of equal cost and productivity	Turakurgan and Kasansay district Administrations
			- Gross income from all the trees on the orchard - Loss of profit which could be gained from all the trees throughout the remaining years of the product bearing period.	Uzbekenergo

No	Type of Loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation and Assistance Package)	Responsible Organizations
5.	Loss of orchard and trees (Temporary loss)	Legally leaseholder (38 households & 2 agricultural companies)**	- Project proponent pays monetary compensation for period of usage in accordance with local commercial rental rate - Gross income from all the trees on the orchard - Loss of profit which could be gained from all the trees throughout the remaining years of the product bearing period.	Uzbekenergo
6.	Loss of trees	- Farmer who has not certificate of land use rights (12 households) - Kasansay district	- Gross income from all the trees on the orchard - Loss of profit which could be gained from all the trees throughout the remaining years of the product bearing period.	Uzbekenergo
7.	Loss of incomplete building	Legally land user (1 household)	- Land as compensation for land with a plot of equal cost	Turakurgan district Administration
			- Construction cost and material cost	Uzbekenergo
8.	Loss of clay fence	Legally land user (3households)	- Land as compensation for land with a plot of equal cost	Turakurgan district Administration
			- Construction cost and material cost	Uzbekenergo

Notes: * ; According to the results of survey on the 220 kV transmission line route, cultivation of annual crops was not observed. However, information will be available after development of final design.

**; Indicates over wrapping households

Source: JICA Study Team

Table 8.10.4-1(3) Entitlement matrix (Kyzyl-Ravat Substation)

No	Type of Loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation and Assistance Package)	Responsible Organizations
1.	Loss of orchard and trees (Permanent loss)	Legally leaseholder (1 household)	- Land as compensation for land with a plot of equal cost and productivity	Uychin district Administration
			- Gross income from all the trees on the orchard - Loss of profit which could be gained from all the trees throughout the remaining years of the product bearing period.	Uzbekenergo
2.		Uychin district	- Gross income from all the trees on the orchard - Loss of profit which could be gained from all the trees throughout the remaining years of the product bearing period.	Uzbekenergo
3.	Loss of orchard and trees (Temporary loss)	Legally leaseholder (1 household)	- Project proponent pays monetary compensation for period of usage in accordance with local commercial rental rate - Gross income from all the trees on the orchard - Loss of profit which could be gained from all the trees throughout the remaining years of the product bearing period.	Uzbekenergo

Source: JICA Study Team

8.10.5 Grievance system

Claims from residences regarding valuation, payments, other forms of compensation or assistance as well as other aspects of project implementation (for example, construction-related impacts) may occur. In this regard, the following mechanisms will be in place to ensure that all claims are considered, and the authorities take measures to resolve them.

Initially, the affected person can submit a claim to the district administration which will register the claim and take measures to resolve it. At this level, there is a committee that includes representatives of the cadastre, an agronomist, a representative of the tax authority, local community leaders, farmers, and an official staff from “Uzbekenergo”. If the claimant does not receive a satisfactory valuation, he can hire an independent appraiser and present the appraisal to this land committee for resolution. By including farmers on the committee, it was envisaged that the risk of claims would be minimized and the opportunity for reaching a compromise among the affected parties would be maximized. After two weeks, however, if the grievance is not resolved, the claim will be referred to the provincial administration.

At the level of the provincial administration, the claim is considered by a commission similar to that of the district administration which includes chairs of the respective provincial authorities as well as representatives of “Uzbekenergo”. The responsible authority in the provincial administration receives and registers the claim and takes measures to resolve the situation. The claimant also can appeal to the court if the district or provincial administrations are not able to resolve the issue.

Reports and process of the claim resolution will be tracked by the Project Management Unit (PMU) staff responsible for internal monitoring and evaluation. Any persons not satisfied with his or her claim consideration may contact the PMU directly at any time to request assistance in seeking resolution of the claim. Contact information will be given to local populations at the public consultations.

8.10.6 Implementation system

The procedures, functions, and powers of organizations responsible for implementation and observation of procedures for land acquisition for purposes other than agriculture and forestry, are established by the Resolution of the Cabinet of Ministers (RCM) No.54 of February 25, 2013.

The regional land acquisition commission, established by a decision of the provincial administration:

(i) Determines the location of constructions and facilities foreseen by the Project

(ii) Selects land plots for construction

(iii) Prepares and approves Certificates of agreement on land acquisition

(iv) Approves Certificates of the right to land use of the plot, with indications of the area of crop land acquired, agreed conditions and total value of losses of agricultural production. The commission, along with permanent members, shall also include representatives or enterprises and/or organizations, to which the plots are being allocated for construction of facilities, and organizations (farm entities) from which the plots are being acquired.

The Department of Hydro-Geological Meliorative Expedition (HGME)[1] within the district administration is the main implementing agency, whose functions include:

(i) Assesses the losses of land being incurred by landowners and land-users, as well as losses of agricultural production

(ii) Defines the extent of and methods for restoring land for farming activity

(iii) Defines, if applicable, the sanitary and water-protection zones around buildings to be constructed and the rules and restrictions to be followed within such perimeters

(iv) Elaborates proposals for compensation with an equivalent surface of land of the same or better quality in other areas, in consultation with citizens

(v) In case of permanent acquisition of irrigated lands, estimating the requirements and cost for reclaiming replacement lands

(vi) Approves the Certificate of land marking with an attached plan; and

(vii) Amends the official documents confirming the right to ownership or the right for land use, and other land and cadastre documents as per changes in land use and ownership due to acquisition of land plots.

[1] HGME is the subsidiary organization of the aforementioned State Committee, taking the role of conducting the survey regarding compensation and submitting the survey result to the State Committee. The State Committee analyses the result and submits it to the regional acquisition commission.

Losses of agricultural production are assessed by an evaluation commission, constituted by instruction of the head of the district administration, along with the determination of losses incurred by landowners and land-users resulting from acquisition of land for public needs, based on the information, provided by the design institute which has developed the planning for land acquisition. The findings of the evaluation commission are formalized in the form of the Certificate of the right to land use, specifying the area of agricultural lands acquired, the agreed conditions, and the total value of the losses of agricultural production.

The Nature Protection Department:

(i) Carries out the environmental examination of the negative impacts of the facilities being commissioned or technologies being introduced

(ii) Approves the location of facilities having negative effects on soil conditions

(iii) Develops measures aimed at land preservation during the location, design, construction, and operation of the new and reconstructed facilities, constructions, and structures, as well as introducing new technologies that have negative effects on land condition; and

(iv) Approves the Certificate of agreement to land acquisition. Finally, the State departments of sanitary and fire supervision, water resources departments approve the Certificate of agreement for land acquisition

For effective implementation of acquisition activities, which in this Project means acquisition of agricultural land, “Uzbekenergo” will have to undertake the following:

(i) Submits an application, with all necessary documents and permissions, to the Provincial administration for the selection of a land plot subject to temporary or permanent acquisition for construction of facilities in the framework of the Project;

(ii) Submits design estimates necessary for calculation of damages and losses of agricultural production to the district department of State Committee of the Republic of Uzbekistan on Land Resources, Geodesy, Cartography and State Cadastre and to the evaluation commission;

(iii) Obtains, following established procedure, a Certificate of land selection and Certificate of agreement for land acquisition;

(iv) Upon approval by the competent authorities of the construction plan, submit an application to the Provincial administration for temporary or permanent allocation of the land plots for construction works;

(v) Transfers funds allocated for compensation of the losses of agricultural production within one month after obtaining the financing for construction, in accordance with the Certificate of agreement for land acquisition; and

(vi) Obtains, in the established procedure, a Certificate of land marking from the district administrations, and a Certificate of the right for land use in the Provincial administration.

8.10.7 Implementation schedule

The project is divided into several kinds of work, which will be carried out in stages in different districts. Thus it is necessary to consider the procedure of compensating the affected households which will be decided on the district level. The detailed plan for implementing the compensation should be worked out separately for each stage of work in each district, taking into account the project-financing schedule (Table 8.10.7-1).

Table 8.10.7-1 Schedule for implementation monitoring and reporting

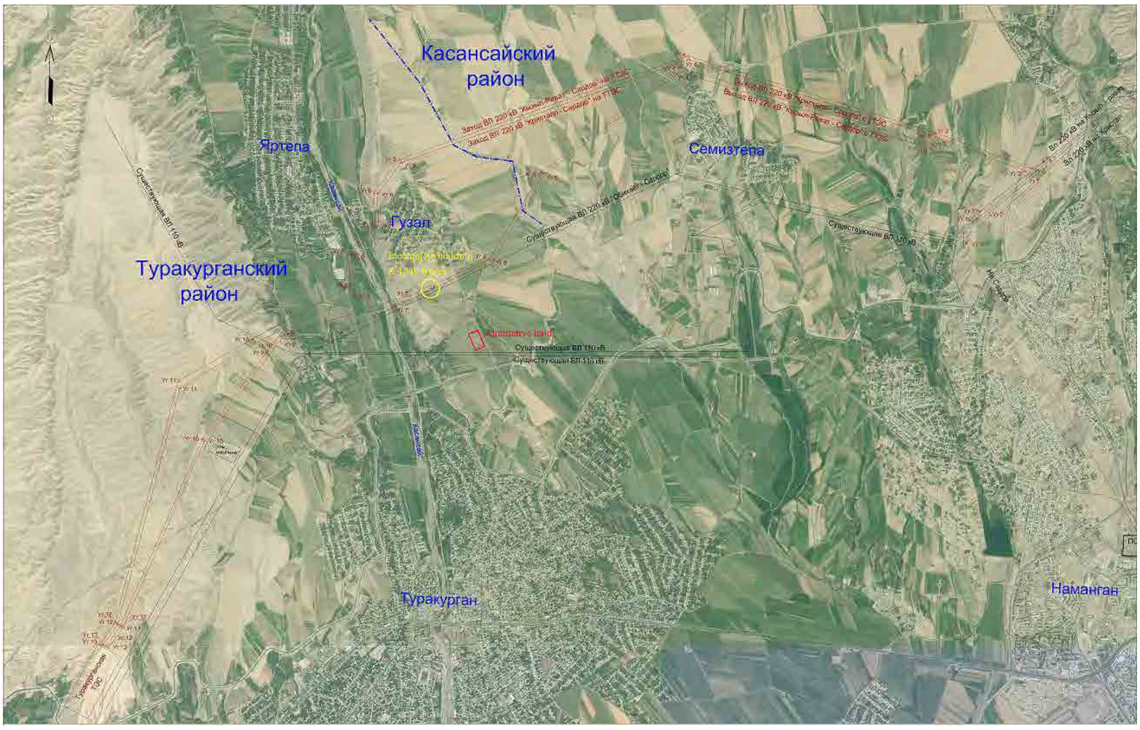
№	Task name	Responsibility Organization	2014												2015											
			Jan	Feb	Ma	Apr	Ma	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Ma	Apr	Ma	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	**LARAP MAKING**																									
2	Implement census survey	Power Plant Operation Department (PPOD)																								
3	Compensation rates fixed	PPOD																								
4	Identification of replacement plots	PPOD																								
5	Legalization of illegal Affected Persons	PPOD																								
6	Identification ofvulnerable Affected Persons	PPOD																								
7	Valuation of asset based on full replacement cost	PPOD																								
8	Determination of individual entitlement(land	PPOD																								
9	Preparation of the LARAP	PPOD and TEPSCO																								
10	Review/Approval of LARAP and issuance no-objection	JICA																								
11	Approval with «Uzbekenergo»	PPOD																								
12	**LOAN AGREEMENT**	PPOD and JICA																								
13	**UPDATE LARAP**	PPOD and TEPSCO																								
14	**REVIEW LARAP BY JICA**	JICA																								
15	**LARAP IMPLEMENTATION**																									
16	Allocation of LARAP funds, including those for relocation and rehabilitation assistance	PPOD																								
17	Offical Notification of Displaced Persons	PPOD																								
18	Preparation of vouchers (written guarentee)	PPOD																								
19	Preparation of places for resettlement	PPOD																								
20	Delivery compensation	PPOD																								
21	Land withdrawal process	PPOD																								
22	**MONITORING (internal)**																									
23	Preparation of implementation schedule	PPOD																								
24	Preparation of compliance report	PPOD																								
25	Review of compliance report and issuance of no-objection	PPOD																								
26	Monitoring(internal)	PPOD																								
27	**MONITORING (external)**																									
28	Employment of external monitoring agency	PPOD																								
29	Action plan preparation by External Monitoring Agency (EMA)	EMA																								
30	Monitoring (external)	EMA																								
31	Advising project mananagement regarding possible	EMA																								
32	**CONSTRUCTION PERIOD**	required approval																								

Source: Uzbekenergo

8.10.8 Alternative land

At the point of 30th April of 2104, the alternative land for legally leaseholders having land use right of the orchard has not been determined yet. The alternative land for land users of the incomplete building and the clay fences is located 500m southeast of the original location (Figure 8.10.8-1). This alternative land is located along the road and water pipe and gas pipe are already introduced. No inhabitant has the land use right for this land.

As for the local people cultivating the fruit trees illegally without land use rights, application of penalty will be discussed by the district administrations. However, the district administrations will provide instruction of legally acquiring land use rights, and those who wish will be able to apply for acquisition of the land use rights.



Source: Uzbekenergo

Figure 8.10.8-1 Alternative land for loss of the incomplete building and clay fences

8.10.9 Cost and funding

As described in Chapter 8.10.4, the district administration is responsible for ensuring the alternative site is prepared, and not the project proponent, who is to pay the compensation costs. The compensation payment is conducted by means of bank transfer prior to the start of the construction. Compensation cost for restitution of agricultural land is included in the project construction cost. Calculation of all the compensation is based on the market price of main crops.

