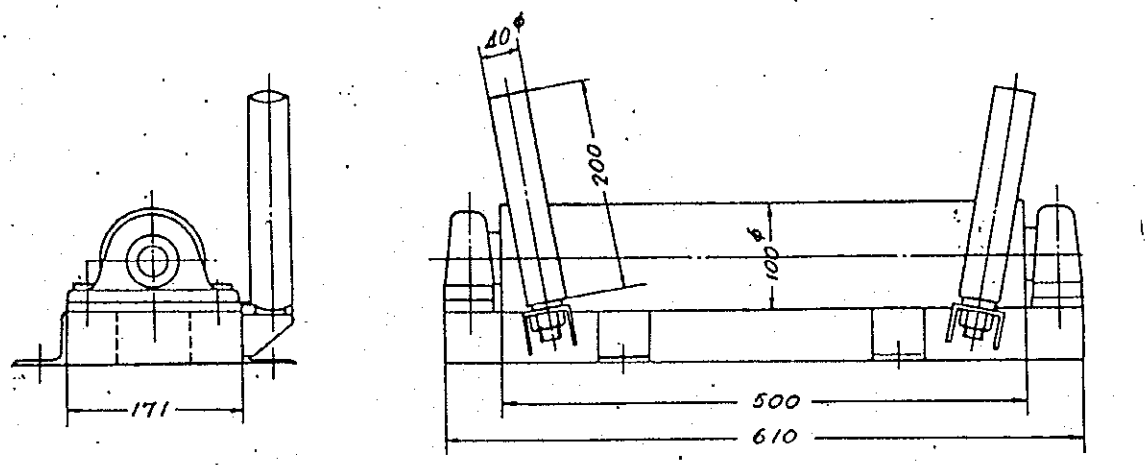
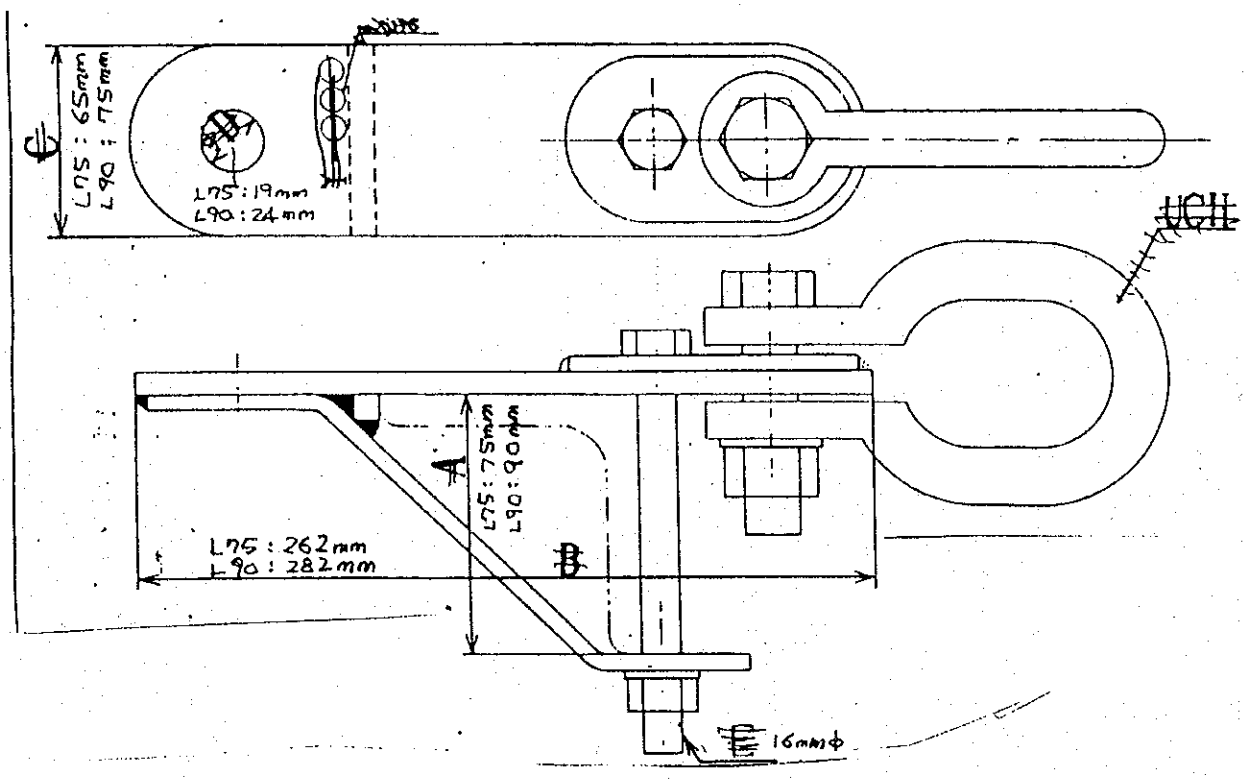
Stringing Roller

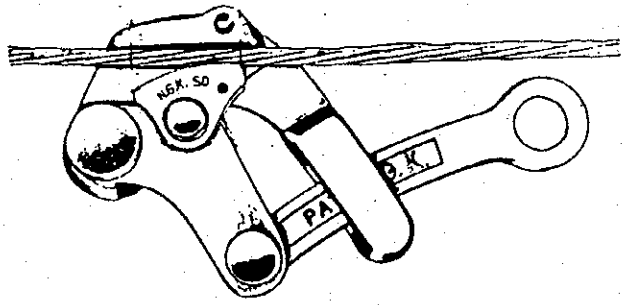


Hanger of Pulley

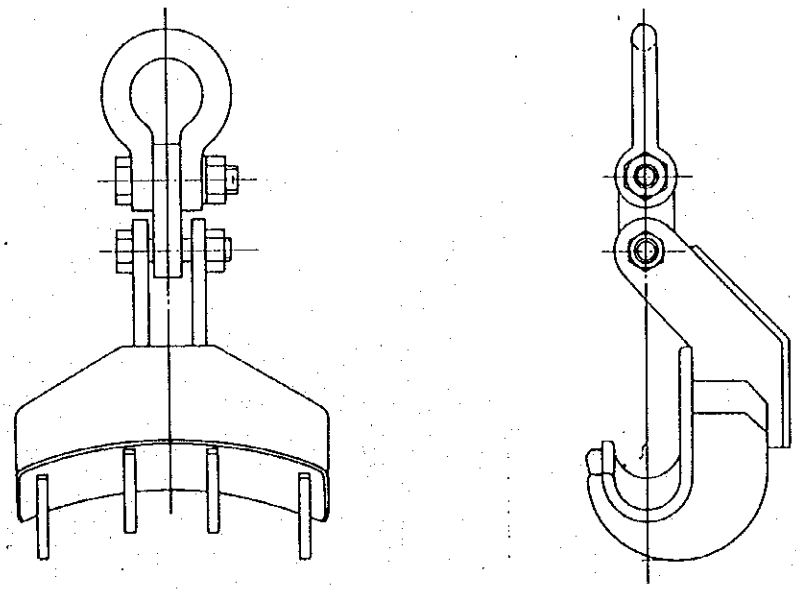


FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure TL-230-05 Stringing Roller and Hanger of Pulley

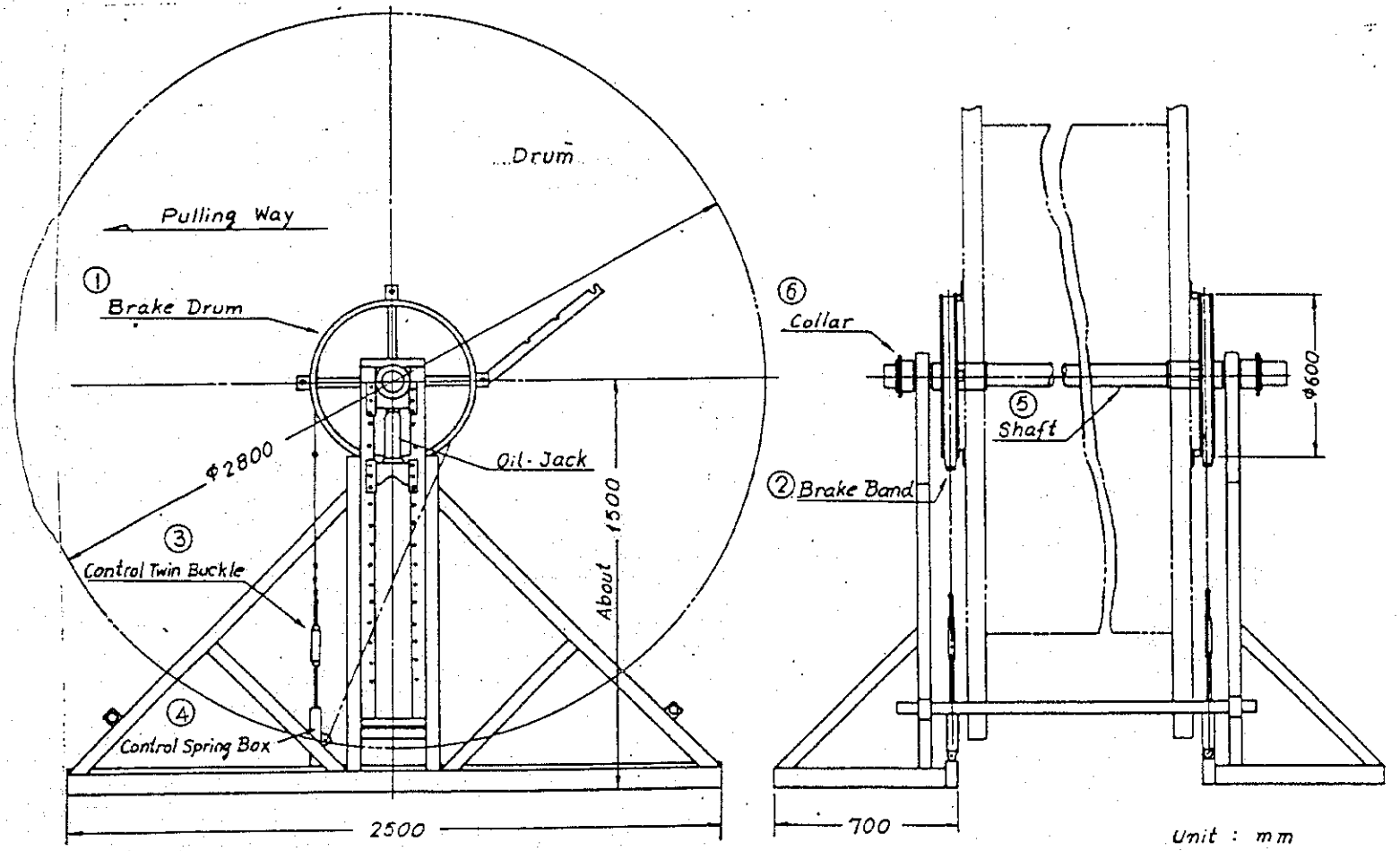
Conductor Grip



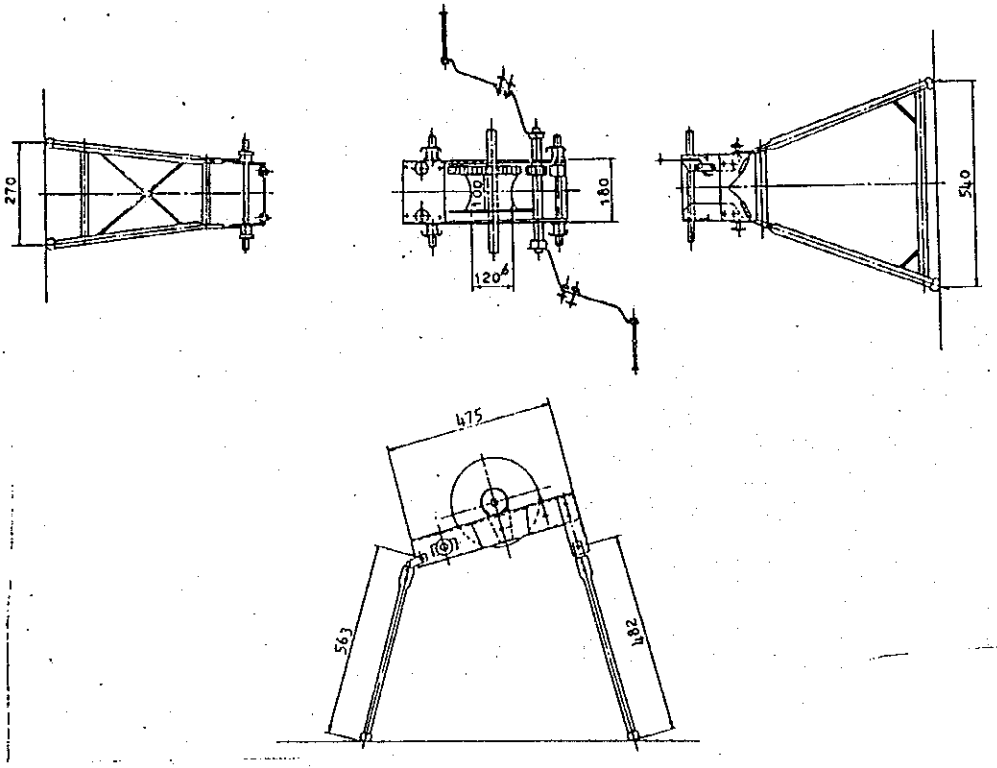
Conductor Hook

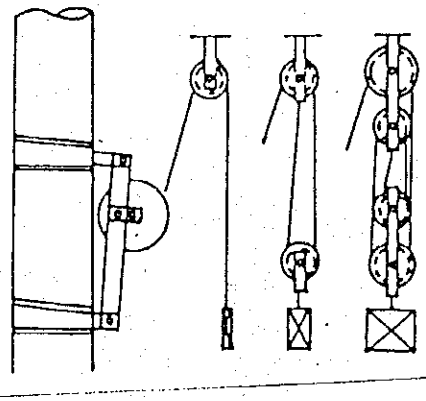


FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure TL-230-06 Conductor Grip and Conductor Hook

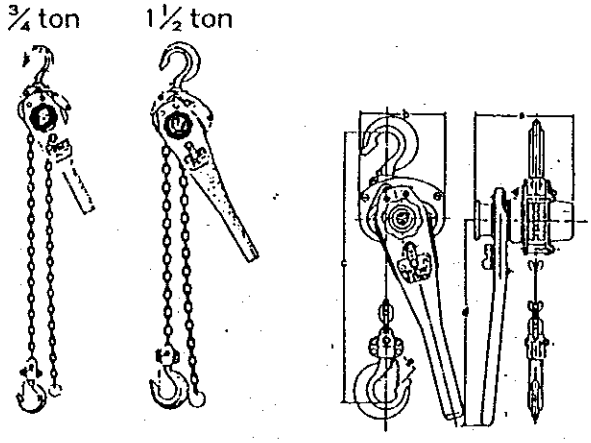


FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure TL-230-07 Drum Stand





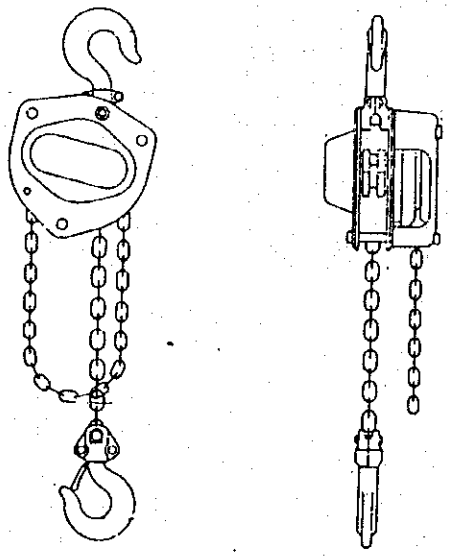
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure TL-230-08 Hand Winch



Lever Block

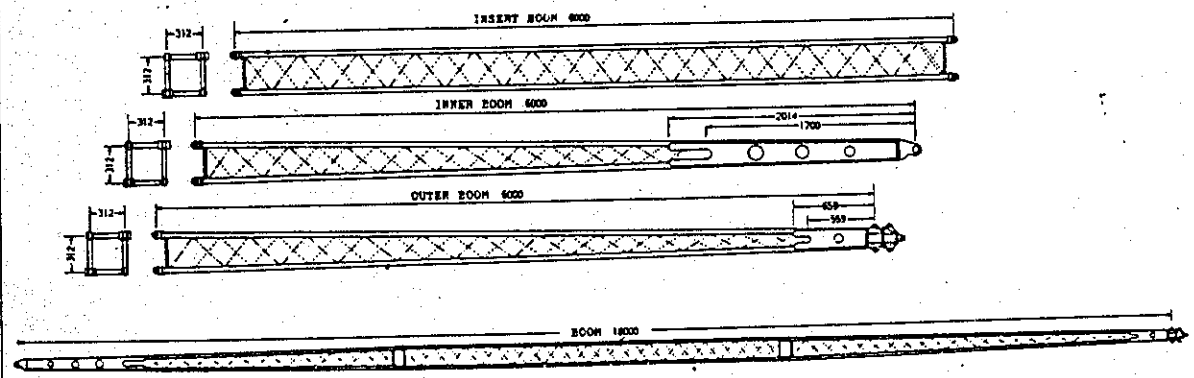
Specifications

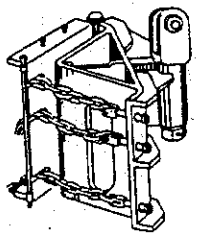
Capacity (tons)		¾	1½	3	6
Standard lift (m)		1.5	1.5	1.5	1.5
Net weight (kg)		6.8	9.5	15.5	28
Minimum distance between hooks (mm)		295	325	395	590
Pull on lever to lift full load (kg)		16	18	33	35
Type No.		08-VR	15-VR	30-VR	60-VR
Dimensions	a (mm)	147	163	192	192
	b (mm)	128	147	181	235
	c (mm)	295	325	395	590
	d (mm)	250	360	360	360
	g (mm)	25	27	37	44



Chain Hoist

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure TL-230-09 Lever Block and Chain Hoist





PEDESTAL

Apolicable Angle Size

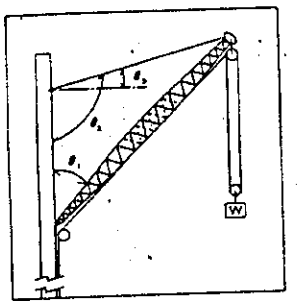
25 x 250 x 250
15 x 150 x 150
10 x 100 x 100

