SECTION 9100 CONTROL SYSTEM

9101 SYSTEM REQUIREMENTS

(1) General

The control system for the Bang Pakong Diversion Dam Project will be introduced for the proper operation of the Diversion Dam and Pumping Station.

The Bang Pakong Diversion Dam Project includes the control system for the Diversion Dam and the Pumping Station, eight (8) water level gauges (two (2) at upstream of Diversion Dam, two (2) at downstream of Diversion Dam, one (1) in suction sump of Pumping Station, one (1) in discharge reservoir of Pumping Station, one (1) in Nakhon Nayok water level gauging station and one (1) in Bang Sang water level gauging station), 2 salinity instruments with 3 measuring points each and 2 pH instruments.

The monitoring of the Tha Lat Diversion Dam (existing), Rabon Dam (existing), Si Yat Dam and sea level gauge at the estuary will be added to the system in future.

The Contractor shall consider the said future conditions, and shall submit the plan of expanding procedures to the Employer.

The control system should be simple to operate and maintain. Therefore, the control and monitoring system for electrical facilities should be adopted.

The control and monitoring system for electrical facilities is convenient for the operation and maintenance of the dispersed electrical facilities in the Hoist House, substations of the Diversion Dam, the Pumping Station and residential area of the O/M building site.

a) Outline of Control System

For realization of the said functions, the control and monitoring system for the Bang Pakong Diversion Dam Project shall compose of the following six (6) sub-systems.

- Gate control and monitoring sub-system
- Pumping Station control and monitoring sub-system

- Electric substation control and monitoring sub-system
- Telemetry data acquisition sub-system
- ITV monitoring sub-system
- Information by paging sub-system

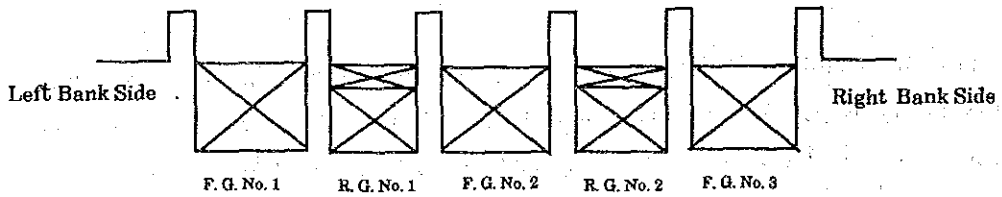
The Control House is the supervisory room for the Diversion Dam, Pumping Station and all facilities of this project. The main functions of this system are as follows.

- Monitoring of water levels and discharges
- Remote control of Diversion Dam, Pumping Station and other electrical facilities.
- Information processing
- Monitoring Diversion Dam by ITV (industrial television)
- Information by paging for Diversion Dam area, Pumping Station, and residential area of the O/M building site.

b) The Method of Gate Operation

1) Gates

The Flood and Regulating Gates are designated from the left bank side to the right bank side, in order, respectively, such as Flood Gate No. 1 to Flood Gate No. 3, Regulating Gate No. 1 and Regulating Gate No. 2, as shown below.



Note: F. G.: Flood Gate
R. G.: Regulating Gate

2) Water Level Gauge

The water level gauges are named as follows:

Water Level Gauge No. 1 (at the left bank in the upstream of the dam)

Water Level Gauge No. 2 (at the left bank in the downstream of the dam)

Water Level Gauge No. 3 (at the right bank in the upstream of the dam)

Water Level Gauge No. 4 (at the right bank in the downstream of the dam)

The water level indicated by the Water Level Gauges No. 1 and No. 2 must be applied for the gate operation. In case of emergency, such as machine trouble of the said gauges, etc., the water level of Water Level Gauge No. 3 and No. 4 will be applied.

3) Salinity Instrument

The salinity instrument, for measuring a salinity at three (3) points in the water depth, are designated as follows:

Salinity Meter No. 1 (at the left bank in the upstream of the dam)

Indicator	No. 1-1	for the water depth at EL	(+)	0.0 m
Indicator	No. 1-2	for the water depth at EL	(-)	1.3 m
Indicator	No. 1-3	for the water depth at EL	(-)	5.0 m

Salinity Meter No. 2 (at the left bank in the downstream of the dam)

Indicator	No. 2-1	for the water depth at EL	(+)	1.3 m
Indicator	No. 2-2	for the water depth at EL	(-)	4.0 m
Indicator	No. 2-3	for the water depth at EL	(-)	7.0 m

Method of Gate Operation

1) Operation Mode

The operation mode, which categorizes the operation method of tide protection gates to comply with the control requirements, consists of the following four (4) modes:

Control Mode	Ruling Values	Gate Operation	Priority
Small Water Discharge	Qi < 30 m³/s	Overflow × 1 set	3
Normal Operation	① 30 < Qi < 80 m³/s	Overflow × 1 set	
	② 80 < Qi < 300 m³/s	Overflow × 2 sets	3
Inverse Flow Prevention	H1 < H2 + 0.10 m	All Gate Closed	2
Flooding	Q1 > 300 m³/s	All Gate Opened	1

Note : Qi = Inflow to the reservoir, H1 = Water levels of the reservoir, and H2 = Water level at the downstream of the dam
The inverse flow prevention mode takes priority of the low water discharge and normal operation modes

2) Control System

For the Flood and Regulating Gates, the operations for each control mode are ruled as follows:

Control Mode	Control System	Note
Small Water Discharge	Const. W. L. Control	To control the water level in the reservoir constantly, subject to the discharge of river maintenance flow.
Normal Operation	Const. W. L. Control	To control the water level in the reservoir constantly, lowering the water level in the reservoir for the purpose of discharging the small flood water and restoring the water quantity in the reservoir required for the Project after small water discharge stage.
Inverse Flow Prevention	All Gates Closed	To prevent the salt water intrusion into the reservoir.
Flooding	All Gates Opened	To open all gates, in case of flood discharge exceeded 300 m³/s, to keep the adequate passage for flood water.

3) Time for All Gates Closing

In the transitional period (around November) from the rainy season to dry season, it is required to close all gates in order to prevent salt water from intruding into the reservoir. This period may begin around November 15, according to the river water discharge data for the latest eight (8) years.

Nevertheless, estimating the time of salt water intrusion based on the salinity contents for the water sampled once a weak at the Chachoengsao bridge, all gates must be opened in time for exceeding a salinity content of 100 mg/ℓ, as specified by the Water Quality Guideline for Plantation of the RID, downstream of the diversion dam, even before November 15. The water sampling at the said bridge continues up to the beginning of water storage, starting in the second week of October.

The water way must be closed by the Regulating Gate No. 1, Regulating Gate No. 2, Flood Gate No. 2, Flood Gate No. 1 and Flood Gate No. 3 in sequence.

4) Time for All Gates Opening

As verified that the salt water intrusion is blocked by the small scale floods in the transitional period (May to July) from the dry to rainy seasons, all gates are opened in this transitional period, where the inflow water discharge exceed 300 m^3/s.

The gates are opened one by one, following the Flood Gate No. 2, Flood Gate No. 1, Flood Gate No. 3, Regulating Gate No. 1 and Regulating Gate No. 2 in sequence.

After opening all the gates, monitoring of salinity downstream of the diversion dam must be conducted by the Salinity Meter No. 2. The gates must be closed in danger of intruding the salt water, if any.

5) Gate Operation for Desalinization

The gate shall operate to release the reservoir water for desalinization, where the salinity indicated by the Salinity Indicator No. 1-1 exceeds a salinity of 250 mg/ℓ as specified in the Water Quality Standard for Water Supply of the MOI. When the Salinity Indicator No. 1-1 is not applicable due to lower water level, the salinity shall be applied by the value of Salinity Indicator No. 1-2 and/or No. 1-3. The water is released by operation of Flood Gate, when the difference between the water levels in the reservoir and the downstream of the dam is great.

According to materials of Kasetsart University, the salt water intrusion is unexpected, where a water flow discharge is over 50 m^3/s at the dam site. Estimating a release water discharge of 50 m^3/s, the height of gate opening shall be determined by the following table.

Height of Flood Gate Opening for Water Released for Desalinization

Water Level in Reservoir (m, MSL)	Water Level in the Downstream of the Dam (m, MSL)										
	1.0	0.8	0.6	0.4	0.2	0.0	-0.2	-0.4	-0.6	-0.8	-1.0
1.4	0.9	0.7	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4
1.2	1.2	0.9	0.7	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4
1.0	-	1.2	0.9	0.7	0.7	0.6	0.5	0.5	0.4	0.4	0.4
0.8	-	-	1.2	0.9	0.7	0.7	0.6	0.5	0.5	0.4	0.4
0.6	-	-	-	1.2	0.9	0.7	0.7	0.6	0.5	0.4	0.4
0.4	-	-	-	-	1.2	0.9	0.7	0.7	0.6	0.5	0.4
0.2	-	-	-	-	-	1.2	0.9	0.7	0.7	0.6	0.5
0.0	-	-	-	-	-	-	1.2	0.9	0.7	0.7	0.6

Note : This table shows the height of gate opening for the outflow discharge of 50 m^3/s under the gate of one (1) set.

Record of Gate Operation

The gate operation records, daily and monthly reports for operation and maintenance shall be prepared in accordance with the report forms.

(2) Gate Control and Monitoring Sub-System

The operation of the gate control and monitoring sub-system shall be controlling and monitoring three (3) flood gates and two (2) regulating gates.

The gates will be operated manually from the gate operation console installed at the Control House.

a) Input Data

a. Gate opening for three (3) flood gates

b. Gate opening for two (2) regulating gates

c. Supervision items for three (3) flood gates and two regulating gates

d. Salinity density of 6 points at total of two fixed sites

e. Salinity density of temporary site (Chachoengsao bridge) by manual measurement (input work from keyboard of personal computer equipment).

f. pH value with water temperature of 2 points at two fixed sites.

b) Output Data

The followings are descriptions of input data.

a. Command signals for controlling flood gates

b. Command signals for controlling regulating gates

c. Output data for graphic panel

- 8 water levels including water levels at Pumping Station
- Outflow data
- Inflow data
- Salinity density
- Operation conditions of gates, open or close.

d. Output data on the visual display equipment

The following items of the pictures shall be equipped on the visual display equipment. The Contractor shall submit the pictures for the visual display equipment designed in detail for approval of the Employer.

- The list of display items	:	Display the menu of display items
- The graph of water level/discharge	:	Display graphs of hydrography/water level for one each station for the last 48h on one screen.
- The dam hydrological data graph	:	Display graphs of hydrography/water level/discharge for one each station for the last 48h on one screen.
- Water Level/discharge data table	:	Display the last 16h water level/discharge data for 4 stations on screen.

- Hydrological data table : Display the last 16h hydrological data for 8 stations on the screen.
- Modification to water level/discharge data : Display water level/discharge data for one station per day with hourly/daily report on one screen.
- Modification to dam hydrological data : Display the dam hydrological data for one station per day with daily report on one screen.
- Dam condition table : Display the condition of the reservoir and discharge facility per minute over the dam typical illustration.
- The outlook of basin : Display the latest data of each station for hydrography, water level and dam every minute.
- Hydrography : Display the reservoir level, quantity of inflow and discharge for 8h on the hydrography every minute.
- Setting constant for water level and discharge : Setting constant for the danger water level and H-Q conversion.
- Setting constant for the dam hydrological data : Setting the constant for the reservoir level and the supremum of quantity inflow.

e. Output data on gate operating console

- Gate opening
- Outflow data
- Inflow data
- Operation condition
- Equipment condition
- Hydrological condition

The following calculations shall be prepared for this system. The Contractor shall submit the proposed calculation procedures in detail for approval of the Employer.

- Smooth processing for dam water levels
- Inflow calculation procedure
- Outflow calculation procedure
- Detecting the alarming water levels
- Target gate opening

The output data items and data processing items in detail shall be submitted to the Employer.

The following items of the record shall be typed by typewriter at the Control House.

- Gate operation report
- Water level/salinity /pH/water temperature daily report
- Hydrological data monthly report
- Water level monthly report
- Discharge monthly report

The Contractor shall submit the form of said record designed in detail to the Employer for his approval.

c) Gate Controlling

The gate controlling will be operated by manual mode, and opening position will be set by manual on the console desk.

The gate control mode shall be as follows.

- ON/OFF control
- Set point control for target opening position

The Contractor shall submit the procedure for gate controlling in detail to the Employer for his approval.

The examples of the console panel for gate control and monitoring sub-system are shown on the drawings. The Contractor shall submit the pictures of console panel for gate control and monitoring sub-system designed in detail for the Employer's approval.

(3) Pumping Station Control and Monitoring Sub-System

The operation of the Pumping Station control and monitoring sub-system will be done from the Control House.

a) Input Data

a. The operation condition of Pumping Station

b. Supervision items for Pumping Station

c. Suction water level

d. Discharge water level

The detail input data items shall be submitted by the Contractor.

b) Output Data

a. Command signals for Pumping Station

b. Output data for graphic display panel

- 2 water levels
- Total discharge
- Operation condition
- Alarm

c. Output data on the visual display equipment

The following items of the pictures shall be equipped on the visual display equipment.

The Contractor shall submit the pictures on the visual display equipment designed in detail to the Employer for his approval.

- The list of display items : Display the menu of display items
- The condition of Pumping Station : Display illustrated condition of Pumping Station

d. Output data on pump operating console

- Operation console
- Alarms

The examples of the pump operating console are shown in the drawings. The Contractor shall submit panel layout of pump operating console designed in detail to the Employer.

The following calculations shall be prepared for this system. The Contractor shall submit the proposed calculation procedures in detail to the Employer for his approval.

- Smoothing processing of suction water level and discharge water level
- The total discharge
- Detecting the alarming water levels.

The output data items and data processing items in detail shall be submitted by the Contractor.

The following items of the record shall be typed by typewriter at the Control House.

- Pump operation report
- Pumping data daily report
- ON/OFF control
- Pumping data monthly report

The Contractor shall submit the form of said record designed in detail for the Employer's approval.

c) Controlling

Pump controlling will be operated by manual mode. The pump control mode shall be as follows.

- ON/OFF control

The Contractor shall submit the procedure for pump controlling in detail to the Employer.

(4) Telemetry Data Acquisition Sub-System

a) General

a. System Composition

Telemetering system to collect the necessary observation data for gate control and display system, consisting of Control House Nakhon Nayok Station and Bang Sang Station.

b. Network of telemetering system

Each station shall be connected with the Control House by the frequency of 150 MHz band.

c. Frequency plan of telemetering system

- The telemetering system shall use one (1) frequency for data collection of gate supervisory status at Control House.

d. Function and behavior of telemetering system

a. Telemetering system shall be of polling telemetering type

b. All the data shall be collected at Control House and displayed on the graphic panel.

(5) Collected data at Control House by the telemetry data acquisition system shall be as follows

- Water level of Nakhon Nayok river
- Water level of Prachin river

a) System Operation

a. The Control House shall collect water level data by calling the station.

b. The stations shall send the data from a water level gauge, on receiving a call from the Control House.

c. Voice communication between the Control House and station for maintenance use shall be possible in this system. Moreover, automatic calling shall have priority over voice communication.

b) System Function

a. Control House

i) The Control House shall transmit calling signal to the stations, and shall collect the data from the stations. The calling method shall be as follows :

Automatic Calling

This calling shall be started by a clock, and shall be directed to all stations in a predetermined order. Calling interval shall be :

- 10 minutes
- 15 minutes
- 30 minutes
- 1 hour

Manual Calling

This calling shall be started manually, and shall be directed to all the stations or the stations arbitrarily selected, in the predetermined order.

Recalling

If any error code has been detected in the data code from a station, or if there is no response from a station, that station shall be automatically re-called once more. If there is an error code or a called station fails to respond again, a visual and audible alarm shall actuate and the system shall shift to the next operation.

ii) The Control House shall output the collected data to the I/O relay equipment.

b. Gauging Station

i) The station shall start at the time that receive a calling signal from the Control House and then shall send the water level data information.

ii) The stations shall convert the input data to digital code before transmitting it to the Control House.

iii) The additional information shall be converted to digital code and shall be transmitted to the Control House.

c. Transmission system

- Communication system	:	Half-duplex communication
- Code format	:	NRZI format
- Synchronous method	:	Asynchronous transmission
- Modulation system	:	Subcarrier frequency shift system
- Communication rate	:	200 bps
- Error detecting method	:	16-bit cyclic redundancy check
- Code (frame) configuration	:	Based on JIS X 5104 (High Level Data Link Control procedures frame structure)

(6) Electric Substation Control and Monitoring Sub-System

The control and monitoring system for the electrical facilities shall be set up at the two sites ;

One is at the Diversion Dam, and the other is the Pumping Station

The Monitored data at the Diversion Dam site and the Pumping Station, shall be displayed on desk type mini graphic panel and visual display equipment installed at Control House.

a) Input Data

a. Voltage, current, power and power factor data

b. Supervision items for two substations

b) Output Data

a. Command signals for electrical facilities.

b. Output data for mini graphic panel.

