

THE REPUBLIC OF ECUADOR

C. R. I. M.

Centro de Rehabilitación de Manabí

WATER TRANSBASIN PROJECT FOR CHONE - PORTOVIEJO RIVER BASINS

TENDER DOCUMENTS

FOR

MECHANICAL AND ELECTRICAL EQUIPMENT

FOR

SEVERINO PUMPING STATION, CONGUILLO INLET AND

POZA HONDA INLET

PACKAGE 3

VOLUME - III

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VOLUME - III

- GENERAL SPECIFICATION
- TECHNICAL SPECIFICATIONS

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REPUBLIC OF ECUADOR

OECF LOAN No. _____

CENTRO DE REHABILITACIÓN DE MANABÍ

C R M

WATER TRANSBASIN PROJECT FOR CHONE-PORTOVIEJO RIVER BASINS

INTERNATIONAL TENDERING No. _____

TENDER DOCUMENTS

FOR

MECHANICAL AND ELECTRICAL EQUIPMENT

FOR

SEVERINO PUMPING STATION, CONGUILLO INLET AND POZA HONDA INLET
(CONTRACT PACKAGE-3)

SUMMARY TABLE OF CONTENTS

VOLUME-I

- : CONVOKING
- PART-I, SECTION 1 : INSTRUCTIONS TO TENDERERS
- PART-II, SECTIONS-1,2&3 : DRAFT CONTRACT, GENERAL DISPOSITIONS AND SPECIAL CONDITIONS.
- PART-III : PRINCIPLES AND CRITERIA FOR THE EVALUATION OF THE TENDERS.
- PART IV : COMMITMENT, TRANSFER AND REIMBURSEMENT PROCEDURES OF OECF

VOLUME-II

- : PRESENTATION AND COMMITMENT LETTER
- : FORMS OF TENDER.

VOLUME-III

- PART-I : GENERAL SPECIFICATIONS
- PART-II : TECHNICAL SPECIFICATIONS

VOLUME-IV

- : TENDER DRAWINGS

REPUBLIC OF ECUADOR

OECF LOAN No. _____

CENTRO DE REHABILITACIÓN DE MANABÍ
C R M

THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS

INTERNATIONAL TENDERING No. _____

TENDER DOCUMENTS
FOR
MECHANICAL AND ELECTRICAL EQUIPMENT
FOR
SEVERINO PUMPING STATION, CONGUILLO INLET AND POZA HONDA INLET
(CONTRACT PACKAGE-3)

VOLUME-III
TABLE OF CONTENTS

PART - I: GENERAL SPECIFICATIONS	Page
GS.1 GENERAL.....	GS-1
GS.1.1 General Description of the Project.....	GS-1
GS.1.2 Scope of Works.....	GS-2
GS.1.3 Works to be Executed by The Employer of Other Contractors.....	GS-2
GS.1.4 Contract Terminal Points.....	GS-3
GS.1.5 Instruction to Project Staff.....	GS-4
GS.1.6 Access to Site.....	GS-4
GS.1.7 Climatic Conditions.....	GS-5
GS.1.8 Water Conditions.....	GS-7
GS.2 DRAWINGS AND MANUALS.....	GS-7
GS.2.1 Drawings.....	GS-7
GS.2.2 Test Procedure Instructions.....	GS-11
GS.2.3 Instruction Manuals.....	GS-11
GS.2.4 Number of Document Submission.....	GS-12

	Page
GS.3 SCHEDULE AND REPORTS	GS-13
GS.3.1 Commencement, Carrying Out and Completion of Works	GS-13
GS.3.2 Liquidated Damages	GS-14
GS.3.3 Construction Programme	GS-14
GS.3.4 Progress Reports.....	GS-15
GS.3.5 Photographic and Video Documentaries	GS-15
GS.3.6 Weekly and Monthly Work Schedules During Erection.....	GS-15
GS.3.7 Joint Progress Meeting.....	GS-16
GS.4 GENERAL PROVISIONS AND TEMPORARY FACILITIES	GS-16
GS.4.1 Cooperation with Other Contractors.....	GS-16
GS.4.2 Bench Marks	GS-16
GS.4.3 Sanitary Arrangements and Clearing of Site.....	GS-16
GS.4.4 Precautions for Safety.....	GS-17
GS.4.5 Temporary Facilities.....	GS-19
GS.5 STANDARDS AND DESIGN BASIS.....	GS-21
GS.5.1 Method of Procedure for Design.....	GS-21
GS.5.2 Standards	GS-21
GS.5.3 Units of Measurement.....	GS-22
GS.5.4 Frequency.....	GS-22
GS.5.5 Insulation Levels.....	GS-22
GS.5.6 Auxiliary Electricity Supplies.....	GS-22
GS.5.7 Grounding.....	GS-23
GS.5.8 Labels for Equipment.....	GS-23
GS.5.9 Change to Equipment or Material.....	GS-24
GS.5.10 Tropicalization.....	GS-24
GS.6 MECHANICAL AND STRUCTURAL WORKS	GS-24
GS.6.1 Working Stresses and Design	GS-24
GS.6.2 Balance.....	GS-26
GS.6.3 Workmanship and Materials.....	GS-26
GS.6.4 Protection, Cleaning and Painting	GS-32
GS.6.5 Embedded Metalwork, Opening, etc.	GS-33
GS.7 ANCILLARY ELECTRICAL EQUIPMENT AND INSTRUMENTS.....	GS-34
GS.7.1 Fuses.....	GS-34
GS.7.2 Motors and Contacts.....	GS-34
GS.7.3 Control Devices	GS-35
GS.7.4 Limit Switches	GS-36