The construction period of the project will be about three years and the market price and production of the agricultural crops may change during that period. In this regard, calculation of compensation is corrected every year based on the data including the actual amount of crops of the affected households during two years before the start of the construction activity. This is because of the basis that the construction activities within the plot of the affected households does not exceed one agricultural season. The calculation of gross annual income from annual crops is conducted every year for that reason. The terms of temporary acquisition and permanent acquisition will be specified after the finalization of the design documentation. For example, in case the construction period is extended by delay and crosses the next agricultural season, additional compensation will be required. The budget for compensation is applied not only for agricultural producers, but also for the management of land acquisition, monitoring, and reserved fund (15%) to prepare for unexpected contingency.

Total compensation regarding JICA-financed portion amounts to 78,380,664 UZS (US$ 35,153) (Table 8.10.9-1).

Table 8.10.9-1Compensation amounts on JICA-financed portion

(Unit: UZS)

Status	Affected items	Compensation amounts			
		TKG TPS	220 kV Transmission line	Kyzyl-Ravat Substation	Total
Legal	Annual crops (cotton, wheat)	N/A	To be determined	N/A	To be determined
	Permanent crops (Orchard productivity)	1,082,726	35,796,998	342,106	37,221,830
	Structures	N/A	21,222,499	N/A	21,222,499
Illegal	Annual crops (cotton, wheat)	N/A	To be determined	N/A	To be determined
	Permanent crops (Orchard productivity)	5,787,533	13,220,499	N/A-	19,008,032
	Structures	N/A	N/A	N/A	N/A
Owned by district	Annual crops (cotton, wheat)	N/A	N/A	N/A	N/A
	Permanent crops (Orchard productivity)	N/A	389,487	538,816	928,303
	Structures	N/A	N/A	N/A	N/A
Total		6,869,809	70,629,483	880,922	78,380,664

Source: LARAP report for the project

8.10.10 Monitoring system

"Uzbekenergo" will appoint a specialist on the compensation internal monitoring who will develop detailed plans and indicators for monitoring the implementation of the LARAP to ensure that all affected households have been compensated as planned. The specialist will submit quarterly information reports on work progress for the inclusion in the management information system in the Project Implementation Unit (PIU) and project monitoring reports. Expenses for internal monitoring should be included in the budget for the compensation.

Table 8.10.10-1 shows the general system of monitoring indicators.

In addition, the project proponent should discuss about “Items of internal monitoring” with JICA in JICA’s appraisal mission.

Table 8.10.10-1 Items of internal monitoring

Goal	Actions	Monitoring Indicators
Identification of compensation recipients	Verification of recipients list with criteria given for compensation. Verification is made on each type of compensation	Number of households in list of recipients not meeting criteria (mistaken inclusion)
	Separately number of persons in list of recipients not meeting criteria (mistaken inclusion). Identification of persons having right for compensation but not included in list of recipients. A separate check on each type of compensation is made.	Number of households having right for compensation but not included in list of affected households (mistaken exclusion)
Control overtypes of Compensation	Confirmation of temporarily or permanently affected areas	Area of temporary land acquisition for which compensation has been paid
		Area of permanent land acquisition for which compensation has been paid
Control overcompensation payment	Verification of financial documents	Number of households receiving compensation in full amount, disaggregated by compensation types
	Identification and analysis of reasons, on base of which compensation is not paid on time and in the full amount	Number of households not receiving compensation in full amount, disaggregated by compensation types
		Number of households receiving compensation in full amount, disaggregated by compensation types
	Identification and analysis of reasons for which funds for compensation were not allocated in set terms and in full volume	Funds allocated for compensation payment as percent of total envisaged by LARAP
Additional compensation in the case construction is delayed (i.e, affected households would receive compensation for the second agricultural season)	Monitoring of time limits of temporary land acquisition	Number of households on whose plots terms of temporary land acquisitoin should be extended
		The construction work will be continued over dead line approval.
Handling of grievances and disputes	Analysis of disputes and claims and conflict Resolution	Number of claims
		Number of solved claims
		Level of satisfaction with compensation types and size

Source: LARAP report for the project

8.10.11 Public consultation

Participation of project-affected parties was provided at the earliest stages of project preparation, and their opinions are reflected in this document. During the initial assessment of social impacts of two times of public consultations (July and December of 2013), local residents' opinions were discussed regarding the need to use part of their land holdings on a temporary or permanent basis.

(1) Public consultation

As described in Chapter 8.9.1 above, Uzbekenergo held the public consultations on 24 June and on 14 December 2013. In the meetings, Uzbekenergo explained compensation for land acquisition and payment of compensation. However, there were no comments or opinions from the audience regarding compensation for land acquisition. Table 8.9.1-1 and Table 8.9.1-2 show a summary of the QA session during the meetings.

(2) Inventory survey

The explanation on the contents and the method of compensation regarding the land acquisition was given to all the households that were subject to the survey of Uzbekenergo conducted in January 2014 for the purpose of the estimation of the compensation for trees and other compensation subjects.

(3) Future consultation

Further, discussions with affected households whose land will be affected during construction will be carried out in 2014 as soon as the location of the towers for the new 220 kV transmission line has been decided, with representatives of all state structures responsible for measures on land condemnation. During these negotiations, will be discussed: (a) the acceptability of the decision to acquire land from the affected households and what consequences this would have for the private land; (b) preferred alternatives for compensation; and(c) mechanisms for paying compensation to the affected households.

8.10.12 Associated facility

(1) Size and area of land acquisition

(a) Potable water pipe

According to the EIA report for Drinking water supply system, the potable water pipeline will be constructed mainly to run along the road or in the residential area, but not through agricultural land. The pipe is installed at 0.6 - 0.7m depth and backfilled later and returned to the land user. Thus, physical resettlement of the residents nor any economic loss will not occur

(b) Fire-fighting facility

The site for the fire-fighting facility is within the area described in LARAP (Figure 8.10.3-1) and the size is 0.7 ha. The land is not guaranteed for land use rights, and physical resettlement of the residents or economic loss will not occur.

(c) Access roads

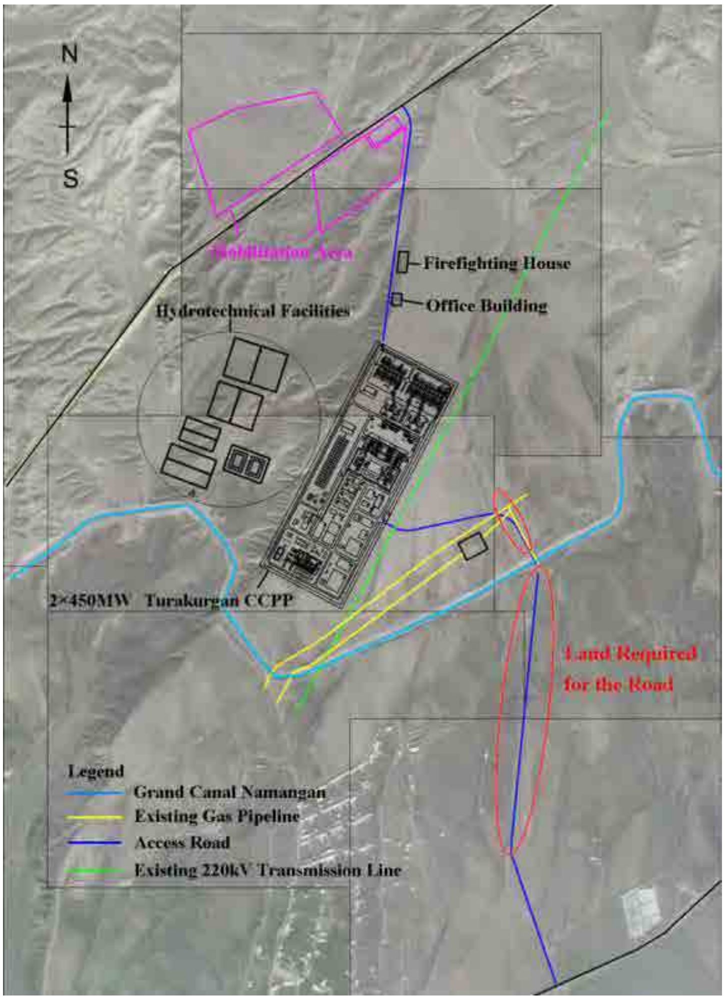
According to Uzbekenergo, the land use right for 4.6ha of land has been issued for the access road for permanent use.

Access roads will be constructed for two routes, north and south of TKG TPS The land for the northern route is not guaranteed for land use rights, and compensation for land acquisition will not occur. The land for the southern route does not contain houses, thus physical resettlement will not occur. Only the orchard located therein will be compensated for economical displacement (Table 8.10.12-1, Figure 8.10.12-1). Land will be acquired not only for the land directly on the access road route but also for a block of land along the route for safety reasons.

Table 8.10.12-1 Overview of land acquisition for access road

Size of site	Number of affected household	Area of land acquisition from the affected households	Current land use
4.6 ~~15.0~~ ha	10 households (with land use rights: 8 households) (without land use rights: 2 households)	3.30 ha* (area to be acquired from one household: 0.06 - 1.05 ha)	Orchard

Notes: * All of orchards within the access road route will be acquired for safety reason
Source: LARAP report for the Project



Source: JICA Study Team

Figure 8.10.12-1 Location of orchards to be acquired for access road construction

(d) Residential housing for TKG TPS

The residential house for the TKG TPS's staff will be constructed on the land of 2.0ha. The land use right for agricultural use for this land was acquired in 2012 by Bakht Fayzli Tongi, an agricultural company in Bakht Makhalla. As the company has not conducted agricultural cultivation on this land, the land use right was annulled and consequently physical displacement of the residents or economic loss will not occur.

(2) Inventory of loss

Table 8.10.12-2 indicates the loss for land, structures and trees.

Table 8.10.12-2 Loss of land, structures and tree on access road

Status	Affected items	Access road
Legally	Land (ha) Permanent loss Temporary loss	 3.125 N/A
	Annual crops (kg) (Cotton, Wheat)	N/A
	Permanent crops (Trees, Number of tree)	810
	Structures	N/A
Illegally	Land (ha) Permanent loss Temporary loss	 0.175 N/A
	Annual crops (kg) (Cotton, Wheat)	N/A
	Permanent crops (Trees, Number of tree)	457
	Structures	N/A

Source: LARAP report for the Project

(3) Requirement of compensation for lost assets

(d) Compensation policy

Compensation policy for the land acquisition of the associated facility (access road) is similar to that of the JICA-finance section.

(e) Entitlement matrix

Table 8.10.12-3 indicates “Type of loss”, “Entitled persons”, and “Detail of compensation” of the affected households by construction of the access road.

Table 8.10.12-3 Entitlement matrix (Access road)

No	Type of Loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation and Assistance Package)	Responsible Organizations
1.	Loss of orchard and trees (Permanent loss)	Legally leaseholder (8 households)	- Land as compensation for land with a plot of equal cost and productivity	Turakurgan District Administration
			- Gross income from all the trees on the orchard - Loss of profit which could be gained from all the trees throughout the remaining years of the product bearing period.	Uzbekenergo

No	Type of Loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation and Assistance Package)	Responsible Organizations
		Farmer who has not certificate of land use rights (2 households)	- Gross income from all the trees on the orchard - Loss of profit which could be gained from all the trees throughout the remaining years of the product bearing period.	Uzbekenergo

Source: JICA Study Team

(4) Grievance system

The grievance system is the same scheme as JICA-financed portion

(5) Implementation system

The implementation system is the same scheme as JICA-financed portion

(6) Implementation schedule

The implementation schedule is incorporated in that of JICA-financed portion.

(7) Cost and funding

Compensation regarding the access road is calculated with the same method as JICA-financed portion. Total compensation amounts to 38,132,535 UZS (US$ 17,102) (Table 8.10.12-4).

Table 8.10.12-4 Compensation amounts on access road

(units: UZS)

Status	Affected items	Compensation amount
Legally	Annual crops (cotton, wheat)	-
	Permanent crops (Orchard productivity)	34,854,581
	Structures	-
Illegally	Annual crops (cotton, wheat)	-
	Permanent crops (Orchard productivity)	3,277,954
	Structures	-
Total		38,132,535

Source: LARAP report for the Project

(8) Monitoring system

The monitoring system is the same scheme as JICA-financed portion.

8.11 Estimation of Greenhouse gas (GHG) and Air pollutants

8.11.1 Estimation about the amount of GHG emission

(1) Outline

This project is a development of the gasified power station. Regarding a concern of climate change, the confirmation of the positive/negative impact by this project was conducted.

GHG emission was calculated in reference to "JICA Climate-FIT (Mitigation) Climate Finance Impact Tool for Mitigation, 2011".

The calculation method for GHG emission reduction is shown as below (Figure 8.11.1-1).