Unit: mm
Common Diferance: ± 10%

Max.Lifting Capacity:
Less than 2 ton

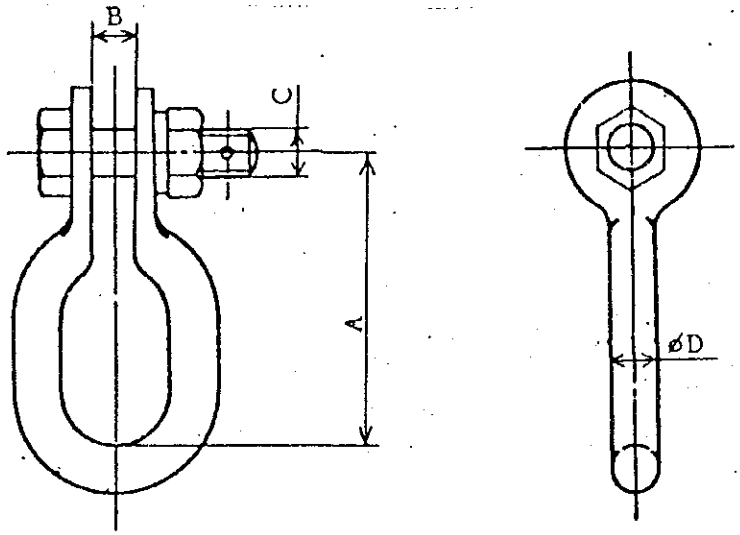
	90 0	95 5	100 10	105 15	110 20	115 25	120 30	125 35	130 40	135 45	140 50	145 55	150 60	155 65	160 70	165 75	170 90
5	--																2.41 1.55
10	--													1.89 1.84	2.39 1.54	3.29 1.01	
15											1.80 1.83	2.06 1.77	2.41 1.85	2.92 1.23	3.66 0.71		
20									1.97 1.88	2.16 1.74	2.44 1.57	2.78 1.33	3.25 1.01	3.79 0.52			
25	--				--		2.11 1.88	2.27 1.75	2.48 1.88	2.73 1.61	3.06 1.17	3.48 0.85	3.87 0.48				
30					2.27 1.81	2.39 1.79	2.53 1.84	2.73 1.48	2.97 1.38	3.27 1.04	3.63 0.73	3.86 0.31					
35	--		2.43 1.87	2.52 1.85	2.63 1.71	2.78 1.58	2.95 1.38	3.17 1.18	3.44 0.94	3.70 0.83	3.78 0.24						
40		2.67 1.83	2.76 1.88	2.86 1.85	2.99 1.48	3.15 1.31	3.34 1.19	3.58 0.88	3.78 0.58	3.72 0.18							
45	2.91 1.81	2.97 1.78	3.06 1.88	3.17 1.43	3.33 1.25	3.50 1.04	3.67 0.78	3.82 0.50	3.64 0.15								
50	3.19 1.74	3.25 1.57	3.37 1.40	3.48 1.20	3.64 0.88	3.77 0.74	3.89 0.48	3.57 0.12									
55	3.46 1.58	3.53 1.37	3.64 1.17	3.76 0.85	3.86 0.70	3.90 0.42	3.42 0.09										
60	3.71 1.38	3.79 1.15	3.86 0.92	3.98 0.88	3.98 0.40	3.34 0.07											
65	3.93 1.14	4.01 0.91	4.07 0.68	4.02 0.38	3.35 0.06												
70	4.12 0.80	4.17 0.65	4.02 0.38	3.32 0.05													
75	4.23 0.64	4.13 0.38	3.26 0.04														
80	4.13 0.35	3.32 0.04															
85	3.36 0.04																

Guy Wire Tension (ton)
Lifting Capacity (ton)

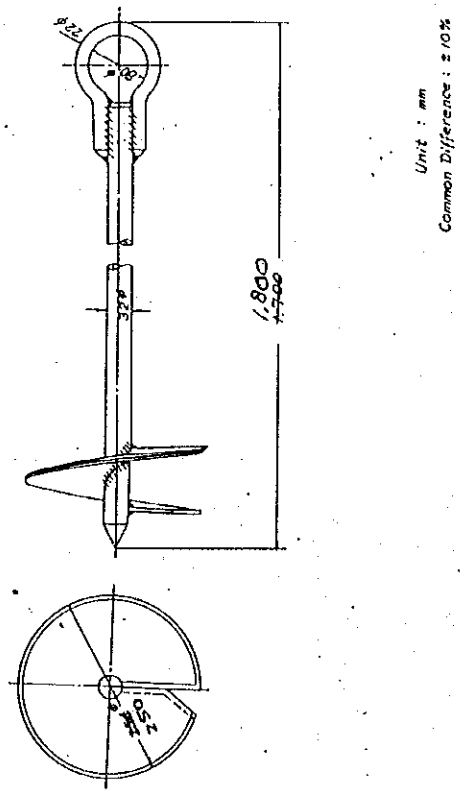


FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure TL-230-10 Derrick

U-type Clevis (Shackle)



Screw Anchor



FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure TL-230-11 U-type Clevis and Screw Anchor

CHAPTER 7

TECHNICAL SPECIFICATION FOR HYDROLOGICAL DATA ACQUISITION SYSTEM

CHAPTER 7 TECHNICAL SPECIFICATION FOR DATA ACQUISITION SYSTEM

SECTION 1 GENERAL REQUIREMENTS

1.1 Scope

These Specifications cover installation and maintenance of rainfall, water-level telemetering system, data processing system, warning system, the communication system and all the necessary parts and materials required for installation for the for hydrological data acquisition system (HDAS) of rehabilitation of da nhim power system in the socialist republic of viet nam Project (referred to as the Project). Civil and building works for HDAS are specified in other part, including mechanical work, electrical work and antenna towers/poles and foundations.

1.2 Ambient Conditions

The equipment shall be suitable for permanent operation, and all guaranteed technical particulars shall be maintained under the following ambient conditions:

(1) Telemetering system and communications system

	CS, PS-S and UHF repeater station	Gauging station and VHF repeater station
- Temperature	0°C to + 40°C	0°C + 50°C
- Relative humidity	90% or less	95% or less

(2) Data processing system

- Temperature	10°C to + 40°C
- Relative humidity	20% to 80% non-condensing

(3) Warning system

The ambient condition of the warning stations shall be the same as those of the gauging stations and VHF repeater station of the telemetering system.

All stations will not be provided with air conditioners.

1.3 Construction

A plug-in type printed circuit boards shall be employed as much as practicable for easy operation and maintenance. Inspections and adjustment shall be able to be performed from the front of each unit.

Equipment to be installed in unfair conditioned houses shall be of moisture-proof construction and packings shall be used to prevent ingress of moisture form cable inlets, etc.

Dimension of equipment bay for major equipment shall not be larger than 2350 m high, 520 mm wide and 250 mm deep. The front door shall be constructed to open outward to both sides from the Center. Connections to external devices shall be made at the top and bottom of the bay.

The equipment to be installed in gauging stations, etc. shall be of wall-hanging type to minimize the installation space and of moisture-proof type.

1.4 Power consumption

The telemetering equipment, repeater equipment and warring equipment including the built-in radio equipment shall be of low power consumption, power-saving type.

The power supply operating range and rating-guaranteed range of this system shall be as follows.

	Operating range	Rating-guaranteed range
AC 230 V	single-phase	single-phase
Supplied to each equipment	AC 220 V ± 10 %	AC 220 V ± 10 %
	50 Hz ± 2Hz	50 Hz ± 2Hz
DC 24 V	DC 21.6 V - DC 26.4 V	DC 21.6 V - DC 26.4 V
Supplied to each equipment	Ripple 3 % or less	Ripple 1 % or less
	Noise voltage 5 mV or less	Noise voltage 5 mV or less
DC 12 V	DC 10.5 V - DC 16.5 V	DC 10.8 V - DC 4.5 V
Supplied to each equipment	Ripple 3 % or less	Ripple 1 % or less
	Noise voltage 5 mV or less	Noise voltage 5 mV or less

1.5 Countermeasures Against Abnormal Voltages and Lightning Surges

The equipment and devices should be fully protected from damage resulting from abnormal voltages and lightning surges by taking appropriate countermeasures such as:

- Use of lightning protectors consisting of a lightning rod, a lightning conductor and grounding electrodes.
- Use of steel pipe enclose the outdoor cables for the coaxial and power supply cable if necessary.
- Use of coaxial arresters for antenna system.
- Use of a power source protective device consisting of a high voltage isolation transformer, lightning arresters, surge absorbers, etc., where a commercial power line is used as a power source.
- Use of surge protectors for measurement cable and signal cables.

All necessary equipment for countermeasures against abnormal voltages and lightning surges shall be supplied by the Contractor.

1.6 Coating and Color

The bay and cabinet shall be of baked coating after rust-resisting processing.

The color of the bay and cabinet shall be Munsell 2.5 B 6/3. The color of the operating console shall be of approved color and the Contractor is required to propose a color scheme, submitting color chips and paint samples.

1.7 Nameplate

The equipment name, model, serial number, date of manufacture and manufacture's name shall be inscribed on the nameplate.

1.8 Indication of Main Sections and Main Component Elements

The main functional sections of the equipment shall be indicated by nameplates, engraved or stamped. The main component elements shall have symbols or numbers that can be collated with the circuit diagram.

Where special handing precautions are required, such instructions shall be indicated in red.

SECTION 2 SYSTEM SPECIFICATION

2.1 Fundamental System Object

For the Project, fundamental system object will be described as follows:

(a) To comprehend overall rainfall in the catchment area of the Da Nhim reservoir by the effective location of the RS (Rainfall gauging stations).

(b) To comprehend inflow and outflow of the Da Nhim reservoir by additional WLs (Water level gauging station).

(c) To provide the function of real time data acquisition by improvement of the radio transmission characteristics including installation of repeater station.

(d) To provide the function of water management at CS (Central station).

(e) To comprehend water management condition at PS-S (Power Plant's Station) which will be installed data transmission circuit and water management leased telephone circuit between CS and PS-S.

(f) To provide the warning facility to secure safe living against inhabitant in the down stream.

2.2 System composition

As explained in the above section, the system shall consist of following four (4) systems:

(1) Telemetering system

This is to collect meteo-hydrological observation data of Da nhim recover, Da nhim river basin and Klong klet river basin, which is necessary for water control consists following stations:

(a) CS in dam site for supervisory control and management of the overall system.

(b) Gauging stations

- Rainfall gauging stations (6)

RS-1	1540m h	108° 31'55.6"E	11° 56'39.8"N

RS-2	1466m h	108° 30'42.3"E	11° 02'13.7"N
RS-3	1520m h	108° 34'35.1"E	11° 06'34.6"N
RS-4	1836m h	108° 38'30.3"E	11° 59'42.1"N
RS-5	2287m h	108° 39'58.3"E	11° 05'21.2"N
RS-6	1562m h	108° 39'29.7"E	11° 56'08.9"N

- Rainfall/water-level gauging stations (4)

WL-1	1080m h	108° 37'02.8"E	11° 50'59.7"N
WL-2	1100m h	108° 34'44.0"E	11° 55'07.9"N
WL-3	1100m h	108° 37'32.5"E	11° 55'21.7"N
WL-4		about 100m down stream of WL-1	

(c) Repeater station (2)

CS-R	1259m h	108° 37'54.7"E	11° 51'41.2"N
RS-4(including RS)	1836m h	108° 38'30.3"E	11° 59'42.1"N

(2) Data processing system (2)

This is aided by computers for exchange of data necessary for carrying out the data transmission, display and recording of the telemetering, warning and processed data.

PS-S	240m h	108° 41'05.5"E	11° 50'05.2"N
CS	1259m h	108° 37'54.7"E	11° 51'41.2"N

(3) Warning system

This is for dissemination of flood warning consisting of the following:

(a) CS for supervisory control.

(b) Warning stations (4)

Not yet decided exact location

(4) Communication system

This is comprises the following three system:

(a) 400 MHz multiplex radio link of 12 channels capacity which consists of data transmission circuit and key telephone system between the CS and the PS-S with two (2) intermediate repeater stations at CS-R and PS-R.

2.3 System Requirements

2.3.1 Telemetering system

(1) Total network

The telemetering system shall be composed of the stations mentioned in the Clause 2.1.
All gauging stations shall be connected with the CS by 150 MHz radio link and two (2) repeater station shall be installed at CS and RS-4.
The other requirements are mentioned bellows:

(a) Solar panels are used for the RS and the WL as power source except that of the WL at the near spillway. AC power source will be used for other stations.

(b) All the WL shall provide with a function of rainfall gauging.

(c) The radio communications among the RS and WL shall be made by VHF radio wave. The frequencies used will be 5 bands consisting of the present 146.575 MHz, newly allocated 143.350 MHz and other three frequencies.

(d) FSK-FM method shall be applied for the modulation and HDLC (High Level Data Link Control) procedure shall be applied for the data control. ID code of the existing stations shall be replaced by the new address code.

(e) Data transmission speed shall be 1200bps.

(f) Considering difficulty of access to the location of each station, all facilities provided shall be fully reliable even under the severe condition of the tropical area, in order to reduce the burden for maintenance as possible.

(g) All the facilities and materials shall be smaller and lighter as possible, low energy type, and of interchangeable unit construction for the easy maintenance in case of damage or malfunction.

(2) Functions and behaviors

The functions and behaviors of the telemetering system shall be as mentioned below:

(a) Supervisory control operation shall be performed at the telemetering supervisory and operating (TSOC) console in the CS.

(b) The repeater station shall receive the calling signals from the CS and relay them to the gauging stations, and shall receive the telemetering data from the gauging stations and relay them to the CS.

(c) The gauging operation of meteo-hydrological data shall be performed at the gauging stations. The observation data shall be sent to the CS on receipt of calling signals.

(d) The capacity of observing equipment shall be designed up to thirty (60) taking account of future extension.

(3) Data collection mode

The data collection mode shall be "Polling system" basically in which data of a gauging station shall be sent out in response to a calling signal from the CS and the data transmission by the event reporting method shall also be applied to this system in the condition that the transmitting station has received the permit of sending from the CS.

(4) Calling mode

This system shall have the following three (3) kinds of calling mode for calling gauging stations.

- Automatic calling

This calling shall be initiated automatically by a system clock, and shall be directed to all the gauging stations except stations under shut down, in the predetermined order. The calling interval shall be selectable at the following three (3) intervals:

- 15 minutes
- 30 minutes
- 1 hour

The automatic calling shall have priority over the other calling operations and voice communication.

- Manual calling

(a) Normal calling

This calling shall be started manually by key operation of TSOC in the CS and shall be directed to all or selected gauging stations which are arbitrarily selected in the predetermined order.

(b) Test calling

This calling shall be started manually from TSCE (Telemetering supervisory and control equipment) in the CS for a maintenance purpose or an emergency case.

(5) Response mode

The gauging station called from the CS shall convert the measured values into digital code and then send it to the CS.

(6) Data code check

TSCE in the CS shall perform the CRC (Cyclic redundancy check) code check each time when a data code is received:

If any error code has been detected in the data code from a gauging station, or if there is no response from a gauging station, or if there is no response from a gauging station, the gauging station shall be automatically re-called once more after 10 + 1 (-0) seconds. If there is an error code or a called gauging station failed to respond again, a visual and audible alarm shall be actuated and the system shall shift to the next operation.

(7) Repeating system

The repeating system of 150 MHz radio link shall be of the simplex radio link and simplex radio link repeating (called "V-V repeating" hereinafter). The repeater station shall be actuated by receiving a starting signal from the CS and closed again on completion of a series of the telemetering operation by receiving a stopping signal.

The repeating system shall be provided with two sets of transmitter and receiver.

- The transmitters shall employ a No. 1 unit/No. 2 unit changeover system.

- The receivers shall employ a No. 1 unit/No. 2 unit parallel operation system.

When the output of an operating transmitter has dropped to 1/2 or less, failure display shall be actuated and operation shall be automatically switched to the other transmitter. However, switching shall not be performed if the other transmitter is already faulty.

Forced switching between No. 1 transmitter and No. 2 transmitter signal from the CS or by the local test buttons.

The receiver a failure detection shall be performed by comparing and detecting the presence or absence of squelch of voltage at the two receivers. However, disconnection of the receiver which is judged to have failed shall be unnecessary. Moreover, the failure display shall be reset automatically when the failed receiver is judged to be normal.

(8) Voice communication

The voice communication between the CS and the gauging stations shall be possible in this system. However the automatic calling for data collection shall have priority over the voice communication.

(9) Telemetering transmission system

(a) General

- Communication system	:	Half duplex communication
- Radio transmission system	:	Simplex
- Data code system	:	NRZI equal length code
- Synchronous mode	:	Asynchronous mode
- Moduration	:	Frequency modulation
- Transmission speed	:	1200bps
- Transmission speed	:	less than $\pm 5 * 10^{-5}$
- Mean frequency	:	1700Hz
- Frequency shift width	:	Mean frequency ±400Hz
- Direction of frequency shift	:	Mark : -400Hz Space : +400Hz
- Accuracy of transmission frequency	:	less than ±10Hz
- Error detection system	:	16bit CRC

- Code structure : HDLC (High level data link control procedure)

(b) Data transmission format

The all data transmission format which consists of calling, response and control shall be in accordance with HDLC format. The basic format shall be described as bellows:

Head space	Synchronous bit 16bit	Flag sequence 8bit	Address 24bit	Control 8bit	Data 8*nbit	FCS 16bit	Flag sequence 8bit

(a) Calling signal transmission chart

TSCE shall send a calling and control signal to repeater station and each gauging station which is formatted T1+T2.
The calling signal transmission time shall be as follows:

- T_1	:	Head space	375 ± 25 msec
- T_2	:	Observation calling code	75 msec
	:	Abnormal activation code	75 msec
	:	Repeater control code	107 msec
	:	Lock & cancel code	107 msec

(c) Repeater station control

The repeating-start signal shall be automatically sent before calling of gauging stations and repeating-stop signal shall be sent after the end of measuring

(d) Response signal transmission time chart

Each gauging station and repeater station shall send a response signal to the CS only when it has received the calling signal allocated.

The response signal transmission time shall be as follows:

- T_1	:	Head space	375 ± 25 msec
- T_2	:	Observation response code	140 msec
	:	Repeater response code	140 msec

(e) Time interval between calling signal and response signal

The time interval between calling signal and response signal shall be 50ms ± 10ms.

(e) Response signal configuration

The data code items and number of digits shall be as follows:

Measured value	:	64 bit for 2 items
Station number	:	8 bit

The measured value shall be binary-coded-decimal (BCD) code to which a parity bit is added.

(10) Typing and display of telemetering data

The measured data for rainfall and water-level shall be printed with a printer connected to TSCE and displayed on mimic board and CRT display connected to the data processing system where are installed at CS.