- Voltage, current, power and power factor data
- The operation condition of electrical facilities
- Alarm

c. Output data on the visual display equipment

The following items of the pictures shall be equipped on the visual display equipment.

The Contractor shall submit the pictures for the visual display equipment designed in detail for the Employer's approval.

- The list of display items	:	Display the menu of display items
- The flow diagram for electrical facilities at Control house	:	Display illustrated flow diagram of electrical facilities at Control House on the screen.
- The flow diagram for electrical facilities at Pumping Station	:	Display illustrated flow diagram of electrical facilities at Pumping Station on the screen.

The display items on piece of each equipment shall be submitted by the Contractor.

The following items of the record shall be typed by typewriter at the Control House.

- Diversion Dam electrical facilities daily report
- Pumping Station electrical facilities daily report
- Diversion Dam electrical facilities monthly report

- Pumping Station electrical facilities monthly report

The Contractor shall submit the form of said record designed in detail to the Employer for his approval.

c) Electrical Facilities Controlling

The electrical facilities controlling will be operated by manual mode.

The electric substation control mode shall be as follows.

- ON/OFF control for circuit breaker

The detail control items on the electric substation operation console shall be submitted by the Contractor.

The Contractor shall submit the procedure for electrical facilities controlling in detail for approval of the Employer.

(7) Telecommunication Sub-System by VHF Radio Links

Voice communication system to communicate between Control House and each portable station by radio telephone facilities, consisting of ten (10) portable stations.

VHF communication between each station shall be possible on a press-to-talk basis of the VHF radio link in 150 MHz band.

(8) ITV Monitoring Sub-System

The ITV monitoring system consists of each two sets of cameras with lamps installed downstream side of the Diversion Dam and upstream side of the Diversion Dam, two sets of monitor televisions installed at Control House and auxiliary equipment.

The auxiliary lighting installed at cameras will be prepared in order to provide lighting intensity sufficient to cover as far as the gate side.

The remote control items on the ITV monitor console shall be as follows.

- Power on
- Zoom
- Tel or wide mode change
- Focus
- Near or far
- Wiper
- Defroster
- Light ON/OFF
- Direction control

(9) Information by Paging Sub-System

a) General

This sub-system shall consist of one (1) paging control equipment installed at Control House and three (3) loudspeaker control equipment installed at Control House, the Diversion Dam site and Pumping Station.

b) System Operation

a. The paging control equipment at the Control House shall transmit a control signal to operate voice broadcasting at specified controlled loudspeaker control equipment.

b. The loudspeaker control equipment shall be installed at the Diversion Dam, the Pumping Station and the Control House, and shall be linked with the paging control equipment by metallic.

c. When the loudspeaker control equipment receives a control signal from the paging control equipment, the loudspeaker equipment shall broadcast a message in voice or synthesized voice from the paging control equipment.

d. The loudspeaker control equipment shall response their operating status to the paging control equipment.

c) System Functions

a. Paging system

The paging system shall be capable of an individually controlled simultaneous control.

i) Control Method

1) Individual Control

Only one selected loudspeaker control equipment shall be manually started with respect to control item listed in 3).

2) Simultaneous Control

All loudspeaker control equipments shall be started simultaneously with respect to control item listed in (a), (b) and (c) of 3).

3) Control Items

(a) Broadcasting by synthesized voice

(b) Broadcasting by microphone

(c) Broadcast stop

(d) Test

4) Automatic Sequential Check

All loudspeaker control equipments shall be automatically checked once a day.

b. Transmission system

- Communication system : Half-duplex communication
- Code format : NRZ or NRZI format
- Synchronous methods : Asynchronous transmission
- Modulation system : Sub-carrier frequency shift
- Communication rate : 200 bps

- Error detecting methods : 16-bit cyclic redundancy check
- Code (frame) configuration : Based on JIS X 5104 (High Level Data Link Control procedures frame structure)

(10) Power Supply Sub-System

a) General

The objective of this section is to present the technical characteristics for the power supply sub-system, the control and monitoring Diversion Dam Project.

b) Power Supply Condition at Each Station

The commercial power with emergency generated power will be supplied at Control House including Diversion Dam site and Pumping Station.

The commercial power will be supplied at water level gauging stations, Nakhon Nayok and Ban Sang.

c) Control House

In the Control House, an uninterruptible power supply system shall be provided for continuous operations of this system, in spite of power failure.

The uninterruptible power supply systems shall consist of charger, battery and inverter.

Specification shall be as follows :

- AC input : AC 220 V + 20 %
  Single phases, 50 Hz + 2 Hz
- AC output : AC 220 V + 2 %, 50 Hz + 1 Hz
  Single phase
- Load capacity : 10 KVA

- Covering time for interruption of commercial line : 10 minutes or more Covered by storage battery. From 10 min to 28 hours or more covered by emergency generator
- Rating : Continuous operating

The power supply system shall be programmed in the following sequence if commercial line fails :

When commercial line is interrupted or fails, DC power of the storage battery shall be automatically activated and then converted to AC power by the inverter so that stable and completely uninterrupted power shall always be supplied to the load.
When commercial line returns within 10 min., DC power rectified by the rectifier/charger (R/C), shall be supplied again to the inverter and take the same procedure as the normal mode of operation, while discharged battery shall be recharged by R/C.

When commercial line is interrupted or fails continuously for more than 10 min., the diesel engine generator shall be started automatically and commercial line shall be changed over to the generated output.

On the Diversion Dam, DC Power supply equipment with battery shall be installed for the loudspeaker control equipment of paging information sub-system and on the site installed salinity instruments, shall be also installed for the salinity instruments.

The guarantee period for power supply interruption shall be 10 minutes more in conditions of normal operation.

The Contractor shall submit the designed calculation sheet in detail for said power supply system for the Employer's approval.

(11) Function of the Personal Computer

The function of the personal computer shall be as shown in the following table.

The List of Software for Diversion Dam Controlling

(Notes)
△ : Internal Processing
○ : Listing
Others : CRT Display

Equipment	Content
△ 1. The Data Communication Processing	Data Communication Processing between the Data processing Equipment.
2. The List of Display Items	Display the menu of display items.
3. The File Management	Initializing a floppy disk, Supplementary to uncataloged data, Copying data between fixed disk ↔ floppy disk.
4. The graph of Water Level	Display graphs of water level for one each station for the last 48h on one screen.
5. The graph of Dam hydrological data	Display graph of dam hydrological data for 48h in the past on one screen.
6. The graph of pumping operation data	Display graph of pumping operation data for 48 in the past on one screen.
7. The graph of salinity data	Display graph of salinity data for 48h in the past on one screen.
8. The graph of Electrical Facilities Data	Display graph of electrical facilities data for 48h in the past on one screen.
9. The graph of pH and water temperature	Display graph of pH and water temperature for 48h in the past on one screen.
10. Water Level data table	Display the last 16h water level data for 2 stations on one screen.
11. Hydrological data table	Display the last 16h hydrological data for 8 items on one screen.
12. Pumping operation data table	Display the last 16h pumping operation data for 8 items on one screen.
13. Electrical Facilities data table	Display the last 16h electrical facilities data for 8 items on one screen.
14. pH and water temperature data table	Display the last 16h pH and temperature data for 8 items on one screen.
15. Salinity data table	Display the last 16h salinity data for 8 items on one screen.
16. Modification to water level data	Display water level data for one station per day with hourly/daily report on one screen.
17. Modification to the Dam Hydrological data	Display the Dam Hydrological data for two items per day with daily report on one screen.
18. Modification to Salinity data	Display the salinity data for two items per day with daily report.
19. Modification to pumping operation data	Display the pumping operation data for two items per day with daily report on one screen.

Equipment	Content
20. Modification to Electrical Facilities data	Display the electrical facilities data for two items per day with daily report on one screen.
21. Modification to pH and water temperature data	Display the electrical facilities data for two items per day with daily report on one screen.
22. Dam Condition table	Display the condition of the reservoir and discharge facility per minute over the dam typical illustration.
23. The outlook of basin	Display the latest data of each station for water level and Dam every minute, included salinity, pH and water temperature.
24. Pump Condition table	Display the condition of the pumping station per minute over the pump typical illustration.
25. Electrical Facilities Condition table	Display the Condition of the electrical facilities per minute over the electrical facility typical illustration.
26. Hydrograph	Display the reservoir level, quantity of inflow and discharge for 8h on the Hydrograph every ten minutes.
27. Setting constant for Water level	Setting constant for the danger water level.
28. Setting Constant for the Dam Hydrological data	Setting Constant for the danger level and the supremum of quantity inflow.
○ 29. Gate Operation Report	Preparation of gate operation report.
○ 30. Water Level/Salinity Daily Report	Preparation of water level/salinity daily report.
○ 31. Hydrological Data Monthly Report	Preparation of hydrological data monthly report.
○ 32. Water Level Monthly Report	Preparation of water level monthly report.
○ 33. Discharge Monthly Report	Preparation of discharge monthly report.
○ 34. Pump Operation Report	Preparation of pump operation report.
○ 35. Pumping data Daily Report	Preparation of pumping data daily report.
○ 36. Pumping data Monthly Report	Preparation of pumping data monthly report.
○ 37. Diversion Dam Electrical Facilities Daily Report	Preparation of diversion dam electrical facilities daily report.
○ 38. Pumping Station Electrical Facilities Daily Report	Preparation of pumping station electrical facilities daily report.
○ 39. Diversion Dam Electrical Facilities Monthly Report	Preparation of diversion dam electrical facilities monthly report.
○ 40. Pumping Station Electrical Facilities Monthly Report	Preparation of pumping station electrical facilities monthly report

9102 EQUIPMENT COMPOSITIONS

(1) General

The system composition shall refer to the following Tables.

List of Equipment Composition (1/2)

STATION: CONTROL HOUSE

No.	Description	Unit	Q'ty	REMARKS
1.	Data Processing Equipment	set	1	
2.	Personal Computer Equipment 245 MB hard disk, 1.44 MB floppy disk, 20" display, key board, and mouse.	set	1	
3.	Color Hard copy	set	1	
4.	Printer			
	(1) Laser Printer	set	1	
	(2) Printer	set	2	
5.	I/O Terminal Equipment with Arrestor	set	1	
6.	I/O Relay Equipment	set	1	
7.	Graphic Panel Equipment	set	1	
8.	Gate Operation Console	set	1	
9.	Pump Operation Console	set	1	
10.	Electric Sub-Station Operation Console	set	1	
11.	Desk Type Mini-Graphic Panel	set	1	
12.	Telemetry Supervisory Equipment	set	1	
13.	Operation Panel for Telemetry System	set	1	
14.	Telemetry Telecontrol Equipment for Pumping Station	set	1	
15.	Radio Telephone Equipment	set	1	150 MHz band Simplex
16.	Portable Radio Equipment	set	10	150 MHz band
17.	Antenna System for Data Acquisition System			
	(1) 3-EL Yagi Antenna	set	1	
	(2) Coaxial Cable Equipment	m	40	10D2E
	(3) Coaxial Arrester	set	1	

List of Equipment Composition (2/2)

STATION : CONTROL HOUSE

No.	Description	Unit	Q'ty	REMARKS
18.	Antenna System			
	(1) Sleeve Antenna	set	1	
	(2) Coaxial Cable Equipment	m	40	10D2E
	(3) Coaxial Arrester	set	1	
19.	Paging System			
	(1) Paging Control Equipment	set	1	
	(2) Operation Console for Paging System	set	1	
	(3) Loud Speaker Control Equipment	set	3	Control House Diversion Dam and Pumping Station
	(4) Loud Speaker with Arrester Box	set	8	70 W × 2
20.	ITV System			
	(1) ITV Camera with Pan, Tilt Head and Lamps	set	4	1 KW × 2
	(2) ITV Operation Console	set	1	With Two Monitors
	(3) Relay Controller	set	4	
21.	Limnimeter (Water · Level Gauge)			
	(1) Water Level Gauge (with and A/D Converter)	set	4	
	(2) Float, Counterweight and Wire	set	4	
	(3) Terminal Box with Arrester	set	4	
22.	Salinity Instruments with 3 Points Sensor	set	2	
23.	pH Measuring Instruments with Water Temperature Gauge	set	2	
24.	Power Supply Equipment			
	(1) Un-Interruptible Power Supply Equipment Including DC/AC Inverter and Battery Bank	set	1	10 KVA
	(2) AC Switch Board	set	1	
	(3) Isolation Transformer	set	1	20 KVA
25.	Installation Materials			
	(1) Cable for Installation	lot	1	
	(2) Miscellaneous Materials for Installation	lot	1	
26.	Installation Work	lot	1	
27.	Adjustment and Testing Work	lot	1	

List of Equipment Composition

STATION : PUMPING STATION

No.	Description	Unit	Q'ty	REMARKS
1.	Telemetry Supervisory Control Equipment with Interface Unit	set	1	
2.	Loud Speaker Control Equipment	set	1	
3.	Loud Speaker with Arrester Box	set	2	70 W × 2
4.	Power Supply Equipment			
	(1) Un-Interruptible Power Supply Equipment including DC/AC Inverter and Battery Bank	set	1	1 KVA
	(2) Isolation Transformer	set	1	2 KVA
5.	Installation Materials			
	(1) Cable for Installation	lot	1	
	(2) Miscellaneous Materials for Installation	lot	1	
6.	Installation Work	lot	1	
7.	Adjustment and Testing Work	lot	1	

List of Equipment Composition

STATION : NAKHON NAYOK WATER LEVEL GAUGING STATION

No.	Description	Unit	Q'ty	REMARKS
1.	Telemetering Equipment	set	1	
2.	Radio Equipment	set	1	150 MHz Band/10 W
3.	Limnimeter (Water · Level Gauge)			
	(1) Water Level Gauge (with and A/D Converter)	set	1	
	(2) Float, Counterweight and Wire	set	1	
	(3) Terminal Box with Arrester	set	2	
4.	Antenna Equipment			
	(1) 8-EL Yagi Antenna (150 MHz)	set	1	
	(2) Coaxial Cable (10 D2E)	m	40	
	(3) Coaxial Arrester	set	1	for 150 MHz band
5.	Power Supply Equipment			
	(1) Charge Equipment (12 v/5A)	set	1	
	(2) Storage Battery (12 v/40 AH)	set	1	
	(3) Isolation Transformer	set	1	0.5 KVA
6.	Installation Materials			
	(1) Cable for Installation	lot	1	
	(2) Antenna Fixed Hardware	lot	1	
	(3) Miscellaneous Materials for Installation	lot	1	
7.	Installation Work	lot	1	
8.	Adjustment and Testing Work	lot	1	

List of Equipment Composition

STATION : BAN SANG WATER LEVEL GAUGING STATION

No.	Description	Unit	Q'ty	REMARKS
1.	Telemetering Equipment	set	1	
2.	Radio Equipment	set	1	150 MHz Band/10 W
3.	Limnimeter (Water · Level Gauge)			
	(1) Water Level Gauge (with and A/D Converter)	set	1	
	(2) Float, Counterweight and Wire	set	1	
	(3) Terminal Box with Arrester	set	2	
4.	Antenna Equipment			
	(1) 12-EL Yagi Antenna (150 MHz)	set	1	
	(2) Coaxial Cable (10 D2E)	m	40	
	(3) Coaxial Arrester	set	1	for 150 MHz band
5.	Power Supply Equipment			
	(1) Charger Equipment (12 v/5A)	set	1	
	(2) Storage Battery (12 v/40 AH)	set	1	
	(3) Isolation Transformer	set	1	0.5 KVA
6.	Installation Materials			
	(1) Cable for Installation	lot	1	
	(2) Antenna Fixed Hardware	lot	1	
	(3) Miscellaneous Materials for Installation	lot	1	
7.	Installation Work	lot	1	
8.	Adjustment and Testing Work	lot	1	

9103 SPECIFICATION FOR EQUIPMENT AND MATERIALS

(1) Data Processing Equipment

a) CPU: 16 bit or more

b) Memory : ROM 2 M byte or more
RAM 4 M byte or more

c) Power supply : AC 220 V ± 10 %

d) Power consumption : 500 VA or less

e) Dimension : Approx. 700 mm (W), 2,000 mm (H), 600 mm (D)

(2) Personal Computer Equipment
(with hard disk, visual monitor, floppy disk, keyboard and mouse)

The specification shall be the same or higher processing quality than the PC/AT 486/33 with INTEL 80486 processor, 66 MHz, EISA, 32bit, cache of 8K and arithmetic coprocessor integrated, in desk top type cabinet.

a) PC/AT 486 DX/33 with intel 80486 processor, 66 MHz, eisa 32 bit, cache of 8 k and arithmetics coprocessor integrated, in desk top type cabinet.

b) 16 MB RAM, expandable 64 MB.

c) (1.44 MB/1.2 MB/720 KB) 3 mode, 3 1/2" floppy disk unit.

d) Hard disk unit, 245 MB.

e) Color video, SVGA, 20" monitor, dot 0.33, 1024 × 768

The following software library shall be included for the operation of this system.