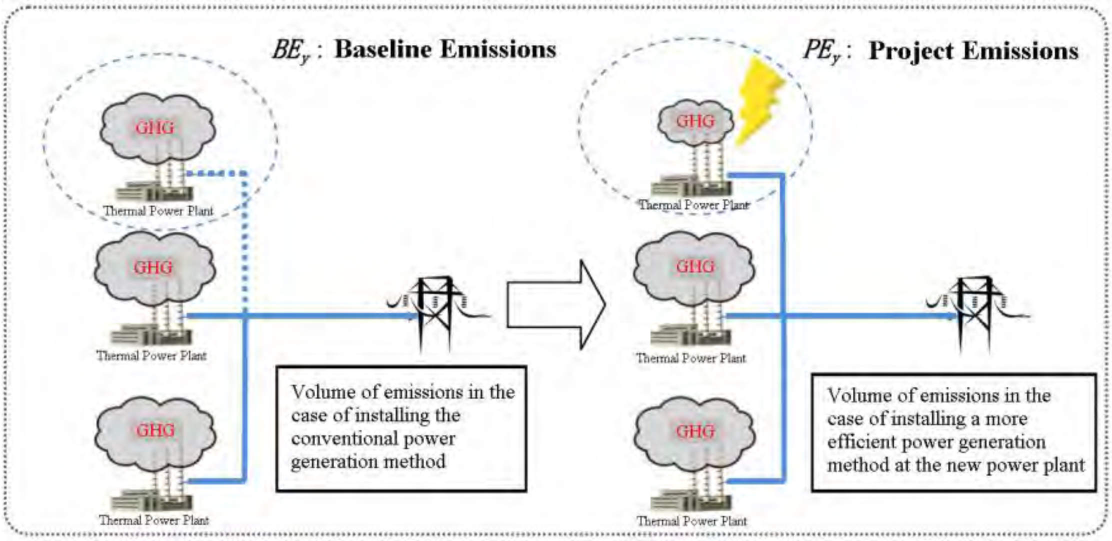
$ER_y = BE_y - PEy$

Where,

ER_y: GHG emission reduction in year y achieved by project (t-CO_2/y)

BE_y: GHG emission in year y with low-efficiency power generator (t-CO_2/y)
(Baseline emission)

PE_y: GHG emission in year y after efficiency improvement (t-CO_2/y)
(Project emission)



Source: JICA Climate-FIT (Mitigation) Climate Finance Impact Tool for Mitigation, 2011

Figure 8.11.1-1 Images of Emissions Reductions

(2) Baseline emission

Since the amount of power output in the grid prior to project commencement is not supposed tochange until after project completion, the power output reduced by the existing power station shall be equivalent to the power generated by the new power station.

$$BE_y = EG_{BLy} \times EF_{BLy}$$

Where,

BEy: Baseline emission (GHG emission with low-efficiency existing power stations), (t-CO_2/y)

EG_{BLy}: Net electrical output by the existing power stations, which shall be equivalent to the power output of new power station EG_{PJy}, (MWh/y)

EF_{BLy}: CO_2 emission factor of the electricity for the low-efficiency power station, (t-CO_2/MWh)

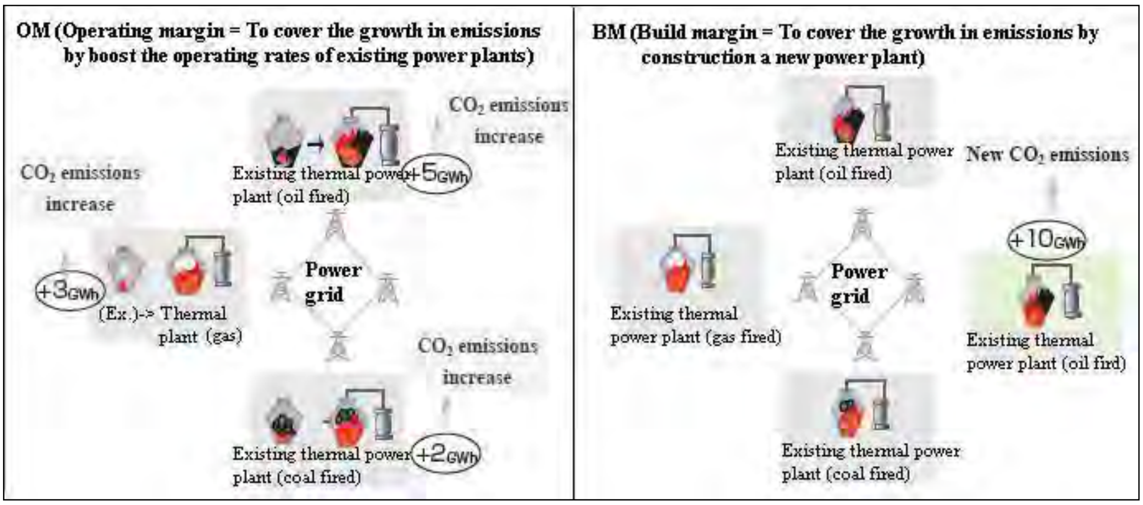
There are three methods for calculating the baseline emission coefficient (t-CO_2/MWh)

Method 1:The build margin emission coefficient (t-CO_2/MWh)

Method 2: The combined margin emission coefficient

Method 3: Emission coefficient (t-CO_2/MWh) identified as the most likely baseline scenario

The images of operating margin (OM) and build margin (BM) emissions coefficient are shown in the Figure 8.11.1-2.



Source: http://gec.jp/gec/jp/Activities/cdm_meth/pACM0002-old-080414.pdf

Figure 8.11.1-2 Images of OM and BM

(3) Project emission

Project emission shall be determined by multiplying the net power output produced by the new power station and the CO_2 emission factor of electricity for the new power stations.

$$PE_y = EG_{PJy} \times EF_{PJy}$$

Where,

$PE_{PJ,y}$: Project emission (GHG emission after project activity (t-CO_2/y))

$EG_{PJ,y}$: Yearly electricity generating capacity after the project (transmission end efficiency) (MWh/y)

$EF_{PJ,y}$: CO_2 emission coefficient of electricity generation (t-CO_2/MWh)

CO_2emission coefficient of electricity for the new power station is calculated using the planned data of CO_2 emission factor of fuel and generation efficiency and power output for the new power station before the project starts, and the measured data shall be used after the project is completed.

CO_2 emission factor of fuel shall be the same as of the baseline, since the fuel properties are the same for the both cases.

$$EF_{PJ,y} = \{COEFi / (\eta_{PJ,y/100})\}x\ 0.0036$$

Where,

EF_{PJy}: Project CO_2 emission factor of electricity, (t-CO_2/MWh)

$COEF_i$: CO_2 emission coefficient of fuel “i” per calorific value, (t-CO_2/TJ)

$\eta_{PJ,y}$: Planned value of generation efficiency after improvement, (%)

0.0036:Conversion factor of electric energy to thermal energy, (TJ/MWh)

(4) Baseline Emission Coefficient of Uzbekistan

IGES (Institute for Global Environmental Strategies) of Japan provides the data of emission factors as below for Uzbekistan on 2011 (Table 8.11.1-1).

Table 8.11.1-1 Grid CO_2 Emission Factors in Uzbekistan on 2011

Margin	Unit	2011
Combined Margin (CM)	t-CO_2/ MWh	0.518
Operation Margin (OM)	t-CO_2/ MWh	0.536
Build Margin (BM)	t-CO_2/ MWh	0.499

Source: http://pub.iges.or.jp/modules/envirolib/view.php?docid=2136

Since not only combined cycle power stations but also conventional TPS are planned for use in Uzbekistan, using combined margin (CM) as the baseline emission seems to be more appropriate than using build margin (BM). Therefore, we will adopt the combined margin (CM) as baseline emission factor.

Baseline Emission Coefficient: 0.518 (t-CO_2/ MWh)

(5) Calculation of CO_2 emission coefficients for TKG TPS

The CO_2 emission factor of fuel (COEFi) and CO_2 emission factor of electricity ($EF_{PJ,y}$) can be calculated using the same equations used for the old power stations and changing only the figure of generation efficiency from Table 8.11.1-1. The results are as shown in Table 8.11.1-2.

Table 8.11.1-2 Calculation of CO_2 emission coefficients for TKG TPS

Item	Unit	Value	Remarks
Gross power output of TKG TPS	MW	867.6	
Gas turbine	MW	598.6	
Steam turbine	MW	269.0	
Capacity factor(CF)	%	86.8	
Kind of fuel	-	Natural gas	
Higher heating value, HHV	kJ/kg	51,923	
Lower heating value, LHV	kJ/kg	46,747	
Carbon content in fuel, C%	weight%	70.71	
CO_2 emission coefficient of fuel, COEFi	t-CO_2/TJ	55.42	Note-1)
Net generation efficiency of new power station, $\eta_{PJ/y}$	%	55.9	
Conversion factor of electric energy to thermal energy	TJ/MWh	0.0036	
CO_2 emission coefficient of electricity generation, $EF_{PJ,y}$	t-CO_2/MWh	0.3569	Note-2)

Note: Abovementioned values are referred to Chapter6.1.5 (VI-24-29).

1) CO_2 emission factor of fuel,
COEFi = (C%/100)/LHVx (44.01/12.011) x10^6

2) CO_2 emission factor of electricity, $EF_{PJ,y}$={COEFi/(η_{PJy}/100)} x 0.0036

(6) Effect of GHGemission by this project

Table 8.11.1-3 shows a trial calculation result of CO_2 emission of the project based on the expected performance data for the combined cycle plant of gas turbine.

The baseline emission BEy is 3,417,222t-CO_2/y, the project mission PEy is 2,354,355 t-CO_2/y, and consequently the reduction of GHG (CO_2) emission is 1,062,867 t-CO_2/y.

Table 8.11.1-3 Reduction of CO_2emission by TKGTPS

Item	Unit	Value	Remarks
Electricity generation	MWh	6,596,953	867.6x8760x86.8/100
Baseline CO_2 emission factor of electricity	ton/MWh	0.518	
Project CO_2 emission factor of electricity	ton/MWh	0.3569	
Baseline emission, BEy	t-CO_2/y	3,417,222	
Project emission, PEy	t-CO_2/y	2,354,355	
Reduction of emission	t-CO_2/y	1,062,867	

Source: JICA Study Team

8.11.2 Estimation about the amount of NOx and SOx emission

The fundamental method of estimation regarding NOx and SOx is the same as the method for GHG in 8.11.1.

However, it is difficult to determine the emission rate of NOx and SOx for TPS in Uzbekistan. IGES of Japan provides the data of emission rate of each fuel factors for TPS (Table 8.11.2-1).

The above - mentioned factor is used to estimate the amount of NOx and SOx emission.

Table 8.11.2-1 Emission rate of NOx and SOx

Item	Unit	Average (1996,1999,2002,2005)	
		NOx	SOx
Coal	kg/GJ	0.034	0.036
Fuel Oil A	kg/GJ	0.067	0.113
Natural gas	kg/GJ	0.017	0.000

Source: http://www.cger.nies.go.jp/db/ef-jass/efjass_index_j.html

According to Energy Balance 2013 (IEA), electricity composition of Uzbekistan is shown in Table8.11.2-2. Almost all fuel used to generate electricity at the CHP plant is natural gas.

Table 8.11.2-2 Energy consumption of electricity and CHP plant in Uzbekistan

Item	Energy consumption for electricity generation(TJ)
Coalfield TPS	4,035 (0.7%)
Oilfield TPS	315 (0.1%)
Gas field TPS	560,900(99.2%)

Note: Based on Energy Balance2013 (IEA), Energy consumption was estimated by JICA Study Team.
Parameter is as follows for calculation.
Heating value of coal is 6,354kcal/kg, oil is 9,126kcal/kg, and density of oil is 0.90 kg /m^3.

According to the amount of electricity generation by TKG TPS, NOx and SOx emissions are estimated based on the composition of existing power stations and TKG TPS.

Table 8.11.2-3 shows a trial calculation result of NOx and SOx emission.

The baseline emission (the composition of existing TPSs) is 729.4 t- NOx /y, 15.5 t- SOx /y.

TKG TPS is 722.2 t- NOx /y, 0 t- SOx /y, and consequently the reduction of emission is 7.2 t-NOx /y, 15.5 t- SOx /y.

Table 8.11.2-3 Reduction of NOx and SOx emission by TKGTPS

Item	Unit	Amount emission			
		NOx		SOx	
		Existing TPSs	TKG TPS	Existing TPSs	TKG TPS
Gross power output of TKG TPS	MW	867.6			
Net generation efficiency of new power station (TKG TPS)	%	55.9			
Capacity factor	%	86.8			
Electricity generation (Output)	MWh	6,596,953			
Input of heat quantity	MWh (GJ)	11,801,347 (42,484,848)			
Coal field TPS	ton	10.1	—	10.7	—
Oil field TPS	ton	2.8	—	4.8	—
Gas field TPS	ton	716.5	722.2	0	0
Total amount of emission	ton	729.4	722.2	15.5	0
Reduction of emission	ton	7.2		15.5	

Note: Input of heat quantity is estimated based on generation efficiency of TKG TPS. Input of heat quantity of existing plants is also used the same value.

Source: JICA Study Team

8.12 Other

8.12.1 Environmental Checklist

Table 8.12.1-1, 2 shows the result of environmental and social consideration reviewed according to the checklist attached to JICA Guideline.