2.3.2 Data processing system

The data processing system shall consist of computer-aided functional systems at the CS, for performing the following functions:

(1) Data exchange

For performing the intended functions of the data transmission, the following exchanges of signals and data between the CS and PS-S shall be considered:

(a) On line, transfer of time clock signals, generated in the data processing equipment of the CS to:

- Telemetering supervisory and operating console in the CS
- Warning supervisory and operation console in the CS
- Data processing equipment in the PS-S

(b) On-line transfer of status signal of telemeter from the telemetering supervisory and operating console in the CS to the data processing equipment in the PS-S

(c) Real time transfer of the received observation data from the telemetering equipment to data processing equipment in the PS-S.

Data transfer from PS-S to the CS shall be possible every time on completion of each measurement operation or when transfer of stored data is desired.

In the CS, the received observation data shall be stored in the memory (hard disk) of the data processing equipment, and indicated on the telemetering supervisory and operating console, displayed on CRT equipment.

(d) On-line transfer of warning operation records from the warning supervisory control equipment to the data processing equipment in PS-S.

In the CS, the warning status shall be stored in the memory (hard disk) of the data processing equipment, and be indicated on the warning supervisory and operating console, displayed on CRT equipment.

(e) The stored data shall be possible to manage following items:

- To make back up to the magnetic tape
- To search and printing out of data

(f) On-line and off-line transfer of processed telemetering data between the data processing equipment, from the CS to the PS-S.

(2) Clock system

The clock system of the entire this system with month, day hour and minute shall be controlled by a clock of the data processing equipment in the CS. The data processing equipment in the PS-S shall also be provided with a clock, which shall normally be calibrated by time clock signals from the CS and used when a time clock signal from the control signal is not received exceeding 70 seconds.

(3) Hydrological calculation

For easy understanding of the basin hydrological situations, hydrological calculations shall be conducted with the help of a micro-processor (co-processor) of the CS The calculation items shall include but not necessarily be limited to, the following:

- Hourly rainfall
- Cumulative rainfall
- Daily rainfall
- Water-level change
- Daily mean water-level
- Daily maximum water-level
- Daily minimum water-level
- Alarm of water-level (3 levels)
- Alarm of cumulative rainfall (1 level)

The starting signal to the main CPU for data analysis shall be sent out automatically.

(4) CRT display and Mimic board

The tentative items of display on a CRT color screen and Mimic board shall include, but not necessarily be limited to, the following items:

(a) CRT display

CS

a) Menu

b) Formatted real-time data table

c) Time table of accumulated point/basin rainfalls including forecasted ones

d) Time table of water-level

e) Prototype basin map with real-time data

f) Warning water-level setting

g) Hyetograph at rainfall gauging station

h) Hyetograph of basin rainfall

i) Observed/forecasted hyetograph and hydrograph at water-level gauging station

j) Observed water-level/discharge hydrographs at several stations

k) Directory display of data stored for transferring

- From magnetic disk to floppy disk
- From floppy disk to magnetic disk
- From magnetic disk (HDD) to magnetic tape
- From magnetic tape to magnetic disk (HDD)

l) Logging format display

- Daily report
- Monthly report
- Annual report
- Applied constant list
- Flood analysis report
- Warning report

m) Used time display (multiplex radio, carrier terminal, diesel engine generator)

n) Flood warning operation record display

o) Equipment status from gauging stations, warning stations and UHF repeater stations.

The data for 72 hours (3 days) from the reference time shall be graphically indicated on the CRT screen.

PS-S

a) Prototype basin map with real-time meteo-hydrological data

b) Observed/forecasted hyetograph and hydrograph at water-level gauging stations

The following display items will be possible to monitor on request.

c) Monitoring collected data from each gauging station (relaying data)

d) Warning operation records

e) Equipment status of gauging stations, warning stations and UHF repeater stations

(b) Mimic board

CS

a) Prototype basin map with real-time meteo-hydrological data

b) Warning operation status

PS-S

Same as the above

(5) Reports

Reports on operation of the flood forecasting and warning system shall be prepared by editing data in the memory of the data processing equipment of the CS.

The items of report shall include, but not necessarily be limited to, the following:

- Daily report, rainfall, water-level, discharge
- Monthly report, rainfall, water-level, discharge
- Annual report
- Applied constant list
- Warning report

The format of report shall be able to be displayed on the CRT screen for editing.

2.3.3 Warning system

(1) System function

The dissemination of flood information shall be conducted by the following system:

(a) Broadcasting by warning stations located in the populated area, which shall be controlled by the CS through a 150 MHz radio link.

(2) 150 MHz radio links

The CS and the warning stations shall be connected with 150 MHz band radio links for exchange of signals and voice. No repeater station shall be considered for the system. The total network of the 150 MHz band warning radio links is shown in the Drawing.

(3) Calling system

The calling of each warning station shall be performed by manual calling operation from the warning operating console in the CS. The calling shall be on the one by one basis, one station at a time.

(4) Warning operation

The flood information shall be sent out from the warning stations by broadcasting voice from the CS and artificial sound generated in the warning station by loudspeakers.

(5) Confirmation method

Confirmation of the warning operation of the warning station shall be performed by sending broadcast voice and confirmation signal back to the CS.

(6) Warning transmission system

(a) General

- Communication system : Half duplex communication
- Radio transmission system : Simplex
- Data code system : NRZI equal length code
- Synchronous mode : Asynchronous mode
- Moduration : Frequency modulation
- Transmission speed : 1200bps
- Transmission speed : less than $\pm 5 * 10^{-5}$
- Mean frequency : 1700Hz
- Frequency shift width : Mean frequency ±400Hz
- Direction of frequency shift : Mark : -400Hz
  Space : +400Hz

- Accuracy of transmission frequency : less than ±10Hz
- Error detection system : 16bit CRC
- Code structure : HDLC (High level data link control procedure)

(b) Data transmission format

The all data transmission format which consists of calling, response and control shall be in accordance with HDLC format. The basic format shall be described as bellows:

Head space	Synchronous bit 16bit	Flag sequence 8bit	Address 24bit	Control 8bit	Data 8*nbit	FCS 16bit	Flag sequence 8bit

(a) Calling signal transmission chart

WSCE shall send a calling and control signal to repeater station and each gauging station which is formatted T_1+T_2.
The calling signal transmission time shall be as follows:

- T_1 : Head space 375 ± 25 msec
- T_2 : Maximum code length 107 msec

(c) Repeater station control

The repeating-start signal shall be automatically sent before calling of gauging stations and repeating-stop signal shall be sent after the end of measuring
The calling signal transmission time chart shall be as follows:

- T_1 : Head space 375 ± 25 msec
- T_2 : Maximum code length 107 msec

(d) Response signal transmission time chart

Each gauging station and repeater station shall send a response signal to the CS only when it has received the calling signal allocated.

The response signal transmission time shall be as follows:

- T_1 : Audible tone 5000 ± 100 msec
- T_2 : Head space 375 ± 25 msec
- T_3 : Response code length 140 msec

(7) Display and recording

For the purpose of display and recording of the warning data, each warning record shall be transferred to the data processing system.

(8) Voice communication

The voice communication for a maintenance purpose between the CS and the warning stations shall be possible in this system.

2.3.4 Communication system

The communication system to be established under the Contract shall be as summarized below:

(1) 400 MHz multiplex radio link

(a) The 400 MHz multiplex radio link shall be provided for establishing an exclusive use telecommunication patches between the CS and the PS-S and shall be used for the following:

- Data exchange of control signals and data for telemetering system
- Data exchange of processed data, flood analysis output, etc.
- Key telephone communication for operation of the flood forecasting and warning system
- Spare channels for future addition of communication traffic not only for communication between CS and PS-S but also connection to the whole water management in the PC-2.

(b) The channel configuration of the 400 MHz multiplex radio link shall be as given below:

- Telemetering	1
- Data exchange	1
- Telephone	3
- Spare	7
Total	12

Total twelve (12) channels are required.

(2) Key telephone system

Two (2) sets of digital key telephone system equipment, one set each for the CS and the PS-S shall be provided for water management telephone communication.

The above 400 MHz radio link shall be utilized for key telephone system between the CS and the PS-S.

2.3.5 Frequency allocation

(1) 150 MHz radio links

The eight (8) frequencies shall be allocated as follows:

- Telemetering	3
- Warning	2
Total	5

The frequency allocation are shown on the Drawing.

(2) 400 MHz radio link

Total four (4) frequencies shall be allocated as follows:

- CS - CS-R
  F_1 : go up
  F_2 : go down

- CD - R - PS-R
  F_3 : go up
  F_4 : go down

- PS - R - PS-S

  F_1 : go up

  F_2 : go down

The frequency allocations are shown on the Drawing.

The final allocation of radio frequencies will be informed to the Contractor at an early stage of the Contract after the frequencies being finally allocated.
The Contractor shall on behalf of the Employer carry out all tasks for processing the application to the authorized Government body to obtain necessary licenses to use radio frequencies for the intended system.

SECTION 3 EQUIPMENT AND MATERIALS

3.1 Telemetering System

3.1.1 Telemetering supervisory and control equipment

This equipment is to be installed in the CS for collecting telemetering data from the gauging stations.

The telemetering supervisory and control equipment (TSCE) shall be of bay type, and shall have, but not necessarily be limited to, the following functional units:

- Modem unit
- Calling control unit
- Receiving control unit
- Time control unit with a crystal clock device
- Printing control unit
- I/O interface
- Branch input output interface
- Repeater control unit (for CS-R and RS-4 station)
- Test panel (backup control function)
- External output interface
- External starting unit
- Built-in radio equipment
- Power supply unit
- Telephone set for voice communication

The measuring data capacity shall be 14 data which consists of five gauging station and one gauging repeater station, and 2 repeater equipment status information data initially, but shall be expandable to a maximum of 120 data with minor modifications when required.

Automatic calling shall be made at the three intervals of 15 minutes, 30 minutes and 1 hour.

The modem unit shall send the calling signals and convert the frequency modulated signals into pulse codes.

The calling unit shall control the gauging stations for the telemetering.

The receiving control unit shall convert the demodulated series code into parallel code and perform the code checks.

The repeater control unit shall control the operation of repeater station by sending a starting signal prior to the data collection and a stop signal on completion of the necessary operation.

The I/O interface unit shall exchange signals among the calling control unit, receiving control unit and test panel, and shall exchange signals with external devices as operating console.

The branch input output interface shall interface be connected with bellow two telemetering equipments by cable.

The time control unit shall normally be driven by one (1) minute clock signal from the data processing equipment. The own clock shall be used when the above clock signals are not available.

The printing control unit shall control the printing operation by the teleprinter.

The test panel for the monitor and maintenance shall have, but not necessarily be limited to, the following functions:

(1) Operation

- Test calling (individual)
- Operation reset
- Alarm off
- Lamp test
- Calling frequency transmission
- Power on/off
- Squelch adjustment (when equipped with the radio equipment)
- Repeater control
- I/O level measurement (by external measuring instruments)
- Voice communication

(2) Display on test panel

- Data bit display
- Manual lock
- Receiving failure

- Transmitting
- Measuring
- Power on/off
- Monitoring by voltmeter (power supply voltage measurement use)

The external output interface shall send the measured data, the observation time and any other data to the data processing equipment.

The built-in radio equipment shall have each one transmitters and receivers.

- The operating status of the built-n radio equipment shall be displayed on TSOC.

- A failure in the working transmitter shall be able to be detected and an automatic changeover to the standby transmitter shall be performed in case of failure in the working transmitter. Failure display shall be made on TSOC.

- A failure in the receivers shall be able to be detected automatically, and shall be displayed on TSOC. The failure display automatically resets when faulty receiver is judged to be normal.

The power supply unit shall supply the necessary power to each unit. Its input voltage shall be DC 24 ± 10% which is to be fed from the DC power supply equipment.

3.1.2 Telemetering supervisory and operating console

One (1) telemetering supervisory and operating console (TSOC) for the CS shall be provided.

TSOC shall be of self-standing console type and shall be capable of handling eighteen (9) gauging stations (13 data), one gauging repeater station (1 data) and one (1) repeater station at the initial stage, and shall be expandable to maximum of 120 data with minor modifications, when required in a future stage. The control of the telemetering system will be performed in the CS.
TSOC shall be able to perform, but not necessarily be limited to, the following control operations and display:

(1) General

- Digital display of the date and time (month, day, hour and minute, 2 digits each)
- Correction of the time
- Power on/off of operating console

(2) Control operations of telemetering system

- Stating selection (maximum 60 data)
- Calling interval setting (15 min, 30 min and 1 hour)
- Calling mode selection
- Measuring mode selection (all stations or individual station)
- Manual starting
- Resetting
- Lamp test
- Alarm off

(3) Display items

- Measuring
- Transmitting
- Power failure (Burnt out fuse)
- Main power source
- Receiving failure
- Manual start lock (before 5 minutes of automatic start)
- Digital display of the received data
- Station under operation
- TRE status display
- Repeater station status display

TSOC shall be operated by the power source of DC 24 ± 10%.

The outlined drawing for TSOC shall be submitted by the Contractor when he wishes to offer it.

3.1.3 Teleprinter

One (1) teleprinter of 24 inches size shall be provided in the CS for recording the observation data from the gauging stations, which shall be controlled by the TSCE.

The teleprinter shall consist of a printer without keyboard and a printer stand with dust cover.

Specifications shall be as follows:

(1) Printer

- Remote controlled functions	:	ASCII 96 characters
- Printing system	:	Impact serial by double-mode-wheel or dot matrix 24 pin.
- Character spacing	:	10/12 characters/inch
- Line spacing	:	6 lines/inch
- Number of columns	:	137/163/line
- Paper width	:	515 mm
- Character code	;	ASCII
- Printing speed	:	48/43 character/sec (average)
- Power supply	:	AC 230V ± 10%
- Ambient conditions		
Temperature	:	0 to 40°C
Humidity	:	90% or less

3.1.4 Telemetering equipment

Ten (10) sets of telemetering equipment shall be provided for transmitting gauging data to the CS; eight (6) for rainfall, four (4) for rainfall/water-level. As stated above four rainfall/water -level gauging station shall be of dual data type. The telemetering equipment shall be of wall-mounted cabinet type and of the moisture-proof type. Two sets for WL-1 and WL-3 shall be connected with TSCE by cable.

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

- Modem unit
- Data transmitting control unit
- Receiving control unit
- Repeater control unit

- Input interface
- Buranch input output interface
- Build-in radio equipment
- Power supply unit

The modem shall have a demodulating function to receive the calling signal and modulating function to send out the observation data.

The data transmitting control unit shall convert the input from the gauging equipment (rainfall, water-level, etc.) into the response signal.

The receiving control unit shall detect the assigned calling signal and actuate the data transmitting control unit.

The input interface shall interface connection of measuring gauge (rainfall, water-level, etc.) including abnormal activation input and the data transmitting control unit.

The branch input output interface shall interface be connected with TSCE by cable.

The following operations shall be able to be performed:

- Voice communication
- Data code test transmission
- Measurement of the transmitter input level
- measurement of the receiving output level
- Measurement of the calling signal selection filter input 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. The protection circuit shall be set for a time length of 6 ± 1 seconds.

Interfacing of the telemetering equipment with a rain gauge, water-level gauge and discharge information shall be as follows:

Output format : Non-potential make contacts (closed by logic 1)

Code format

- Rain gauge : BCD code with odd parity bit per digit (max. 3 digits)
- Water-level gauge : BCD code with odd parity bit per digit (max 4 digits)
- Abnormal activation : Max 8 bit

The telemetering equipment shall be operated by the power source of DC 12V providing from the solar cell power supply equipment.

The current consumption of the telemetering equipment with the radio equipment shall satisfy the following ratings at DC 12V power supply voltage:

- Stand by : 15 mA or less
- Receiving : 150 mA or less
- Transmitting
  (10W) : 5.5A or less

3.1.5 Rainfall gauging equipment

Ten (10) sets of rainfall gauging equipment shall be provided; six (6) sets for rainfall gauging stations and four (4) sets for the rainfall/water-level gauging stations.

The rainfall gauging equipment shall be of tipping bucket type, and shall consist of a rainfall collector, a tipping bucket, an A/D converter and a rainfall automatic recorder which is able to make automatic recordings of the amount of rainfall.

The tipping bucket shall tip once per 1 mm of rainfall and in turn the A/D converter drives one (1) digit each time the rain gauge is tilted. The A/D converter which shall output accumulative rainfall data on a binary coded decimal code to the telemetering equipment shall be provided with a direct digital reading mechanism.

The rainfall automatic recorder shall be of pen recording type with roll paper.

The rainfall gauging equipment shall conform to the following requirements:

- Inlet of rainfall collector : 20 cm diameter
- Measuring value : 3 digits (000 to 999) on BCD code with odd parity check bit per digit
- Measuring unit : 1 mm/tilt

- Measuring error : Within ± 3 mm at 100 mm/hr rainfall
- Chart width : 50 mm
- Chart length : 15 m
- Chart speed : 6 mm/hr
- Recording period : 3 months
- Clock : Crystal clock driven by a dry battery
- Construction : Moisture-proof

3.1.6 Water-level gauging equipment

Four (4) sets of water-level gauging equipment shall be provided for the water-level and rainfall/water-level gauging stations.

The water-level gauging equipment shall be of float type consisting of a float, wire with balls, a counter-weight, a double pulley with ratio 1:10, an A/D converter and an automatic recorder.

The water-level automatic recorder shall be of two pen recording type, one (green) for meters recording and the other (red) for recording centimeters with roll paper.

The A/D converter shall be able to be mechanically connected with the pulley of the water-level gauge. the A/D converter shall convert measured water-level changes into digital codes, and shall send the converted digital codes to the telemetering equipment.

The A/D converter shall be housed in the automatic recorder, and shall have a direct digital reading mechanism.

Specifications shall be as follows:

- Measuring value : 4 digits (0000 to 9999)
- Output signal : BCD code with odd parity check bit per digit
- Chart speed : 6 mm/hr
- Chart width : 200 mm
- Chart length : 15 m
- Measuring range : shall be as mentioned below
- Measuring accuracy : ± 1 cm

- Reduced scale : 1/5
- Recording period : 3 months
- Clock : Crystal clock driven by a dry battery
- Diameter of float : 250 mm or more

3.1.7 Communication cable and cable protector

In case of necessary to connect by cable between gauging apparatus and telemetering equipment, the following manners shall be applied.

- The water-level gauging equipment and the telemetering equipment shall be connected by overhead self-supporting polyethylene insulated and PVC sheathed with aluminum or copper shield mesh communication cables or equivalent of 30 pairs, 0.9 mm diameter of each conductor.

- The communication cables shall be supported by messenger wires on steel poles with the minimum ground clearance of 5 m.

- The cable protector which shall consist of suitable terminal boxes with arresters shall be provided at the both ends of the communication cable for protecting the telemetering facilities from being damaged by lightning surges appearing on these cable lines.

- Terminal box with arresters shall be of self-restoring gas arresting tube type and shall have impulse discharge current of 5 kA, (1 x 40) μ sec.