- Operation system
- FORTRAN compiler
- "C" complier

The software of the personal computer system shall have, but not necessarily be limited to, the functions :

- Display tool
- Easy correction for storage data
- Ability to easily update for parameter in the data base
- Ability to use high level language corresponding to the compiler

The following accessories shall be provided for each set of this system. Consumables and spare parts shall be able to be supplied in local market.

- Cables 1 set
- Spare fuse for each 1 set
- Dust cover for each 1 set
- Instruction manual 1 set
- Programming manual 1 set
- Blank diskettes 30 pcs
- Ribbon cartridge for printer 10 pcs
- Printing paper for tractor feed 4,000 sheets
- Others 1 set

(3) Laser Beam Printer

a)	Printing system	:	Semi-conductor laser and dry electric photograph
b)	Clearness	:	600 DPI/480 DPI or more
c)	Printing Speed	:	A4 8 sheets/min B4 5 sheets/min A3 4 sheets/min
d)	Memory	:	4 MB or more
e)	Power supply	:	AC 220 V ± 10 %
f)	Power consumption	:	1.2 KW (MAX) or less
g)	Dimension	:	approx. 500 mm (W), 300 mm (H), 530 mm (D)

(4) Printer

a)	Remote controlled function	: Number, symbols and others
b)	Printing system	: Dot matrix impact with 24 pins
c)	Character spacing	: 1/10 or 1/12 inch
d)	Line spacing	: 1/6 inch
e)	Number of columns	: 136/163/line
f)	Paper width	: 15 inches
g)	Character code	: ASCII 96 characters
h)	Printing speed	: 108 characters/sec (average)
i)	Power supply	: AC 220 V ± 10 %
j)	Power consumption	: 300 VA or less
k)	Dimension	: Approx. 700 mm (W), 1,000 mm (H), 700 mm (D)

(5) Color Hard Copy Equipment

a)	Printing method	: Heat copy method
b)	Dot density	: 300 DPI
c)	Color	: Max 16,7000,000 colors
d)	Printing speed	: Approx 60 second or more
e)	Ink sheet	: 3 color
f)	Video signal frequency	: 7.5 MHz-130 MHz
g)	Picture size	: Max 1,280 × 1,024 picsel
h)	Printing speed	: Approx. A4 1 sheet/min
i)	Power supply	: AC 220 V ± 10 %
j)	Power consumption	: 400 VA or less
k)	Dimension	: Approx. 430 mm (W), 300 mm (H), 450 mm (D)

(6) I/O Terminal Equipment with Arrester

a)	Input points	: BCD 4 digits (double brush type) × 4 Analog (4-20 mA) × 15 SV 150 points or more

b) Output points : Control signal 30 points or more

c) S/D converter : 7 sets for gate opening

d) Arrester : DC discharge-over voltage for BCD : DC 16 V or less for analog and SV : DC 400 V or less for control signal : AC 335 V or less

e) Power supply : AC 220 V ± 10 %

f) Power consumption : 400 VA or less

g) Dimension : Approx. 700 mm (W) × 2, 2,000 mm (H), 600 mm (D)

(7) I/O Relay Equipment

a) Input relay : SV : 150 points or more

b) Output relay : Control signal : 30 points more

c) Power supply : AC 220 V ± 10 %

d) Power consumption : 500 VA or less

e) Dimension (with desk stand) : Approx. 700 mm (W) ×2, 2,000 mm (H) 600 mm (D)

(8) Graphic Panel Equipment

The graphic display equipment shall be of self-standing type, and shall comprise map, flow chart display panel, and necessary Indicators. On the map panel, centering on the Bang Pakong River, main mountains, each city and town, dams and Gauging Stations shall be illustrated.

a) MAP : Approx. 1,800 mm (W), 1,400 mm (H)

b) Flow chart : Approx. 1,200 mm (W), 1,400 mm (H)

c) Indicators : Lamps Approx : 40 sets
Numerical 25 set or more

d) Power supply : AC 220 V ± 10 %

e) Power consumption : 440 VA or less

f) Dimension : Approx. 3,500 mm (W), 2,500 mm (H), 800 mm (D)

(9) Gate Operation Console

The operating console for gate control and monitoring system shall be of the desk type, and shall be capable of handling the gate control and monitoring system.

a) Functions

- Manual operation for gates
- Set gate positioning operation
- Display of gate operation conditions
- Target value of gate opening and discharge

b) Power supply : AC 220 V ± 10 %

c) Power consumption : 300 VA or less

d) Dimension : Approx. 2,500 mm (W), 1,100 mm (H)
1,200 mm (D)

The examples of the console panel for the gate control and monitoring system are shown in the drawings.

The outlined drawing for the operating console for the gate control and monitoring system that the Contractor wishes to offer, shall be submitted to the Employer for his approval.

(10) Pump Operation Console

The operating console for pump control and monitoring system shall be of the desk type, and shall be capable of handling the pump control and monitoring system.

a) Functions

- Manual operation for Pumping Station facilities
- Display of pump operation conditions

b) Power supply : AC 220 V ± 10 %

c) Power consumption : 200 VA or less

d) Dimension : Approx. 1,300 mm (W), 1,200 mm (H)
1,200 mm (D)

The examples of the console panel for the electric sub-station facilities are shown on the drawings.

The outlined drawing for the operating console for the pump control and monitoring system that the Contractor wishes to offer, shall be submitted for approval of the Employer.

(11) Electric Sub-Station Operation Console

The operating console for electric sub-station control and monitoring system shall be of the desk type, and shall be capable of handling the electric substation control and monitoring system.

a) Functions

- Manual operation for electric substation facilities
- Display of electrical facilities conditions
- Flow chart for electric substation facilities

b) Power supply : AC 220 V ± 10 %

c) Power consumption : 400 VA or less

d) Dimension : Approx. 3,300 mm (W), 1,200 mm (H),
1,200 mm (D)

The examples of the console panel for electric substation control and monitoring the system are shown on the drawings.

The outlined drawing for the operating console for electric substation control and monitoring the system that the Contractor wishes to offer, shall be submitted for approval of the Employer.

(12) Mini Graphic Panel

The examples of the desk type mini graphic panel are shown on the drawings.

The outlined drawing for the desk type mini-graphic display that the Contractor wishes to offer, shall be submitted for approval of the Employer.

(13) Telemetry Supervisory Control Equipment
(with operation panel)

These specification shall apply to the telemetry supervisory equipment at the Control House.

a) Functions

The telemetry supervisory equipment shall have the following functions.

1. The equipment shall transmit calling signal to the gauging stations, and shall receive the response signal (FS) from the gauging stations.
2. The equipment shall decode the response signal (FS) to BCD code.
3. The equipment shall output the received data to the I/O relay equipment.
4. Display and operation: The equipment shall have the following functions at the test panel.

b) Operations

- Test calling
- Operation reset
- Alarm off
- Voice communication
- Lamp test

c) Display

- Receiving failure
- Transmitting
- Measuring
- Power on/off

d) Specifications

- Capacity : 10 stations
- Transmission code configuration: Conforms to JIS X 5104 (HDLC)
- Transmission code type system : NRZI equal length code
- Communication rate : 200 bps
- Dimensions : 2,000 (H) × 650 (W) × 600 (D) mm or less

e) Power Supply

The equipment shall be operated on 220 V AC, single phase, 50 Hz fed from UPS.

(14) Telemetry Telecontrol Equipment

a) Transmission System

- Communication system : Duplex communication system
- Correspondence method : 1 : 1 method
- Communication system code configuration : Conforming to JIS 5104 or equivalent (high level data link control procedure frame configuration)
- Communication rate : 200 bps or more
- Transmission system : Cyclic
- Transmitting speed : 200 bit/sec or more

b) Power supply : AC 220 V ± 10 %

c) Power consumption : 200 VA or less

d) Dimension : Approx. 700 mm (W), 2,000 mm (H)
600 mm (D)

(15) Radio Equipment for Data Acquisition System

The radio equipment for the telemetering system shall be of plug-in type construction, and shall fully satisfy the following specifications :

a) General characteristics

- Frequency range : 138 to 172 MHz band
- Modulation system : Phase modulation
- Frequency stability : Within $\pm 10 \times 10^{-6}$
- Radio frequency input
- Output power : 10 W/5 W/3 W/1 W
- Operating voltage : DC 12 V

b) Transmitter ratings

- Type of emission : F_2 and F_3
- Rated output : 10 W/5 W/3 W/1 W
- Modulation system : Phase modulation
- Modulation input : 1 KHz, linear up to 70%
  Input level required for 70%
- Maximum frequency deviation : Within ± 5 KHz
- Occupied bandwidth : Within 16 KHz
- S/N ratio : 45 dB or more, at 1 KHz, 70 % modulation

c) Receiver ratings

- Receiving system : Crystal controlled, super-heterodyne system
- Bandwidth : 12 KHz or more at 6 dB down
- Selectivity : Within 25 KHz at 70 dB down
- Spurious response : More than 80 dB
- S/N ratio : 30 dB or more at 15 dBμV input at 1 KHz, 70% modulation
- Receiving sensitivity : 3 dBμV or less
- Current consumption : 10 mA or less (at DC 12 V)

The radio equipment shall have a means for protecting the transmitter and receiver against opening and short-circuiting of the antenna system and excessive input.

Check terminals for the transmitter output for the modulation input, and for the demodulation output shall be provided in addition to providing the check point for the major functional units.

Name of Station	RF Power
1. Control House	10 W
2. Nakhon Nayok Station	10 W
3. Ban Sang Station	10 W

(16) Radio Telephone Equipment for Voice Communication System at Control House

The radio telephone equipment for communication system shall connect with each portable radio telephone set.

The radio telephone equipment shall be of desk top type or rack-mount type construction, and shall fully satisfy the following specifications :

a) General characteristics

- Frequency range : 136 to 174 MHz
- Modulation system : Phase modulation
- Frequency stability : Within $\pm 10 \times 10^{-6}$
- Radio frequency input
- Output power : 10 W
- Operating voltage : AC 100 V or DC 12 V

b) Transmitter ratings

- Type of emission : F_3
- Rated output : 10 W
- Modulation system : Phase modulation
- Maximum frequency deviation : Within ± 5 KHz
- Occupied bandwidth : Within 16 KHz
- S/N ratio : 45 dB or more, at 1 KHz, 70 % modulation
- Distortion : 10 % or less, at 1 KHz, 70 % modulation

c) Receiver ratings

- Receiving system : Double super-heterodyne system
- Bandwidth : 12 KHz or more at 6 dB down
- Selectivity : Within 25 KHz at 70 dB down
- S/N ratio : 40 dB or more at 30 dBμV input at 1 KHz, 70 % modulation
- Receiving sensitivity : 20 dB SINAD-113 dBm
  12 dB SINAD-116 dBm

The radio equipment shall have a means for protecting the transmitter and receiver against opening and short-circuiting of the antenna system and excessive input.

(17) Portable Radio Equipment

The portable radio telephone equipment for communication system shall connect with Control House.

The radio telephone equipment shall be of portable type, and shall fully satisfy the following specifications :

a) General characteristics

- Frequency range : 136 to 174 MHz
- Modulation system : Phase modulation
- Frequency stability : Within $\pm 4 \times 10^{-6}$
- Radio frequency input
- Output power : 5 W
- Operating voltage : DC 10 V

b) Transmitter ratings

- Type of emission : F3
- Rated output : 10 W
- Modulation system : Phase modulation

- Maximum frequency deviation : Within ± 5 KHz
- Occupied bandwidth : Within 16 KHz
- S/N ratio : 45 dB or more at 1 KHz, 70 % modulation
- Distortion : 10 % or less, at 1 KHz, 70 5 modulation

c) Receiver ratings

- Receiving system : Double super-heterodyne system
- Bandwidth : 12 KHz or more at 6 dB down
- Selectivity : Within 25 KHz at 70 dB down
- S/N ratio : 40 dB or more at 30 dBμ input at 1 KHz, 70 % modulation
- Receiving sensitivity : 20 dB SINAD-113 dBm
  12 dB SINAD-116 dBm

(18) Antenna Equipment

The antenna equipment shall satisfy the following specifications :

a) Operating frequency : 140 to 170 MHz

b) Type and gain

a. Sleeve antenna : 2 dB or more

b. 3-element Yagi : 9.0 dB or more

c. 8-element Yagi : 13.15 dB or more

c) Impedance : 50 Ohms

d) Standing wave ratio : 1.5 or less

e) Polarization : Vertical as standard

f) Insulation resistance : More than 500 M Ohms when measured by a 500 V megger at a feeding point under dry conditions

g) Dielectric strength : AC 1,000 V for one minute

h) Telemetering system (150 MHz band)

Name of Station	Type of Antenna
Control House	3-element Yagi
Nakhon Nayok Station	8-element Yagi
Ban Sang Station	8-element Yagi

i) Telemetering system (150 MHz band)

Name of Station	Type of Antenna
Control House	Sleeve antenna
Portable stations	Whip antenna

(19) Coaxial Cable Equipment

- Impedance : 50 Ohms
- Insertion loss : 0.5 dB or less
- Standing wave ratio (VSWR) : 1.2 or less at the specified frequency
- Frequency range : 140 to 170 MHz

(20) Coaxial Arrester

The coaxial arrester shall be installed between the antenna and the radio equipment for protecting the radio equipment and coaxial cable against lighting surges.

Rating shall be as follows :

- Type : Feeder type
- Impedance : 50 Ohms
- Frequency range : DC to 1,000 MHz
- Insertion lose : 0.5 dB or less
- V. S. W. R. : 1.2 or less

(21) Paging Control Equipment

These specifications shall apply to the paging control equipment at the Control House.

a) Functions

The paging control equipment shall have the following functions.

a. The equipment shall be capable of controlling up to eight (8) loudspeaker control equipment.

b. The equipment shall receive the confirmation signal that shows the condition of the loudspeaker control equipment.

c. Display and operation

The equipment shall have the following functions at the test panel.

Operation

- Operation reset
- Test control
- Alarm off
- Lamp test
- Power supply on/off

Display

- Condition of loud speaker control equipment
- Control failure
- Controlling
- Power on/off

b) Specifications

a. Capacity : 8 loud speaker control equipments

b. Control system : Individual control and all control

c. Transmission code configuration : Conforms to JIS X 5104 (HDLC)

d. Transmission code type : NRZI equal length code system

e. Communication rate : 200 bps

f. Dielectric strength : 1,500 V AC/min

g. Dimensions : Shall be equipped in the telemetry supervisory equipment

c) Power Supply

This equipment shall be operated on 220 V AC fed from UPS.

(22) Operation Console for Paging System

These specifications shall apply to the operating console of standalone type at the Control House.

The operating console for paging system shall be of the desk type, and shall be capable of handling the paging system.

The operating console for paging system shall be able to perform, but not necessarily be limited to, the following control operations and display :

a) Functions

The operating console shall be provided with the following items on control operation and display.

1. Display

- Status displays for each piece of equipment, regarding:

  Controlling

  Equipment control impossible

  Testing

  Power supply voltage drop for loudspeaker

  Control equipment

- Time and date

- Controlling
- Power source
- Fuse blown out

2. Operation Control

- Selection of loudspeaker control equipment and its indication

  The sites to be broadcast shall be as follows :

  Downstream of Diversion Dam

  Upstream of Diversion Dam

  Pumping Station

  Around Control House

- Selection of items to be performed. Regarding :

  Broadcast start

  Broadcast stop

  Test

  Sequential test

- Start of operation for above items
- Resetting
- Confirmation reset
- Alarm off
- Lamp test

b) Specifications

a. Capacity	: 8 loudspeaker's control equipment
b. AC input	: 220 V AC ± 10 %
c. Dielectric strength	: 1,500 V AC/min
d. Dimensions	: Approx. 1,260 (W) × 1,100 (H) × 1,200 (D) mm

c) Power Supply

This equipment shall be operated on 220 V AC fed from UPS.

The outlined drawing for the operating console for paging that the Contractor wished to offer shall be submitted for the Employer's approval.

(23) Loud Speaker Control Equipment at Local Site

These specifications shall apply to the loudspeaker control equipment of the paging subsystem.

a) Functions

The loudspeaker control equipment shall be installed at the Control House, the Diversion Dam and the Pumping Station, and shall have the following functions.