Table 8.12.1-1 Check List of TKG TPS

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) Y (c) Y (d) N	(a) The EIA of this project has been prepared in accordance with Regulations for State Ecological Assessment in the Republic of Uzbekistan. (b) The EIA report has been approved by The state Environmental Committee of Republic of Uzbekistan(2013.07.10_No.18-649з) in accordance with the Decree of Cabinet Ministers of Republic of Uzbekistan(31.12.01 No 491). (c) There are no conditions/comments on the approval of EIA report from the relevant authorities. (d) Project proponent will give the notice on consequences of ecological impact before construction start from the relevant authorities. All permissions will be received on this procedure.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
1 Permits and Explanation	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is the understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) Project proponent held a stakeholder meeting twice in 2013. Moreover, Project proponent and JICA study team have to hold the stakeholder meetings twice in order to obtain the consent from the residents. The first stakeholder meeting was held on 16 February 2014. The second stakeholder meeting was held on 27 April 2014. On 24 June 2013, a public consultation was held in Turakurgan, Shirinnlk to give an explanation of the project overview and its environmental and social impact to the local residents. 190 people attended, including an independent ecosystem advisor, government officials, staff of TKG TPS, District Hall, medical staff, and local residents. On 14 December 2013, a public consultation was held in Turakurgan, Shirinnlk to give an explanation regarding an overview of the project, the potable water pipeline improvement project, construction material acquisition, etc. to the local residents. 177 people attended (including 69 women), including government officials, staff of TKG TPS, school teachers, and local residents. (Reference: Chapter 8.9 Stakeholder meeting) (b) The comments are adequately reflected in the project through environmental management plan. (Reference: Chapter 8.8 Environmental monitoring plan)
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) The alternatives were discussed regarding zero-option, site selection, fuel selection, and power generation method. (Reference: Chapter 8.6 Consideration of alternatives)

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
2 Pollution Control	(1) Air Quality	(a) Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust emitted by the power station operations comply with the country's emission standards? Is there a possibility that air pollutants emitted from the project will cause areas that do not comply with the country's ambient air quality standards? Are any mitigating measures taken? (b) In the case of coal-fired power stations, is there a possibility that fugitive dust from the coal piles, coal handling facilities, and dust from the coal ash disposal sites will cause air pollution? Are adequate measures taken to prevent the air pollution?	(a) Y (b) N/A	(a) Natural gas used for fuel contains almost no sulfur, ash and SOx, therefore it generates very little SOx and particulate matter. NOx concentration in the gas emission will comply with Russian standards (GOST 29328-92).This standard value is equivalent to the guideline value for TPS stipulated in IFC/WB EHS Guideline. Atmospheric diffusion simulation of NOx emitted from TKG TPS was conducted, and the result indicated that NOx concentration satisfies Environmental standard of Uzbekistan as well as IFC/WB EHS Guidelines. Project proponent will take the following action to mitigate air quality concerns - Use of natural gas - Introduction of low NOx combustion appliances - Use of high stack - Monitoring of exhaust gas and ambient air in the residential area (Reference: Chapter 8.5.1a air pollution) (b) The project is not a coal-fired power station.
	(2) Water Quality	(a) Do effluents including thermal effluents from the power station comply with the country's effluent standards? Is there a possibility that the effluents from the project will cause areas that do not comply with the country's ambient water quality standards or cause any significant temperature rise in the receiving waters? (b) In the case of coal-fired power stations, do leachates from the coal piles and the coal ash disposal sites comply with the country's effluent standards? (c) Are adequate measures taken to prevent contamination of surface water, soil, groundwater, and seawater by the effluents?	(a) Y (b) N/A (c) Y	(a) Blowdown water from the cooling tower system will be discharged to Grand channel Namangan (GCN). GCN is an artificial irrigation channel made of concrete. The estimated water temperature rise at the timing of discharge is less than 1℃. The chemical substances in blowdown effluent will be condensed up to 2.4 times by the cooling tower system. Water quality of blowdown water will comply with the standards of Uzbekistan (SanPin No.0056-96). General wastewater from TKG TPS is neutralized using CCDI(Comprehensive cleaning of the industrial discharge) in order to comply with the regulations of Uzbekistan and IFC/WB EHS Guidelines. (Source: Chapter 8.5.1b Water quality) (b) The project is not a coal-fired power station. (c) Project proponent will take the following action to mitigate water quality concerns. - Installation of water treatment facility - Drain system will be introduced to gather oily rain water

<table>
<tr><th>Cate gory</th><th>Environmental Item</th><th>Main Check Items</th><th>Yes: Y
No: N</th><th>Confirmation of Environmental Considerations
(Reasons, Mitigation Measures)"</th></tr>
<tr><td></td><td></td><td></td><td></td><td>- Monitoring of wastewater and river water</td></tr>
<tr><td>2 Pollution Control</td><td>(3) Wastes</td><td>(a) Are wastes, (such as waste oils, and waste chemical agents), coal ash, and by-product gypsum from flue gas desulfurization generated by the power station operations properly treated and disposed of in accordance with the country's regulations?</td><td>(a) Y</td><td>(a) The project will employ a gas-fired power station, so coal ash and byproducts of flue gas desulfurization will not be generated. However, domestic waste, waste oil and hazardous waste will be generated from TKG TPS. The project proponent will be adhere to relevant regulations (RD 118,0027714.60-97).
Treatment/ processing plan of waste materials
<table>
<tr><th>Waste materials</th><th>Treatment/ processing plan</th></tr>
<tr><td>Black metal scrap, Colored scrap metal, Metal shavings of black metal, Waste electrodes</td><td>Delivery to repair shops, the processing plant of scrap metal in Namangan city after temporary storage</td></tr>
<tr><td>Waste transformer oil, Waste turbine oil</td><td>Reuse after temporary storage of used oil Delivery to the relevant facility for oil recovery</td></tr>
<tr><td>Used tires</td><td>Delivery to the processing company after temporary storage</td></tr>
<tr><td>Cotton waste, Oily sand, Oily crushed stone, Oily sludge</td><td>Delivery to the processing company for the production of asphalt in Namangan city after temporary storage</td></tr>
<tr><td>Liquid mud from the cleaning of turbine oil</td><td>Transport to the treatment plants of industrial wastewaters (Oil is burned in the boiler)</td></tr>
<tr><td>Used batteries, Sludge from waste water purification unit, The sludge from the pre-treated raw water, Removal of dirt, turbidity of river water, The residue from the chemical treatment of compressors and piping system HRSG, Lime waste, Waste in the processing of salt, Waste from the insulating materials, Debris</td><td>Transport to the landfill for industrial materials in Namangan</td></tr>
<tr><td>Municipal solid waste, clothing material</td><td>Transport to the landfill for domestic waste in Namangan city</td></tr>
<tr><td>Used paper</td><td>Transport to the center of waste paper</td></tr>
<tr><td>Food waste</td><td>Reuse as animal feed</td></tr>
</table>
Source: Chapter 8.4 Scoping and TOR of the survey</td></tr>
</table>

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
2 Pollution Control	(4) Noise and Vibration	(a) Do noise and vibrations comply with the country's standards?	(a) Y	(a) The predicted noise level is approximately 55-70dB at the boundary of TKG TPS, and approximately 45 dB in the residential area 1km away from the boundary, which meets daytime/ nighttime environmental standards in the Uzbekistan and IFC/WB guidelines. Especially, the further mitigation measures such as "low-noise type equipment", "tree planting on the boundary of the site", and "installation of soundproof wall" will be considered if necessary. Source: Chapter 8.5.1c Noise and vibration
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N/A	(a) Potable water consumed in TKG TPS is supplied through the potable water pipeline. Ground water will not be used.
	(6) Odor	(a) Are there any odor sources? Are adequate odor control measures taken?	(a) N	(a) Domestic waste will be generated from TKG TPS. However, domestic waste will be disposed/reused on a periodic basis to ensure that odor by putrefaction is not produced.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) The project site is not located within the protected area, and there is no protected area within 50km.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms? (e) Is there a possibility that discharge of thermal effluents, intake of a large volume of cooling water or discharge of leachates will adversely affect the ecosystem of surrounding water areas?	(a) N (b) N (c) N (d) N (e) N	(a) The project site is composed cultivated land, pastureland, and unusable land with poor vegetation, and no virgin forests or natural forests exists. No coral reef, mangrove marsh, or tidal flats exist around the project site. (b) The project site is composed of cultivated land, pastureland, and unusable land with poor vegetation. No precious species of flora/fauna inhabit the project site. (c) Impact of terrestrial ecosystem is estimated to be insignificant based on the current conditions at the project site. Additionally, mitigation measures for air pollution, noise and vibration will be adequately implemented to reduce the impact on flora/fauna. (d) The increased amount of water intake for TKG TPS will be supplied by discharging the equivalent amount of water from the upstream water basin. Moreover, very few aquatic organisms are found in the artificial irrigation channel. As result, adverse impacts on the ecosystem will be very limited. (e) Thermal effluent is small in quantity compared to water flow in the artificial irrigation channel, water temperature rise will be less than 1^{o}C, and the affected water area will be limited to the vicinity of the water outlet.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a)Y (b)Y (c)Y (d)Y (e)Y (f)Y (g)Y (h)Y (i)Y (j)Y	(a) Project site is governmental land and involuntary resettlement (physical displacement) will not occur. However, economic displacement will occur. Turakurgan district decided on the allocation about land use of TKG TPS (Decision No.300). According to the land approved by Decree of the Cabinet of Ministers of the Republic of Uzbekistan #54(25 February 2013),the compensation of land acquisition should be conducted in accordance with Decree of the Cabinet of Ministers of the Republic of Uzbekistan #223(16 June 1995). The project proponent prepared land acquisition and resettlement action plan (LAPAP). (b) Project proponent held public meetings in July and December 2013 and February 2014. (c) The standard of living and income as before should be compensated based on LARAP. (d) When the competent authorities approve the certificate of the quality of productive land and the right for land use, allocated funds will be distributed for loss of agriculture production within one (1) month. (e) Decision No. 300 is described in compensation policy. (f) There is no description of vulnerable groups. However, the gender equality is described in LARAP. (g) Project proponent prepares the organization for implementation. (h) Decision No.300 details compensation payment. Project proponent will secure a budget for compensation in accordance with Decision No.300. (i) Compensation procedures are conducted by competent authorities. (j) Project proponent will monitor any complaints from residents (Reference: Chapter 8.10 Land acquisition and compensation)

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
4 Social Environment	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is sufficient infrastructure (e.g., hospitals, schools, and roads) available for the project implementation? If the existing infrastructure is insufficient, are any plans developed to construct new infrastructure or improve the existing infrastructure? (c) Is there a possibility that large vehicles traffic for transportation of materials, such as raw materials and products will have impacts on traffic in the surrounding areas, impede the movement of inhabitants, and any cause risks to pedestrians? (d) Is there a possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (e) Is there a possibility that the amount of water used (e.g., surface water, groundwater) and discharge of thermal effluents by the project will adversely affect existing water uses and uses of water areas (especially fishery)?	(a) Y (b) Y (c) Y (d) Y (e) Y	(a) Project proponent prepares the environmental management plan to reduce the risk of accidents, impact of noise, vibration, and degradation of air/water quality. (b) Project proponent plans the developments of access road, residential house for power station staff, potable water pipeline. (c) Project proponent plans natural forest s. -Slowdown of vehicles in the residential and school area -Construction vehicle traffic during school commuting hours shall be avoided -Checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, vehicle equipment checkups (brake, horn) (d) Periodic medical check-ups will be conducted for workers (technical workers, etc.). Moreover, the education and health care training for workers will be conducted. (e) GCN nearby project site is the artificial irrigation channel, and no fishing takes place here. Local residents near the project site are using waterworks. The increased amount of water intake for TKG TPS will be supplied by discharging the equivalent amount of water from the upstream water basin. Therefore, water use is hardly disturbed by the project.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N/A	(a) Historical, cultural and/or archaeological property and heritage does not exist around the project site.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N/A	(a) There is no scenic area around the project site.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N/A (b) N/A	(a) There are no minority groups living around the project site, any impact on ethnic minorities and indigenous peoples will not occur. (b) -
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?"	(a) Y (b) Y (c) Y (d) Y	(a) The project proponent insisted on the compliance to the labor laws and regulations (b) The project proponent insisted they will fully consider the safety of workers by s installing safety equipment and managing hazardous substances in order to prevent labor accidents. (c) The project proponent will develop a safety and sanitation management plan including training on traffic safety and public sanitation for staff. (d) The project proponent will monitor employees and ensure they all comply with laws and regulations. Project proponent will subcontract a security firm to deploy security guards.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?	(a) Y	(a) The following pollution-preventive measures will be taken by the project proponent and EPC Contractor. <Air pollution> - Periodic checkup and maintenance of vehicles - Shutdown of engine during waiting time - The rear deck of the sand-transport trucks shall be covered - Periodic car wash - Periodic watering of the site and surrounding road in case of strong wind - Monitoring of ambient air in the residential area <Water pollution> - Installation of temporary rainwater drainage - Installation of temporary sedimentation pond and oil-separating system - Storage of waste oil and chemical materials in a storage site and method to prevent permeation into ground - Installation of septic tank and temporary toilet - Monitoring river water quality <Waste> - Development of waste management program including education of workers to encourage reduction and reuse of waste - Prohibition of illegal dumping - Separation of waste by type, storage in an appropriate storage site and legal disposal in an appropriate disposal site <Noise and vibration> - Periodic checkup and maintenance of vehicles - Construction activity and traffic of vehicles is essentially limited to daytime - Use low-noise/vibration type equipment - Temporary soundproof wall around the project site - Monitoring of Noise level at site boundary and the residential area

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
5 Others	(1) Impacts during Construction	(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?"	(b) N (c) Y	(b) Impact of terrestrial ecosystem is estimated to be insignificant based on the current conditions of the project site. Additionally, mitigation measures for air pollution, noise and vibration will be adequately implemented to reduce the impact on flora/fauna. (c) The following preventive measures will be taken by the project proponent and EPC Contractor. <Infrastructure> - Development of necessary infrastructures for the contractor’s mobilization area according to the EPC contract <Traffic accident> - Slowdown of vehicles in the residential and school area - Traffic of construction vehicles during school commuting hours shall be avoided - Checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake, horn) <Public sanitation> - Compliance of safety laws and regulations - Development of safety and sanitation management plan and implementation of regular medical checkups - The workers will have a medical examination every year - Construction of a medical facility on the working site with an onsite nurse - Establishment of cooperative relationship with the local medical facilities
	(2) Accident Prevention Measures	(a) In the case of coal-fired power stations, are adequate measures planned to prevent spontaneous combustion at the coal piles (e.g., sprinkler systems)?	(a) N/A	(a) The project is not a coal-fired power station.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
5 Others	(3) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) N/A	(a) The project proponent will create an environmental monitoring plan. (b) The Plan contains monitoring of environmental and social aspects during construction and operation. The methods, frequencies of the monitoring are also planned. (c) The project proponent establishes an adequate monitoring framework for the project during construction and operation phase. (d) The project proponent will inform periodically the results of monitoring to JICA. Source: Chapter 8.8 Environmental monitoring plan
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities). (b) Where necessary, pertinent items described in the Ports and Harbors checklist should also be checked (e.g., projects including construction of port and harbor facilities).	(a) Y (b) N/A	(a) The project proponent prepared EIA report for transmission line project. (b)The project does not involve construction and expansion of the port facility.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as trans boundary waste treatment, acid rain, destruction of the ozone layer, and global warming).	(a) N	(a) This project is adopted the high-efficiency combined cycle power generation system and maintenance of capacity of the facility. The reduction of CO_2 emission concerning this project compared with an average power generation facility in Uzbekistan is more than one million tons per year. Source: Chapter 8.11 Estimation of Exhaust Gas Reductions