3.1.8 Repeater equipment

Two (2) sets of repeater equipment shall be provided at CS-R repeater station and RS-4 gauging repeater station for the 150 MHz telemetering radio network.

The repeater equipment shall be of the squelch repeating system and have the bay type construction.

The repeater equipment shall have, but not necessarily be limited to, the following functional units:

- Repeating control unit
- Status return unit
- Remote changeover unit
- Test panel
- Power supply unit
- Built-in radio equipment (transmitter and receiver, 2 sets each)

(1) Functions

Two transmitters shall operate on an automatic changeover basis and two receivers shall operate in parallel at all time, and shall have the following functions:

- The transmitters shall be remotely changeover by a control signal from TSOC in the CS.

- The operating status of the repeater equipment, including power supply information, shall be converted into numerals and shall be transmitted to the CS.

- A failure in the working transmitter shall be detected, and an automatic changeover to the standby transmitter shall be performed in case of a failure in the working transmitter. Failure display shall be made both at the CS and the repeater station.

- A failure in the receivers shall be able to be detected automatically, and shall be displayed both at the CS and the repeater station. The failure display shall automatically reset when the failure receiver is judged to be normal.

- Manual changeover of the transmitters shall be able to be performed locally at the repeater station.

- Simplex, point-to-point voice communication shall be available for maintenance and a telephone set for maintenance shall be provided.

- At the RS-4, repeater equipment and telemetering equipment shall be connected by the cable without any interfering of observation.

(2) Status return

The items of the repeater station status as stipulated hereunder shall be transmitted to the CS:

- Transmitter No. 1 working
- Transmitter No. 2 working
- No transmitter failure
- Transmitter No. 1 failure
- Transmitter No. 2 failure
- No receiver failure
- Receiver No. 1 failure
- Receiver No. 2 failure
- Station number
- Power supply information

(3) Test panel

The repeater equipment shall be provided with a test panel and shall be able to perform the following operations and display for the monitor and maintenance:

- Power on/off
- Voice communication on a press-to-talk basis
- Starting
- Stopping
- Manual changeover of the transmitter No. 1 and No. 2 and Vice versa
- Lamp test
- Transmitter changeover lock
- Receiving parallel connection
- Receiver disconnecting
- Transmitting
- Display off

In addition, the working radio equipment, faulty radio equipment, etc. shall be displayed on the test panel.

The repeater equipment shall be operated by the power source of DC 12V which is to be fed from the solar cells power supply equipment.

The current consumption of the repeater equipment with the radio equipment shall satisfy the following ratings at DC 12V power supply voltage.

- Stand by : 50 mA or less
- Receiving : 1.3A or less
- Repeating (10W) : 4.7A or less

3.1.9 Radio equipment

The same type radio equipment consisting of transmitter and receiver shall be provided for the telemetering system.

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

(1) General characteristics

- Frequency range : 150 MHz band
- Modulation system : Phase modulation
- Type of emission : F2 and F3
- Frequency stability : Within $\pm 10 \times 10^{-6}$
- Radio frequency input and output impedance : 50 ohms, unbalanced
- Load S.W.R. : Less than 2.0
- Operating voltage : DC 12V

(2) Transmitter ratings

- Rated output : 10W
- Modulation system : Phase modulation
- Modulation input : 1 kHz, linear up to 70%
  Input level required for 70% modulation shall be within -4 dBm ± 3 dB
- Maximum frequency deviation : Within ± 5 kHz
- Occupied bandwidth : Within 16 kHz

- Modulation frequency response (referred to 1 kHz, 30% modulation) : 0.3 kHz, - 10.5 ± 2 dB
  2.0 kHz, + 6.0 ± 2 dB
  2.7 kHz, + 6.0 ± 2 dB
  3.0 kHz, + 8.0 ± 2 dB
- S/N ratio : 45 dB or more, at 1 kHz, 70% modulation
- Distortion : 10% or less, at 1 kHz, 705 modulation
- Spurious emission : 1 mW or less, 80 dB in-band, 60 dB or more out-of-band lower fundamental wave

(3) Receiver ratings

- Receiving system : Crystal controlled, super hetero dyne system
- Bandwidth : 12 kHz or more at 6 dB down
- Selectivity : Within 25 kHz at 70 dB down
- Demodulation frequency response (referred to 1 kHz, 30% modulation) : 0.3 kHz, - 10.5 ± 2 dB
  2.0 kHz, + 6.0 ± 2 dB
  2.7 kHz, + 8.5 ± 2 dB
  3.0 kHz, + 9.5 ± 2 dB
- Spurious response : -80 dB or less
- S/N ratio : 30 dB or more at 15 dBμV input at 1 kHz, 70% modulation
- Squelch : Opened at 10 dB or less of noise suppression voltage, and continuously variable to 20 dB noise suppression voltage
- Receiving sensitivity : 3 dBμV or less
- Blocking : with a desired signal 6 dB higher the necessary input voltage for 20 dB noise quieting, the input voltage of an undesired signal being 20 kHz detuned shall be 80 dBμV or more
- Intermodulation characteristic - Noise quieting shall be 20 dB or less when an undesired signal causing an Intermodulation is applied at 65 dBμV input voltage without any desired signal

The radio equipment shall have 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.

The transmitting power of each radio equipment is listed in the attached equipment lists.

3.1.10 Antenna

The following numbers of antenna shall be supplied for the telemetering system:

(1) Collinear antennas

- 3-Stage collinear (CS (1), CS-R (2), RS-4 (2)) 5

(2) Yagi antennas

- 5-element Yagi: (CS (1), WL (2), RS (5)) 8

The specifications of the antenna are mentioned below:

Collinear and Yagi antennas

- Frequency range	:	142 to 170 MHz
- Applicable band width	:	5 MHz
- Type and gain		
a. 3-stage collinear (with lightning arrester and cover)	:	5.65 dB or more
c. 5-element Yagi	:	11.15 dB or more
- Impedance	:	50 ohms
- Standing wave ratio	:	1.5 or less
- Polarization	:	Vertical as standard
- Insulation resistance	:	More than 500 M ohms when measured by a 500V megger at a feeding point under dry conditions
- Dielectric strength	:	AC 100V for one minute

3.1.11 Coaxial cables

The coaxial cables shall be used for the connection of the antennas and the radio equipment for the telemetering system.

(1) The coaxial cables for CS

Type AF50-4 applied for the CS, shall be of foamed polyethylene insulated, aluminum sheathed, PE jacketed type having the following physical and electrical properties.

(a) Construction

- Inner conductor : 4.1 mm bare copper wire
- Outside conductor : 12.7 mm aluminum tube
- Jacket : 15.3 mm, polyethylene, colored black

(b) Electrical properties

- Nominal cable impedance : 50 ohms
- Attenuation at 150 MHz : 38 dB/km
- Capacitance : 82 pF/m
- Velocity of propagation : 81%
- maximum operating voltage : 1.5 kV (effective value)
- Insulation resistance : 1,000 Mohm/km or more

(2) The coaxial cables for gauging stations

Type 10D-2E applied for the gauging stations, shall be of annealed copper wires braided, polyvinyl chloride sheathed type having the following physical and electrical properties:

(a) Construction

- Insulator : 9.7 mm polyethylene
- Inner conductor : 2.9 mm annealed copper
- Outer conductor : 10.7 mm braided annealed copper
- Jacket : 13.7 mm, PVC colored gray

(b) Electrical properties

- Nominal cable impedance : 50 ± 2 ohms, at 10 MHz
- Attenuation at 150 MHz : 58 dB/km or less
- Maximum operating voltage : 5 kV (effective value)
- Insulation resistance : 1,000 Mohm/km or more

The connectors shall be provided at the both ends of the coaxial cable.

3.1.12 Coaxial arresters

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

Rating shall be as follows:

- Type : Feeder type
- Impedance : 50 ohms
- Frequency range : DC to 1,000 MHz
- Insertion loss : 0.5 dB or less
- V.W.S.R. : 1.2 or less
- DC speak-over voltage : 90V

3.2 Data Processing System

3.2.1 Data processing equipment at CS

(1) Central processing unit (CPU)

CPU shall have two (2) processors. One is main CPU of 32 bit capacity for the meteorological analysis calculation and the other is coprocessor for the hydrological graphics processing and floating point computation.

CPU shall be manufactured based on the latest state of process computer technology and ensure the trouble-free operation.

The main memory shall be of sufficient capacity to perform all process tasks without mutual interface and shall be suitable to provide efficient execution of all programs supplied by the Contractor and to cater for future expansion of the system.

Error check of the main memory shall be performed automatically by error check code (ECC).

The following data check functions shall be provided for the telemetering data received from the CS.

- Binary Coded decimal (BCD) check

- Parity check (odd/even)
- High/low limit check
- Time out check

Specifications of CPU shall be as mentioned below:

- CPU 1 (main processor)	:	32 bit microprocessor
- CPU 2 (coprocessor)	:	Coprocessor for graphics processing and for floating point computation
- Speed of calculation	:	1 MIPS (MIPS: Million Instructions Per Second)
- Kind of memory	:	I.C. Memory
- Capacity of memory	:	10 M-byte or more

(2) Magnetic disk unit

The magnetic disk unit shall be furnished in the CPU cabinet. The unit shall be of fixed type. The disk unit shall be suitable to store the programs, data base for process, system data base and operating system. The storage capacity shall be determined based on the functional requirements of the Specifications.

The magnetic disk shall satisfy the following specifications:

- Storage capacity	:	200 M-byte or more
- Transfer speed	:	1.2 M-byte/sec or more
- Average access time	:	30 msec or less
- Seek time	:	20 msec or less
- Rotation time	:	8.0 msec or less
- Byte per sector	:	256 bytes or more

(3) Cassette magnetic tape unit

The cassette magnetic tape unit shall be provided with connection to CPU and shall be mounted in the CPU cabinet.

Programs and data files shall be stored in the tape to secure the data. this unit shall be utilized for backup function of the magnetic disk.

Specifications shall be as follows:

- Density : 1,600 BPI or more
- Capacity : 70 M-bytes or more
- Tape velocity : 75 inches/sec or better
- Number of tracks : 9 tracks or more

(4) Telecommunication control unit (synchronous interface)

The telecommunication control unit shall facilitate data transfer between CPU and 400 MHz multiplex radio link through the telecommunication modem. The control unit shall be able to constitute a high level data link control (HDLC).

The telecommunication control unit shall conform to CCITT V-23 and satisfy the following specifications:

- Data transmission rate : 9,600 bps
- Communication mode : Full duplex

(5) Line interface

The line interface shall have the capacity of 8 lines and shall facilitate the data traffic between CPU and TSCE, WSCE, peripheral equipment such as CDP and FDD as well as the transmission of data base of the telemetering control equipment.

(6) Color graphic display

The color display equipment shall support graphics capability and shall be adequate for indication of characters, lines and symbols of various types related to the project.

The color graphic display shall satisfy the following specifications:

- Screen size : 19 inch as or larger
- Number of display characters : At least 4,000 characters or more
- Character size : 16(W) x 16(H) dots
- Color elements : 7 colors (red, blue, green, yellow, cyan, magenta, white)
- Range of possibility : Multi-screen display

The color graphic display shall have the function as an operating console CRT for computer system starting.

(7) Keyboard

The keyboard for color graphic display equipment shall have alphanumeric characters in common, which conforms to the ASCII standard. the numerical ten keys shall be arranged on the right-hand side and the number of function keys shall not be to many.

(8) Color graphic printer (hard copy equipment)

The color graphic printer shall be provided to make copies of the displayed image on the color graphic display.

The color graphic printer (hard copy equipment) shall satisfy the following specifications:

- Copy system : Dry type
- Copy size : A4, 210 mm x 297 mm
- Copy time : About 50 sec.
- Sensitive paper : Dry type roll paper

(9) Telecommunication modem

The telecommunication modem shall facilitate interface of the 400 MHz multiplex radio link and the CPU system for transfer of various data and signals.

The telecommunication modem shall conform to CCITT V-23 and satisfy the following requirements:

- Modulation rate : 9,600 baud
- Data transmission rate : 9,600 bps
- Communication mode : Full duplex

(10) Color dot printer

The color dot printer shall be suitable for preparation of reports and be able to prepare copies of the displayed images on the color graphic display when the color graphic printer is not working.

The color dot printer shall satisfy the following specifications:

- Printing method : dot matrix impact
- Printing speed : 160 characters/sec or more
- Printing color : 7 colors (red, blue, green, yellow, cyan, magenta, black)
- Art technology : 180 x 180 dots/inch
- Paper width : 11 inches or more

(11) Floppy disk drive unit

The floppy disk driven unit shall be connected to CPU. One side of the diskette drive shall be used for the monthly data and the other side for the flood forecasting and warning data.

The floppy disk drive shall satisfy the following requirements:

- Type : Double sided, high density, dual diskette drive, 3.5 inches
- Storage capacity : 1 M-bytes or more

(12) Telemetering control equipment

The telemetering control equipment shall be provided to facilitate interface of the computer system with the telemetering operating console for the telemetering system and the supervisory control equipment for the 400 MHz multiplex radio link. The automatic starting function shall be provided with this equipment.

The telemetering control equipment shall satisfy the following specifications:

- CPU : 16 bit microprocessor
- cycle time : 0.5 micro sec or better
- Number of input/output : 300 bit or more

(13) RS-232C cables

The RS-232C cables with connectors shall be provided for connection between the CPU system and the peripheral equipment for line interface. The RS-232C cables and connectors shall comply with EIA (Electronic Industries Association) standard.

(14) Accessories

The following accessories shall be supplied for operation of the data processing equipment:

- Cables for power source and interface ..... 1 lot
- Dust cover for each equipment ..... 1 lot
- Initialized diskettes, 3.5 inches (2 HD) ..... 50 pcs.
- Blank diskettes, 3.5 inches (2 HD) ..... 110 pcs.
- Cleaning diskettes, 3.5 inches ..... 10 pcs.
- Cassette magnetic tape ..... 5 pcs.
- Cleaning cassette tape or head cleaning kit ..... 1 set
- Special maintenance tools ..... 1 set

(15) Provision for future extension

The CPU cabinet shall be provided with terminals for future interface with Ethernet and other purposes.

(16) Power source

Power for the data processing equipment shall be supplied at AC 23V ± 2% from the UPS equipment.

3.2.2 Data processing equipment at PS-S

(1) Central processing unit (CPU)

CPU shall be manufactured based on the latest state of process computer technology. The computer system shall ensure trouble-free operation though the amount of data increases. The coprocessor shall be used for controlling graphics.

The main memory of CPU shall have sufficient capacity so that the all process tasks can be performed without mutual interface and that efficient execution of all programs can be provided even taking into account future extension of the system.

Error check of the main memory shall be done automatically by the Error Check Code (ECC).

The following data check function shall be provided for the telemetering data received from telemetering remote equipment.

- Binary Coded Decimal check
- Parity check (odd/even)
- High/low limit check
- Time out check

Automatic restart functions, same as that for the CS, shall be provided.

Bootstrap loader shall be provided to initiate the loading of all system software from the auxiliary storage.

Halt signals shall be sent to the telemetering remote equipment and warning supervisory control equipment in the event of the computer has stopped its function.

The clock shall be preset by the user's application program.

The CPU shall satisfy the following requirements:

- CPU 1 (main processor) : 32 bit microprocessor
- CPU 2 (coprocessor) : Coprocessor suitable for its functions
- speed of calculation : 1 MIPS
- Kind of memory : IC memory
- Memory capacity : 10 M-byte or more

(2) Magnetic disk unit

The magnetic disk unit shall be furnished in the CPU cabinet. The unit shall be of fixed type and shall be capable to store programs, data base for process, system data base and operating systems. the memory capacity shall be based on the functional requirements of the Specification.

The magnetic disk unit shall satisfy the following specifications:

- Storage capacity : 200 M-byte or more
- Transfer speed : 5 M-byte/sec or more
- Average access time : 40 msec or less

- Seek time : 30 msec or less
- Rotation time : 9.0 msec or less
- Byte per sector : 256 byte or more

(3) Cassette magnetic tape unit

The cassette magnetic tape unit shall be provided in the CPU cabinet with the connection to CPU. This unit shall perform backup function of the magnetic disk unit and programs and data files shall be stored in tape for the purpose of securing the data.

The specification shall be as given below:

- Density : 1,60 BPI or more
- Capacity : 50 M-byte or more
- Tape velocity : 75 inches/sec or better
- Number of tracks : 9 tracks or more

(4) Telecommunication control unit

Particulars of this equipment are same as those for the CS.

(5) Line interface

The line interface shall have 8 lines or more capacity and shall facilitate the data traffic between CPU, telecommunication control unit, peripheral equipmnts.

(6) Color graphic display

Particulars of this equipment are same as that for the CS.

(7) Keyboard

Same as the CS.

(8) Color graphic printer

Same as the CS.

(9) Telecommunication modem

Same as the CS.

(10) RS-232C interface

Same as the CS.

(11) Accessories

The following accessories shall be supplied for operation of the data processing system:

- Cables for power source and interface ..... 1 lot
- Dust cover for each equipment ..... 1 lot
- Cassette magnetic tape ..... 5 pcs.
- Cleaning cassette tape or head cleaning kit ..... 1 set

(12) Power source

Power for operation of the data processing equipment shall be supplied at AC 230V ± 2% from the UPS equipment.

3.2.3 Software

The following software shall be furnished by the Contractor:

- Operating system or utility : UNIX, VMS or MVS
- Compiler : FORTRAN level ANS 177 or more C-language
- Graphic display : GKS (Graphic Kernel System) or better
- Word-processing system : Word Star or better

3.3 Warning System

3.3.1 Warning supervisory and control equipment

One (1) set of warning supervisory and control equipment shall be provided at the CS for overall control of the warning system.

The warning supervisory and control equipment shall be of bay type, and shall have, but not necessarily be limited to, the following functional units:

- Modem unit
- Calling control unit
- Response signal receiving unit
- Time control unit with a crystal clock device
- I/O interface
- Test panel
- External output interface
- Built-in radio equipment
- Power supply unit

Four (4) warning stations and one warning repeater station are controlled at the initial stage, but shall be extendible to a maximum of sixty (60) warning stations.

The warning station calling shall be made manually with the one-by-one basis.

The calling control unit shall control the warning stations.

The response signal receiving unit shall detect frequency component and judge whether signals are received or not.

The I/O interface unit shall exchange signals among the calling control unit, response signal receiving unit and test panel, and shall exchange signals with external devices such as the operating console and data processing equipment.

The time control unit shall normally be driven by one (1) minute clock signals from the data processing equipment. The own clock shall be utilized when the clock signals are available. The day and time data shall be controlled by this signal.