1. Voice Broadcast Control

   The loudspeaker control equipment shall receive a voice broadcast control signal from the paging control equipment to provide the assigned voice broadcasting. The loudspeaker control equipment shall collect chime sound and return it to the paging control equipment for the first 5 seconds, which shall be followed by a 1.2-second confirmation signal.

2. Confirmation Signal

   The confirmation signal includes :

   - Check abnormal
   - Power failure (220 V AC)
   - Charger failure
   - Audio amplifier failure
   - Loudspeaker failure
   - Audio amplifier power on

b) Specifications

1. Type : Moisture-proof, and standing cabinet type
2. Transmission code configuration
   X 5104 (HDLC) : Conforms to JIS

3. Transmission code type : NRZI equal length code system
4. Communication rate : 200 bps
5. Dielectric strength : 500 V DC/min.
6. Power source : 220 V AC ± 10 %
7. Dimensions : 1,500 (H), 520 (W), 300 (D) mm or less

c) Power Supply

This equipment shall be operated on 220 V AC fed from UPS.

(24) Loudspeaker Equipment

These specifications shall apply to the loudspeaker equipment of the paging subsystem.

The equipment shall be used for broadcasting voice, and shall consist of a voice amplifier, reflex speakers and a speaker junction box and shall satisfy the following specifications.

a) Voice Amplifier

The voice amplifier shall be panel type and built in a warning equipment.

- Dimensions : 150 (H), 240 (W), 200 (D) mm or less
- Power requirements
  Input voltage : 12 V DC (nominal)
  Power consumption : 18 A or less
- Output : 100 W
- Frequency response : 300 Hz to 3 KHz within ± 3 dB
- Distortion : - 30 dB or less
- S/N ratio : 40 dB or more

b) Speaker

- Type : Horn

- Input power : 70 W
- Output power level : 110 dB/1 m 1W

(25) ITV Camera with Pan, Tilt Head and Lamps

ITV camera set shall consists of ITV camera, pan and tilt head, local control box and lams equipped on pan and tilt head.

a) Monitoring Camera

- Lightness of subject : 10 to 10,000 LX
- Lens of camera : Power zooming
- Power supply : AC 220 V ± 10 %
- Power consumption : 200 VA or less

b) Pan and Tilt Head

- Tilting Angle : Up approx. 30°
  Down approx. 60°
- Panning Angle : Each approx. 160°
- Tilting speed : 4°/ sec or less

c) Lamps (Xenon-Search Light)

- Class of Protection : Light body IP 45
- Lamp : H-3 (300 W)
- Front glass : ø 232.5 t
- Reflector rotation : ø 220
- Elevation angle : Up above 300 EG, down below 300 EG
- Azimuth angle : 360 DEG
- Maximum luminous Intensity of beam (cd) : 8.5×10^6 cd
- Power : 300 W (700 VA), 1 ø, 220 V, 3.2 A
- Dimension : 370 × 440 × 515

- Weight : 24 kg

(26) ITV Operating Console

The operating console for ITV monitoring system shall be of the desk type, and shall be capable of handling the ITV control and monitoring system.

a) Functions

- Manual operation for ITV cameras
- Display of operation conditions
- Television set : 14 inches, Color

b) Power Supply : AC 220 V ± 10 %

c) Power consumption : 200 VA or less

d) Dimension : Approx. 1,100 mm (W), 1,200 mm (H), 1,200 mm (D)

The examples of the console panel for ITV monitoring system are shown in the drawings.

The outlined drawing for the operating console for ITV monitoring system that the Contractor wished to offer shall be submitted to the Employer for his approval.

(27) Water Level Gauge (with A/D Converter)

The water level gauging equipment shall consist of a float, wire with balls, counterweight, A/D converter and automatic recorder.

Specifications shall be as follows :

- Measuring value : 4 digits (000 to 9999)
- Output signal : BCD system with parity check bit per digit
- Chart : 6 mm/hr
- Chart width : 200 mm
- Measuring range : 0 to 10 m

- Measuring unit : 1 cm
- Reduced scale : 1/5
- Recording accuracy : Daily error within ± 2 minutes
- Clock : Driven by a dry battery (UM-2)
- Diameter of float : 300 mm

(28) Terminal Box with Arrester for Water Level Gauge

The terminal box with arresters shall be of self-restoring gas arresting tube type, and shall have impulse discharge current of 5 KA, (1 × 40) μsec. This cable protector should be installed at the side of the limnimeter, float counterweight and at the remote terminal unit to protect the equipment from the lighting surges.

The specifications are as follows :

- Type : Semiconductor type
- Number of poles : 50 CH or more
- Impulse spark over voltage : 70 V or less
- DC spark over voltage : 18 V
- AC discharger current withstand : 5 A
- Impulse discharge withstand : 5 KA
- Resister : 10 Ohms
- Zener diode rated voltage : 18 V
- Insulation resistance : 100 M Ohms
- Dielectric strength : DC 500 V/1 min
- Dimensions : 280 (W) × 198 (H) × 142 (D) mm
- Weight : Approx. 6kg

(29) Salinity Instrument

a) Sensor : Electric pole system (3 points measuring)
b) Method : Measuring water conductive
c) Measuring range : 20-15,000 ppm
d) Power supply : AC 220 V ± 10 %

e) Power consumption : 200 VA or less

f) Dimension : Approx. 700 mm (W), 2,000 mm (H), 600 mm (D)

(30) pH Instruments with Water Temperature Gauging Equipment

The pH instruments shall consist of a pH instrument, a water temperature and cabinet.

The pH instruments shall satisfy the following specifications ;

a) pH gauge

- Measuring Range : pH 2 to pH 12
- Accuracy : ± 10 %

b) Water temperature gauge

- Measuring range : - 5°C to 35 °C
- Accuracy : ± 0.1 °C

c) Cabinet

- Power supply : AC 220 V ± 10 %
- Power consumption : 200 VA or less
- Dimensions : Approx. 700 (W), 2,000 (H), 600 (D) mm

(31) Telemetry Gauging Equipment

The telemetering equipment to be installed at the gauging stations shall be of wall-mounted cabinet type.

The telemetering equipment shall have, but not necessarily be limited to, the following function units :

- Modem unit
- Data transmitting control unit

- Receiving control unit
- Built-in radio equipment
- Power supply unit

The following operations shall be performed :

- Speech
- Data code test transmission
- Measurement of the transmitter input level
- Measurement of the receiver output level
- Measurement of the FS modulator input signal level

In addition, a protection circuit shall be included so as to halt its signal transmission automatically after a fixed period of time to prevent the telemetering equipment from transmitting continuously because of control failure.

Interfacing of the telemetering equipment with water level gauge shall be as follows:

- Water-level gauge : BCD code with odd parity bit per digit (max. 4 digits)

The telemetering equipment shall be operated by the power source of DC 12 V.

The current consumption of the telemetering equipment with the radio equipment shall satisfy the following rating :

a) DC 12 V provided telemetering equipment including radio equipment at DC 12 V power supply voltage.

- Stand by : 15 mA or less
- Receiving : 0.05 A or less
- Transmitting (10 W) : 3.6 A or less

(32) Isolation Transformer

The isolation transformer shall be provided to protect each piece of equipment from the surge coming through the power source line.

The specifications of the isolation transformer shall be as follows :

- Input phase : Stipulated as below
- Input voltage : Stipulated as below
- Output phase : stipulated as below
- Output voltage : Stipulated as below
- Rated capacity : Stipulated as below
- Impulse withstand : 30 KV, 1 × 40 micro sec.between primary-secondary primary-ground
- Surge transfer ratio : Less than 40 dB at balance
  Less than 20 dB at unbalance
- Efficiency (%) : 95 % or more

Name of Station	Input Phase/Voltage	Output Phase/Voltage	Rated Capacity
1. Control House	3 phases/AC 380 V	3 phases/AC 380 V	20 KVA
2. Pumping Station	Single/AC 220 V	Single/AC 220 V	2 KVA
3. Water Level Gauging Station	Single/AC 220 V	Single/AC 220 V	0.5 KVA

(33) Un-Interruptible Power Supply Equipment

In the Control House and Pumping Station, the un-interruptible power supply system shall be provided for continuous operations of gate control and monitoring system, the telemetering system, pumping control and monitoring subsystem, etc., in spite of power failure.

The un-interruptible power supply system shall consist of charger with battery and inverter.

Specification shall be as follows :

- AC input : Stipulated as below
- AC output : Stipulated as below
- Load capacity : Stipulated as below
- Covering time for interruption of commercial line : 10 minutes or more
  Covered by storage battery

- Rating : Continuous operating

Name of Station	AC Input	AC Output	Rated Capacity
1. Control House	AC 380 V ± 15 %	AC 220 V ± 2 %	10 KVA
	3-phase 50 Hz ± 2 Hz	Single 50 Hz ± 0.5 Hz	
2. Pumping Station	AC 220 V ± 15 %	AC 220 V ± 2 %	1 KVA
	Single 50 Hz ± 2 Hz	Single 50 Hz ± 0.5 Hz	

(34) Charger and Battery

- Type

Rectification system : Single-phase full wave

Cooling system : Natural air cooling

Rating : Continuous duty

- AC input

Phase : Single-phase two-wire

Rated voltage : 220 V

Voltage fluctuation range : ± 15 %

Rated frequency : 50 Hz

Frequency fluctuation range : ± 2 Hz

- Rectifier output

Power factor : 80 % or more at 65 % to 100 % rated load

Normal voltage : 13.6 V

Set voltage

Floating charge voltage : 13.6 V

Equalizing charge voltage : 14.4 V

Floating charge voltage : ± 5 %

Adjustable range

Equipment charge voltage	: ± 5 %
Adjustable range	
Rated current	: 5 A
Current variation range	: 0 % to 100 %
Dropping current	: Less than 120 % of rated current at 13.6 V
Voltage regulation	: Within ± 2 %

- Load

Efficiency	: 60 % or more (at specified input voltage and rated road)
Nominal voltage	: 12 V
Voltage variation range	: Less than 17.0 V
Rated current	: 5 A
Current variation range	: 0 % to 100 %

(35) AC Switching Board

The AC switching board shall be of wall-mounted cabinet type and shall have the following specifications :

a)	Input voltage	: AC 220 V
b)	Total capacity	: 10 KVA
c)	Maximum current capacity of output circuit and number of output circuits	: 15 A, 15 circuits (with no fuse breaker)
d)	Insulation resistance	: 10 M Ohms or more
e)	Dielectric strength	: AC 1.5 KV/1 min
f)	Dimensions	: 1,000 (H) × 600 (W) × 300 (D) mm or less

SECTION 9200 ELECTRICAL FACILITIES

9201 SYSTEM REQUIREMENTS

(1) General

Outline of schematic drawing for the electrical facilities of the Bang Pakong Diversion Dam Project is shown on the drawings. These electrical facilities supply electrical power to Diversion Dam area and the Pumping Station from P.E.A 22 KV distribution lines.

The Bang Pakong Diversion Project include the two (2) substations and two (2) electric houses at the Diversion Dam area and the Pumping Station area. As following description, No. 1 Substation mean the substation and electrical facilities in Electric House at the Diversion Dam area, and No. 2 Substation mean the substation and electrical facilities in Pump House at the Pumping Station area. But, electrical facilities in the Pump House except the substation shall be included in the Division 7 "PUMP WORKS".

(2) No. 1 Substation

No. 1 Substation at the Diversion Dam area shall supply electric power and send it to the Control House for necessary signal by directly control cable.

a) Power Supply

a) -1 In-coming

In-coming installation are composed of two sets of metal clad switch gears and one transformer.

a) - 1 - a Function of M1, M2 Metal Clad Switch Gear

Voltage detection for 22 KV incoming distribution line on/off of 22 KV line by remote and push button : 24 KV 600 A out draw type vacuum necessary relay and meters for protection and metering. Surge protection : 24 KV 20 KA lighting arrester.

a) - 1 - b Transformer

3ø - 50 Hz - 1500 KVA - R 22 KV/ 380 - 220 V 3ø 4 W delta-star transformer step down from 2 KV to 380 - 220 V 3ø - 4 W and supply electric power to all load for Diversion Dam area except residential area. This transformer is connected by enclosed metal clad bus duct for primary and secondary. Live energized conductor must not be exposured.

a) - 2 L3 Panel

L3 Panel side of low voltage is main panel of low tensions panels. Protective relay for low voltage side are setted in this panel so as over current, under over voltage and ground relay for neutral. 4P, 2500 A 65 KA air circuit breaker shall be out draw type and operation are manual and remote operation.

a) - 3 L4 Panel

Three changeover contactors are changed to emergency generator automatically in case of power suspension. Two feeders supply power to gate motor panel L2 and gate power panel L1, and other one for battery charger for emergency generator.

a) - 4 L5 Panel

This panel is used for the Electric House and Control House. Two changeover contactors have the same function with L4 panel.

a) - 5 L6 Panel

This panel for Training Center and Dormitory will be used for future development. But all equipment shall be provided.

a) - 6 L7 Panel

Three feeders for road lighting are 3ø, 380 V using for road lighting panel A,B,C and three feeders for compound lighting are 1ø, 220 V.

a) - 7 L8, L9 Panel

L8 for condenser are controlled by automatic power factor relay, and include IT 20 KVA source feeder for central control equipments. IT 20 KVA feeder has changeover contactor for electricity suspension same as L4 panel. L9 panel supply power battery charger using for control voltage 105 V.

a) - 8 L2 Panel

L2 panel have six (6) feeders (one feeder spare) and each feeder shall supply electric power to each local panel in Hoist House. Two kinds of local panel installed in Hoist House for 1 leaf and 2 leaf gate. Capacity of electric power for 1 leaf local panel are 121.1 KVA on starting and 2 leaf local panel are 333.2 KVA on starting of 22 KW motor 2 sets include 11 KW motor 2 sets on normal state.

Each feeder must be guaranteed a supply of electric power to each local panel in Hoist House perfectly.

a) - 9 L1 Panel

L1 panel are composed of six (6) main feeders including one spare. One distribution panel feeder is also equivalent to a spare feeder. Gate lighting feeder has 11 feeders including one spare feeder and each feeder will supply power of 400 W 380 V high tension sodium lamp color rendering type. Fittable stabilizer shall be as specified in the Specifications.

b) Remote Control and Metering

Remote control and metering are operated with control wire.

b) - 1 Remote Control (on, off)

Panel	M1	24 KV, 600 A, 25 KA	VCB
	L3	600 V, 2500 A, 65 KA	ACB
	L4	〃 , 400 AF,	MCCB for L2 panel
	〃	〃 , 100 AF,	MCCB for L1 panel
	L5	〃 , 150 AF,	〃 〃 S/S
	〃	〃 , 150 AF,	〃 〃 C.C room
	L7	〃 , 60 AF,	〃 〃 road light
	〃	〃 , 60 AF,	〃 〃 compound light

L1	.....	600 V, 30 AF × 11 feeder, MCCT for gate light
〃	.....	〃 , 30 AF × 6 〃 , 〃 for hoist house
〃	.....	〃 , 60 AF × 2 〃 , 〃 for ITV

b) - 2 Metering

Panel	M1	24 KV, voltage detector white lamp
	〃	Watt hour meter
	〃	Ammeter
	M2	Volt meter
	Transformer	Temperature of oil, dial type temperature gauge
	L3	Ammeter
	〃	Volt meter
	〃	Watt meter
	〃	Power factor
	L4	Ammeter × 2
	L5	〃 × 2
	ACG	Volt meter
	〃	Ammeter
	〃	Frequency meter

b) - 3 Fail Indication

M1	.....	Over current relay	
〃	.....	Over current ground relay	
M2	.....	Over voltage relay	
〃	.....	Under voltage 〃	
Transformer	.....	Heavy or light indication for conservator oil inner fail and others	
L3	.....	Natural over current ground relay	
〃	.....	Over current relay	
〃	.....	Over voltage relay	
〃	.....	Under voltage relay	
L4	.....	Over current ground relay for L1 panel	
L5	.....	Over current ground relay	For substation
〃	.....	〃	For 2 spare feeder
L6	.....	〃	For 10 feeder
L7	.....	〃	For road lighting
〃	.....	〃	For compound lighting
L9	.....	〃	For battery
ACG	.....	Heavy or light fail indication	For generator

c) Emergency Generator

3ø - 50 Hz - 270 KVA - 380/220 V 4 W emergency generator shall respond by electric suspension automatically at each time delay.

For operation mode are mentioned below.