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are requested to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Table 8.12.1-2 Check List of Transmission line

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) Y (c) Y (d) N	(a)The EIA of this project has been prepared in accordance with Regulations for State Ecological Assessment in the Republic of Uzbekistan. (b)The EIA report has been approved by the state Environmental Committee of Republic of Uzbekistan(2014.03.10_No.181238з) in accordance with the Decree of Cabinet Ministers of Republic of Uzbekistan(31.12.01 No 491). (c)There are no conditions/comments on the approval of EIA report from the relevant authorities. (d) Project proponent will give a notice on consequences of ecological impact before commencement of construction from the relevant authorities. All permissions will be received for this procedure.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is the understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) Regarding TKG TPS project and transmission line project, Project proponent and JICA study team have to hold the stakeholder meetings twice in order to obtain the consent from the residents. The first stakeholder meeting was held on 16th February 2014. The Second stakeholder meeting will be held during April 2014. (b) The comments are adequately reflected in the project through the environmental management plan. Source: Chapter 8.9 Stakeholder meeting
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) N	(a) According to alternative plans, zero option was described in EIA report. However, the project proponent will consider the transmission line route in detail to reduce any impact.
2 Pollution Control	(1) Water Quality	(a) Is there any possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? If the water quality degradation is anticipated, are adequate measures considered?	(a) Y	(a)Project proponent plans will take the following action to mitigate water quality concern. - Tower design considering the elevation of tower foundation around the river - Foundation will be built on concrete - Installation of temporary rainwater drainage, and the connection of existing drainage systems

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a)The proposed transmission line route does not pass through protected areas such as national park.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate measures taken to prevent disruption of migration routes and habitat fragmentation of wildlife and livestock? (e) Is there any possibility that the project will cause the negative impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystem due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In cases where the project site is located in undeveloped areas, is there any possibility that the new development will result in extensive loss of natural environments?	(a) N (b) N (c) N (d)N/A (e)N/A	(a) The proposed sites of tower foundation and transmission line route are almost all cultivated land, and no virgin forest or natural forest exists. No coral reef, mangrove marsh, or tidal flats around the project site. (b) The proposed sites of tower foundation and transmission line routes are almost all cultivated land. No precious species of flora/fauna inhabits within the propose route. (c)Impact of terrestrial ecosystem is estimated to be insignificant based on the current conditions. Additionally, mitigation measures for air pollution, noise and vibration will be adequately implemented to reduce the impact to flora/fauna. (d) Because of construction work, disruption of migration routes will occur temporally. However, the land of under transmission line will be restored as before. (e)/ (f) Proposed sites of tower foundation and transmission line route are almost all in cultivated land.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
3 Natural Environment	(3) Topography and Geology	(a) Is there any soft ground on the route of power transmission and distribution lines that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there any possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a)Y (b)Y (c)Y	(a) Based on survey about the geographical features, the location of transmission towers are chosen the stable plain land. (b) Project proponent will take the following action to mitigate geographical concerns. - Check of the stability of slope /hill -In case of excavation work, the consideration of reinforcement work for slope /hill - Reclamation/ restoration of construction site (c) Tower foundations will be built on concrete. According to excavation soil, project proponent will transport the drilled soil to storage site for backfill or sale.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly	(a)Y (b)Y (c)Y (d)Y (e)Y (f)Y (g)Y (h)Y (i)Y (j)Y	(a) Project site is governmental land and involuntary resettlement (physical displacement) will not occur. However, economic displacement will occur. Turakurgan district determined the allocation of land use for the four-transmission line project (Decision No.45).According to the land approved by Decree of the Cabinet of Ministers of the Republic of Uzbekistan #54(25 February 2013),the compensation of land acquisition should be conducted in accordance with Decree of the Cabinet of Ministers of the Republic of Uzbekistan #223(16 June 1995). The project proponent prepared land acquisition and resettlement action plan (LAPAP). (b) Project proponent held a stakeholder meeting in February 2014. (c) The standard of living and income as before should be compensated based on LARAP. (d)When the competent authorities approve the certificate of the quality of productive land and the right for land use, Funds allocated will be distributed for loss of agriculture production within 1 month. (e) Decision No.45 is described in the compensation policy. (f) There is no description of vulnerable groups. However, the e gender equality is described in LARAP. (g) Project proponent will prepare the organization for implementation.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
		implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?		(h) Decision No.45 describes compensation payment. Project proponent will secure a budget for compensation in accordance with Decision No.45. (i) Compensation procedures are conducted by competent authorities.. (j) Project proponent will monitor any complaints from residents Source: Chapter 8.10 Land acquisition and resettlement action plan
4 Social Environment	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (c) Is there any possibility that installation of structures, such as power line towers will cause a radio interference? If any significant radio interference is anticipated, are adequate measures considered? (d) Are the compensations for transmission wires given in accordance with the domestic law?	(a) Y (b) Y (c) Y (d) Y	(a)Project proponent prepares the environmental management plan to reduce the risk of accidents, impact of noise, vibration, and degradation of air/water quality. (b) Periodic medical check-ups will be conducted for workers (technical workers, etc.). Moreover, the education and training on health care for workers will be conducted. (c)Project proponent designs the transmission line route to avoid running through residential areas. (d) In the case of 220kV transmission line, the height of transmission line must be secured to a height higher than 7m from ground as per regulations, and the distance between transmission line and trees should be secured to a height higher than 4m. In addition, to build the structure from the transmission line center within 25 m of both sides is forbidden. The compensation for these regulations will be conducted in accordance with law.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a)N/A	(a)Historical, cultural and/or archaeological property and heritage does not exist around the proposed transmission line route.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)N/A	(a)There is no scenic area around the proposed transmission line route.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N/A (b) N/A	(a)There are no minority groups living around the proposed transmission line route, any impact on ethnic minorities and indigenous peoples will not occur. (b) N/A
	(6) Working Conditions	"(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?"	(a) Y (b) Y (c) Y (d) Y	(a) The project proponent insisted on adhering to labor laws and regulations (b) The project proponent insisted they will take due consideration on the safety of workers on the hardware aspect such as installation of safety equipment and management of hazardous substances in order to prevent labor accident. (c) The project proponent will develop a safety and sanitation management plan including training on traffic safety and public sanitation for staff. (d) The project proponent will monitor employees and ensure they all comply with laws and regulations. Project proponent will subcontract a security firm to deploy security guards.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?	(a) Y	(a) The following pollution-preventive measures will be taken by the project proponent and EPC Contractor. <Air pollution> -Periodic checkup and maintenance of vehicles -Shutdown of engine during waiting time -The rear deck of the sand-transport trucks shall be covered -Periodic car wash -Periodic watering of the site and surrounding road in case of strong wind -Monitoring of ambient air in the residential area <Water pollution> - Tower design taking into consideration the elevation of tower foundation around the river - Foundation built over concrete - Installation of temporary rainwater drainage, and the connection of existing drainage system <Waste> - Development of waste management program including education of workers to encourage reduction and reuse of waste - Storage of waste oil and chemical materials in a storage site and method to prevent permeation into ground - Prohibition of illegal dumping - Transportation of the drilled soil to storage site for backfill or sale <Noise and vibration> - Periodic checkup and maintenance of vehicles -Construction activity and traffic of vehicles is essentially limited to daytime -Use low-noise/vibration type equipment -Temporary soundproof wall around the project site -Monitoring of Noise level at site boundary and the residential area

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
5 Others	(1) Impacts during Construction	(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?"	(b) Y (c) Y	(b) The following measures will be taken by the project proponent and EPC Contractor. -Implementation of mitigation measures for air pollution, noise and vibration -The start of construction from autumn to avoid the breeding and feeding season -To keep birds from nesting on towers, the tower will be painted colors that will repel them, along with the installation of a guard. - Collection of plant bulbs/seeds during civil work, putting to practical use during the backfilling (c) The following measures will be taken by the project proponent and EPC Contractor. -Development of necessary infrastructures for the contractor's mobilization area according to the EPC contract -Slowdown of vehicles in the residential and school area -Traffic of construction vehicles during school commuting hours shall be avoided -Checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake, horn)

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
5 Others	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) N/A	(a) The project proponent will create an environmental monitoring plan.. (b) The Plan contains monitoring of environmental and social aspects during construction. The methods, frequencies of the monitoring are also planned. (c) The project proponent establishes an adequate monitoring framework for the project during construction phase. (d) The project proponent will inform periodically the result of monitoring to JICA. Source: Chapter 8.8 Environmental monitoring plan
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Road checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities).	(a) N	(a) Project proponent will use the existing road for the procurement/transportation of materials.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans boundary or global issues should be confirmed, (e.g., the project includes factors that may cause problems, such as trans boundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	(a) CO_2 will be produced by construction work. However, construction period is short and the number of equipment and machinery used for construction work is comparatively few. Global issues are not foreseen.

1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are requested to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Source: EIA report and JICA Study Team

8.12.2 The associated projects

Table 8.12.2-1 shows Checklist of access road.

Table 8.12.2-2 shows Summary of EIA report about associated projects (except access road).

Table 8.12.2-1 Check List of Access road

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) Y (c) Y (d) N	(a) The EIA of this project has been prepared in accordance with Regulations for State Ecological Assessment in the Republic of Uzbekistan. (b) The EIA report has been approved by The state Environmental Committee of Republic of Uzbekistan(2013.07.10_No.18-649з) in accordance with the Decree of Cabinet Ministers of Republic of Uzbekistan(31.12.01 No 491). (c) There are no conditions/comments on the approval of EIA report from the relevant authorities. (d) Project proponent will give the notice on consequences of ecological impact before construction start from the relevant authorities. All permissions will be received on this procedure.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is the understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) Project proponent held the stakeholder meeting four times about TKG TPS project and the associated facilities. Project proponent explained about the access road as the associated facilities in the meeting (b) There are no comments about access road.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Access road will be planned by the most suitable conditions such as expense, civil work (technical aspect), compensation for land, environmental aspect based on the consideration of the site selection.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
2 Pollution Control	(1) Air Quality	(a) Is there a possibility that air pollutants emitted from the project related sources, such as vehicles traffic will affect ambient air quality? Does ambient air quality comply with the country's air quality standards? Are any mitigating measures taken? (b) Where industrial areas already exist near the route, is there a possibility that the project will make air pollution worse?	(a) Y (b) N	(a) Land for access road is composed of cultivated land, pastureland, and unusable land. There is no significant impact by air pollutants. In addition, project proponent will consider the equalization of traffic amount, use of bus for commuters. (b) The area near access road is cultivated land, pastureland, and unusable land.
	(2) Water Quality	(a) Is there a possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? (b) Is there a possibility that surface runoff from roads will contaminate water sources, such as groundwater? (c) Do effluents from various facilities, such as parking areas/service areas comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas not to comply with the country's ambient water quality standards?	(a) N (b) N (c) N	(a) (b) Access road will be paved with asphalt. The ditch will be set up on the roadside to drain rainwater to the irrigation channel. Therefore, there is no significant impact by soil runoff (c) Access road will be 1km and 1.4km, and there is no plan of any facilities.
	(3) Wastes	(a) Are wastes generated from the project facilities, such as parking areas/service areas, properly treated and disposed of in accordance with the country's regulations?	(a) N	(a) There is no waste generated from any facilities
	(4) Noise and Vibration	(a) Do noise and vibrations from the vehicle and train traffic comply with the country's standards?	(a) Y	(a) Land for access road is composed of cultivated land, pastureland, and unusable land. There is no significant impact by noise and vibration.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) Land for access road is not located within the protected area, and there is no protected area within 50km.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and livestock? (e) Is there a possibility that installation of roads will cause impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystems due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In cases the project site is located at undeveloped areas, is there a possibility that the new development will result in extensive loss of natural environments?	(a) N (b) N (c) N (d) N (e) N	(a) (b) Land for access road is composed cultivated land, pastureland, and unusable land with poor vegetation, and no virgin forests or natural forests exists and so on. (c) Impact of terrestrial ecosystem is estimated to be insignificant based on the environmental consideration of TKG TPS project. There is no significant impact by noise and vibration. (d) Project proponent considers that the checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake, horn) (e) (f) Land for access road is composed cultivated land, pastureland, and unusable land with poor vegetation.
	(3) Hydrology	(a) Is there a possibility that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?	(a) N	(a)There is no area of particular concern for topographic features.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
3 Natural Environment	(4) Topography and Geology	(a) Is there any soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a) N (b) N (c) N	(a)There is no area of particular concern for topographic features. (b)(c) Access road will be planned based on the consideration of civil work (technical aspect). Soil created civil work will be used for embankment and so on. Soil may be placed at construction area temporary; however, there is no transportation to disposal site.