The test panel for the monitor and maintenance shall have but not necessarily be limited to, the following functions:

(a) Operation

- Test calling (individual)
- Operation reset

- Alarm off
- Lamp test
- Calling frequency transmission
- Power, on/off
- Squelch adjustment
- Voice communication

(b) Display on test panel

- Test operation status
- Control impossible
- Transmitting
- Controlling
- Power, on/off
- Monitoring by voltmeter (power supply voltage measurement)

The external interface shall send the warning operation records to the data processing equipment.

The built-in radio equipment shall have two (2) sets each of transmitter of 10W capacity and receiver.

The power supply unit shall supply the necessary power to each unit. Its input voltage shall be DC 24V ± 10%.

3.3.2 Warning operating console

The warning operating console shall be of self-standing type.

Four (4) warning stations and one warning repeater station are controlled at the initial stage, but shall be extendible to a maximum of sixty (60) warning stations.

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

(a) General

- Digital display of the date and time (month, day, hour and minute, 2 digits each)
- Correction of the time

- Power on/off of the operating console

(b) Control operations

- Station selection
- Control item selection
- Manual starting
- Resetting
- Display reset
- Test signal setting
- Tape start
- Tape stop
- Microphone broadcast
- Lamp test
- Alarm off
- Volume control of monitoring speaker
- Voice communication by handiest and speaker
- Changeover control of No. 1 and No. 2 transmitter

(c) Display

- Transmitting
- Controlling
- Controlling station
- Warning operation status
- Controlled station
- Control impossible
- Broadcast monitoring
- Power source
- Power failure (Burnt out fuse)
- Radio equipment status

For delivering warning voice to the warning stations, a microphone and a cassette tape player shall be provided on the operating console.

The operating console shall be designed for operating by DC 24V ± 10% power source.

3.3.3 Warning station equipment

Four (4) warning station equipment, one (1) set each for the four (4) warning stations, shall be provided. The equipment shall be of bay type construction.

The warning station equipment shall have, but not necessarily be limited to, the following functional units:

- Modem
- Receiving control unit
- Alarm control unit
- Return signal unit
- Chime
- Artificial sound generator
- Test panel
- Built-in radio equipment
- Power supply unit

The modem shall have functions to receive the control signal from the CS and to send back the response signal.

The receiving control unit shall detect the calling signal assigned to the station and control the alarm control unit according the instruction for alarming mode.

The alarm control unit shall control broadcast by artificial sound and warning voice from the CS.

The response signal unit shall send back the collected broadcast sound 10 seconds are then the confirmation signal for 5 seconds.

The chime and artificial sound generator shall generate broadcasting sound.

The test panel shall perform the following operations:

- Voice communication
- Warning tone broadcast (I)
- Warning tone broadcast (II)
- Broad cast start
- Broadcast stop

- Measurement of transmitter input level
- Measurement of receiver output level
- Measurement of control signal selection filter input level

In addition, protection circuits shall be provided for transmission protection and amplifier protection.

The warning station equipment shall be suitable for two (2) patterns of broadcast, spoken voice from the CS and artificial sound. The artificial sound shall be mixed tone of two frequencies, 523.5 Hz and 526.5 Hz.

The warning station equipment shall be operated by the power source of DC 12V ± 10%.

3.3.4 Repeater equipment

One (1) set of repeater equipment shall be provided at CS-R repeater station for the 150 MHz warning radio network.

The repeater equipment shall be of the squelch repeating system and have the bay type construction.

The repeater equipment shall have, but not necessarily be limited to, the following functional units:

- Repeating control unit
- Status return unit
- Remote changeover unit
- Test panel
- Power supply unit
- Built-in radio equipment (transmitter and receiver, 2 sets each)

(1) Functions

Two transmitters shall operate on an automatic changeover basis and two receivers shall operate in parallel at all time, and shall have the following functions:

- The transmitters shall be remotely changeovered by a control signal from WSOC in the CS.

- The operating status of the repeater equipment, including power supply information, shall be converted into numerals and shall be transmitted to the CS.

- A failure in the working transmitter shall be detected, and an automatic changeover to the standby transmitter shall be performed in case of a failure in the working transmitter. Failure display shall be made both at the CS and the repeater station.

- A failure in the receivers shall be able to be detected automatically, and shall be displayed both at the CS and the repeater station. The failure display shall automatically reset when the failure receiver is judged to be normal.

- Manual changeover of the transmitters shall be able to be performed locally at the repeater station.

- Simplex, point-to-point voice communication shall be available for maintenance and a telephone set for maintenance shall be provided.

(2) Status return

The items of the repeater station status as stipulated hereunder shall be transmitted to the CS:

- Transmitter No. 1 working
- Transmitter No. 2 working
- No transmitter failure
- Transmitter No. 1 failure
- Transmitter No. 2 failure
- No receiver failure
- Receiver No. 1 failure
- Receiver No. 2 failure
- Station number
- Power supply information

(3) Test panel

The repeater equipment shall be provided with a test panel and shall be able to perform the following operations and display for the monitor and maintenance:

- Power on/off
- Voice communication on a press-to-talk basis
- Starting
- Stopping
- Manual changeover of the transmitter No. 1 and No. 2 and Vice versa
- Lamp test
- Transmitter changeover lock
- Receiving parallel connection
- Receiver disconnecting
- Transmitting
- Display off

In addition, the working radio equipment, faulty radio equipment, etc. shall be displayed on the test panel.

The repeater equipment shall be operated by the power source of DC 12V which is to be fed from the solar cells power supply equipment.

The current consumption of the repeater equipment with the radio equipment shall satisfy the following ratings at DC 12V power supply voltage.

- Stand by : 50 mA or less
- Receiving : 1.3A or less
- Repeating (10W) : 4.7A or less

3.3.5 Amplifier, horn speakers and sound collecting equipment

Four (4) sets of amplifier and sound collecting equipment, one set each for the four (4) warning stations, shall be provided together with the warning station equipment specified in Sub-Clause 3.3.4.

The equipment shall consist of a voice amplifier, two sets of horn speakers with a junction box and a sound collecting microphone with particulars as mentioned below:

(1) Voice amplifier

A voice amplifier with the following shall be provided.

- Output : 100W ± 10% (continuous)
- Current : 18a or less (at DC 12V supply and 100W output)
- Clipping distortion : 10% or less at 100W output
- Crossover distortion : Nil at 10.8V power supply and 40°C ambient temperature
- Frequency response : Within 3 dB at 0.3 - 3 kHz
- Output impedance : Matching with speaker impedance
- S/N ratio : 40 dB or more
- Input level : 0 dBm or - 4 dBm (deviation ± 3 dB)
- Input impedance : 600 ohm ± 20%
- Operation and display : a. Power on/off
  b. Output level adjustment
  c. Output measurement by meter
  d. Microphone connection

(2) Horn speakers

Two (2) horn speakers with total input powers of 100W, shall be provided for each warning station.

- Output sound pressure:
  104 dB or greater at the point 1 m in front by 1W input power

- Insulation resistance:
  Voice coil - body ..... 1 Mohm by DC 100V
  Matching Tr., 1ry - body..... 10 Mohm by Dc 500V

- Dielectric strength:
  Voice coil - body ..... AC 100V, 1 min
  Matching Tr., 1ry - body..... AC 500V, 1 min

- A guard net against birds are to be provided

- The equipment shall be suitable for all-weather operation

(3) Sound collecting microphone

A horn or dynamic type microphone, suitable for collecting sound of broadcast voice and artificial sound, and chime shall be provided for each warning station.

3.3.6 Radio equipment

The same type radio equipment as those for the telemetering system shall be provided for the warning supervisory and control equipment and the warning station equipment.

3.3.7 Antenna

The following numbers of antenna shall be supplied for the warning system.

(1) Collinear antennas

- 3-stage collinear (CS-R) 2

(2) Yagi antennas

- 5-element Yagi: (WS) 4

The specifications of each type of antenna are mentioned below:

(1) Collinear and Yagi antennas

- Frequency range	:	142 to 170 MHz
- Applicable band width	:	5 MHz
- Type and gain		
a. 3-stage collinear with lightning arrester and cover	:	5.65 dB or more
c. 5-element Yagi	:	11.15 dB or more
- Impedance	:	50 ohms
- Standing wave ratio	:	1.5 or less
- Polarization	:	Vertical as standard
- Insulation resistance	:	More than 500 Mohms when measured by a 500V megger at a feeding point under dry conditions
- Dielectric strength	:	AC 1000V for one minute

3.3.8 Coaxial cables

The coaxial cables shall be used for the connection of the antenna and the radio equipment for the warning system.

(1) Coaxial cables at CS

Type AF 50-4 applied for the CS, shall be of foamed polyethylene insulated, aluminum sheathed, PE jacketed type having the following physical and electrical properties:

(a) Construction

- Inner conductor : 4.1 mm bare copper wire
- Outside conductor : 12.7 mm aluminum tube
- Jacket : 15.3 mm, polyethylene, colored black

(b) Electrical properties

- Nominal cable impedance : 50 ohms
- Attenuation at 150 MHz : 38 dB/km
- Capacitance : 82 pF/m
- Velocity of propagation : 81%
- Maximum operating voltage : 1.5 kV (effective value)
- Insulation resistance : 1,000 Mohm/km or more

(2) Coaxial cables for warning station

Type 10D-2E applied for the warning stations, shall be of annealed copper wires braided, polyvinyl chloride sheathed type having the following physical and electrical properties:

(a) Construction

- Insulator : 9.7 mm polyethylene
- Inner conductor : 2.9 mm annealed copper
- Outer conductor : 10.7 mm braided annealed copper
- Jacket : 13.7 mm, PVC colored gray

(b) Electrical properties

- Nominal cable impedance : 50 ± 2 ohms, at 10 MHz
- Attenuation at 150 MHz : 58 dB/km or less
- Maximum operating voltage : 5 kV (effective value)
- Insulation resistance : 1,000 Mohm/km or more

The connectors shall be provided at the both ends of the coaxial cable.

3.3.9 Coaxial arresters

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

Ratings shall be as follows:

- Type : Feeder type
- Impedance : 50 ohms
- Frequency range : DC to 1,000 MHz
- Insertion loss : 0.5 dB or less
- V.S.W.R. : 1.2 or less
- DC spark-over voltage : 90V

3.4 Communication System

3.4.1 400 MHz multiplex radio equipment

Six (6) sets of 400 MHz multiplex radio equipment, one set each at the CS and at the PS-S, and two sets each at the two repeater stations at CS-R and PS-R, shall be provided for establishing exclusive use telecommunication paths between dam site and generating house.

The multiplex radio equipment shall be of bay type and shall fully satisfy the following specifications:

(1) General

- Frequency range : 335 - 470 MHz

- Modulation system : SS-PM
- Channel capacity : 12 channels + 1 services channel
- Transmission frequency bandwidth:
  Baseband : 12 - 108 kHz
  Service channel : 0.3 - 8.0 kHz
- Radio frequency input and output impedance : 50 ohm, unbalanced
- Power source : DC 24V ± 10%
- Relay system : Baseband relay

(2) Configuration and features

- Active elements used : All solid state
- Unit configuration : Plug-in unit type
- Loop back testing circuit : Shall be capable of performing self-loop back test
- Standby transmitter : special hot-standby system
- Standby receiver : Parallel operation system
- Transmission fault localizing system : Automatic switch-over system which shifts from faulty section by detecting recorded output power
- Reception fault localizing system : automatic release system which cut off faulty section by detecting outband noise
- Transfer time of transmitter : Approx. 30 m-sec. including fault-confirmation time

(3) Transmitter characteristics

- Frequency stability : Within 20×10^{-6}
- Transmitter output : 10W
- Modulation index : 0.2 rad. r.m.s./ch.
- spurious radiation : -60 dB or better

(4) Receiver characteristics

- Receiving system : Crystal-controlled single superheterodyne
- Frequency stability of local oscillator : Within 20×10^{-6}
- If bandwidth : Approx. 460 kHz at 3 dB point

- Noise figure : 6.5 dB or better
- Spurious response : -60 dB or better
- Threshold level : -101.5 dB or better

(5) Overall characteristics

- Input/output impedance : Baseband, 75 ohm and return loss unbalanced 24 dB or better
  Service channel, 600 ohm balanced 20 dB or better
- Input/output level : Baseband input -25 dBm/ch
  output -15 dBm/ch
  Service channel input -8 dBm/ch
  output 0 dBm/ch
- Overall frequency characteristic : Baseband within 1 dB
  Service channel within 3 dB (0.3 - 4 kHz)
  within 4 dB (4 - 8 kHz)
- Variation at receiver output : Within 0.5 dB against RF input level from -55 dBm to -85 dBm, or against ±10% fluctuation of input line voltage
- Insertion loss
  RF coaxial relay : 0.5 dB or less
  RF signal driver : 3.5 dB or less (incl. hybrid loss)
  Antenna duplexer : Transmitter 1.0 dB or less
  Receiver 2.0 dB or less

3.4.2 Carrier terminal equipment

Two (2) sets of carrier terminal equipment, one set each for the CS and for the PS-S, shall be provided for connection of the radio circuits with the voice circuits.

The voice band output shall be of 4-wire E&M signaling.

The carrier terminal equipment shall be of self-supporting bay type and shall have technical properties as given below:

(1) General

- Channel capacity : 12
- Baseband frequency : 12 - 108 kHz
- Transmission system : Carrier suppressed single side band system
- Voice frequency band : 300 - 3,400 Hz

- Frequency band : Conforms to CCITT
- Attenuation distortion : Ditto
- Group delay distortion : Ditto
- Power source : DC 24V ± 10%

(2) Electrical performances

- Overall noise/CH : -63 dBm op
- Linearity : ±0.3 dB or better, variation of overall loss with audio power level of +3.5 dBm0 applied
- Intelligible crosstalk
  - Far-end crosstalk : 65 dB or more
  - Near-end crosstalk : 65 dB or more
- Signing stability : 12 dB or better, with terminated by 400 ohm resistor across 2-w terminal
- Harmonic distortion
  - 2nd-order harmonic : -40 dBm0 or better
  - 3rd-order harmonic : -40 dBm0 or better
- Carrier leak : -30 dBm0 or better at modulator output of each translator
  -35 dBm0 or better at demodulator output of each translator
- Dial pulse distortion : Within ±3 msec. where,
  dial impulse; 10, IMP make ratio; 33%,
  level fluctuation; ±3.5 dB
- Input/output impedance
  - Voice side : 600 ohm balanced, return loss; 20 dB or more
  - Baseband side : 75 ohm balanced or unbalanced, return loss; 20 dB or more
- Input/output level
  - 2-wire voice side : Input: 0 dBr or -3 dBr
    Output: -8 dBr or -4 dBr
  - 4-wire voice side : Input: -8 dBr or -16 dBr (7.75 to -16 dBr)
    Output: 0 dBr or +4 dBr (8 to -15.75 dBr)
  - Baseband side : Transmission: -25 dBr
    Reception: -15 dBr
- Carrier supply
  - Master oscillator : 8 MHz
  - Accuracy : $\pm 1 \times 10^{-6}$
  - Producing method : Phaselock loop
- Carrier frequency
  - Pre-modulation carrier : 128 kHz
  - Channel carrier : 192 to 236 kHz at 4 kHz spacing
  - Group carrier : 120 kHz

- Signaling
  - Frequency : 131.85 kHz
  - Accuracy : ±5 Hz or better
  - Level : -15 dBm0 or -20 dBm0
- Synchronization : Perfect synchronization

3.4.3 Supervisory and control equipment

The supervisory and control system, consisting of two master station equipment at the CS and at the PS-S and two (2) controlled station equipment for two repeater stations at CS-R and PS-R which shows operating status of equipment and devices in the repeater stations.

The supervisory and control equipment for the master station shall be of self-standing bay type and controlled station equipment shall preferably be encased in the multiplex radio equipment, and for transmission of necessary signals, the out of voice frequency band of the service channel shall be utilized.

The supervisory and control items shall be listed below:

(1) Supervisory items

(i) Operation-on the transmitter No. 2 of the multiplex radio equipment
(ii) Fault detection of the transmitter No. 1 of the multiplex radio equipment
(iii) Operation-off of the receiver No. 1 of the multiplex radio equipment
(iv) Operation-off of the receiver No. 2 of the multiplex radio equipment
(v) Fault detection of the carrier terminal equipment
(vi) Low and high voltage detection of power supply

Specifications of the equipment shall be as given below:

(a) General

- Transmission frequency band : 2.58 to 3.3 kHz
- Number of supervisory items : 12 items/station
- Number of control items : 6 items/station
- Number of controlled stations : 10 stations (maximum)
- Number of routes : Up to 3 routes

(b) Electrical performances

- Input and output impedance : 600 ohm balanced
- Signal level : -24 dBm0/carrier, connecting at -8 dBr transmitting level and 0 dBr receiving level
- Operation signal-to-noise ratio : 25 dB (unweighted) or more

(c) Master station panel

- Visual indication : 12 items/controlled station
- Visual and audible alarm : LED indication and buzzer
- Scan supervision : Automatic sequential supervision of remote stations (normal operation)
- Fixed supervision : Continuous supervision of particular remote station (selective switch is to be provided)
- Selection of remote station : Selective switch action

(d) Controlled station panel

- Visual indication : 6 control items and 12 supervisory items with one common alarm (change of status)
- Visual and audible indication : Common alarm (change of status)

The power supply for these equipment shall be made by DC 24V ± 10%.

3.4.4 Baseband repeaters

Two (2) baseband repeaters, one each for the two repeater stations at CS-R and PS-R, shall be provided for the baseband repeating of the multiplex radio circuits. The repeater equipment shall be encased in the bay for the 400 MHz multiplex radio equipment.

In this equipment, radio frequency signals shall be demodulated into baseband and connected to the next multiplex radio equipment after passing through a band-path filter. Particulars of the filter shall be as follows:

- Repeating baseband signal frequency : 12 to 108 kHz
- Impedance : 75 ohm
- Input level : -15 dBm

- Output level : -25 dBm

3.4.5 Branch circuits of service channel

A branch circuit of the service channel shall be provided in the bays of multiplex radio equipment with particulars as mentioned hereunder.

(1) Frequency band

The service channel shall be utilized for the following purposes:

(a) Order wire telephone : 0.2 to 2.1 kHz
(b) Supervisory and control equipment : 2.58 to 3.3 kHz

(2) Order wire telephone system

The functions of this telephone system shall be as mentioned below:

- Each order wire telephone shall be able to talk with any of other telephones in omnibus for the purpose of operation and maintenance.

- The calling method of the order wire telephone system shall be of speakers calling and talking shall be performed by an order wire telephone hand set.

- The telephone hand set shall be mounted on the top portion of the multiplex radio equipment.

3.4.6 Telephone repeater

Two (2) sets of telephone repeater shall be provided at the CS and PS-S to provide an interface to connect the key telephone system with the carrier terminal equipment of the multiplex radio link.