Time delay engine start	2 sec
Time delay transfer	4 sec
Time delay retransfer	30 sec
Time delay engine stop (engine cool down)	180 sec
Time delay signal reset	30 sec
Starting failure (over crank)	17 sec

(3) No. 2 Substation

No. 2 Substation at pumping station area shall supply electric power and send it to the Control House for necessary signal by T/M, T/C system.

a) Power Supply

a) - 1 In-Coming

In-coming installation shall be composed of two sets of metal clad switch gear and one transformer

a) - 1 - a Function

Metal clad switch gear voltage detection for 22 KV incoming distribution line

On/Off of 22 KV line by manual operation	:	24 KV 800 A disconnected isolator
On/Off of 22 KV line by remote and push button	:	24 KV 600 A draw out type vacuum circuit breaker

Necessary relay and meters for protection and metering surge protection

Surge Protection	:	24 KV 20 KA lightning arrester

a) - 1 - b Transformer

3ø - 50 Hz - 3000 KVA - R 22 KV/3.3 KV 3ø - 3W (delta-delta) transformer step down from 22 KV to 3.3 KV and supply electric power to pump motors and others at Pumping Station

area. This transformer are connected by enclosed metal-clad bus duct for primary and secondary. Live energized conductor must not be exposure.

b) Remote Control and Metering

Switches and meters as follows shall be controlled by Control House. The Contractor shall provide these functions.

b) - 1 Remote Control

a.	No. 1 Motor Pump	On/Off	2
b.	No. 2 Motor Pump	On/Off	2
c.	No. 3 Motor Pump	On/Off	2
d.	No. 4 Diesel Pump	On/Off	2
e.	ACG	On/Off	2
f.	In coming Switch	On/Off	2
g.	S.C. Feeder	On/Off	2
		Sub-total	(14)

b) - 2 Fail Indication

a.	No. 1 Motor Pump	Heavy/Light	2
b.	No. 2 Motor Pump	〃	2
c.	No. 3 Motor Pump	〃	2
d.	No. 4 Diesel Pump	〃	2
e.	ACG	〃	2
		Sub-total	(10)

b) - 3 Operation Indication

a.	Remote From Control House		1
b.	Local Operation in Pumping Station		1
c.	Operation Mode		3
d.	Suction Water Level Normal		1
e.	Fail Return	(No. 1 ~ No. 4 pump, ACG)	5
f.	Furnished for Provision	(〃)	5
g.	Starting	(〃)	5
h.	Run	(〃)	5
i.	Discharge	(〃)	5
j.	No Operation	(〃)	5
k.	Incoming	(On, Off)	2
l.	SC Feeder	(On, Off)	2
m.	4 Set of SC	(On, Off)	8
n.	Low Voltage	(On, Off)	8

o.	DEG		6
p.	Discharge Valve Open	(No. 1 ~ No. 4, pump)	8
q.	Cooling Water Normal		1
		Sub-total	(71)

b) - 4 Metering

a.	Voltage		
	Incoming		1
	ACG		1
b.	Current		
	Incoming		1
	Induction Motor		3
	Low Voltage Source		1
	ACG		1
c.	Incoming Watt hour		1
d.	Incoming Power Factor		1
e.	Diesel Operation Hour		1
f.	〃 RPM		1
g.	Fuel Level of Oil Tank		1
h.	Discharge		1
i.	Other		18
		Sub-total	(32)
		Total	(127)

c) Gate Lighting, Road Lighting and Lightning Rod

c) - 1 Gate lighting shall install on the each pier upstream side and downstream side for each gate pier. Total 40 lamps are used for additional lighting of ITV lighting.

c) - 2 Road Lighting

Road lighting with steel pole shall be installed at downstream side from the Diversion Dam.

c) - 3 Lightning Rod

Lightning rod shall be installed each Hoist House and Pumping House. Specification for the lightning rod will be described later.

9202 EQUIPMENT COMPOSITION

(1) No. 1 Substation

a) Substation (out-door)

No.	Name	Q'ty
1	Incoming metal enclosed cubicle (M1,M2)	2 sets
2	3ø - 50 Hz - 1500 KVA 22 KV - 380/200 V DYn1	1 set
3	High tension bus duct	1 set
4	Low tension bus duct	1 set

b) Electric House

No.	Name		Q'ty
1	Incoming secondary panel	L3	1 set
2	Main panel for L1,L2 panel and ACG batt.	L4	1 set
3	Feeder panel for substation control house	L5	1 set
4	〃 〃 for control building, training center and dormitory	L6	1 set
5	Feeder panel for road lighting, compound light	L7	1 set
6	Condenser Panel and IT feeder	L8	1 set
7	Battery panel for control	L9	1 set
8	Gate motor panel	L2	1 set
9	Gate power panel	L1	1 set
10	3ø - 50 Hz - 270 KVA - 380 V/200 V 3ø - 4 W emergency generator		1 set

c) Other Places

No.	Name	Q'ty
1	Gate Light with two lamps and accessories	20 sets
2	Switch box for Ban Sang, Nakhon Nayok Station	4 sets
3	〃 〃 Substation	2 sets
4	〃 〃 Control House	2 sets
5	〃 〃 Hoist House	6 sets
6	〃 〃 Road Lighting	3 sets

(2) No. 2 Substation

a) Substation (Out-door)

No.	Name	Q'ty
1	Incoming metal enclosed cubicle	2 sets
2	3ø - 50 Hz - 3000 KVA 22 KV - 3.3 KV - Ddo	1 set
3	High tension bus duct	1 set
4	Low tension bus duct	1 set

b) Pump House (refer to Division 7 PUMPS)

9203 SPECIFICATION FOR EQUIPMENT AND MATERIALS

(1) General

a) Intent

These Specifications cover the general requirements for design, manufacture, test and supply and erection of the equipment and materials for the Bang Pakong Diversion Dam Project. The Contractor shall submit shop drawings prepared based on these Specifications. In case of alternative plan or deviation from these specifications, the Contractor shall get the Employer's approval with documents of under these specifications.

b) Common Item For These Specifications

These specifications are composed of 22KV outside equipments and inside equipment. Common items are as follow.

b) - 1 Structure For Out Door Cubicle

The high voltage switch gear shall be fabricated from flat rolled steel not less than 3.2mm thick panel,reinforced where necessary, in such a manner that the completed structure shall be rigid and free from twist and weave during handling and after installation.

The panel enclosure type shall be "JEM 1153, G form" or equivalent. The complete switch gear including circuit breakers, bus bars and instrument transformers shall be capable

of withstanding, without damage the electromagnetic and thermal stresses resulting from the maximum asymmetrical value of short circuit current corresponding to the fault level specified in the Specifications. Casing shall be water proof type.

b) - 2 Structure of in Door Low Voltage Panel

The low voltage switch gear shall be fabricated from a flat rolled steel panel, reinforced where necessary, in such a manner that the complete structure shall be rigid and free from twist and weave during handling and after installation.

The panel shall be fabricated of not less than 3.2mm thick steel. The complete switch gear including circuit breakers, bus bars and electro-magnetic and thermal stresses resulting from the maximum symmetrical value of short circuit current corresponding to the fault level specified in the Specifications.

b) - 3 Instrument Transformer

The voltage of current transformer shall be epoxy resin moulded for 22KV and low voltage switch gear. Moulding shall be manufactured high quality technic in vacuum tank without air babble. Impregnating mould by glass cloth or other is not acceptable.

b) - 4 Instruments and Relays

All equipment, materials and fabrication shall conform to the latest applicable IEC 51, IEC 473, IEC 521, JIS C1102, JIS C1103 or equivalent.

Voltmeters and ammeters shall be not less than 110 mm square, 240 degree from zero to full scale, ± 1.5% of full scale accuracy, panel mounted type and shall be provided with external zero adjustment. But above meter frame are not limited.

A ground fault relay shall be furnished for incoming or another service. The relays shall have adjustable trip settings.

Induction dirt type or digital type relays shall be panel mounted and induction disc type relays are drawout type.

b) - 5 Power Bus Bar and Earth Bus Bar

Power buses shall be copper having suitable current rating, and shall be supported by non-hygroscopic insulators designed to withstand forces due to the momentary short circuit current of the system. They shall be color coded by plastic sticker.

Earth bus shall be made of copper and size shall be more than 6 mm × 50 mm.

All bus bar shall be made of copper conforming to JIS H3140, "Copper Bus Bar", class C1100 or equivalent.

Color of bus bars is as follows.

For 3 phase	No. 1 phase	Red
	No. 2 phase	White
	No. 3 phase	Blue
	Zero or neutral	Black
For 1 phase 3 wire	No. 1 phase	Red
	No. 2 phase	white
	Neutral	Black
For 1 phase 2 wire	No. 1 phase	Red
	No. 2 phase	white

Disposition of bus bars is as follows, but this is no limited.

In case of horizontal, from left side No. 1,No. 2,No. 3 phase
In case of vertical, from above side No. 1,No. 2,No. 3 phase
In case of distance, from near side No. 1,No. 2,No. 3 phase

For disc circuit.

In case of horizontal, from left side N,P,
In case of vertical, from above side P,N,
In case of distance, from near side P,N,

b) - 6 Phase Selector Switches

Phase selector switches shall be heavy-duty, rotary type.

b) - 7 Test Terminals

Test terminals shall be furnished secondary circuit of the potential transformer and the current transformer. Matching test plugs shall be furnished.

b) - 8 Small Wiring

All small wirings shall be made with 600 V PVC insulated wire of 2 mm square and larger having enough flexibility for operation for long duration.

Color of PVC insulant shall be as follows :

Earthing circuit	:	Green
AC small wirings other than earthing circuit	:	Yellow
DC small wiring other than earthing circuit	:	Blue

They shall be provided with solderless terminal lug to connect to terminal boards.

b) - 9 Terminal Boards

The terminal boards shall be rated at 600 V providing with transparent cover terminal log of small wirings can be fixed tightly with screws to prevent loose connection for operation for long duration.

b) - 10 Painting

The panel and switch gear shall be painted with double coats of sealing primer for surface plate. Before prime painting, surface of the panel shall be treated by sand blast or dipping with acid solution.

Painting color shall be approved by the Employer.

b) - 11 Name Plates

Name plates shall be laminated plastic with black letters on a white background.

b) - 12 Installation

The panel shall be mounted on steel channels. The steel channels shall be embedded in the concrete floor. The channels shall have the full length for the panel and shall be installed level in all directions

b) - 13 Factory Tests

Type test and routine test in accordance with IEC 439 and JEM 1265 shall be conducted.

(2) Technical Specification

a) Power Transformer

a) - 1 Scope of Work

The Contractor shall furnish and install all power transformers as hereinafter specified and as shown on the drawings.

a) - 2 Standard

All equipment, materials and fabrication shall conform to the applicable standard described in section 1003 of the Specifications or equivalent.

All thread parts requiring connections to any external equipment shall have ISO screw threads.

a) - 3 Type and Rating

a) - 3 - a Type

The transformer shall be the out-door, oil immersed, diaphragm type conservator complete with oil and specified accessories.

a) - 3 - b Rating and Electrical Characteristics

	No. 1 Substation	No. 2 Substation
1. Number of phases	3	3
2. Frequency, hertz	50	50
3. Type of cooling	ON AN	ON AN
4. Continuous rating	1,500 KVA	3,000 KV
5. Rated voltage		
High voltage	22 KV	22 KV
Low voltage	380/220 V	3.3 KV
6. Taps		
Manually operated Off-load tap changer, Full KVA capacity, 4 taps	± 2.5% and ± 5.0% of Rated high voltage	same as left
7. Winding connection		
High Voltage	Delta	Delta
Low Voltage	Wye, Neutral Grounded	Delta
8. Vector group	DY 1	Ddo
9. Dielectric strength		
a) Power frequency test Voltage - - - 1 minute	50 KV for 22 KV WIDG 4 KV for 380/280 V include neutral	same as left 16 KV for 3.3 KV WIDG
b) Basic impulse level, not applicable below 400 V	150 KV for 22 KV WIDG	150 KV for 22 KV WIDG 45 KV for 3.3 KV WIDG
10. Temperature rise winding resistance method oil thermometer surface of core and other metallic parts adjacent to insulating materials, thermometer	55 °C 55 °C Temperature adjacent	55 °C 55 °C not to damage insulating materials
11. Impedance at rated voltage connection	6%	6%
12. Exciting current, at rated voltage and frequency based on continuous KVA.	less than 1.5%	same as left
13. Variation in voltage and frequency	Transformer shall operated successfully without any practical difficulty, if either one of the primary voltage or frequency varies as follows	

$$\frac{V_1 - V_{1n}}{V_{1n}} \leqq +0.1$$

$$\left|\frac{f_n - f}{f_n}\right| \leqq 0.05$$

$$\frac{V_1 - V_{1n}}{V_{1n}} + \frac{f_n - f}{f_n} \leqq +0.1$$

V1 : Primary voltage during operation
V1n : Voltage of used tap on the primary side
f : Frequency during operation
fn : Rated frequency

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a) - 3 - c Accessories

Each power transformer shall be equipped with the following accessories:

a. Dial-type liquid thermometer with alarm contacts
b. Oil-level gauge, with low-level alarm contacts
c. Bursting or pressure relief device with alarm contacts for failures of winding of transformer.
d. Oil inlet, outlet valves
e. Oil Sampling valves
f. Two ground terminal for earthing copper wire 60 ~ 100 mm^2.

a) - 3 - d Alarming

The Contractor shall provide alarm and trip systems for the folowing items.

a. Top oil temperature ..... High
b. Oil Level ..... Low
c. Bursting or pressure relief device ..... Tripped

a) - 3 - e Transformer Construction

a. Tank

The transformer shall be housed in a steel tank with all permanent joints welded, backed up by a sturdy steel structure as required to obtain the desired rigidity and strength. The material shall be of a high-grade steel structure as required to obtain the desired rigidity and strength. The materials shall be of high-grade steel plate having good welding qualities. All seams, flanges, lifting and jacking lugs, braces, and other parts attached to the tank shall be welded. No rivets shall be used. The cover may be welded or bolted.

All openings, such as the joint between the case cover (if cover is bolted), bushing insulator mountings, etc,. shall have welded-on flanges to provide gasket surfaces and allow for bolt holes. No bolts shall pass to the inside of the case and cover. Flanges shall have gaskets which will remain oil-tight and will not deteriorate under service conditions.

The tank shall be designed and constructed to withstand an internal pressure of -1.0 kg. per square centimeter (gauge pressure) measure at the top of the tank.

1. Eye bolts and/or lugs for fittings the essential parts and also for lifting the assembled oil filled transformer.
2. Guides for the cores and windings on the inside of the tank.
3. Jacking pads for lifting the assembled oil filled transformer.
4. Pulling eyes for moving the transformer horizontally.
5. Base designated with heavy steel skids to permit moving the transformer on steel rollers.

Flat base plates are not acceptable.

b. Cores

Cores for the transformer shall be constructed of the highest quality, non-aging high permeability grain oriented silicon steel. The steel shall be in thin laminations, annealed after cuttings and rolled to insure smooth surface at the edges.

The laminations must be free from impurities and must receive stress relief treatment after punching. The laminations shall be accurately flattened, especially at the edges and insulated by suitable procedures with long-life heat resistant insulating coat.

Both sides of each sheet shall be insulated with a durable, hear resistant insulation. The cores shall be rigidly clamped to ensure adequate mechanical strength to support the windings and prevent shifting of the laminations during shipment of transportation. The core shall be solidly grounded to the tank.

c. Windings

Windings for the transformer shall be of the best modern design of conductor having constant cross-section and uniform insulation or graded insulation as required. The coils shall be wound and supported in manner to provide sufficient oil ducts which will be maintained without contraction.

The windings shall be designed to permit practically no change or very small change in transformer impedance regardless of tap position.

d. Cooling Equipment

The transformer shall be designed with a sufficient number of radiators or cooling units to operate as natural air-cooled units.

Radiators shall be connected to the transformer tank by machined steel flanges with the flanges welded to the radiator and to the tank, and the flanges shall be provided with gaskets. Radiator valves shall be installed on each radiator connection, so that any individual radiator may be removed without taking the transformer out of service. An oil tight bank flange shall be provided for each connection, for use when radiators are detached. Each radiator shall have a lifting eye, an oil drain, and a vent.

Cooling units for example corrugated sheet steel tank shall be rigid and tight and effectively cooling same as radiators.

e. Off Load Tap-Changers

Off load tap-changing equipment shall be furnished. The tap changers shall be designed so that they can be operated conveniently and include an operating handle, indicating pointer and dial means for locking the tap changer in any desired position. The locking device shall be arranged to prevent locking the tap changer in the off position.

f. Bushings

The bushings shall conform to the applied standard. All porcelain parts shall be one piece. Porcelain parts constructed of assembled segments will not be acceptable. Threaded studs shall be furnished on all bushings.