Table 8.12.2-1 Check List of Access road

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a)Y (b)Y (c)Y (d)Y (e)Y (f)Y (g)Y (h)Y (i)Y (j)Y	(a) Project site is governmental land and involuntary resettlement (physical displacement) will not occur. However, economic displacement will occur. Turakurgan district decided on the allocation about land use of TKG TPS (Decision No.300). According to the land approved by Decree of the Cabinet of Ministers of the Republic of Uzbekistan #54(25 February 2013),the compensation of land acquisition should be conducted in accordance with Decree of the Cabinet of Ministers of the Republic of Uzbekistan #223(16 June 1995). The project proponent prepared land acquisition and resettlement action plan (LAPAP). (b) Project proponent held public meetings in July and December 2013 and February 2014. (c) The standard of living and income as before should be compensated based on LARAP. (d) When the competent authorities approve the certificate of the quality of productive land and the right for land use, allocated funds will be distributed for loss of agriculture production within one (1) month. (e) Decision No. 300 is described in compensation policy. (f) There is no description of vulnerable groups. However, the gender equality is described in LARAP. (g) Project proponent prepares the organization for implementation. (h) Decision No.300 details compensation payment. Project proponent will secure a budget for compensation in accordance with Decision No.300. (i) Compensation procedures are conducted by competent authorities. (j) Project proponent will monitor any complaints from residents (Reference: Chapter 8.10 Land acquisition and compensation)

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
4 Social Environment	(2) Living and Livelihood	(a) Where roads are newly installed, is there a possibility that the project will affect the existing means of transportation and the associated workers? Is there a possibility that the project will cause significant impacts, such as extensive alteration of existing land uses, changes in sources of livelihood, or unemployment? Are adequate measures considered for preventing these impacts? (b) Is there any possibility that the project will adversely affect the living conditions of the inhabitants other than the target population? Are adequate measures considered to reduce the impacts, if necessary? (c) Is there any possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (d) Is there any possibility that the project will adversely affect road traffic in the surrounding areas (e.g., increase of traffic congestion and traffic accidents)? (e) Is there any possibility that roads will impede the movement of inhabitants? (f) Is there any possibility that structures associated with roads(such as bridges) will cause a sun shading and radio interference?	(a) N (b) N (c) N (d) N (e) N (f) N	(a-e) This project is one of the associated facilities of TKG TPS project. Therefore, adequate measures will be conducted under the implementation of TKG TPS project. (f) Access road will be 1km and 1.4km, and there is no plan of any facilities, structures associated such as bridges, tunnel.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N/A	(a) Historical, cultural and/or archaeological property and heritage does not exist around access road.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N/A	(a) There is no scenic area around access road.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a) N/A (b) N/A	(a) There are no minority groups living around access road, any impact on ethnic minorities and indigenous peoples will not occur. (b) -
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures being taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a) The project proponent insisted on the compliance to the labor laws and regulations (b) The project proponent insisted they will fully consider the safety of workers by s installing safety equipment and managing hazardous substances in order to prevent labor accidents. (c) The project proponent will develop a safety and sanitation management plan including training on traffic safety and public sanitation for staff. (d) The project proponent will monitor employees and ensure they all comply with laws and regulations. Project proponent will subcontract a security firm to deploy security guards.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) Y (c) Y	(a-c) The following pollution-preventive measures will be taken by the project proponent and EPC Contractor. <Air pollution> The total amount of air pollutant emitted by construction work is estimated to be 0.4 ton, of which dust is 0.3 ton and aerosol/gas is 0.1 ton. Air pollutants will not exceed MPC. Therefore, regulation will be met. Watering will be conducted around construction site by an automobile sprinkler. <Water pollution> Rainwater and wastewater will be treated by water treatment equipment. Water treatment equipment prevents permeation into ground. The ditch will be set up on the roadside to drain rainwater to the irrigation channel. <Waste> Environmentally friendly materials will be adequately used. <Other> Landscape to be taken into consideration.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)"
5 Others	(3) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) N (b) N (c) N (d) N	(a-d) The project proponent does not plan an environmental monitoring plan.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation). (b) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of power transmission lines and/or electric distribution facilities).	(a) N (b) N	(a) There is no concern about forestry issues. (b) Transmission line is shown in Table8.12.1-2.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed, if necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	(a) There is no concern about transboundary or global issues.

1) Regarding the term “Country's Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made.

In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).

2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Table 8.12.2-2 Summary of EIA report about associated projects (except access road)

Item	Potable water pipe	Fire-fighting facility	The residential housing for power station staff
Title of EIA report	"DRAFT STATEMENT OF ENVIRONMENTAL IMPACT" (DSEI) For construction of "Straight Artesian Well Excavation and Soft Drinking Water Supply System"	"DRAFT STATEMENT OF ENVIRONMENTAL IMPACT" (DSEI) For construction of "FIRE SAFETY BUILDING"	"DRAFT STATEMENT OF ENVIRONMENTAL IMPACT" (DSEI) for 5 multistory apartment buildings with 160 apartments to be constructed in Bakht Makhalla, Sayram Rural Community, Turakurgan district
Construction period	Approx.3months	Approx.4months	Approx.8months
Assessment, Mitigation and safety measure			
Air quality	The total amount of air pollutant emitted by construction work is estimated to be 0.26 ton, of which dust is 0.25 ton and aerosol/gas is 0.02 ton. Air pollutants will not exceed MPC. Therefore, regulations will be met.	The total amount of air pollutant emitted by construction work is estimated to be0.09 ton, of which dust is 0.05 ton and aerosol/gas is 0.04 ton. Air pollutants will not exceed MPC. Therefore, regulation will be met.	The total amount of air pollutant emitted by construction work is estimated to be 0.9 ton, of which dust is 0.6 ton and aerosol/gas is 0.3 ton. Air pollutants will not exceed MPC. Therefore, regulation will be met.
Water quality		Wastewater of facility will be treated by water treatment equipment. Water treatment equipment prevents permeation into ground. Rainwater is drained irrigation channel.	Wastewater will be transported to district water treatment plant Rainwater is drained into the irrigation channel.
Waste	-The pipeline will be installed mainly along the road and underground of the residential area. The excavation soil will be backfilled after installation of pipeline. - Environmentally friendly materials will be adequately used.	-Separation by waste type, appropriate storage is encouraged. -Prohibition of illegal dumping. - Storage area/waste pits preventing permeation into ground. -Waste is encouraged to be reduced and reused.	-Separations by waste type, appropriate storage is encouraged. -Prohibition of illegal dumping. - Storage area/waste pits preventing permeation into ground. - Waste is encouraged to be reduced and reused..
Others		-Plants will be planted on the surrounding edge of the project site area	-Plants will be planted on the surrounding edge of the project site area
General/safety	-Compliance of environmental conservation laws and regulations and laws is enforced.	-Compliance of environmental conservation laws and regulations and laws is enforced. - Fire hydrants, fire extinguishers etc. will be installed.	-Compliance of environmental conservation laws and regulations and laws is enforced. - Fire hydrants, fire extinguishers etc. will be installed. -Housing equipment which complies with electric safety code will be installed.

8.12.3 Monitoring Form

Monitoring items shall be decided on with reference to the kind of sector, the characteristic of the project etc. According to this project, monitoring items are as follows.

8.12.3.1 Thermal power station

(1) Pre-construction phase

Aug/2014

Name	Status	Agreement	Date of compensation		Remarks
			Land	Trees	
Household-1	NH		-	??/Aug/2014	
Household-2	NH		-	??/Aug/2014	
Household-3	Certificate		??/Aug/2014	??/Aug/2014	
Household-4	NH		-	??/Aug/2014	
Household-5	NH		-	??/Aug/2014	

Notes: “NH” means person who has not a land use right

Sep/2014 (if need)

Name	Status	Agreement	Date of compensation		Remarks
			Land	Trees	
Household-1	NH		-	??/Sep/2014	
Household-2	NH		-	??/Sep/2014	
Household-3	Certificate		??/Sep/2014	??/Sep/2014	
Household-4	NH		-	??/Sep/2014	
Household-5	NH		-	??/Sep/2014	

Notes: “NH” means person who has not a land use right

(2) Construction phase

(a) Air pollution

Location: The project site, residential area (Decision after detail design)

Regulation: Sanitary norms, rules and hygiene normative documents of the Republic of Uzbekistan. San Pin No.0015-94

Unit mg/m^3

Date	Item	Measured Value (30min)			Uzbkistan maximum permissible concentration (30min)	IFC/ EHC Guideline General;2007
		Average	Max	Min		
	NO_2				0.085	0.2(1hour)
	NO				0.6	-
	SO_2				0.5	0.5(10min) 0.125(24hours)
	Dust				0.15	0.15(24hours)

(b) Water pollution

Location: Outtake (GCN)

Regulation: Rules for protection of surface water from contamination by discharge water (San Pin No.0056-98)

Sampling Date:

Item	Unit	Measured Value	Environmental standard in Uzbekistan	IFC/ EHC Guideline (General; 2007)
pH	—		6.5- 8.5	6-9
SS	mg/L		500	50
Oil and Grease	mg/L		0.1	10
BOD	mg/L		-	30
COD	mg/L		-	125
Total nitrogen	mg/L		-	10
Total phosphorus	mg/L		-	2
Total coliform bacteria	MPN/100mL		-	400

(c) Noise

Location: The project site, residential area (Decision after detail design)

Regulation: Protection from noise" (State committee of Uzbekistan for architecture and construction. Tashkent. 1996) (Norms for household construction)(KMK 2001.08-96)

Unit:dBA

Date (Period)	Location	Average (L_{eq} or L_{50})	Max (L_{max})	Uzbekistan Noise standards	IFC/ EHC Guideline (General; 2007) residential area
				Residential area Day: 55 Night: 45	Residential area Day: 55 Night: 45

Note; Noise situation in residential area is mainly assessed by average value. Noise level of the project boundary is mainly assessed by maximum value.

(d) Waste

Location: Project site and associated facilities

Regulation: RD 118,0027714.60-97 Nature protection. Treatment of waste from production and consumption. Terms and definitions. Goskompriroda of Uzbekistan. Tashkent. 1997.

Reporting Date;

Item	Hazardous Class	Place of generated waste	Storage amount (Unit: t or kg)	Disposal amount (Unit: t or kg)	Disposal method and place

(e) Ecosystem

Location: The project site and its vicinity

Observation Date;

Category (Amphibia, Reptiles etc)	Observation Location	Local name	The scientific name	Red Book of Uzbekistan	IUCN

(f) Geology and soil

Location: Construction area (Excavation site and earth fill)

Date	Locations	Status of geology and soil (stability, ground transformation etc)	Provision	Remarks

(g) Labor and working conditions

Location: Construction area

Reporting Date;

Construction Contents	Inspection Item	Contents	Status	Provision	Remarks

(h) Accident

Location: Construction area

Reporting Date;

Construction Contents	Inspection Item	Contents	Status	Provision	Remarks

(i) Grievances

Location: The project site

Date	Name	Contents	Status	Results	Remarks

(3) Operation phase

(a) Air pollution

<Ambient air quality >

Location: The project site, residential area (Decision after detail design)

Regulation: Sanitary norms, rules and hygiene normative documents of the Republic of Uzbekistan. San Pin No.0015-94

Unit mg/m^3

Date	Item	Measured Value			Uzbkistan maximum permissible concentration (MPC)		IFC/WB EHC GuidelineGeneral;2007	
		30min Min－Max	24hr Min－Max	Average	30min	24hr	1hr	1year
	NO_2				0.085	0.06	0.2	0.04
	NO				0.6	0.25	-	-

<Exhaust gas >

Location: Gas duct

Regulation: GOST 29328-92

Parameter	Unit	Min –Max	Excess period of the standard	GOST 29328-92	IFC/ WB EHC Guideline (Thermal Power station; 2008)
NO_X	mg/Nm^3			51	51

Note dry gas base,O_2=15%

(b) Water quality

< Wastewater>

Location: Outlet of waste treatment facility

Regulation: Rules for protection of surface water from contamination by discharge water (San Pin No.0056-98)

Sampling Date:

Item	Unit	Measured Value	Standard of the relevant country	IFC/WB EHS Guidelines
Temperature	^oC		-	-
pH	-		6.5-8.5	6.5-9.0
SS	mg/L		500	50
DO	mg/L		-	-
Oil and Grease	mg/L		0.1	10
Nitrites	mg/L		3.3	-
Nitrates	mg/L		45	-
Sulfates	mg/L		500	-
Chloride	mg/L		350	-
Calcium	mg/L		487	-
Sodium	mg/L		170	-
Potassium	mg/L		-	-
Phosphate	mg/L		2.5	-
Fe	mg/L		5.0	1.0
Magnesium	mg/L		170	-
Residual chlorine	mg/L		-	0.2
Chrome trivalent Chrome hexavalent	mg/L		0.5 / 0.1	0.5

Item	Unit	Measured Value	Standard of the relevant country	IFC/WB EHS Guidelines
Copper	mg/L		1.0	0.5
Zinc	mg/L		1.0	0.5
Lead	mg/L		0.1	0.5
Cadmium	mg/L		0.1	0.5
Mercury	mg/L		0.01	0.005
Arsenic	mg/L		0.1	0.5

< Domestic wastewater>
Location: Discharge point of domestic wastewater
Regulation: Rules for protection of surface water from contamination by discharge water.(San Pin No.0056-98)
Sampling Date:

Item	Unit	Measured Value	Environmental standard in Uzbekistan	IFC/ EHC Guideline (General; 2007)
pH	—		6.5- 8.5	6-9
SS	mg/L		500	50
Oil and Grease	mg/L		0.1	10
BOD	mg/L		-	30
COD	mg/L		-	125
Total nitrogen	mg/L		-	10
Total phosphorus	mg/L		-	2
Total coliform bacteria	MPN/100mL		-	400

<River water quality>
Location: Outtake (GCN)
Regulation: Rules for protection of surface water from contamination by discharge water.(San Pin No.0056-98)
Sampling Date:

Item	Unit	Measured Value	Environmental standard in Uzbekistan
pH	—		6.5- 8.5
DO	mg/L		Summer: 4.0 or higher Winter: 6.0 or higher
BOD	mgO_2/L		3.0
SS	mg/L		30
Oil	mg/L		0.05
Ammonia	mg/L		0.08
Nitrite	mg/L		0.08
Nitrate	mg/L		40
Sulfate	mg/L		100
Phenol	mg/L		0.001
Chloride	mg/L		300
Calcium	mg/L		180
Sodium	mg/L		120
Potassium	mg/L		50
Phosphate	mg/L		0.01
Fe	mg/L		0.5
Cu	mg/L		0.001
Zn	mg/L		0.01
Cr	mg/L		0.5
Pb	mg/L		0.03

(c) Noise

Location: The project site, residential area (Decision after detail design)

Regulation: Protection from noise” (State committee of Uzbekistan for architecture and construction. Tashkent. 1996) (Norms for household construction)(KMK 2001.08-96)

Unit:dBA

Date (Period)	Location	Average (L_{eq} or L_{50})	Max (L_5 or L_{10})	Uzbekistan Noise standards	IFC/ EHC Guideline (General; 2007) residential area
				Residential area Day: 55 Night: 45	Residential area Day: 55 Night: 45

Note; Noise situation in residential area is mainly assessed by average value. Noise level of the project boundary is mainly assessed by maximum value.