The telephone repeater shall be of subrack type, contained in the bay of the carrier terminal equipment and performances shall be as mentioned below:

- Transmission loss : 1.5 dB or less at 800 Hz

- Dc loop resistance of telephone set including line resistance : less than 300 ohms
- Signal output frequency 20 Hz oscillator : 20 Hz + 2 Hz (-4 Hz)
- Signal output voltage 20 Hz oscillator : 60 V p-p or more
- Number of telephone sets to be connected : 6 sets maximum

The power source shall be DC 24V ± 10%.

3.4.7 Key telephone system equipment

Two (2) sets of digital key telephone system equipment for the PS-S and CS shall be provided for water management of telephone communication between PS-S and CS.

Major functions of the key telephone system shall be as given below:

(a) A call terminated to the key telephone system from multiplex radio link through telephone repeater with visual display and electronic sound shall be indicated on all extensions.

(b) Any extension can respond to the call and talk; he can transfer the call to any other extension easily, if necessary.

(c) Any extension can originate a call through a vacant trunk line and dial the destination number.

(d) Holding of trunk call shall be possible.

Major particulars of the key telephone system shall be as given below:

- System control : Stored program/microprocessor control
- Speech path : time division (PCM) speech path, non blocking
- Capacity; maximum : 5 trunks and 10 extensions
- Loop resistance of extension : 40 ohms or less

- Wiring between master unit and extensions : 2 pairs (4 wires)
- Dialling to trunk line : Dial pulse system of 10 pps; but extension can use push button dialling

Power supply shall be AC 230v ± 10%.

The following items shall be supplied as accessories:

- 5 sets of key telephone set

3.4.8 Antenna

The following numbers of antenna are to be provided:

(1) Grid parabolic antenna for 400 MHz radio links

- 3m diameter: CS (1), CS-R (2), PS-R (2), PS-S (1)..... 6

Specifications of each type of antenna are mentioned below:

(1) Parabolic antennas

- Frequency range : 360 to 470 MHz, one or two pair
- Transmitter/receiver frequency separation
  3 m dia. parabolic : Less than 10% of center frequency
- Gain
  3 m dia. parabolic : 19 dB or more
- V.S.W.R. : Less than 1.2 at transmission frequency of ±2 MHz
- Impedance : 50 ohms unbalanced
- Front-to-back ratio
  b. 3 m dia. parabolic : 20 dB or more
- Radiation power : 100W maximum
- Insulation resistance : More than 500 Mohm when measured by a 500V megger at a feeding point under dry condition
- Dielectric strength : AC 1000V for one minute

3.4.9 Coaxial cables

The coaxial cables shall be used for the connection of the antenna and the radio equipment for both of the 400 MHz band.

(1) The coaxial cables for 400 MHz band

Type AF 50-7 applied for the 400 MHz band, shall be of foamed polyethylene insulated, aluminum sheathed, PE jacketed type having the following physical and electrical properties:

(a) Construction

- Inner conductor : 7.3 mm bare copper wire
- Outer conductor : 22.2 mm aluminum tube
- Jacket : 25.8 mm, polyethylene, colored black

(b) Electrical properties

- Nominal cable impedance : 50 ohms
- Attenuation at 400 MHz : 36 dB/km
- Capacitance : 82 pF/m
- Velocity of propagation : 81%
- Maximum operating voltage : 2.5 kV (effective value)
- Insulation resistance : 1,000 Mohm/km or more

3.4.10 Coaxial arresters

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

Ratings shall be as follows:

- Type : Feeder type
- Impedance : 50 ohms
- Frequency range : DC to 1,000 MHz
- Insertion loss : 0.5 dB or less

- V.S.W.R. : 1.2 or less
- DC spark-over voltage : 90V

3.5 Power supply system

The power supply system shall be consist of followings two types.

- Solar power supply system	: RS	6 sets
	WL	2 sets
	CS-R	1 set
	PS-R	1set
- Uninterrruptible power supply system	: WS	4 sets
	CS	1 set
	PS-S	1 set

All necessary materials shall be supplied power supply system by the Contractor.

(1) Solar power system

In total ten (10) sets of solar cells power supply equipment shall be provided for DC 12V and DC 24V power supply to all the gauging stations and repeater station.

The solar cells power supply equipment shall consist of solar cells, a power distribution board and alkaline storage battery, and shall be able to receive solar energy during the sunshine hours and to directly convert it into electrical energy and to supply it to the equipment and, at the same time, to charge the alkaline storage battery.

The solar cells shall be suitable for normal operations under the following ambient conditions:

Temperature : 0°C to + 70°C
Relative humidity : 100% or less

The solar cells shall have the properties of water proof and moisture proof and the hot-dip galvanized steel stand shall be supplied.

The tilt angle of modules surface shall be corresponded to the latitude of gauging stations.

The solar cells shall have the following specifications:

- Type : Silicon solar cells
- Type of element : Silicon semiconductor
- Incident energy : 100 mW/cm^2 or more
- Open circuit voltage : 20V or more
- Operating voltage : 16V or more

The power distribution board shall be of overage protection type, and shall include a charge controller, a blocking diode and a multirange DC V-I meter with a selector switch for the following current and voltage measurements:

- Solar cell output current
- Solar cell output voltage
- Load current
- Storage battery voltage

The power distribution board shall have also the following specifications:

- Insulation resistance : 10 Mohm or more
- Dielectric strength : Dc 500V/1 min

The power distribution board shall be housed in a steel case suitable for wall mounting and moistureproof type.

The power cells with suitable size shall be provided for connections among the solar cells, the power distribution board and the storage battery. The connectors to and from the solar cell shall be of waterproof type.

The battery shall be 12V and 24V, vented pocket-plate nickel-cadmium alkaline storage battery with an anti-corrosion container.

The rated capacity of the solar cells and storage battery shall be as given below:

(a) Solar cells

24W capacity	:	7 stations
70W capacity		2 stations
100W capacity	:	1 station

(b) Storage battery

Battery capacity should be sufficient to back up DC power one month without sunshine. The design calculation sheet of power consumption shall be submitted by the contractor for approval.

(2) Uniterruptible Power Supply System (UPS)

In total six (6) sets of UPS equipment shall be provided for AC 220V, DC 12V and DC 24V power supply at CS, WS, PS-S.

The UPS shall consist of rectifier, power distribution board, alkaline storage battery, automatic voltage regulator (to supply constant voltage) and inverter where necessary, and shall be able to receive commercial power and to convert or none-convert it into DC or AC to supply it to the equipment and, at the same time, to charge the alkaline storage battery.

For power supply to the WL-1 and WL-2 shall be used the above UPS where will be installed at CS by over head power supply cable. The contractor shall install poles , cables and other necessary materials such as joint box and so forth. Suitable power supply units which are connected to the equipment shall be supplied by the Contractor.

(a) Type

-	Cooling system	:	Natural air cooling
-	Rating	:	continuous duty

(b) AC input

-	Number of phases	:	Single phase
-	Rated frequency	:	50 Hz
-	Rated voltage	:	220 v AC

(c) AC output (CS, PS-S)

-	Number of phases	:	Single phase

- Rated frequency : 50 Hz
- Rated voltage : 220 V AC
- Voltage regulation range : With 220 V ±2 %
- Frequency stability : With 50 Hz ±0.1 % (at asynchronous)

(d) DC output (CS, WS, PS-R, PS-S)

- Rated voltage : 12 V DC (WS, CS-R)
  24 V DC (CS, PS-S)

(d) Battery capacity

Battery capacity should be sufficient to back up AC power for 5 hours.

The design calculation sheet of power consumption shall be submitted by the contractor for approval.

(3) Isolation Transformer

The isolation transformer should be provided to protect each equipment from the surge coming through the AC power source line.
The characteristics of the isolation transformer should be as follows;

- Number of Phases : Single phase
- Input voltage : 220 V AC
- Output : 220 V AC
- Capacity : 5 kVA (WS)
  10 kVA (CS)
  10 kVA (PS-S)

3.6 Miscellaneous Materials

The Contractor shall supply all erection and installation materials required for completing the Works and commissioning the plant. The Contractor shall supply all the installation drawings required for erection and installation at site.

3.7 Measuring Instrument and Tools

Measuring instruments and tools for site tests, maintenance and servicing shall be provided and placed in the CS and PS-S, respectively.

The list of equipment to be supplied shall be as given below.

Description	Specification	CS	PS-S
- Multimeter		2	2
- Digital multi meter		1	1
- Termination power meter (through type)	140 to 170 MHz	1	
- Termination power meter	DC to 500 MHz	1	-
- CM type power meter	140 to 500 MHz	1	1
- Oscillator	100 Hz to 1 MHz	1	1
- Oscilloscope	DC to 60 MHz dual channel	1	1
- Oscilloscope	DC to 5 MHz portable	1	1
- Linear detector		1	1
- Level meter	0.2 to 100 kHz	1	1
- Field strength meter	25 to 520 MHz	1	1
- Output tester		1	1
- Telemetry code checker		1	-
- Telemetering calling tester		1	-
- Frequency counter	10 Hz to 600 MHz	1	1
- Repeater controller		1	1
- Signal generator	140 to 170 MHz 335 to 470 MHz	1	1
- Program checker		1	1
- Engine generator	500 VA	1	-
- Radio telephone set	10W, Mobile type 150 MHz	3	-
- Radio telephone set	2W, Handy type 150 MHz	3	-
- Tool set		4	2
- Recommended testing equipment		1 lot	1 lot

Specifications of the major testing equipment shall be as follows:

(1) Multimeter

(a) DC voltmeter

- Measuring range : 20m/3/12/30/120/300/1,200/25 kV
- Accuracy : Within ± 2.5% of max. graduation (below 1,200V)

(b) DC current

- Measuring range : 50μ/3m/30m/0.3A
- Accuracy : Within ± 2.5% of max. graduation

(c) AC voltmeter

- Measuring range : 3/12/30/120/300/1,20V
- Accuracy : Within ± 3% of scale length
  Within ±5% for 3V only

(d) Capacity check meter

- Measuring range
  x 1,000 μF range : 1,000 μF to 1F
  x 100 μF range : 100 μF to 0.1F
  x 1 μF range 1 μF to 1,000 μF
- Accuracy : Within ± 6% of max. graduation

(e) Ohmmeter

- Measuring range
  Multiplying factor : x1/x10/x1K/x10K
  Central value : 20/200/20k/200K ohms
  Max. value 3k/30k/3M/30M ohms
  Min. value 0.2/2/200/2K ohms
- Accuracy : Within ± 3% of scale length

(2) Digital multimeter

(a) DC voltmeter

- Measuring range : 200m/2/20/200/1,200V
- Accuracy
  200 mV : ± (0.1% of reading + 2 courts)
  2 to 1,200V : ± (0.1% of reading + 1 count)

(b) DC current

- Measuring range : 200μ/2m/20m/200m/1,200 mA
- Accuracy
  - 200 μA to 200 mA : ± (0.3% of reading + 2 counts)
  - 2,000 mA : ± (0.6% of reading + 2 counts)

(c) AC voltmeter

- Measuring range : 200m/2/20/200/1,200V
- Accuracy
  - 30 to 50 Hz : ± (1.5% of reading ± 3 counts)
  - 50 Hz to 20 kHz : ± (0.3% of reading ± 3 counts)
  - 320 to 100 kHz : ± (1.5% of reading ± 10 counts)

(d) AC current

- Measuring range : 200μ/20m/200m/2,000 mA
- Accuracy
  - 200 μA to 200 mA
    - 30 to 50 Hz : ± (1.7% of reading + 5 counts)
    - 50 Hz to 10 kHz : ± (0.9% of reading + 5 counts)
  - 2,000 mA
    - 30 to 50 Hz : ± (2% of reading + 5 counts)
    - 50 Hz to 10 kHz : ± (1.2% of reading + 5 counts)

(e) Ohmmeter

- Measuring range : 20/200/2k/20k/200k/2M/20M ohms
- Accuracy
  - 200 ohms : ± (0.5% of reading + 2 counts)
  - 200 ohms to 2M ohms : ± (0.2% of reading + 2 counts)
  - 20 M ohms : ± (0.8% of reading + 2 counts)

(f) Others

- Display LED's : 7 segments red 0.3 inch high
- Ranging : automatic or manual on ACV, DVC and ohms
  Manual only on AC & DC current
- Power : AC 230V, battery

(3) Terminated power meter

- Frequency range : 140 to 170 MHz

- Power range : 6/12W
- Impedance : 50 ohms
- Connector : N type
- Indicating error : Within ± 5% of the full scale
- V.S.W.R. : Less than 1.2
- Continuous operating condition : Performance shall be satisfied for one hour continuous operation at the rated wattage (approx. 80% of the maximum wattage)
- Cooling system : Air cooling
- Dimensions : 100 x 110 x 200 mm or less
- Weight : Approx. 1.5 kg

(4) Terminated power meter

- Frequency range : DC to 500 MHz
- Power range : 20W
- Impedance : 50 ohms
- Connector : N type
- Indicating error : Within ± 10% of maximum scale
- V.S.W.R. : Less than 1.2
- Continuous operating condition : Performance shall be satisfied for one hour continuous operation at the rated wattage (approx. 80% of the maximum wattage)
- Cooling system : Air cooling
- Dimensions : 100 x 110 x 200 mm or less
- Weight : Approx. 1.5 kg

(5) CM type power meter

- Frequency range : 140 to 500 MHz
- Power range : 3/6/12 W
- Impedance : 50 ohms
- V.S.W.R. : Less than 1.3 with a load of less than 1.1W connected
- Indicating error : Within ± 10% of the full scale
- Connector : N type
- Dimensions : 90 x 145 x 90 mm or less

- Weight : Approx. 1.5 kg

(6) Oscillator

- Frequency range : 100 Hz to 1 MHz
- Frequency accuracy : Within ± (2% + 5 Hz)
- Output level : -30 to 15 dBm (1 dB step)
- Output impedance
  100 Hz to 100 kHz : 600 ohms ± 20%
  100 to 150 kHz : 600 ohms ± 30%
  4 kHz to 1 MHz : 75 ohms ± 20%
- Output level accuracy : Within ± 1 dB of display value
- Distortion factor : Above 30 dB t output of +15 dBM
- Power supply : AC 230V ± 10%
  Dc + 18V ± 2V with dry battery
- Dimensions : 210(H) x 190(W) x 140(D) mm or less
- Weight : Approx. 3.5 kg

(7) Oscilloscope

(a) Vertical deflection (2 identical channels)

- Bandwidth : DC to at lest 50 MHz
- Deflection factor : 5 mV/div to 5 V/div in 10 calibrated steps, 1-2-5 sequence
- Accuracy : ±5%
- Display modes : CH1, CH2 (normal or invert), alternate, chopped (250 kHz rate), added
- 3rd channel display (A trigger view) : Display simultaneously channel 1, channel 2, land external trigger signal Deflection factor is approx. 200 mV/div

(b) Horizontal deflection

- Time base A : 50 nsec/div to 0.5 sec/div in 22 calibrated steps, 1-2-5 sequence
- Time base B : 50 nsec/div to 50 sec/div in 19 calibrated steps, 1-2-5 sequence
- Accuracy : ±5%
- Display modes : A only, A intensified, B delayed

(c) Triggering A and B

- A trigger modes : Automatic, normal, single sweep, TV-V, TV-H
- A trigger source : Internal (CH1, CH2), line, external
- A trigger sensitivity
  - Internal : 0.5 div (DC to 10 MHz)
    1.5 div (10 to 50 MHz)
  - External : 150 mV (DC to 10 MHz)
    500 mV (10 to 50 MHz)
- B trigger mode and source : Automatic, normal (internal, external)

(d) X-Y operation (CH1: horizontal, CH2: vertical)

- Deflection factor : Same as vertical deflection
- Accuracy : Within ± 7%
- Bandwidth : DC to at least 500 kHz

(e) Others

- CRT display : 8 x 10 div (1 cm/div)
- Power supply : AC 230V, ± 10% at 50 Hz
- Dimensions : 180(H) x 310(W) x 410(D) mm
- Weight : Approx. 9.3 kg

(8) Synchroscope

(a) Vertical deflection

- Bandwidth : DC to at least 5 MHz
- Deflection factor : 5 mV/div to 10 V/div, 1-2-5 sequence
- Accuracy : Within 4%
- Display modes : CH1, CH2, chopped, alternate, added

(b) Horizontal deflection

- Time base : 500 msec/div to 1 sec/div, 1-2-5 sequence
- Accuracy : Within 5%

(c) Trigger

- Modes : Normal, auto (p-p)

- Trigger source : Internal CH1, internal CH2, external, TTL

- Trigger sensitivity
  Internal : 0.3 div (to 0.5 MHz)
  0.75 div (at 5 MHz)
  External : 15 mV (to 0.5 MHz)
  50 mV (at 5 MHz)

(d) X-Y operation

- Input : X-axis input is via CH1 connector
  Y-axis input is via CH2 connector
- X-Y characteristic : Same as stated for vertical deflection
- X-axis bandwidth : DC to 150 kHz

(e) Others

- CRT display : 8 x 10 div (06 cm/div)
- Power supply : External AC source 90 to 132V or 180 to 250V with a line frequency of 48 to 440 Hz
  External DC source +9 to +32V
- Dimensions : 112(H) x 236(W) x 371(D) mm or less
- Weight : Approx. 4.8 kg

(9) General

- Carrier frequency : 20 to 550 MHz, 6 ranges
- Input level : 100 to 126 dBμV
- Intermediate frequency : 2.5 MHz
- Differential characteristics : ± 0.1 dB at a range of 2.5 ± 0.6 MHz
- Frequency deviation
  Demodulation frequency : 10 Hz to 200 kHz
  Measuring range : 0 to 3, 10, 30, 100, 300 kHz
  Measuring accuracy : ±5% of full scale for each range
- Demodulation band limit filters
  Cutoff frequency (fc) : 3, 20, 120 kHz or off (LPF)
  50, 300 Hz, 4 kHz or off (HPF)
  Deviation with path band : ± 0.3 dB
  Attenuation : 40 dB or more at 1.4 fc (LPF)
  20 dB or more at 0.5 fc (HPF)

- S/N ratio : 55 dB or more (2p to 250 MHz)
  50 dB or more (250 to 550 MHz)
  (S: 3.5 kHz, Band: 0.3 to 3 kHz)
  : 65 dB or more (20 to 250 MHz)
  60 dB or more (250 to 550 MHz)
  (S: 25 kHz, Bane: 50 Hz to 20 kHz)
  : 70 dB or more (20 to 250 MHz)
  65 dB or more (250 to 550 MHz)
  (S: 100 kHz, Band: 50 Hz to 120 kHz)
- Power supply : AC 230V, 50 Hz
- Dimensions : 140(H) x 426(W) x 300(D) mm or less
- Weight : Approx. 16 kg