Expansion-type terminal connectors shall be furnished and equipped with an alignment guide. Terminal connectors for aluminum conductor shall be bronze plated with hot-flowed electro-tin or cadmium. The size of conductor and method of take-off will be furnished when shop drawings are submitted by the Contractor for Employer's approval.

g. Insulating Oil

Insulating oil shall be pure mineral oil prepared and refined especially for use in power transformers. It shall be free from moisture, acid alkali, and sulfur compounds and shall not form a deposit at normal operating temperature. The oil shall have the following properties as determined by tests listed in ASTM D117 - "Standard Methods of Testing Electrical Insulating Oil".

a) Dielectric strength, not less than 30,000 volts between one-disc spaced 1/10 - inch apart.

b) Power factor, measure at 100°C, with 60 herts a.c., not more than 0.30%.

c) Viscosity, not over 57 seconds Saybolt Universal at 40°C.

d) Pour point, not higher than minus 27.5°C.

e) Flash point, not less than 130°C (open cup).

f) Burning point, not less than 145°C (open cup).

g) Color, very pale amber to water white, clear, ASTM maximum No. 3.

The Contractor may use oil of other characteristics than those stated : above if of a quality satisfactory to the Employer.

The Contractor shall inform the commercial name and specifications of the oil to be furnished.

h. Oil Preservation

The transformer shall be equipped with an oil preservation system of the conservator type. Expansion tanks shall be preferably mounted on brackets welded to the ends of the transformer. If the expansion tanks are separately mounted; the required steel supporting structure shall be furnished by the Contractor.

The conservator tank may be either the type which completely excludes air from contract with the oil by means of a diaphragm or by means of a separate tank which will act as a gas-oil-seal tank.

This thermometer shall be of the dial type mounted approximately 1,500 mm above ground level. The dial shall have an indicating pointer with manual reset feature, and a set of ungrounded, normally -open contacts for operating an annunciator. The temperature element shall be located in the path of the hottest oil. A well shall be provided so that the thermometer bulb can be removed without lowering the oil in the transformer.

j. Bursting or Pressure Relief Device

These relief devices with alarm contacts for failure of winding of transformer shall be worked exactly so that failure of transformer.

h. Anchor Bolts

Anchor Bolts and clamps for securing the transformer to its foundation to prevent moving shall be furnished.

l. Painting

All surfaces shall be thoroughly cleaned before paintings. The color of the finish paint will be chosen by the Employer. The method of applying the outside coats of paint shall be in accordance with the manufacturer's established practice. At least five (5) liters of finish paint shall be shipped with transformer for use in touching up damaged surfaces.

m. Spare parts for each 1500 KVA and 3000 KVA transformers

The following spare parts but not limited to these shall be furnished for the transformer.

m - 1 Each one for 22 KV bushing
m - 2 Each one for low tension side busing
m - 3 Each one final type thermometer
m - 4 Each 1 set gaskets
m - 5 Each 2 pieces glass plate if using for bursting tube
m - 6 If need, special tools

a) - 3 - f Factory Assembly and Tests

The transformer shall be completely assembled at the factory. The transformer shall be subject, unless otherwise noted, to the following test by and at the expense of the Contractor.

The test can be made at either 50 Hz or 60 Hz. If the tests are made at 60 Hz, the manufacturer shall submit 3 certified sets of calculations showing the equivalent 50 Hz test parameter together with the 60 Hz test data.

a. Impulse Tests

The tests shall be performed on the 22 KV and 3.3 KV winding without normal frequency excitation. The Contractor may perform any other impulse tests desired after initial reduced-wave and prior to the last chopped-wave and the final full wave tests. No impulse testing shall be performed after the tests were completed.

b. Other Tests

b - 1 Applied potential test
b - 2 Induced potential test
b - 3 No-load loss by the average-voltage voltmeter method.
(To be made after the impulse tests)
b - 4 Exciting current test
b - 5 Impedance and load loss at rated current on the rated voltage connection
b - 6 Resistance measurements on all windings on all rated voltage connections of the transformer and at each tap
b - 7 Temperature rise (heat run)
b - 8 Ratio tests on the rated voltage connections and on all tap connections
b - 9 Polarity and phase-relation tests
b - 10 Audible noise level test shall be made in accordance with the applied standard

c. Data to be Furnished

The Contractor shall furnish desired certified copies of reports of the results of tests, curves and standard application data. The costs of the tests and report shall be borne by the Contractor.

d. Field Tests

After installation, before energized, transformer shall be tested the following tests.

d - 1 Visual and dimensional check
d - 2 Measurement of insulation resister
d - 3 Measurement of voltage ratio
d - 4 Check of vector-group symbol
d - 5 Check of insulation oil

e. Function Test for Protection Devices

The instruments for above tests shall be prepared by the Contractor.

b) Incoming out door 22 KV cubicle, M1, M2 and No. 2 Substation

b) - 1 Standards

All equipment, materials and fabrication shall conform to the latest applicable IEC or JEC or equivalent.

b) - 2 24 KV, 800 A, 22 KA (2 SEC) disconnecting switch with hook stick

b) - 2 - a Type, Rating and Characteristics

The main high voltage disconnecting switch shall have the following ratings and features:

a.	Type	:	Three-pole, single-throw, vertical or horizontal break
b.	Rated Voltage	:	24 KV (Nominal Voltage 22 KV)
c.	Rated Frequency	:	50 Hz.
d.	Basic impulse insulation level (BIL)	:	for 24 KV, 150 KV

b) - 2 - b Factory Assembly and Tests

Each switch shall be completely assembled at the factory and shall be subjected.

a. Insulator tests
b. Dielectric test, including impulse withstanding tests
c. Mechanical operation tests

b) - 2 - c Spare parts for M1, M2, and No. 2 Substation

Two set hook stick

b) - 3 24 KV Circuit Breaker

b) - 3 - a Type, Rating and Characteristic

The main high voltage circuit breaker shall have the following ratings and features:

a.	Type	:	Three (3)-pole, single-throw, vacuum or gas filled, sulfur-hexafluoride, draw out type
b.	Rated voltage	:	24 KV (Nominal voltage 22 KV)
c.	Rated frequency	:	50 Hz
d.	Rated insulation level		
	Power frequency withstand voltage	:	for 22 KV class, 60 KV R.M.S.
	Basic impulse insulation level (BIL)	:	22 KV class, 150 KV
e.	Rated operating duty	:	Co-15 second-Co duty cycle
f.	Interrupting time	:	5 cycles
g.	Rating current and interrupting current	:	600 A, 25 KA

b) - 3 - b Closing Mechanism

The closing mechanism shall be 110 V DC or 380/220 V, 3 phase, 4 wire, 50 Hz motor driven spring charged operation. The closing mechanism shall also be capable of manual operation. The mechanism shall be designed so that the breaker cannot be closed under any conditions unless the spring is fully charged.

The mechanism shall be trip free in any position and shall include auxiliary contract, operation center position indicator, space and terminal blocks.

b) - 3 - c Tripping and Closing

Tripping and closing control power shall be obtained from a 110 V DC battery and charger.

b) - 3 - d Accessories

All standard accessories shall be furnished with the breaker. The accessories shall include but not be limited to the following:

a. Motor driven spring charging mechanism
b. 220 V AC thermostatically controlled space heater for the mechanism housing
c. Auxiliary switch
d. Operation counter
e. Position indicator (lamps and mechanical indicator)
f. Operating panel with wiring complete to terminal blocks
g. Control switch (local control only)
h. Manual spring charging handle
i. Nameplate including bushing type current transformer

b) - 3 - e Factory Assembly and Tests

The circuit breaker and its mechanism shall be assembled at the factory on a common frame. The porcelain bushing and other appurtenances which might be damaged during shipment shall be packed to prevent such damage happening.

The following tests shall be performed.

a. Visual and dimensional check
b. Operation test
c. Temperature rise test
d. Short-circuit breaking current test
e. Charging current-breaking test
f. Small inductive current breaking test
g. Mechanical endurance test
h. Power frequency voltage dry test
i. Measurement of resistance
j. Mechanical operation test

b) - 3 - f Field Tests

After installation, before energized, circuit breaker shall be tested for the following tests:

a. Visual and dimensional check

b. Operation test
c. Measurement of insulation resister

The cost of the tests shall be borne by the Contractor.

b) - 3 - g Spare Parts for M1, M2 and No. 2 Substation

The following spare parts but not limited to these shall be furnished for the circuit breaker.

a. Two pieces of vacuum interrupting build or two phase of SF6.
b. Two sets of dash port mechanism

b) - 4 24 KV Lightning Arrester Draw Out Type

b) - 4 - a Type, Rating and Characteristic

The lightning arrester shall have the following ratings and features:

a.	Type	:	Single-pole, station valve type
b.	Rated voltage	:	18 KV (22 KV)
c.	Rated Frequency	:	50 Hz
d.	Impulse withstand voltage	:	For 22 KV, 150 KV
e.	Power frequency withstand voltage	:	For 22 KV, 50 KV
f.	Nominal discharge current	:	10 KA

b) - 4 - b Factory Tests

The lightning arrester shall withstand the following tests:

a. Shop Test

The following factory tests shall be conducted prior to delivery.

(a) Inspection of general construction
(b) Insulation resistance measurement test current test
(c) Critical operating voltage test

b. Site Test

Insulation resistance test shall be carried out.

b) - 4 - c Spare parts for M1, M2 ad No. 2 Substation

a. 2 pieces of arrester

b) - 5 Other equipment and control voltage

Control voltage are DC 110 V. specification and quantity of equipment are described as follows.

No.	Equipment and Specification	No. of Quantity	
		No. 1 S/S	No. 2 S/S
1	Mould type instrument voltage transformer 1ø - 22000/ 110 V, 200 VA class 1 with fuse	2	2
2	Mold type instrument voltage transformer 1ø - 23 KV, 80/40/5 A class 1, 25 KA m> 10	3	-
3	〃 〃 1ø - 23 KV, 100/5 A class 1, 25 KA m> 10	-	3
4	Ammeter with phase selector switch	1	1
5	Voltmeter	1	1
6	Watt meter	1	1
7	Watt hour meter	1	1
8	Over current relay	2	2
9	Over current ground relay	1	1
10	Under voltage relay	1	1
11	Target type group indicator	1	1
12	Auxiliary relay	1 set	1 set
13	Power factor meter	1	1
14	Signal lamp (red, green)	2 pair	2 pair
15	Test terminal	1 set	1 set
16	Each transmitter		

c) Low Voltage Switch Gear and Panels

This section covers low voltage switch gear and panels for No. 1 Substation at Diversion Dam area, according to the drawing of single line diagram.

c) - 1 Standard

All equipment, materials and fabrication shall conform to the latest applicable IEC 439, JEM 1265 or equivalent.

c) - 2 Type and Rating

The low voltage switch gear or panels shall have the following type and ratings:

a.	Type	:	Indoor, self-supported, metal-enclosed type
b.	Rated voltage	:	460 V AC (Nominal voltage 380 AC), three (3)-phase four (4)wire
c.	Rated insulation voltage	:	600 V AC
d.	Rated frequency	:	50 Hz
e.	Power frequency with stand voltage	:	2,500 V R.M.S.

c) - 3 Specification and quantities of equipments for each switch gear and panels are as follows.

c) - 3 - a L1 For Gate Power Panel

No.	Equipment and Specification	Quantity
1	Mould type instrument voltage transformer 1ø - 440/ 110 V, 50 VA class 1.0 with fuse primary	2
2	Mould type instrument current transformer 1ø - 440 V, 100/5 A 10 VA class 1.0	2
	〃 , 60/5 A 10 VA 〃 1.0	10
3	600 V, MCCB 4P 100 AF	1
	〃 , 〃 4P 6 AF	5
4	600 V, MCTT 3P 30 A	11
	〃 , 〃 4P 30 A	6
5	Volt meter with phase selector switch	1
6	Ammeter 〃 〃	6
7	Fuse	1 set

c) - 3 - b L2 For Gate Motor Panel

No.	Equipment and Specification	Quantity
1	Mould type instrument voltage transformer 1ø - 440/ 110 V, 50 VA class 1.0 with fuse primary	2
2	Mould type instrument current transformer 1ø - 600 V, 300/5 A 10 VA class 1.0	12
3	600 V, MCCB 4P 225 AF	6
4	Volt meter with phase selector switch	1
5	Ammeter 〃 〃	6
6	Fuse	1 set

c) - 3 - c L3 Low Voltage Incoming Panel

No.	Equipment and Specification	Quantity
1	Air circuit breaker JEC-160 or equivalent 600 V, 2500 A, 65 KA 3ø -4P draw out type Electric magnet operation Operation , control trip voltage DC 110 V	1
2	Mould type instrument voltage transformer 1ø - 440/110 V, 200 VA Class 1.0 drawout type, with fuse	3
3	Mould type instrument current transformer 1ø - 1150 V, 2500 A/5 40 VA	3
4	Power factor control relay	1

No.	Equipment and Specification	Quantity
5	Under voltage relay	1
6	Over voltage relay	1
7	Over current relay	3
8	Over current ground relay	1
9	Volt meter with phase selector switch	1
10	Ammeter 〃 〃	1
11	Watt meter	1
12	Watt hour meter	1
13	Power factor meter	1
14	Signal lamp (red, green)	1 set
15	Fuse	1 set
16	Each transmitter	4 set

c) - 3 - d L4 Panel Supply to Gate motor and Gate Power Panel

No.	Equipment and Specification	Quantity
1	MCTT, change over switch 600 V, 2P, 60 A	1
2	〃 〃 〃 4P, 100 A	1
3	〃 〃 〃 4P, 400 A	1
4	Mould type instrument current transformer 1ø - 600 V, 400/5 A class 1.0, 100/5 A, Class 1.0	Each 2
5	Mould type zero phase current transformer	2
6	600 V, MCCB 3P 100 AF, 2P 30 AF	1
7	〃 , 〃 4P 100 AF	1
8	〃 , 〃 4P 400 AF	1
9	Over current ground relay	1
10	Ammeter with phase selector switch	2
11	Each transmitter	2 set

c) - 3 - e L5 For Substation, Control House

No.	Equipment and Specification	Quantity
1	MCTT, change overswitch 600V 4P 150A	2
2	Mould type instrument current transformer 1ø - 600 V, 150/5 A class 1.0 100/5A	8
3	Mould type zero phase current transformer	Each 4
4	600 V, MCCB 4P 150 AF	Each 2
5	Overcurrent ground relay	4
6	Ammeter with selector switch	4
7	Each transmitter	1 set

c) - 3 - f L6 For Control Bldg, Training Center, Dormitory

No.	Equipment and Specification	Quantity
1	Mould type instrument current transformer 1ø - 600 V, 150/5 A 20 VA, class 1.0	20
2	Mould type zero phase current transformer	10
3	600 V, MCCB 4P 225 AF	10
4	Overcurrent ground relay	10
5	Ammeter with selector switch	10

c) - 3 - g L7 For Road Lighting, Compound Lighting Equipment and Specification

No.	Equipment and Specification	Quantity
1	Mould type zero phase current transformer	2
2	Mould type instrument current transformer 1ø - 600 V, 60/5 A 20 VA, class 1.0 100/5A class 1.0	Each 2
3	600 V, MCCB 3P 100 AF	1
	〃 , 〃 4P 60 AF	1
4	〃 , 〃 2P 100 AF	3
	〃 , 〃 2P 30 AF	3
5	Overcurrent ground relay	2
6	Ammeter with selector switch	2

c) - 3 - h L8 Condenser Panel

No.	Equipment and Specification	Quantity
1	Mould type instrument current transformer 1ø - 600 V, 600/5 A 15 VA, class 1.0	2
2	600 V, MCCB 3P 800 AF	1
3	〃 , 〃 3P 225 AF	6
4	〃 , 〃 3P 100 AF	1
5	〃 MCTT change over switch 60 A	1
6	〃 〃 3P 100 A	6
7	Discharge coil for condenser	6
8	Series reactor for 〃	6
9	Condenser, 600 V, 3ø -60 KVA	6 set
10	Ammeter with selector switch	1
11	Cos	1
12	Signal map (red, green)	1 set

c) - 3 - i L9 For Battery

No.	Equipment and Specification	Quantity
1	600 V, MCCB 3P 60 AF	1
2	Full wave rectifier with AVR	1 set
3	Pocket type alkali battery 1.2 V 92 cell, 50 AH/5 HR	1 set
4	DC Am meter	1
5	DC Volt meter	1
6	600 V MCCB 3P 50 AF	2
7	600 V MCCB 2P 50 AF	2

d) Emergency Generator in No. 1 Substation

d) - 1 General Information

a. This specification covers the design, manufacturing and supply of the Denyo power standby system.

b. Standard to be Applied

All items, unless otherwise specified, are in accordance with JIS, JEC and JEM.