(d) Waste

Location: Project site and associated facilities

Regulation: RD 118,0027714.60-97 Nature protection. Treatment of waste from production and consumption. Terms and definitions. Goskompriroda of Uzbekistan. Tashkent. 1997.

Reporting Date;

Item	Hazardous Class	Place of generated waste	Storage amount (Unit: t or kg)	Disposal amount (Unit: t or kg)	Disposal method and place

(e) Labor and working conditions

Location: Construction area

Reporting Date;

Construction Contents	Inspection Item	Contents	Status	Provision	Remarks

(f) Accident

Location: Construction area

Reporting Date;

Construction Contents	Inspection Item	Contents	Status	Provision	Remarks

(g) Electric magnetic field (EMF)

Location: Control room, electrical room

Reporting Date;

Date	Location	Status	Provision	Remarks

(h) Grievances

Location: The project site

Date	Name	Contents	Status	Results	Remarks

8.12.3.2 Transmission Line & Substation

(1) Pre-construction phase

(a) Transmission Line

(i) Land and Trees

Aug/2014

Name*	Status	Agreement	Date of compensation			Remarks
			Temporary	Permanent		
			Trees	Land	Trees	
HH**-1	Certificate		??/Aug/2014	??/Aug/2014	??/Aug/2014	
HH-2	Certificate		-	??/Aug/2014	??/Aug/2014	
HH-3	NH		??/Aug/2014	-	-	
・ ・	・ ・	・ ・	・ ・	・ ・	・ ・	・ ・
HH-59	Certificate		-	-	??/Aug/2014	
HH-60	Certificate		??/Aug/2014	-	-	
AC-1	Certificate		??/Aug/2014	??/Aug/2014	??/Aug/2014	
AC-2	Certificate		-	??/Aug/2014	??/Aug/2014	
・ ・	・ ・	・ ・	・ ・	・ ・	・ ・	・ ・

Notes: 1. Excepting the land "owned by District"
2. "HH" means "household"
3 "AC" means "agricultural company"
4."NH" means person who has not a land use right

Sep/2014 (if required)

Name*	Status	Agreement	Date of compensation			Remarks
			Temporary	Permanent		
			Trees	Land	Trees	
HH-1	Certificate		??/Sep/2014	??/Sep/2014	??/Sep/2014	
HH-2	Certificate		-	??/Sep/2014	??/Sep/2014	
HH-3	NH		??/Sep/2014	-	-	
・ ・	・ ・	・ ・	・ ・	・ ・	・ ・	・ ・
HH-56	Certificate		-	-	??/Sep/2014	
HH-57	Certificate		??/Sep/2014	-	-	
AC-1	Certificate		??/Sep/2014	??/Sep/2014	??/Sep/2014	
AC-2	Certificate		-	??/Sep/2014	??/Sep/2014	
・ ・	・ ・	・ ・	・ ・	・ ・	・ ・	・ ・

Notes: 1. Excepting the land "owned by District"
2. "HH" means "household"
3 "AC" means "agricultural company"
4."NH" means person who has not a land use right

(ii) Land and structure

Aug/2014

Name	Status	Agreement	Date of compensation		Remarks
			Land	Structure	
Household-1 (Incomplete building)	Certificate		??/Aug/2014	??/Aug/2014	
Household-2 (Clay fence)	Certificate		??/Aug/2014	??/Aug/2014	
Household-3 (Clay fence)	Certificate		??/Aug/2014	??/Aug/2014	
Household-4 (Clay fence)	Certificate		??/Aug/2014	??/Aug/2014	

Sep/2014 (if required)

Name	Status	Agreement	Date of compensation		Remarks
			Land	Structure	
Household-1 (Incomplete building)	Certificate		??/Sep/2014	??/Sep/2014	
Household-2 (Clay fence)	Certificate		??/Sep/2014	??/Sep/2014	
Household-3 (Clay fence)	Certificate		??/Sep/2014	??/Sep/2014	
Household-4 (Clay fence)	Certificate		??/Sep/2014	??/Sep/2014	

(b) Kyzyl-Ravat Substation

Aug/2014

Name	Status	Agreement	Date of compensation		Remarks
			Land	Trees	
Household-1	Certificate		??/Aug/2014	??/Aug/2014	

Notes: Excepting the land “owned by District”

Sep/2014 (if required)

Name	Status	Agreement	Date of compensation		Remarks
			Land	Trees	
Household-1	Certificate		??/Sep/2014	??/sep/2014	

Notes: Excepting the land “owned by District”

(2) Construction phase

(a) Air pollution

Location: The project site, residential area (Decision after detail design)

Regulation: Sanitary norms, rules and hygiene normative documents of the Republic of Uzbekistan. San Pin No.0015-94

Unit mg/m^3

Date	Item	Measured Value (30min)			Uzbkistan maximum permissible concentration (30min)	IFC/ EHC Guideline General;2007
		Average	Max	Min		
	NO_2				0.085	0.2(1hour)
	NO				0.6	-
	Dust				-	0.15(24hours)

(b) Noise

Location: The project site, residential area (Decision after detail design)

Regulation: Protection from noise" (State committee of Uzbekistan for architecture and construction. Tashkent. 1996) (Norms for household construction)(KMK 2001.08-96)

Unit:dBA

Date (Period)	Location	Average (L_{eq} or L_{50})	Max (Lmax)	Uzbekistan Noise standards	IFC/ EHC Guideline (General; 2007) residential area
				Residential area Day: 55 Night: 45	Residential area Day: 55 Night: 45

Note; Noise situation in residential area is mainly assessed by average value. Noise level of the project boundary is mainly assessed by maximum value.

(c) Waste

Location: Project site and associated facilities

Regulation: RD 118,0027714.60-97 Nature protection. Treatment of waste from production and consumption. Terms and definitions. Goskompriroda of Uzbekistan. Tashkent. 1997.

Reporting Date;

Item	Hazardous Class	Place of generated waste	Storage amount (Unit: t or kg)	Disposal amount (Unit: t or kg)	Disposal method and place

(d) Geology and soil
Location: Construction area (Excavation site and earth fill)

Date	Locations	Status of geology and soil (stability, ground transformation etc)	Provision	Remarks

(e) Labor and working conditions
Location: Construction area
Reporting Date;

Construction Contents	Inspection Item	Contents	Status	Provision	Remarks

(f) Accident
Location: Construction area
Reporting Date;

Construction Contents	Inspection Item	Contents	Status	Provision	Remarks

(g) Grievances
Location: The project site

Date	Name	Contents	Status	Results	Remarks

(3) Operation phase
(a) Geology and soil
Location: The transmission line route
Reporting Date;

Construction Contents	Inspection Item	Contents	Status	Provision	Remarks

(b) Labor and working conditions
Location: The transmission line route
Reporting Date;

Construction Contents	Inspection Item	Contents	Status	Provision	Remarks

(c) Accident

Location: The transmission line route

Reporting Date;

Construction Contents	Inspection Item	Contents	Status	Provision	Remarks

(d) Grievances

Location: The transmission line route

Date	Name	Contents	Status	Results	Remarks

ANNEX

JICA's Resettlement Policy

The key principle of JICA policies on involuntary resettlement is summarized below.

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
II. When, population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.
III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.
IV. Compensation must be based on the full replacement cost ※as much as possible.
V. Compensation and other kinds of assistance must be provided prior to displacement.
VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.
VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.
VIII. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.
IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows.

X. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.
XI. Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such

※Description of "replacement cost" is as follows.

Land	Agricultural Land	The pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes.
	Land in Urban Areas	The pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes.
Structure	Houses and Other Structures	The market cost of the materials to build a replacement structure with an area and quality similar or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes.

land or assets and the PAPs who have no recognizable legal right to the land they are occupying.

XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

XIII. Provide support for the transition period (between displacement and livelihood restoration.

XIV. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.

XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

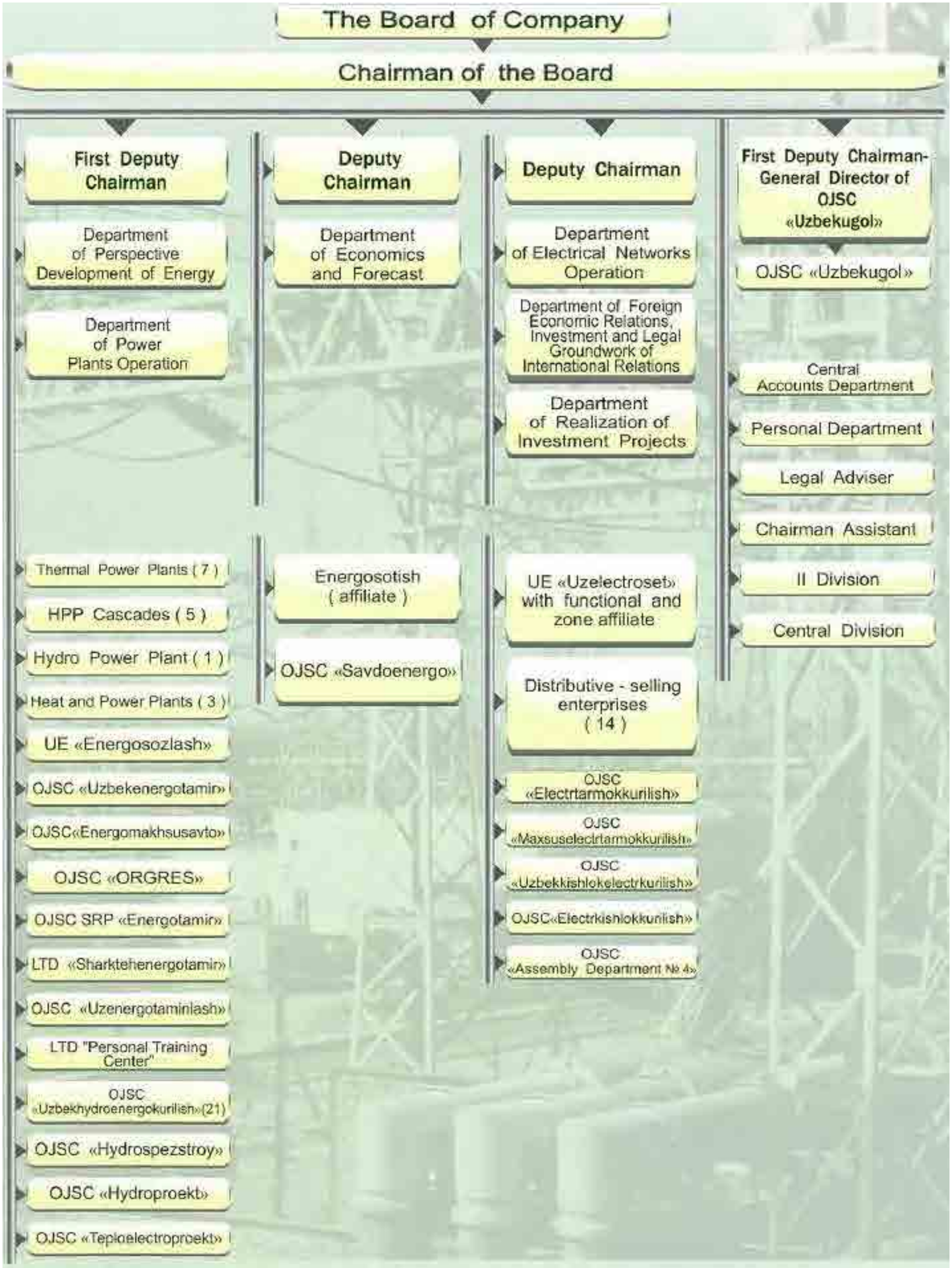
In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed Financial Plan etc.