(10) Level meter

- Measuring frequency : 0.2 to 100 kHz with 600 ohms (balance)
  40 to 650 kHz with 75 ohms (balance)
- Measuring range : -60 to +30 dBm
- Accuracy
  600 ohms side : 0.2 to 60 kHz ± 0.6 dB
  0.2 to 100 kHz ± 1 dB
  75 ohms side : 50 to 600 kHz ± 0.6 dB
  4 to 650 kHz ± 1 dB
- Input impedance
  0.2 to 100 kHz : More than 10 kohms or 600 ohms
  4 to 650 kHz : More than 1 kohms or 75 ohms
- Power supply : AC 230V or dry battery
- Dimensions : 100(H) x 250(W) x 130(D) mm or less
- Weight : Approx. 2.3 kg

(11) Field strength meter

- Frequency : 25 to 520 MHz, 6 bands
- Input impedance : 50 ohms
- Voltage measuring range
  25 to 222 MHz : 0 to 120 dBμV
  222 to 520 MHz : 50 to 120 dBμV
- Field strength measuring range
  25 to 222 MHz : -10 to 11 dBμV/m - 110 to 130 dBμV/m
  222 to 520 MHz : 16 to 24 dBμV/m - 130 dBμV/m
- Measuring accuracy : ± 2dB
- Bandwidth (6 dB) : 15 kHz ± 2 kHz, 120 kHz ± 20 kHz
- Power supply : Battery or AC 230V

- Dimensions : 145(H) x 280(W) x 350(d) mm or less
- Weight : Approx. 11 kg

(12) Output tester

(a) Carrier power measurement

- Frequency : 150, 400 MHz bands
- Range : 0 to 15W, full scale, 5, 15W
- Accuracy : ± 10% of full scale

(b) Carrier frequency deviation measurement

- Modulation : 50 Hz to 3 kHz
- Range : 0 to 0.5, 1.5, 5, 15 kHz, 4 ranges
- Accuracy : ± 5% of full scale + 50 Hz
  (0 to 0.5 kHz and 0 to 1.5 kHz ranges)
  ± 5% of full scale
  (0 to 5 kHz and 0 to 15 kHz ranges)

(c) Audio frequency power measurement

- Frequency : 50 Hz to 3 kHz
- Input impedance : 600 ohms and high impedance
- Range : -50 to +30 dBm
- Accuracy : ± 0.5 dB

(d) DC measurement

- Range : 50A (internal resistance: 2k ohms), polarity switch selectable
- Accuracy : ± 2.5% of full scale

(e) Others

- Power supply : Supplied from the signal generator
- Dimensions : 200(H) x 300(W) x 180(D) mm or less
- Weight : Approx. 6 kg

(13) Telemetry code checker

(a) Functions

- This equipment shall decode the DC level response signal (the ratio of long mark to short mark signal is 3 to 1 RZ signal) from telemetering equipment and the like, and shall indicate the signal in bit with LEDs.

- This equipment shall demodulate the FS response signal to the DC level signal and shall decode the data and indicate the signal in bit with LEDs.

(b) Specifications

- Input signal code	:	RZ code 50/25 baud The ratio of long mark to short mark signal is 3 to 1.
- Sub carrier frequency (fo)	:	425 + 170 (N-1)Hz N=1 to 18
- FS signal	:	Mark (fo + 35 Hz) Space (fo - 35 Hz)
- FS signal input level	:	-5 to -30 dBs at the attenuation of 0 dB +6 to -10 dBs at the attenuation of 20 dB
- FS signal input impedance	:	Approx. 10 Kohms
- DC level signal (code)	:	Mark (L) Space (H) Threshold voltage approx. 2.5V
- Code signal input impedance	:	approx. 10 Kohms
- Power supply	:	Battery DC 10.5 to 16.5V
- Dimensions	:	135(H) x 100(W) x 235(D) mm or less

(14) Telemetering calling tester

- Oscillation frequency	:	300 to 3,400 Hz variable by step
- Oscillation frequency accuracy	:	$\pm 1 \times 10^{-4}$
- Output level	:	-8 to -30 dBs variable by 2 dB step
- Output level accuracy	:	±1 dB
- Distortion factor	:	Less than -30 dB
- Power supply	:	Battery DC 10.5 to 16.5V
- Dimensions	:	135(H) x 50 (W) x 235(D) mm or less

(15) Frequency Counter

- Frequency range	:	10 Hz to 600 MHz
- Input voltage range	:	10 mV to 100 Vrms
- Input impedance	:	1 Mohms or more, shunted by 25 pF or less, 50 ohms
- Accuracy	;	±1 count ± time base accuracy
- Digit	:	9 digits
- Display	:	7-segment LED, zero-blanking, memory display
- Frequency stability of crystal oscillator	:	2 x 10^{-8}/day or less after 24 hours warm-up
- Power supply	:	Ac 90 to 140V/180 to 280V DC 10 to 30V
- Dimensions	:	85(H) x 205(W) x 280(D) mm or less
- Weight	:	Approx. 4.3 kg

(16) Repeater controller

- Signal output level	:	-10 ± 1 dBm (40 ohms load)
- Signal frequency		
Group (A) signal	:	487.5 to 697.5 Hz (15 Hz step)
Start signal	:	382.5 Hz
Stop signal		397.5 Hz
Tolerance		±10^{-4} or less
- Output time		
Unmodulation	:	1.0 sec
Group signal	:	0.6 sec
Start or stop signal		0.6 sec
Tolerance		10^{-3} or less
- Supply voltage	:	10.5 to 16.5V
- Dimensions	:	135(H) x 50(W) x 235(D) mm or less

(17) Signal generator

(a) Carrier frequency

- Range	:	140 to 174 MHz, 335 to 470 MHz, 2 ranges
- Main dial accuracy	:	± 1%

- Fine adjustment
  - Range : ± 50 kHz
  - Finest scale : 2 kHz (within ± 20 kHz)
    5 kHz (± 20 to ± 50 kHz)
  - Scale accuracy : ± 1 kHz (within ± 10 kHz)
    ± 10% (within ± 50 kHz)
- Stability : 1 kHz/3 min, or less after 20 min warm-up

(b) Output

- Source impedance : 50 ohms
- Level : -5 to 90 dB
- Level accuracy : ± 2 dB

(c) Modulation

- Frequency : 1 kHz (internal)
  50 Hz to 3 kHz (external)
- Deviation range : 0 t 0.5, 1.5, 5, 15 kHz; 4 range
- Deviation accuracy : ± 10% of full scale +50 Hz
  (0 to 0.5 kHz, 0 to 1.5 kHz ranges)
  ± 10% of full scale
  (0 to 5 kHz and 0 to 15 kHz ranges)

(d) Others

- Power supply : AC 230V ± 10%, 50 Hz, also built-in battery operation is available
- Dimensions : 200(H) x 300(W) x 180(D) mm or less
- Weight : Approx. 9 kg

(18) Program checker

The Tenderer shall submit the specification of the proposed equipment.

(19) Engine generator

- AC output : 500 VA or more, 50 Hz, 1-phase, 230V
- DC output : 12V, 100W

- Engine
  - Type : 4-stroke, air cooled
  - Displacement : About 60 cm^3
  - Ignition system : Transistor
  - Starting system : Recoil
- Equipment : AC frequency switch, Hz meter, fuel gauge, OIL ALERT, AC circuit breaker shall be equipped
- Dimensions : 325(H) x 250(W) x 325(D) mm or less
- Dry weight : Approx. 18 kg
- Fuel tank capacity : 2 lit, or more

(20) Tool set

The Tenderer shall submit a complete list of the testing equipment (including all accessories), together with unit price.

The tool set shall at least include the following items:

- Side cutting plier
- Plier
- Wrench
- Radio plier
- Nipper
- Screw driver set
- Knife
- file set
- Soldering iron
- Tweezer
- Solder

3.8 Spare Parts

The Contractor shall provide all spare parts necessary for maintenance and repair.

The Tenderer shall submit a complete list of all necessary spare parts with unit prices, together with his tender. The prices for recommended spare parts will not be taken into account in comparison of tenders.

The following parts shall be supplied:

(1) For the CS

	Description	Quantity	Remarks
(a)	Telemetering equipment	2 sets	Exclude radio equipment
	- For rainfall	1 set	
	- for rainfall/water level	1 set	
(b)	Repeater equipment		Exclude radio equipment
	- For telemetering system (V-v repeating)	1 set	
(c)	Warning station equipment		Exclude radio equipment
	- Warning equipment	1 set	
(d)	Print circuit boards		One for each kind
	- Telemetering supervisory and control equipment	1 lot	
	- Telemetering supervisory and operating console	1 lot	
	- Telemetering equipment	1 lot	
	- Repeater equipment	1 lot	
	- Data processing equipment	1 lot	
	- Warning supervisory control equipment	1 lot	
	- Warning operating console	1 lot	
	- Warning equipment	1 lot	
	- Multiplex radio equipment	1 lot	
	- Carrier terminal equipment	1 lot	
	- Multiplex radio supervisory and control equipment	1 lot	
	- Telephone repeating equipment	1 lot	
	- Key telephone master unit	1 lot	
	- Baseband repeater	1 lott	
(e)	Teleprinter, 24 inches	1 set	
(f)	Tipping bucket rain gauge	1 set	
(g)	Automatic recorder	1 set	
(h)	Float type water-level gauge	1 set	
(i)	A/D converter	1 set	
(j)	Keyboard for CRT display	1 set	
(k)	Horn speaker	2 sets	
(l)	Radio equipment for telemetering and warning systems	4 sets	One for each frequency and power
(m)	Coaxial arrester	2 sets	

(n)	Radio equipment for multiplex radio link (400 MHz, 10W)	3 sets	One for each frequency
(o)	Consumable spare parts	200%	Of working quantity
(p)	Power supply unit	1 lot	One for major kind
(q)	Solar cell power supply equipment	1 lot	
(r)	Alkaline battery	1 lot	
(s)	Battery charger and rectifier	1 lot	
(t)	Recording paper, ink and pen for 3 years	1 lot	One set for each gauging station
(u)	Recording paper	2 x 4,000 sheets	For each typewriter
(v)	Ink sheet for color hard copy	50 pcs.	
(w)	Dry type roll paper for color hard copy	50 rolls	
(x)	Photo switches	2 pcs.	
(y)	Lamps and fuses	300%	Of working quantity

(2) For the PS-S

	Description	Quantity	Remarks
(a)	Printed circuit board		One for each kind
	- Data processing equipment	1 lot	
	- Multiplex radio equipment	1 lot	
(b)	Keyboard for CRT display	1 set	
(c)	Ribbon cartridge for color dot printer	100 pcs.	
(d)	Ink sheet for color hard copy	50 pcs.	
(e)	Dry type roll paper for color hard copy	50 pcs.	
(f)	Printing paper for color dot printer	20,000 sheets	
(g)	Floppy disk, 2HD 3.5 inch	100 sheets	
(h)	Floppy cleaning disk, 3.5 inch	2 sheets	
(i)	Cassette magnetic tape	4 pcs.	
(j)	Cassette cleaning tape	2 pcs.	
(k)	Lamps and fuses	300%	Of working quantity

(3) Telemetering gauging stations (10 stations)
VHF repeater station (1 station)
Warning stations (4 stations)
VHF repeater station (1 station)
Multiplex repeater stations (2 stations)

	Description	Quantity	Remarks
(a)	Lamps and fuses	300%	Of working quantity

3.9 Equipment Composition

The equipment composition of each station shall be such as to be enough for performing functions of the complete this project. It shall be noted that all components, testing equipment, accessories, spare parts and miscellaneous materials required for completing the Works and commissioning the Plant shall be supplied by the Contractor regardless of whether explicitly stipulated in this Specification or not.

SECTION 4. TESTS AT FACTORY BEFORE SHIPMENT

The Contractor shall carry out the tests in the factory before shipment in the presence of the Engineer and/or the Employer or their appointed representative in accordance with General Conditions, (Inspection and Testing during manufacture).

Before carrying out the tests, the Contractor shall submit the test procedure to the Engineer his for approval.

4.1 Telemetering System

4.1.1 Telemetering Supervisory Control Equipment

(a) General inspection and dimension check
(b) Operational check
- Telemetering
- Speech
- Alarm

(c) Electrical characteristic tests
- Signal level
- Signal frequencies, calling tone and transfer tone
- Duration of calling signal
- Input and output voltage
- Power consumption

(d) Dielectric strength
(e) Insulation resistance
(f) Other tests as required

4.1.2 Telemetering operating console

(a) General inspection and dimension check
(b) Operational check
- Telemetering
- Speech
- Display
- Alarm

(c) Electrical characteristic tests
- Input and output signal level
- Power supply voltage
- Power consumption

(d) Dielectric strength
(e) Insulation resistance
(f) Other tests as required

4.1.3 Printer

(a) General inspection and dimensions check
(b) Operational check
(c) Input voltage
(d) Power consumption

4.1.4 Telemetering equipment

(a) General inspection and dimensions check
(b) Operational check
- Receiving
- Starting
- Speech

(c) Electrical characteristic tests
- Signal detection level of calling signal
- Signal frequencies
- Input and output level
- Power consumption, waiting, receiving and control

(d) Dielectric strength
(e) Insulation resistance
(f) Other tests as required

4.1.5 Rainfall gauge

(a) General inspection and dimensions check
(b) Measuring unit
(c) Operational check
(d) Characteristic tests
- Measuring
- Following speed
- Accuracy

4.1.6 Rainfall A/D converter (Electric counter)

(a) General inspection and dimensions check

(b) Operational check

(c) Characteristic tests

4.1.7 Automatic recorder (for rainfall)

(a) General inspection and dimensions check

(b) Characteristic tests

- Recording pen shift
- Recording paper width
- Roll paper shift speed
- Clock accuracy
- Operational period
- Chart speed

4.1.8 Water-level A/D Converter

(a) General inspection and dimensions check

(b) Operational check

- Measured value
- Output contact
- Output signal

(c) Characteristic tests

- Contact rating
- Contact resistance
- Torque
- Following speed

(d) Measuring unit

(e) Measured value

4.1.9 Water-level automatic recorder

(a) General inspection and dimensions check

(b) Recording pen shift

(c) Role paper shift speed

(d) Clock accuracy

4.1.10 Repeater equipment

(a) General inspection and dimensions check

(b) Operational check

- Repeating start/stop
- Transmitter changeover
- Detection of failure
- Speech

(c) Electrical characteristic tests
- Signal detection level of calling and control signal
- Signal frequencies
- Input and output voltages
- Power consumption, waiting and control

(d) Dielectric strength

(e) Insulation resistance

(f) Other tests as required

4.1.11 Radio equipment

(a) General inspection and dimensions check

(b) Transmitter
- Transmitting frequency
- Frequency stability
- Maximum frequency deviation
- S/N ratio
- Spurious
- Frequency response
- RF output

(c) Receiver
- Sensitivity
- Selectivity
- Output signal level
- Receiving input power level
- S/N ratio
- Squelch
- Spurious response

(d) Power consumption

(e) Other tests as required

4.1.12 Terminal box with Arresters

(a) General inspection and dimensions check

(b) Electrical characteristic test

- Spark over voltages

(c) Dielectric strength

(d) Insulation resistance

(e) Other tests as required

4.2 Data Processing System

4.2.1 CPU AND peripheral equipment

The Contractor shall submit a plan for testing for review and approval by the Engineer.

4.2.2 Color graphic display

(a) General inspection and dimensions check

(b) Operational check

- Operating
- Display

(c) Electrical characteristic test

- Power consumption

(d) Other tests as required

4.2.3 Key board

(a) General inspection and dimensions check

(b) Operational check

- Operating

(c) Electrical characteristic test

(d) Other tests as required

4.2.4 Color printer

(a) General inspection and dimensions check

(b) Operational check

(c) Electrical characteristic tests

- Power consumption

(d) Other tests as required

4.2.5 Telemetering control equipment

(a) General inspection and dimensions check

(b) Operational check
- Operating signal

(c) Electrical characteristic tests
- Signal level
- Input and output voltages
- Power consumption

(d) Other tests as required

4.3 Warning System

4.3.1 Warning supervisory control equipment

(a) General inspection and dimension check

(b) Operating check
- Warning signaling
- Speech
- Alarm

(c) Electrical characteristic tests
- Signal detection level of supervisory signal
- Signal frequency
- Time duration of control signal
- Input and output signal level
- Power consumption

(d) Dielectric strength

(e) Insulation resistance

(f) Other tests as required

4.3.2 Warning operating console

(a) General inspection and dimension check

(b) Operating check
- Warning signal
- Speech
- Display
- Alarm

(c) Electrical characteristic tests
- Input and output signal level
- Power supply voltage
- Power consumption

(d) Dielectric strength
(e) Insulation resistance
(f) Other tests as required

4.3.3 Warning station equipment

(a) General inspection and dimensions check
(b) Operating check
- Receiving
- Warning operation
- Response
- Speech

(c) Electrical characteristic tests
- Signal detection level of control signal
- Signal frequencies of supervisory tone
- Time duration of protect timer
- Input and output signal level
- Power consumption, waiting, receiving and warning control

(d) Dielectric strength
(e) Insulation resistance
(f) Other tests as required

4.3.4 Voice amplifier

(a) General inspection and dimensions check
(b) Operational check
(c) Electrical characteristics
- Output power
- Signal level

(d) Dielectric strength
(e) Insulation resistance
(f) Other tests as required

4.3.5 Horn speakers

(a) General inspection and dimensions check
(b) Operational check
(c) Electrical characteristic tests
- Output sound
- Power consumption

(d) Other tests as required

4.3.6 Radio equipment for warning system

(a) General inspection and dimensions check

(b) Transmitter
- Transmitting frequency
- Frequency stability
- Maximum frequency deviation
- S/N ratio
- Spurious
- Frequency response
- RF output

(c) Receiver
- Sensitivity
- Selectivity
- Output signal level
- Receiving input power level
- S/N ratio
- Squelch
- Spurious response

(d) Power consumption

(e) Other tests as required

4.3.7 Solar cells power supply equipment

(a) General inspection and dimensions check

(b) Characteristic tests
- Solar cells temperature
- Peak output (at 100 mW/cm^2)
- Open circuit voltage
- Short circuit current
- Storage battery terminal voltage
- Solar energy with tilt angle for solar cells panel

(c) Battery
- General inspection and overall dimensions check
- Capacity test

4.4 Power supply equipment

4.4.1 Solar cells power supply equipment

(a) General inspection and dimensions check

(b) Characteristic tests

- Solar cells temperature
- Peak output (at 100 mW/cm^2)
- Open circuit voltage
- Short circuit current
- Storage battery terminal voltage
- Solar energy with tilt angle for solar cells panel

(c) Battery

- General inspection and overall dimensions check
- Capacity test

4.4.2 Uninterruptible power supply equipment

(a) General inspection and dimension check

(b) Operational check

- Starting test
- Operational check

(c) Electrical characteristic tests

- Loading test
- Insulation resistance
- Dielectric strength

(d) Other tests as required

4.4.3 AC power distribution board

(a) General inspection

(b) Operation check

(c) Insulation resistance

(d) Dielectric strength

4.4.4 DC power supply equipment

(a) General inspection and dimensions check

(b) Operational test including meter check

(c) Temperature rise

(d) Output characteristic
(e) Drooping characteristic
(f) Efficiency
(g) Noise and ripple voltage
(h) Output voltage adjustment range
(i) Dielectric strength
(j) Insulation resistance
(k) Battery
- General inspection and dimensions check
- Capacity test

4.4.5 Isolation transformer

(a) General inspection and dimensions check
(b) Electrical characteristic tests
- Input and output voltage ratio
- Impulse discharge current withstand
- Surge transfer ratio
- Capacity
- Efficiency
- Temperature rise

(c) Dielectric strength
(e) Insulation resistance
(f) Other tests as required

4.4.6 Automatic voltage regulator

(a) General inspection and dimensions check
(b) Electrical characteristic tests
- Output voltage accuracy
- Capacity
- Efficiency
- Temperature rise

(c) Dielectric strength
(d) Insulation resistance
(e) Other tests as required

4.5 Measuring Instruments and Tools

The Contractor shall furnish a test report of each equipment.