JIS : Japanese Industrial standards

JEC : Standard of The Japanese Electrotechnical Committee

JEM : Standard of The Japan Electrical Manufactures' Association

c. Ambient Conditions

Ambient Temperature	:	5 °C or higher, 35 °C or lower
Altitude	:	Up to 500m above sea level
Relative Humidity	:	80% or lower
Place of Installation		
Engine generator	:	Indoor or Outdoor
Automatic control panel	:	Indoor

d. Operation System

Automatic
Manual

e. Scope of Supply

1) Engine Generator

AC generator
Diesel Engine
Radiator
Muffler
Air cleaner
Fuel oil tank
3-way valves for fuel oil supply
Battery
Generator control panel
Engine operating panel

2) Automatic Control Panel

Sequence controller
3-pole load transfer switch
Battery charger

3) Accessories and Spare parts

f. Painting

Unless otherwise specified, the equipment is finish painted in the following colors.

Engine Generator	:	Munsell No. 6 YR 6/14
Automatic Control Panel	:	Munsell No. 5 Y 7/1

g. Name Plate

The name plate of all the equipments are described in English letters.

h. Units of Measurement, Weight and Capacity

Concerning all of the equipment supplied by the Contractor, metric units are used.

d) - 2 Engine Generator

a. AC Generator

Generator model	:	Denyo DB-3520K
Type	:	Rotating-field, protection type synchronous generator
Excitation	:	Brushless type (with AVR)
Continuous duty rating	:	270 KVA
Voltage	:	380V
Current	:	410A
Frequency	:	50Hz
Speed	:	1500rpm
Power factor	:	0.8 (lagging)
Phase	:	3 (4 wires)
No. of pole	:	4
Winding connection	:	Star
Insulation	:	Armature winding F class Field winding F class
Cooling system	:	Self-ventilation
Aux. power (single phase)	:	100V, 1.5KVA × 2

b. Diesel engine

Type	:	4-cycle, water cooled diesel engine, direct injection type
Rated output	:	323PS / 1500rpm
No. of cylinders	:	6
Bore × stroke	:	140mm × 165mm
Total displacement	:	15240cc
Direction of rotation	:	Clockwise (viewed from the fan side)
Governor	:	Mechanical all speed governor
Cooling system	:	Water cooling by radiator with fan
Lubrication system	:	Gear pump
Starting motor	:	24V-7.5KW

Battery for engine start	:	12V - 200Ah × 2pcs.
Fuel oil	:	Diesel fuel (JIS No.2, ASTM No.2 or equivalent)
Fuel oil tank	:	Approx. 490 liter
Fuel consumption	:	55 liter / hour
Lube oil	:	API service class CD class or higher
Lube oil capacity	:	Approx. 38 liter
Cooling water capacity	:	Approx. 64 liter

c. Generator Control Panel

The following meters and apparatus are mounted on the Generator Control Panel.

Frequency meter	1 pc.
AC Voltmeter	1 pc.
Voltmeter change-over switch	1 pc.
AC ammeter	1 pc.
Ammeter change-over switch	1 pc.
Voltage regulator	1 pc.
Circuit breaker (3-phase molded case circuit breaker)	1 pc.
Pilot lamp	1 pc.
Panel light	1 pc.
Panel light switch	1 pc.
Single-parallel change-over switch	1 pc.
Synchronizing lamp	2 pc.

d. Engine Operating Panel

The following meters, gauges and other control equipment are mounted on the Engine Operating Panel.

Tachometer (provided with integrating time meter)	1 pc.
Oil pressure gauge	1 pc.
Oil temperature gauge	1 pc.
Water temperature gauge	1 pc.
Charging ammeter	1 pc.
Battery switch	1 pc.
Starter switch	1 pc.
Preheat lamp	1 pc.
Stop button	1 pc.
Throttle handle	1 pc.
OK monitor	1 pc.
Air cleaner indicator	1 pc.

e. Performance

voltage regulation

The voltage regulation from no load to the rated load under the rated power factor shall be within ± 1.5% of the rated voltage.

Speed regulation

The speed regulation from no load to the rated load under the rated power factor shall be within 5% of the rated speed.

Limits of temperature rises

Limits of temperature rise of the generator shall be in accordance with relevant Japanese standards, based on ambient temperature not exceeding 40 ℃ 、 and shall not exceed the following :

Armature windings	85 ℃
Field windings	85 ℃
Bearing	40 ℃

Dielectric strength test

The strength of the windings of the generator and the control box shall meet the specifications of the high voltage test according to Japanese standards :

Armature windings	- Grounding	AC 1760V	(one minute)
Field windings	- Grounding	AC 1500V	(one minute)

Sound level

The average rated load sound is limited within 75 dB (A) at a distance of 7 meters.

d) - 3 Automatic Control Panel

Model	:	ACP-400D
Type	:	Floor-standing type

Rated voltage	;	AC
No. of phase	:	3 (4 wires)
Transfer switch	:	AC 600V 460V 3-pole
Control voltage	:	DC 24V

The load transfer switch is mechanically held type electromagnetic contactor in 3-pole and has the capacity of making 10 times larger than rated current and of breaking 8 times larger of it.

a. Meters

The following meters are mounted on the control panel.

AC voltmeter	1 pc.
AC ammeter	1 pc.
Frequency meter	1 pc.
DC voltmeter (battery charger output)	1 pc.

b. Indicating Lamp

The following indicating lamps are mounted on the control panel.

Control power	1 pc.
Mains failure	1 pc.
Generating	1 pc.
Generator supply (to the load)	1 pc.
Main supply (to the load)	1 pc.
starting failure alarm	1 pc.
Over speed alarm	1 pc.
Low oil pressure alarm	1 pc.
High water temperature alarm	1 pc.
Emergency stop alarm	1 pc.

c. Operating Switch

The following operating switches are mounted on the operating panel.

Control power switch (ON-OFF)	1 pc.
Operation mode selector switch (AUTO-MANU)	1 pc.
Manual start pushbutton	1 pc.
Manual stop pushbutton	1 pc.
Manual transfer pushbutton (generator supply)	1 pc.

Manual retransfer pushbutton (main supply)	1 pc.
Emergency stop pushbutton	1 pc.
Reset pushbutton	1 pc.
Alarm buzzer switch (ON-OFF)	1 pc.

d. Time Delays

Each time delays at automatic operation mode is mentioned below.

Time delays engine start (confirmation of mains failure)	2 sec.
Time delays transfer	4 sec.
Time delays retransfer	30 sec.
Time delays engine stop (engine cool down)	180 sec.
Time delays stop signal reset	30 sec.
Starting failure (over crank)	17 sec.

e. Battery Charger

This control panel is equipped with a full automatic floating battery charger.

Floating voltage	26.4V
Floating current	3.0A

d) - 4 Safety Controls

Engine protection circuit and alarm circuit actuate for the following items.

	Engine shut down	Transfer switch Gene → Mains	Alarm buzzer	Alarm lamp
STARING FAILURE	○		○	○
OVER SPEED	○	○	○	○
LOW OIL PRES.	○	○	○	○
HIGH WATER TEMP.	○	○	○	○
EMERGENCY STOP	○	○	○	○

d) - 5 Accessories and Spare Parts

Accessories

standard tool set	1 set

Anchor bolt (SUS, M20, L=200mm)	8 pcs.
Exhaust flexible pipe (with flange & gasket)	1 pc.

Spare parts

Fuse	Full set

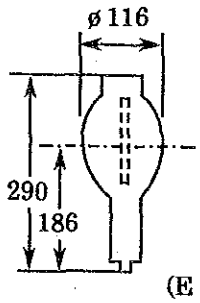
e) Gate Lighting High Tension Sodium Lamps

HIGH-TENSION SODIUM LAMP

(HIGH-COLOR RENDERING TYPE)

LAMP CHARACTERISTIC

kind		diffusion type	EXAMPLE
model		NH 400 FD × 380	1. IWASAKI ELECTRI CO LTD
Lamp	Power	400W	2. HYLUX LIGHTING G
Lamp	Voltage	380A	3. SPECIAL ORDER
Lamp	Current	1.3A	
Total	Luminous flux	23,000ℓm	
Lamp	Efficiency (ℓm/w)	57.5	
Lamp	Life (hour)	9,000	



(E 39)

BALLASTER CHARACTERISTIC

kind	For 400W
model	NHX 4TC 38A(B)50
Rated Voltage	380V
Rated Frequency	50Hz
Voltage Tap (V)	361, 380, 399
Input Starting Current	LESS. 1.7A ± 20%
Ballansing Current	1.3A ± 15%
Input Power	450W
Power Factor	90%

f) Road Lighting

Specification of stabilizer are as follows.

Type form	TEP · 38 · A (R) 40
Voltage	1 ø -380 V
Frequency	50 / 60HZ
In put current	
No load	0.85A
Starting	0.65A
Steady state	0.55A
Power	180W
Power factor	90%
Secondary voltage	200V
Secondary short current	2.5A
Lamp current	2.0A

g) Lightning Rod Refer to Drawing

Standard shall be JIS A 4201 or equivalent.

g) - 1 Hoist House

Air terminal	30ø × 450mm chromium plating copper Bar	18 pcs
Conductor	1.79 × 19	500m
Grounding Rod	16ø × 2.5M copper Bar	72pcs
Fastener	brass	130pcs
Connector	brass casting	18pcs
Test terminal box	.....	12pcs

g) - 2 Pumping Station

Air terminal	30ø × 450mm chromium plating copper Bar	3 pcs
Galvanized steel pole	48.6ø × 1500	5
Support frame	.....	5 set
Air terminal	30ø × 700mm chromium plating copper Bar	18 pcs
Conductor	1.79 × 19	300m
Grounding Rod	16ø × 2.5M copper bar	24pcs

Test terminal box 4pcs

Miscellaneous material ..... 1 set

g) - 3 Earth resistance

Earth resistance shall be less than ten Ohms for total resistance. Grounding copper bar shall be burried more than 0.5m under ground.

h) Cable Materials

Cable materials shall be provided high quality cable by the Contractor. Reference standard and specifications is as follows.

h) - 1 Reference Standard

JIS - C - 3605, JIS - C - 3606, JIS - C - 3401	For XLPE - pvc & XLPE - PE power cable CV & CE Polyvinyl Chloride Insulated & Sheathed Control Cable CVV

h) - 2 Reference Specification

		A-C Test Voltage KV	Insulation Resis. MΩ/Km
600V Single Core	Below 5.5 mm^2	1.5	2,500
	8 mm^2	1.5	2,000
	Below 30 mm^2	2.0	1,500
	Below 60 mm^2	2.5	1,500
	80 mm^2	2.5	1,000
	Below 200 mm^2	3.0	1,500
	250 mm^2	3.0	1,000
600V three Core	8 ~ 14 mm^2	1.5 ~ 2.0	2,000 ~ 1,500
	22 ~ 60 mm^2	2.0 ~ 2.5	1,500
	80 ~ 200 mm^2	2.5 ~ 3.0	1,000 ~ 1,500
600V four Core	8 ~ 50 mm^2	1.5 ~ 2.5	2,000 ~ 1,500
	60 ~ 150 mm^2	2.5 ~ 3.0	1,000 ~ 1,500
3,300V Single Core	60 ~ 150 mm^2	9.0	2,000 ~ 1,500
22,000V triplex CVT	150 mm^2	44	2,000

9204 INSTALLATION AND ADJUSTMENT

(1) Preparatory Works

a) The preparatory woks shall consist of the following items :

1. Survey and Investigation
2. Transportation and Storage

The preparatory works shall be conducted for preparation of the installation of the system equipment. All the expenses necessary for the preparatory works shall be born by the Contractor.

b) Survey and Investigation

Before commencement of the installation works, the survey and investigation shall be made at each job site to get information such as the road condition, site condition and civil works condition.

(2) Installation Works

a) General

1. Installation of Equipment

The equipment and facilities shall be installed in accordance with the drawings. The Contractor shall provide all the machinery, tools and consumable materials necessary for the installation works at his own expense.

2. Materials Furnished with System Equipment

Materials furnished with system equipment shall include signal cable, power cable, junction box, power distribution board and so on.

The materials shall be made of rustproof processing. The standard of the materials shall be equal to or more than the JIS.

The wiring materials shall have an ample voltage and current capacity.

The signal cable shall be such that it can withstand external noises such as induction interference.

The outdoor cable shall be of the waterproof type. This cable shall also be able to withstand high temperature due to direct sunlight without detriment to its original functions.

3. Grounding Works

All the telecommunication equipment shall be grounded. The materials of grounding wires from the equipment shall be provided by the Contractor.

b) Installation Method and Procedure

The installation method and procedure shall be equal to or better than the following :

1. Installation of Indoor Equipment

The floor-mounting type equipment shall be anchored to the floor or table with anchor bolts and if necessary, the swing checks such as bolts and angles shall be provided for the upper part of the equipment in order to withstand against violent vibrations.

The wall-mounting type equipment shall also be anchored firmly to the wall with anchor bolts.

2. Wiring

The interconnection between equipment shall be made with the use of cable ladder, pit, conduit and so on.

A tag indicating its destination shall be attached to each cable.

Sections of exposed cable which are liable to be damaged shall be protected with a duct or the like.

Where a wire or cable is to be installed into a station house from the outside, this wire or cable shall be given careful waterproof treatment.

For a long-distance outdoor cable, lighting protection or a preventive measure shall be provided by the Contractor.

3. Installation of Antenna

The antenna shall be mounted on an antenna tower/pole with fixtures in a manner that it can withstand a specified wind load, maximum wind velocity 45 meter per second. The fixtures shall be treated with galvanized coating.

The outdoor coaxial cable shall be strong enough to withstand direct sunlight.

A messenger wire or the like shall be used to protect the coaxial cable located between the antenna tower/pole and station house.

The coaxial connector shall be set strictly in accordance with the manufacturers installation procedure. Its connection shall be waterproofed.

The coaxial cable shall be provided with a lightning arrester for the protection of the equipment from lightning.

The Contractor shall carry out the antenna orientation after the installation.

4. Water Level Gauge (Float Type)

The water level gauge shall be installed at specified positions. The sensor with a cable of the float type water level gauge shall be accommodated with stilling well.

The terminal box with arresters shall be installed at both sites, stilling well site and Control House.

5. Gate Opening Gauge

The place where the gate opening gauge is to be mounted shall be determined so that the gate operation may be fully performed without any problems at the time of gate maintenance.

The Contractor shall submit the installation drawing to the Employer for approval.

9205 TRAINING OF EMPLOYER'S STAFF

The Contractor shall provide the training services by qualified instructor(s) who are fully skilled in operation and maintenance of control system and electrical facilities, after installation of the equipment at the site, for the Employer's employees who will subsequently be responsible for the operation and maintenance. The Contractor shall provide twenty (25) copies of operation and maintenance manual and textbooks for the training services.

The training services for the Employer's employees shall be carried out as follows.

Two (2) electrical instructors : One (1) month each.

Payment for training services will be made at the price for the pay item No. 6801. The price shall include the cost of all instructors to be dispatched by the Contractor, operation and maintenance manual, textbooks and all other materials required for successful training services.

SECTION 9300 MEASUREMENT AND PAYMENT

9301 MEASUREMENT AND PAYMENT

All the costs required for supply and installation of the control system and electrical facilities indicated in Division 9 "Control System and Electrical Facilities" of the Specifications and the drawings shall be included in the prices for the pay item Nos. 6101 to 6801 in the Bill of Quantities.

Equipment and materials to be supplied under the pay item Nos. 6201 to 6701 shall include the equipment and materials indicated in table "B", and all other equipment and materials necessary to complete the control system and electrical facilities. The quantities of works and materials in table "B" are shown only for purposes of reference and shall not be considered as limited the work to be done and the materials to be supplied by the Contractor.

Payment for the pay item Nos. 6201 to 6701 will be made after the Employer's acceptance for the site testing. The prices for the pay item Nos. 6201 to 6701 shall include the costs of design, supply, fabrication, manufacture, shop assembly and testing, delivery, painting, handling, installation and site testing of the equipment and materials to be supplied under the respective pay items, and all other costs required for complying the applicable requirements specified in the Specification.

TABLE "B" EQUIPMENT AND MATERIALS OF CONTROL SYSTEM AND ELECTRICAL FACILITIES INCLUDED IN THE PAY ITEM NOS. 6201 TO 6701

Pay Item No. 6201 Bang Sang water level gauging station

1) Water level gauge with transmitter, and staff gauge ..... 1 set each
2) Telemetry gauging equipment (141 MHZ, 10W) ..... 1 set
3) Power supply unit
   a) Battery charger (AC220V, 12V, 5A) ..... 1 set
   b) Alkaline battery (12V, 60AH) ..... 1 set
4) Isolation transformer (AC220V, 0.5KVA) ..... 1 set
5) Antenna System
   a) Antenna (8 Element, YAGI) ..... 1 set
   b) Coaxial arrester ..... 1 set
6) Antenna tower (H=30m) ..... 1 set
7) Cabling materials and accessories, including two (2) switch boxes
8) Installation of equipment (1) ~ 7)) and cabling works
9) Earth and stone works, concrete works, piling works, housing works and other works necessary to complete the observation house shown on the drawings.