Chapter 11 Proposal for implementation scheme and operation, maintenance and management system

11.1 Verification of the project implementation system, financial stability, technological capacities and others of the implementation body

11.1.1 Project implementation system

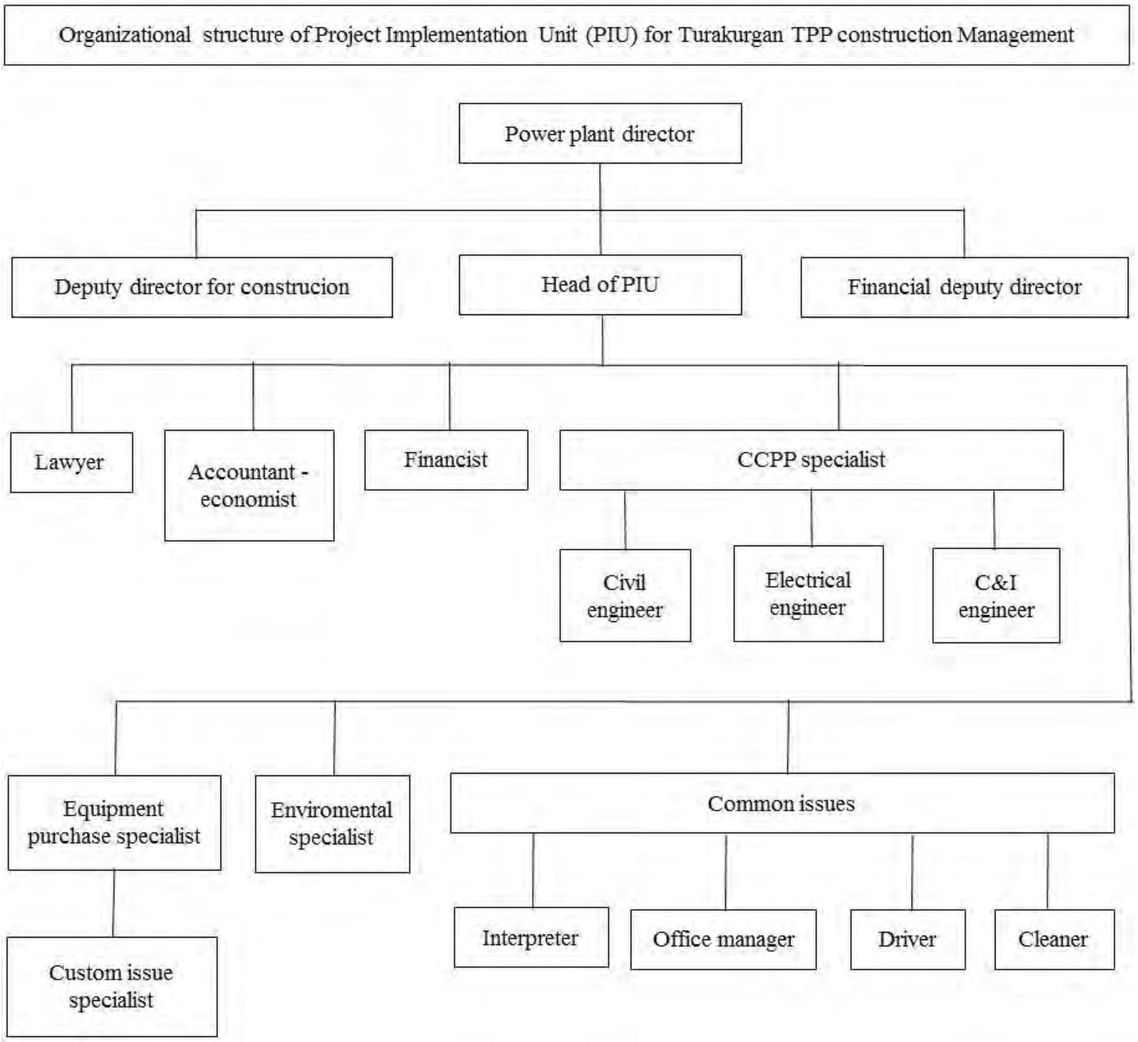
Figure 11.1.1-1 shows the organization chart of the SJSC Uzbekenergo. The organization is operated by Chairman and four Deputy Chairmen. TKG No.1&2 pertains to the Department of Power Plants Operation and is placed under the jurisdiction of the first Deputy Chairman.



Source: Uzbekenergo

Figure 11.1.1-1 Organization Chart of SJSC "Uzbekenergo"

Figure 11.1.1-2 shows the organization chart for TKG No.1&2 construction period. The Project Implementation Unit (hereinafter referred to as "PIU") will be organized in Uzbekenergo headquarters for construction period. This organization will take charge of the administrative reception office for the construction work of TKG NO.1&2 Project.



Source: Uzbekenergo

Figure 11.1.1-2 Organization chart for TKG No.1&2 construction period

11.1.2 Financial stability

The financial performance of Uzbekenergo has been strong over the last 5 years. It has achieved high profitability, with a low debt–equity ratio, helped by accelerated depreciation of fixed assets. Most of the fixed assets were inherited as equity, not as debt, and their residual value appears to have been already depreciated. The liquidity level has been high, due to a large balance between accounts receivable and payable.

The projected financial sustainability for 2009–2015 incorporates Uzbekenergo's investment plan for expanding its power facilities. The total investment, including this project, will require funding of about $4 billion. It should be possible to implement the financial plan, with a good mix of debt and Uzbekenergo's internal sources, without putting undue stress on Uzbekenergo’s future finances and creditworthiness. However, the tariff should be adjusted to reflect the cost of services and inflation.

A financial management assessment of Uzbekenergo found it has sound financial and accounting systems, procedures and policies, and has adopted accrual accounting, double entry bookkeeping and other generally accepted accounting principles and conventions in compliance

with current national standards. Capacity development under the project will strengthen Uzbekenergo's financial management capability, as well as overall accounting and auditing practices.
Uzbekenergo's procurement capacity was also assessed. It has experience in working with other multilateral and bilateral financiers. It is implementing similar CCGT power plant projects. Procurement lessons from these projects will be applied to this project.
At the end of 2012, SJSC Uzbekenergo was financially sound. Both current ratio and quick ration are more than 1.0 time with sizable margins upon 0.7 times, which is conventionally considered a cut-off point as shown below. As both current assets and quick assets were larger than current liabilities, liquidity is unlikely to be a problem in the foreseeable future. SJSC Uzbekenergo depended mostly on internal funding for its capital investment. Although the debt-to-equity ratio increased for the last several years, Uzbekenergo’s debt decreased to around 20% of its equity in 2012.
This suggests that size of debt was at manageable level. In addition, net interest payment was far smaller than Earnings before Interests and Taxes (EBIT.) Thus, Uzbekenergo’s profitability effectively covered interest payment.

Table 11.1.2-1 Financial Ratios of SJSC Uzbekenergo

Financial Ratios	2008	2009	2010	2011	2012	Average
Liquidity						
Current Ratio	1.16	1.18	1.20	1.21	1.38	1.23
Quick Ratio	1.10	1.12	1.15	1.06	1.26	1.14
Solvency						
Net Interest Payment/EBIT	0.01	0.01	0.02	0.02	0.12	0.04
Debt-to-Equity Ratio	3.0%	7.6%	27.1%	30.1%	38.4%	21.2%
Debt-to-Total asset	1.2%	3.0%	10.1%	10.7%	10.9%	7.2%
Profitability						
Net Profit Margin	5.9%	8.6%	7.3%	6.4%	7.3%	7.1%
Return on Equity (before tax)	14.5%	21.3%	15.8%	14.0%	11.3%	15.4%
Return on Equity (after tax)	11.5%	17.5%	12.8%	11.4%	9.4%	12.5%

(Source: JICA Study Team)

This project is unlikely to affect the financial health of SJSC Uzbekenergo. As shown in “9.4.4 Financial Analysis”, cash flow from operating activities can cover debt service in the base case. Although cash flow is expected to be tight in the initial stage for operation, healthy balance sheet can absorb unexpected adverse changes in cash flow as long as cash is retained for several years after commissioning. The result suggests that this project is self-sufficient in terms of cash flow and unlikely to need additional financial support after the commencement of commercial operation.

11.1.3 Technological capacities

Uzbekenergo has an experience of CCPP O&M ability for Navoi No.1 construction and commissioning period and will have a sufficient O&M level for TKG No.1&2 Project. Also TKG No.1&2 workers will participate in the training course held by the gas turbine manufacturer and have taken part in the witnessed inspection implemented in the factories of the manufacturer so that their O&M abilitywill be improved.

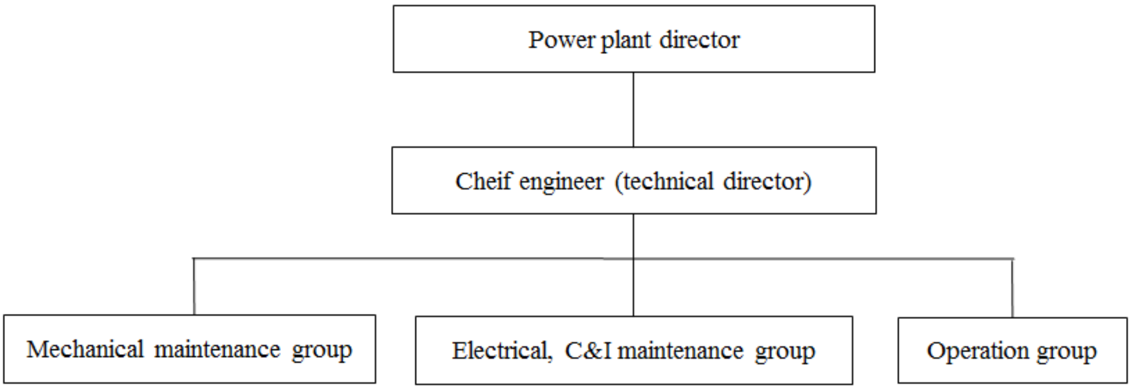
11.2 Proposal for the operation maintenance management system and scheme for this Project

TKG No.1&2 workers are necessary to be trained in the following skills.

- Trouble response
- Performance management
- Maintenance for gas turbine

The Study Team proposes the following for O&M management for this Project.

(1) Operation maintenance management system for this Project
Figure 11.2-1 shows O&M management system proposed by the Study Team.



Source: Study Team
Figure 11.2-1 O&M management system proposed by the Study Team

Table 11.2-1 shows typical number and the duties of each group.

Table 11.2-1 Typical number and the duties of each group

Group	Type	Number	Duties
Operation Group	Shift Worker	20	• Stable power supply operation in accordance with the demand power by load dispatch center • Operation and monitoring from CCR • Daily maintenance • Trouble response operation
	Daytime Worker	10	• Response to load dispatch center • Performance management of CCPP • Response to regular and combustor inspection of piping isolation and power outages operation
Electrical, I&C Maintenance Group	Daytime Worker	10	• Repair or replacement for gas turbine, steam turbine, HRSG, condenser, pumps, fans and heat exchanger after the accident and for regular and combustor inspection
Mechanical Maintenance Group	Daytime Worker	10	• Repair or replacement for generators, transformers, power supplies, switchgear, instruments, control equipment and computer after the accident and for regular and combustor inspection

Source: Study Team

(2) Operation ability improvement by simulator facility

Operation ability will be acquired for commissioning period. The Study Team proposes simulator facility installation for operation ability improvement. The simulator facility shall be operated by mainframe PC as same as CCR in TKG No.1&2. The simulator facilitiy includes not only normal operation, startup and shutdown operation training functions, but also troubleshooting training functions.

(3) Performance management

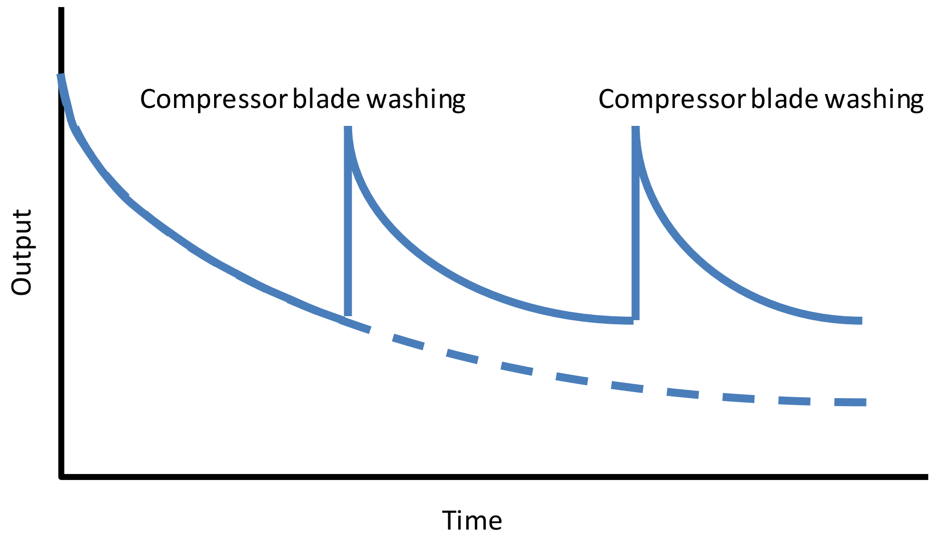
The most important management item to keep the CCPP efficiency is to manage the axial compressor efficiency. It is possible to stick contamination on axial compressor blades when the gas turbine has been operated for long-term. The compression cycle consumes large quantities of air and despite intake filtration, small quantities of dust, aerosols and water pass through and deposit onto the blades. These deposits impede air flow through the compressor and over time degrade overall performance of the gas turbine. As the result, CCPP efficiency will be decreased. To avoid such an incident, compressor water wash is an effective method. Benefits of compressor wash include:

- Restoration of lost performance
- Reduced turbine operating costs
- Reduction of gas turbine fuel consumption

There are two methods used for compressor cleaning:

- Online compressor wash for operation hours with full speed and loaded
- Offline compressor wash for shutdown hours with the machine on crank

Cleaning consists of injecting detergents into the compressor inlet following defined procedures. Figure 11.2-2 shows efficiency recovery by offline wash. Offline wash is definitely more effective than online cleaning, thus explaining why the offline system is an indispensable tool for the proper operation of gas turbines. Consequently, online wash is used in conjunction with offline wash in order to extend time between shutdowns as much as possible.



Source: Study Team

Figure 11.2-2 Efficiency recovery by offline compressor wash

(4) Maintenance for gas turbine

CCPP maintenance includes the major inspections for gas turbine, steam turbine and HRSG. The maintenance level for gas turbine influences on the availability factor of CCPP.

Hot parts of gas turbine such as combustor and turbine blade are operated at a high temperature of more than 1,000°C. Thus, these hot parts require inspection, repair and replacement in shorter intervals of time due to more serious deterioration and damage, as compared with the blade of the steam turbine. For each of these hot parts, the expected service life and inspection time intervals are determined by the Original Equipment Manufacturer (hereinafter referred to as “OEM”). Table 11.2-2 shows typical inspection intervals for gas turbine. The Study Team would like to propose that the hot parts should be inspected and replaced under supervision of the technical advisor from OEM.

Table11.2-2 Typical inspection intervals for gas turbine

Type of Inspection	Inspection Interval
Combustor Inspection	8,000 hour
Turbine Inspection	16,000 hour
Major Inspection	48,000 hour

Source: Study Team

Since the hot parts are made of superalloy based on nickel and cobalt, special welding technique and coating skills are required to repair these parts. Thus, it is a common practice to repair these hot parts in the OEM factory. Generally, approximately three months are required to repair the hot parts, although this depends on the degree of a particular damage. Further, when consideration is given to the transportation period from the power plant to the OEM factory, a considerable time period will be required. To solve this problem, The Study Team would like to propose that one set of spare parts should be kept in stock as spare parts.