4.6 Mechanical Facilities

The Contractor shall furnish a test report of each facility.

4.7 Antenna Towers/Poles

4.7.1 Antenna Towers

(a) General inspection and structural check
(b) Material strength test
(c) Galvanizing test

4.7.2 Antenna poles

Same items as above antenna towers.

SECTION 5. TESTS ON SITE

The contractor shall carry out the on-site tests as given hereunder.

However, before carrying out the tests, the Contractor shall submit the test schedule including objectives of tests, procedure/method and required values/numbers to the Engineer and the Employer for review and approval.

5.1 Telemetering System

5.1.1 Telemetering Supervisory Control Equipment

(a) General inspection

(b) Operational check
- Telemetering
- Speech
- Alarm

(c) Electrical characteristic tests
- Signal level
- Signal frequencies
- Input and output voltage

(d) Other tests

5.1.2 Telemetering operating console

(a) General inspection

(b) Operational check
- Telemetering
- Speech
- Display
- Alarm

(c) Electrical characteristic test
- Input and output voltages

(d) Other tests

5.1.3 Printer

(a) General inspection

(b) Operational check

5.1.4 Telemetering equipment

(a) General inspection
(b) Operational check
- Receiving
- Starting
- Speech

(c) Electrical characteristic tests
- Signal level
- Signal frequencies
- Input and output voltage

(d) Other tests

5.1.5 Rainfall gauge

(a) General inspection
(b) Measuring unit
(c) Operational check
(d) Characteristic tests

5.1.6 Rainfall A/D converter (electric counter)

(a) General inspection
(b) Operational check
(c) Characteristic tests

5.1.7 Automatic recorder (for rainfall)

(a) General inspection
(b) Operational check
(c) Characteristic tests

5.1.8 Water-level A/D Converter

(a) General inspection
(b) Operational check
(c) Characteristic tests

5.1.9 Water-level automatic recorder

(a) General inspection
(b) Operational check
(c) Characteristic tests

5.1.10 Repeater equipment for telemetering system

(a) General inspection
(b) Operational check
- Repeating start/stop
- Transmitter changeover
- Detection of failure
- Speech

(c) Electrical characteristic tests
- Signal level
- Signal frequencies
- Input and output voltages

(d) Other tests

5.1.11 Radio equipment for telemetering system

(a) Transmitter
- General inspection
- Radio frequency
- Maximum frequency deviation
- R.F. output
- V.W.S.R.
- Check points measurement
- Other tests

(b) Receiver
- General inspection
- Local oscillator frequency
- Sensitivity
- Squelch sensitivity

-Audio output
- Check points measurement
- Other tests

(c) Overall frequency characteristic test
(d) Operational tests

- Data and signal transmission
- Voice communication

5.1.12 Terminal box with arresters

(a) General inspection
(b) Insulation resistance

5.2 Data Processing System

5.2.1 Data processing equipment

(a) General inspection
(b) Operational check
- Data processing (including printing and data display)
- Alarm

(c) Other tests

5.2.2 Color graphic display

(a) General inspection
(b) Operational check
(c) Electrical characteristic test
(d) Other tests

5.2.3 Key board

(a) General inspection
(b) Operational check
(c) Other tests

5.2.4 Color printer

(a) General inspection
(b) Operational check
(c) Other tests

5.2.5 Telemetering control equipment

(a) General inspection

(b) Operational check
(c) Electrical characteristic test
(d) Other tests

5.3 Warning System

5.3.1 Warning supervisory control equipment

(a) General inspection
(b) Operational check
- Warning signaling
- Speech
- Alarm

(c) Electrical characteristic tests
- Signal level
- Signal frequency
- Input and output voltages

(d) Other tests

5.3.2 Warning operating console

(a) General inspection
(b) Operational check
- Warning signal
- Speech
- Display
- Alarm

(c) Electrical characteristic tests
- Input and output voltages

(d) Other tests

5.3.3 Warning station equipment

(a) General inspection
(b) Operating check
- Receiving
- Warning operation
- Response
- Speech

(c) Electrical characteristic tests
- Signal level
- Signal frequencies
- Input and output voltages

(d) Other tests

5.3.4 Voice amplifier

(a) General inspection
(b) Operational check
(c) Electrical characteristics
(d) Other tests

5.3.5 Horn speakers

(a) General inspection
(b) Operational check
(c) Other tests

5.3.6 Radio equipment for warning system

(a) Transmitter
- General inspection
- Radio frequency
- Maximum frequency deviation
- R.F. output
- V.S.W.
- Check points measurement
- Other tests

(b) Receiver
- General inspection
- Local oscillator frequency
- Sensitivity
- Squelch sensitivity
- Audio output
- Check points measurement
- Other tests

(c) Overall frequency characteristic test

(d) Operational tests
- Data and signal transmission

- Voice communication

5.4 Power supply equipment

5.4.1 Solar cells power supply equipment

(a) General inspection
(b) Cell voltage and specific gravity before, during and after charging
(c) Terminal voltage at the end of the charging
(d) Operational check
(e) Insulation resistance
(f) Other tests

5.4.2 Uninterruptible power supply equipment

(a) General inspection
(b) Operational check
(c) Other tests

5.4.3 AC power distribution board

(a) General inspection
(b) Operation test
(c) Insulation resistance

5.4.4 DC power supply equipment

(a) General inspection
(b) Cell voltage and specific gravity before, during and after charging
(c) Terminal voltage at the end of the charging
(d) Operational check
(e) Insulation resistance
(f) Other tests

5.4.5 Isolation transformers

(a) General inspection
(b) Input and output voltages
(c) Insulation resistance

5.4.6 Automatic voltage regulators

(a) General inspection
(b) Input and output voltages
(c) Insulation resistance

5.5 Antenna Towers/Poles

5.5.1 Antenna towers

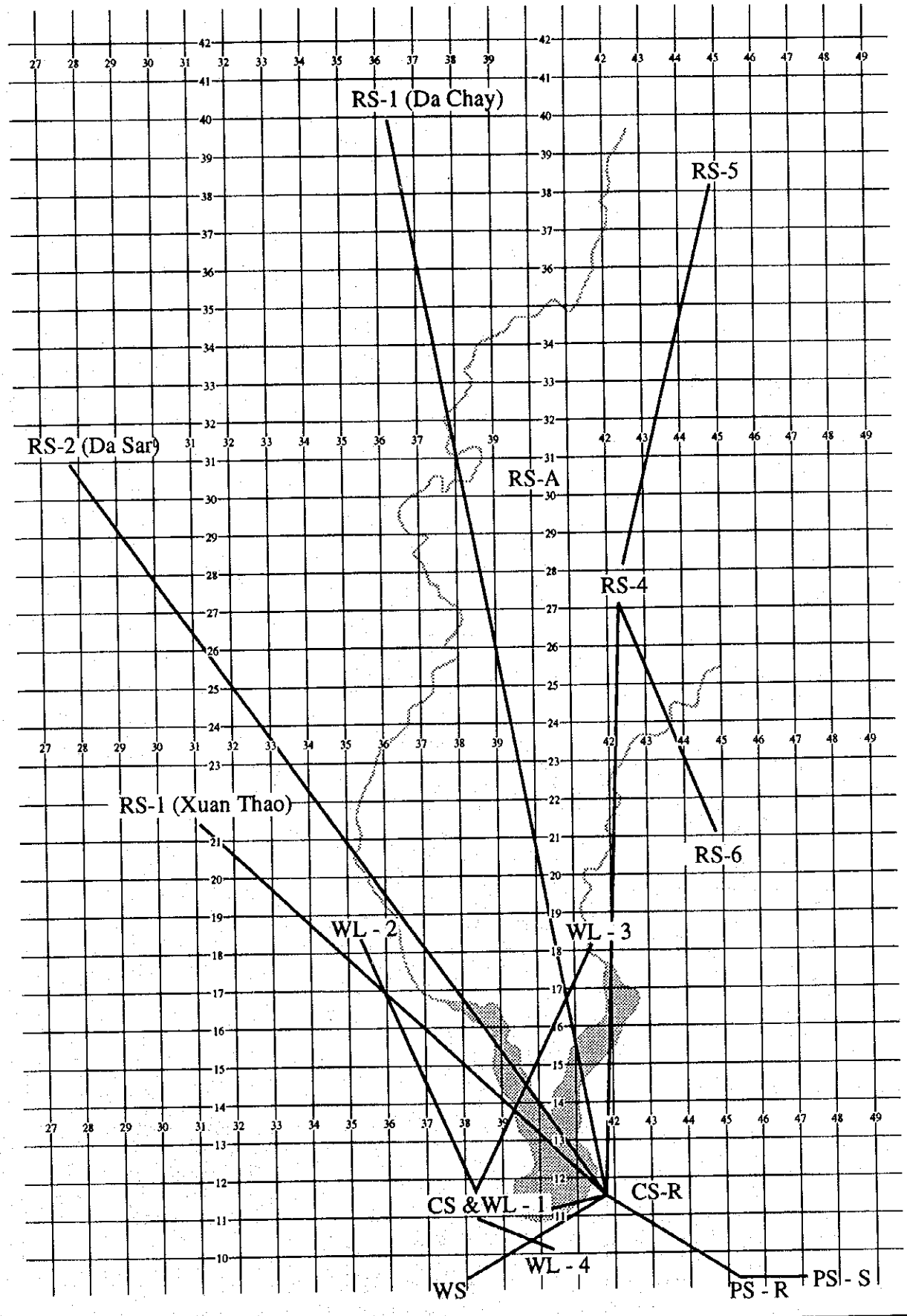
(a) General inspection

5.5.2 Antenna poles

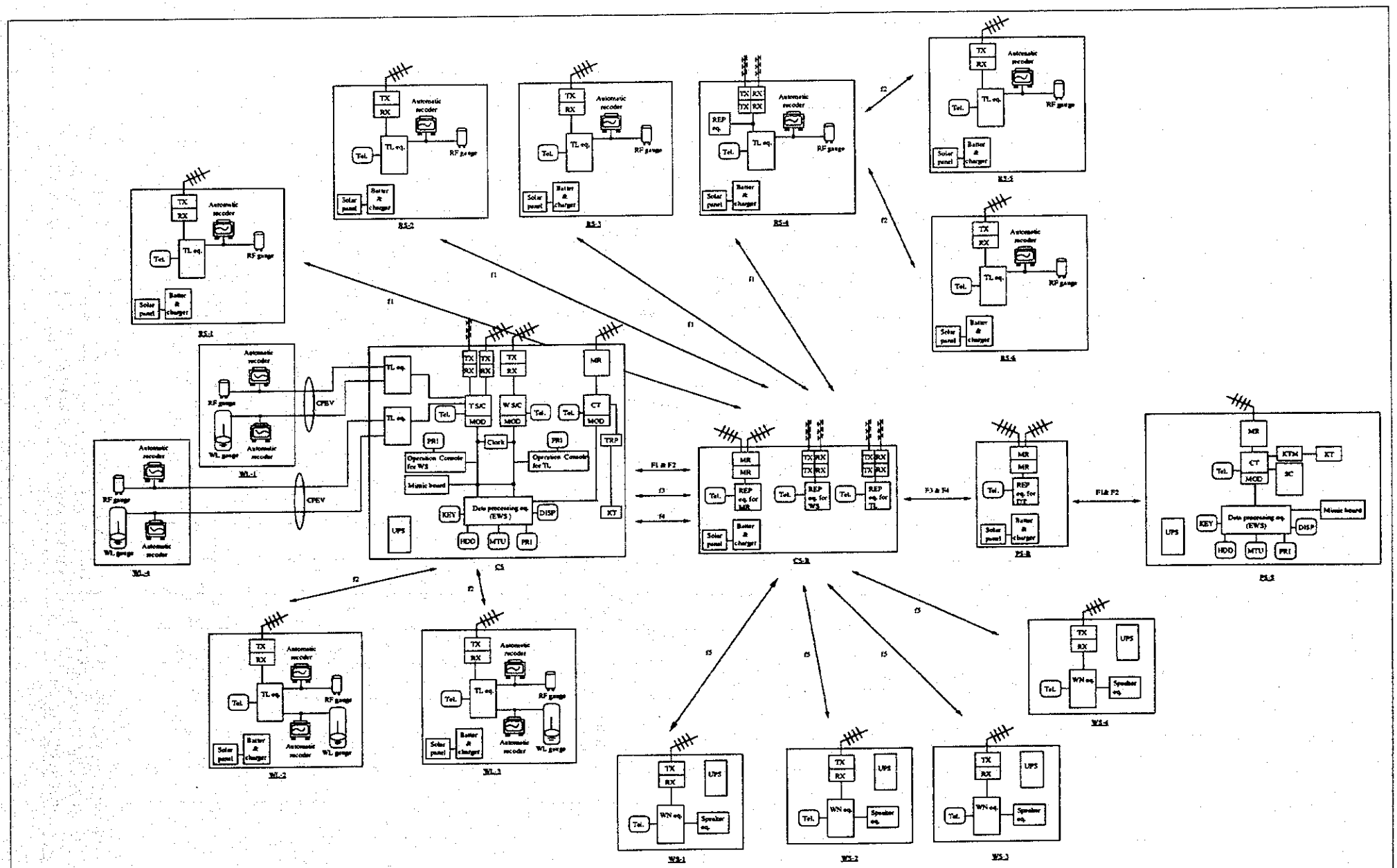
(a) General inspection

DRAWINGS FOR CHAPTER 7

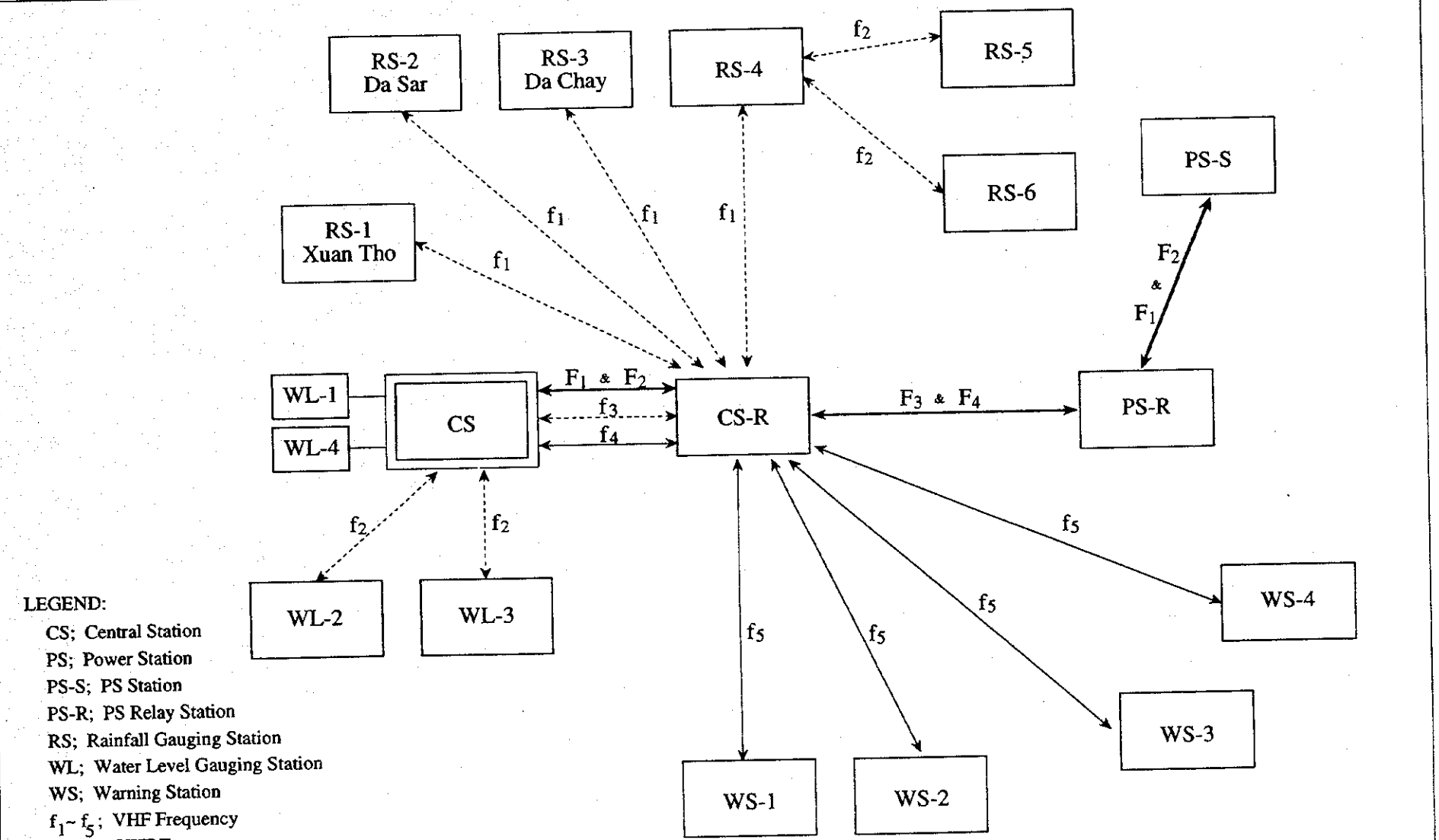
HYDROLOGICAL DATA ACQUISITION SYSTEM



FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 7.1 Location map



FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 7. 2 System Block Diagram



FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 7.3 Frequency allocation

JICA