Pay Item No. 6202 Nakhon Nayok water level gauging station

1) Water level gauge with transmitter, and staff gauge ..... 1 set each
2) Telemetry gauging equipment (141 MHZ, 10W) ..... 1 set
3) Power supply unit
   a) Battery charger (AC220V, 12V, 5A) ..... 1 set
   b) Alkaline battery (12V, 60AH) ..... 1 set
4) Isolation transformer (AC220V, 0.5KVA) ..... 1 set
5) Antenna System
   a) Antenna (8 Element, YAGI) ..... 1 set
   b) Coaxial arrester ..... 1 set
6) Antenna tower (H=30m) ..... 1 set
7) Cabling materials and accessories, including two (2) switch boxes
8) Installation of equipment (1) ~ 7)) and cabling works

9) Earth and stone works, concrete works, piling works, housing works and other works necessary to complete the observation house shown on the drawings.

Pay Item No. 6203 T/M and T/C systems of pumping station

1) Telemetry, Telecontrol equipment ..... 1 set
2) Un-interruptible power supply equipment, including isolation transformer ..... 1 set
3) Cabling materials and accessories
4) Installation of equipment and cabling works

Pay Item No. 6204 Overhead wiring works for T/M and T/C systems of pumping station, between control house and pumping station

1) CPEVS 0.9ø × 10P ..... about 7,000 m
2) Messenger wire, hunger and accessories
3) Overhead cabling works and erection

Pay Item No. 6204 Observation systems for diversion dam and pumping station

1) No. 1 and No. 2 observation houses
   a) Water level gauge with transmitter ..... 2 sets
   b) Salinity instrument with three (3) point sensor ..... 2 sets
   c) pH instrument ..... 2 sets
   d) Coaxial arrester ..... 2 sets
   e) CVVS 2 mm^2 × 6C ..... about 700 m
   f) CPEVS 0.9ø × 30P ..... about 700 m
   g) Staff gauge ..... 2 sets
   h) Installation of equipment and cabling works
   i) Earth and stone works, concrete works, housing works and other works necessary to complete the No. 1 and No. 2 observation houses shown on the drawings.

2) No. 3 and No. 4 observation houses
   a) Water level gauge with transmitter ..... 2 sets
   b) Coaxial arrester ..... 2 sets
   c) Installation of equipment
   d) Earth and stone works, concrete works, housing works and other works necessary to complete the No. 3 and No. 4 observation houses shown on the drawings
3) Water level gauges in pumping station
   a) Water level gauge with transmitter, and staff gauge ..... 2 sets each
   b) CPEVS 0.9ø×30P ..... about 160 m
   c) Coaxial arrester ..... 2 sets
   d) Steel Pipe, ø800 mm, L ≒ 5.5 m
   e) Installation of equipment and cabling works
   f) Earth and stone works, concrete works, housing works and other works necessary to complete two observation houses as shown on the drawings.

Pay Item No. 6206 T/M, T/C and Remote Control systems in control house

1) Data processing equipment ..... 1 set
2) Personal computer equipment ..... 1 set
3) Laser beam printer ..... 1 set
4) Printer and Color Hard Copy ..... 2 set
5) I/O terminal equipment with arrester ..... 1 set
6) I/O relay equipment ..... 1 set
7) Graphic panel equipment ..... 1 set
8) Gate operation console ..... 1 set
9) Pump operation console ..... 1 set
10) Two (2) substations operation console ..... 1 set
11) Desk type mini-graphic panel ..... 1 set
12) Telemetry supervisory control equipment, including operation panel telemetry system ..... 1 set
13) Telemetry, telecontrol equipment for the pumpingstation ..... 1 set
14) Radio telephone equipment for voice communication system ..... 1 sets

15) Portable radio equipment ..... 10 set

16) Antenna system for portable radio

a) Sleeve antenna ..... 1 set

b) Coaxial cable equipment ..... about 100 m

c) Coaxial arrester ..... 1 set

17) Power supply equipment

a) Un-interruptible power supply equipment, including DC/AC inverted and battery, 10KVA ..... 1 set

b) Distribution board ..... 1 set

c) Isolation transformer, 20KVA ..... 1 set

18) Cabling materials and miscellaneous materials

19) Installation of equipment and cabling works

Pay Item 6207 Antenna tower and cabling works to control house

1) Three (3) element YAGI antenna ..... 1 set

2) Coaxial cable equipment ..... about 100 m

3) Coaxial arrester ..... 2 sets

4) Antenna tower (H = 50m) ..... 1 set

5) Cable materials and accessories

6) Installation of equipment and cabling works

7) Earth and stone works, concrete works and other works required for the installation of antenna tower and cabling works.

Pay Item No. 6208 Cabling works for T/M, T/C, Remote Control systems, etc. of diversion dam

1) Cabling works to hoist houses through O/M bridge

a) CVVS $2mm^2 \times 30C$, LCP main ..... about 3,700 m

b) CVVS $3.5mm^2 \times 5C$, LCP position meter ..... about 3,700 m

c) CVVS $2mm^2 \times 2C$, LCP ammeter ..... about 7,200 m

d) CVVS $2mm^2 \times 7C$, LCP MCTT ..... about 3,700 m

e) CVVS $2mm^2 \times 4C$, LCP speaker ..... about 1,400 m

f) CVVS $2mm^2 \times 2C$, LCP SCE ..... about 1,400 m

2) Cabling works to No. 3 and No. 4 observation houses
   a) CPEVS 0.9ø×30P, WLG ..... about 1,600 m
   b) Coaxial cable 7C-2V, ITV ..... about 1,000 m
   c) CVVS 2mm2×24C, ITV control ..... about 1,000 m
3) Metal cable duct to O/M bridge pit (refer to Dwg. No. CEF-1033) .. 1 unit
4) Metal cable duct to hoist house (refer to Dwg. No. CEF-1034) ..... 6 sets
5) Miscellaneous materials
6) Flexible tubes required for cabling
7) Manholes and handholes required for cabling
8) Cabling works
9) Earth and stone works, concrete works and other works necessary to complete the cabling works.

Pay Item 6301 Monitoring system

1) ITV camera with pan, tilt head and lamps ..... 4 sets
2) ITV operation console ..... 2 sets
3) Coaxial cable 7C-2V, (ITV) ..... about 1,500 m
4) CVVS 2mm^2×24C, (Control) ..... about 1,500 m
5) Installation of ITV cameras and accessories ..... 4 sets
6) Installation of equipment and cabling works
7) Earth and stone works, concrete works and other works necessary to complete the monitoring system.

Pay Item 6302 Paging system

1) Paging control equipment ..... 1 set
2) Operation console for paging system ..... 1 set
3) Loudspeaker control equipment, 1 set in the control ..... 3 sets
   house, 1 set in the pumping station and 1 set in No. 5
   hoist house for speakers in No. 2 and No. 5 hoist houses.
4) CPEVS 2mm^2×4P, paging speaker ..... about 1,200 m
5) Installation of equipment and cabling works

Pay Item 6401 Electrical facilities of No. 2 substation & Pumping Station

1) 22KV incoming cubicle ..... 2 sets
2) Transformer, 3ø - 50HZ - 3,000KVA - 22KV/3.3KV ..... 1 set
3) 22KV bus - duct ..... 1 set
4) 3.3KV bus - duct ..... 1 set
5) 22KV CVT 150mm^2 ..... about 120 m
6) 3.3KV CV 1C×150mm^2(×2×3) ..... about 300 m
7) 22KV termination material ..... 2 sets
8) 3.3KV termination material ..... 6 sets
9) Lightning rod for the pumping station (This cost shall be included in the price for the pay item No. 5239)
   a) Air terminal 30ø × 450mm, chromium plating copper bar ..... 5 pcs
   b) Galvanized steel pole, 48.6ø×1,500 ..... 5 pcs
   c) Support frame ..... 5 pcs
   d) Air terminal 30ø×700mm, chromium plating copper bar ..... 20 pcs
   e) Copper conductor, 1.79×19 ..... about 300 m
   f) Grounding rod 16ø×3,000mm, copper bar ..... 24 pcs
   g) Test terminal box ..... 4 pcs
   h) Miscellaneous material ..... 1 set
10) Cables and other materials for outdoor lighting in the pumping station
11) Cable and other materials for mechanical and electrical equipment in the pumping station
12) Miscellaneous material for termination and other works
13) Installation of equipment and cabling works
14) Earth and stone works, concrete works and other works necessary to complete the electric facilities of the No. 2 substation and pumping station, not including piling works and foundation concreteing for No. 2 substation.

Pay Item No. 6501 Electrical facilities of No. 1 substation and electric house

1) Electrical facilities of No. 1 substation
   a) 22KV incoming cubicle ..... 2 sets
   b) Transformer,3ø - 50 HZ - 1,500KVA - 22 KV/380 - 220V - 3ø - 4W 1 set
   c) 22KV bus - duct ..... 1 set
   d) 380 - 220V bus - duct ..... 1 set
   e) 22KV CVT 150mm^2 ..... about 200 m
   f) 600V 1C - 250mm^2 (×5×3) ..... about 450 m
   g) 600V 1C - 250mm^2 (×3) neutral ..... about 20 m
   h) 22KV terminal material ..... 2 sets
   i) 600V terminal material ..... 36 sets
   j) Miscellaneous materials for termination and other works
   k) Installation of equipment
2) Electrical facilities of electric house
   a) Incoming low voltage cubicle ..... 1 set
   b) Low voltage cubicle for diversion dam area ..... 1 set
   c) Motor power cubicle ..... 1 set
   d) Gate lighting and ITV cubicle ..... 1 set
   e) Control house and electric house cubicle ..... 1 set
   f) Low voltage cubicle for O/M building ..... 1 set
   g) Low voltage cubicle for road and premises lighting ..... 1 set
   h) Low voltage condenser panel ..... 1 set
   i) DC battery panel ..... 1 set
   j) 270KVA emergency generator, including operation panel ..... 1 set
   k) Switch box ..... 2 sets
   l) 600V CV 150mm^2 ×4C (×2) for c) cubicle ..... about 40 m
   m) 600V CV 150mm^2×4C for d) cubicle ..... about 30 m
   n) 600V CV 200mm^2 ×4C for j) cubicle ..... about 30 m
   o) Miscellaneous materials for termination and other works
   p) Lightning rod (This cost shall be included in the prices for the pay item Nos. 2237 and 2238.)
      i) Air terminal 30ø × 450mm, chromium platingcopper bar 5 pcs
      ii) Galvanized steel pole 48.6ø×4,000mm ..... 4 pcs
      iii) Support frame ..... 4 pcs

iv) Copper conductor, 1.79×19 ..... about 200 m
v) Grounding rod, 16ø × 3,000mm, copper bar ..... 18 pcs
vi) Test terminal box ..... 3 pcs
vii) Guy wire, galvanized steel wire, 1.8×7 ..... about 120 m
viii) Miscellaneous materials
ix) Installation work

r) Installation of Equipment

3) Cabling works for No. 1 substation and electric house
4) Earth and stone works, concrete works and other works necessary to install the electrical facilities of No. 1 substation and electric house, not including piling works and foundation concreting for No. 1 substation.

Pay Item No. 6601 Cabling works between electric house and control house

1) Switch box, to be installed in control house ..... 2 sets
2) 600V CV 60mm^2×4C, for two (2) switch boxes ..... about 180 m
3) 600V CVV 2mm^2×2C(×2) ..... about 180 m
4) 600V CVV 2mm^2×3C(×20) ..... about 1800 m
5) 600V CVV 2mm^2×4C(×10) ..... about 900 m
6) 600V CVV 2mm^2×5C(×2) ..... about 180 m
7) 600V CVV 2mm^2×8C ..... about 90 m
8) 600V CVVS 2mm^2×2C(×20) ..... about 1,800 m
9) 600V CVV 2mm^2×30C(×2) ..... about 180 m
10) Steel shaft for cabling, 1,000×1,000×4,000mmH ..... 1 set
11) Miscellaneous materials cabling works.
12) Installation of switch boxes, sheel shaft, etc.
13) Cabling works
14) Earth and stone works, concrete works and other works necessary to complete the

TABLE "B"

(9/11)

Pay Item No. 6602 Cabling works between electric house and hoist houses

1) 600V CV 100mm^2×1C (×3) ..... about 1,100 m
2) 600V CV 60mm^2×1C ..... about 400 m
3) 600V CV 150mm^2×1C (×3×2) ..... about 2,500 m
4) 600V CV 100mm^2×1C (×2) ..... about 900 m
5) 600V CV 200mm^2×1C (×3) ..... about 1,500 m
6) 600V CV 100mm^2×1C ..... about 500 m
7) 600V CV 150mm^2×1C (×3) ..... about 1,600 m
8) 600V CV 100mm^2×1C ..... about 600 m
9) 600V IV 60mm^2×1C, for earth ..... about 700 m
10) 600V IV 8mm^2×1C, for earth ..... about 500 m
11) 600V CV 8mm^2×4C, switch box ..... about 3,100 m
12) Metal cable duct on abutment
13) Metal cable duct on O/M bridge
14) Switch box, to be installed in hoist houses ..... 6 sets
15) Miscellaneous materials for termination and other works
16) Installation of cable ducts and switch boxes
17) Conduit pipes buried in piers of diversion dam
    a) Galvanized conduit pipe
        i) 113.4ø × 104ø × 3.66m ..... 20 pcs
        ii) 87.9ø×82ø×3.66m ..... 76 pcs
        iii) 75.2ø×70ø×3.66m ..... 88 pcs
    b) 90° elbow
        i) 104 ø ..... 6 pcs
        ii) 82 ø ..... 20 pcs
        iii) 70 ø ..... 23 pcs
    c) Bushing
        i) 104 ø ..... 12 pcs
        ii) 82 ø ..... 40 pcs
        iii) 70 ø ..... 46 pcs
    d) Coupling
        i) 104 ø ..... 5 pcs
        ii) 82 ø ..... 19 pcs
        iii) 70 ø ..... 22 pcs
    e) Installation of conduit pipes and fittings

18) Cabling works

19) Lighting rod with accessories for hoist houses

a) Air terminal 30ø×450mm, chromium plating copperbar ..... 18 pcs

b) Copper conductor 1.79×19 ..... about 500 m

c) Grounding rod 16ø×3,000mm, copper bar ..... 72 pcs

d) Test terminal box ..... 12 pcs

e) Miscellaneous materials

f) Installation works

20) Earth and stone works, concrete works and other works necessary to complete the cabling works.

Pay Item No. 6603 Cabling works between electric house and gate lighting facilities

1) 600V CV 8mm^2×3C ..... about 6,000 m

2) Gate light with stabilizer, 1ø - 380W high-tension sodium lamp, colour rendering type ..... 40 sets

3) Stanchion of gate light ..... 20 unit

4) Miscellaneous materials

5) Cabling works

Pay Item No. 6604 Cabling works between electric house and No. 1, No. 3, ITV unit, No. 1, No. 3 ITV unit, No. 1, No. 3, No. 4, Observation houses

1) 600V CV 60mm^2×4C ..... about 2,500 m

2) 600V IV 8mm^2×1C, for earth ..... about 600 m

3) Switch box ..... 3 sets

4) Miscellaneous materials

5) Installation of equipment and cabling works

6) Earth and stone works, concrete works and other works necessary to complete the cabling works.

Pay Item No. 6605 Cabling works between electric house and No. 2, No. 4 ITV unit, No. 2 observation house

1) 600V CV 38mm^2×4C ..... about 700 m
2) 600V IV 8mm^2×1C, for earth ..... about 300 m
3) Switch box ..... 1 set
4) Miscellaneous materials
5) Installation of equipment and cabling works
6) Earth and stone works, concrete works and other works necessary to complete the cabling works

Pay Item No. 6606 Earthing works

1) Earth materials, for No. 1 and No. 2 substations
2) Earth materials, for neutral of two (2) transformers
3) Earth materials, for each earthing point
4) Miscellaneous materials
5) Earth and stone works, concrete works and other works necessary to complete the earthing works.

Pay Item No. 6701 Road lighting works

1) 600V CV 100mm^2×3C, panels A and B ..... about 3,300 m
2) 600V CV 60mm^2×3C, panels C ..... about 500 m
3) Lighting panel, for points A, B and C ..... 3 sets
4) 600V CV 38mm^2×2C ..... about 2,000 m
5) 600V CV 22mm^2×2C ..... about 2,200 m
6) 600V CV 14mm^2×2C ..... about 2,100m
7) 600V CV 8mm^2×2C ..... about 1,100 m
8) Miscellaneous materials
9) Cabling works
10) Earth and stone works, concrete works and other works necessary to complete the road lighting works.