	Page
GS.7.5 Auxiliary Switches.....	GS-36
GS.7.6 Electrical Relays.....	GS-36
GS.7.7 Indicating Instruments.....	GS-37
GS.7.8 Indicating Lamps.....	GS-39
GS.7.9 Enclosures for Electrical and Control Equipment	GS-40
GS.7.10 Wiring and Wiring Accessories	GS-41
GS.7.11 Cabling.....	GS-43
GS.7.12 Terminal Strips.....	GS-45
GS.7.13 Grounding of Equipment	GS-45
GS.8 PARTICULAR REQUIREMENT FOR OUTDOOR ELECTRICAL PLANT.....	GS-45
GS.8.1 General Requirements for Outdoor Electrical Plant.....	GS-45
GS.8.2 Marking.....	GS-46
GS.8.3 Bolts and Nuts	GS-46
GS.8.4 Galvanizing.....	GS-47
GS.9 PACKING, DELIVERY AND STORAGE.....	GS-48
GS.9.1 Packing.....	GS-48
GS.9.2 Delivery	GS-50
GS.9.3 Storage at Site	GS-50
GS.10 MAINTENANCE TOOLS AND SPARE PARTS.....	GS-51
GS.10.1 Maintenance Tools.....	GS-51
GS.10.2 Spare Parts.....	GS-52
GS.11 TESTS AND INSPECTIONS.....	GS-53
GS.11.1 Tests at Shop	GS-53
GS.11.2 Tests at Site.....	GS-53
GS.11.3 Test Reports	GS-55
GS.11.4 Employer's Shop Inspection	GS-55

PART - II: TECHNICAL SPECIFICATIONS

SECTION-I: SEVERINO PUMPING STATION

Subsection A	Main Pumps and Valves.....	A-1
A.1	General	A-1
A.2	Main Pumps.....	A-3
A.3	Non-Return Valves.....	A-10
A.4	Guard Valves	A-13

		Page
Subsection B	Electric Motors.....	B-1
B.1	General	B-1
B.2	Motors	B-1
B.3	Control System.....	B-6
B.4	Cooling Water Supply for Pump Motor Units.....	B-9
B.5	Motor Control Center	B-10
B.6	Accessories.....	B-11
B.7	Spare Parts	B-12
B.8	Tests	B-12
Subsection C	Transformers.....	C-1
C.1	General	C-1
C.2	10,000 KVA Transformer.....	C-2
C.3	1,000 KVA Transformer	C-8
C.4	300 KVA Transformer.....	C-10
Subsection D	Static Condensers	D-1
D.1	General	D-1
D.2	Static Condenser Set	D-1
Subsection E	Switchgear and Control Equipment.....	E-1
E.1	General	E-1
E.2	138 KV Switchgear	E-4
E.3	13.8 KV Switchgear	E-11
E.4	4.16 KV Switchgear	E-15
E.5	Low Tension Switchgear.....	E-24
E.6	Control Switchboard.....	E-27
E.7	Water Level and Flow Indicators.....	E-46
E.8	Erection.....	E-47
Subsection F	Ancillary Equipment	F-1
F.1	General	F-1
F.2	Overhead Travelling Cranes.....	F-1
F.3	Drainage Pumping Systems.....	F-6
F.4	Machines and Tools for Repair Shop and Others.....	F-10
F.5	Storage Battery	F-12
F.6	Oil Handling and Purifying Equipment.....	F-13
F.7	Diesel Engine Generator Set	F-16

		Page
Subsection G	Miscellaneous Materials	G-1
G.1	General	G-1
G.2	Electrical Conductors and Fittings.....	G-1
G.3	Insulators and Fittings	G-5
G.4	Steel Structures and Towers	G-7
G.5	Other Materials.....	G-10
G.6	Erection.....	G-11
Subsection H	13.8 KV Distribution Line.....	H-1
H.1	General	H-1
H.2	Distribution Line Materials	H-1
H.3	Receiving Facilities.....	H-6
H.4	Test.....	H-8
H.5	Erection.....	H-9
Subsection I	138 kV Transmission Line	I-1
I.1	Conductors, Overhead Earthwire and Fittings.....	I-1
I.2	Insulators and Fittings	I-5
I.3	Towers.....	I-11
I.4	Tools, Appliance and Materials for Maintenance Use.....	I-23
I.5	Erection.....	I-26
Subsection J	Powerline Carrier Telephone System	J-1
J.1	General	J-1
J.2	Powerline Carrier Terminal Equipment.....	J-3
J.3	Line Traps	J-8
J.4	Coupling Capacitor Potential Device.....	J-9
J.5	Coupling Device.....	J-10
J.6	Power Supply Unit.....	J-12
J.7	Telephone Wire.....	J-13
J.8	Tests	J-14
Subsection K	Intake Trash Racks and Rake	K-1
K.1	General	K-1
K.2	Design Loads and Stresses.....	K-2
K.3	Detailed Requirements for Trash Racks	K-3
K.4	Detailed Requirements for Rake.....	K-3
K.5	Spare Parts	K-4
K.6	Shop Assembly and Test	K-4
K.7	Installation.....	K-5

		Page
Subsection L	Intake Gates and Gantry Crane	L-1
L.1	General	L-1
L.2	Design Loads and Stresses	L-2
L.3	Detailed Requirements for Gates	L-5
L.4	Detailed Requirements for Guide Frames	L-7
L.5	Detailed Requirements for Gantry Crane	L-9
L.6	Detailed Requirements for Lifting Beam	L-15
L.7.	Spare Parts	L-15
L.8	Shop Assembly and Test	L-15
L.9	Installation	L-16
Subsection M	Discharge Penstocks	M-1
M.1	General	M-1
M.2	Design Loads and Stresses	M-1
M.3	Fabrication	M-6
M.4.	Spare Parts	M-8
M.5	Tests and Inspections	M-8
M.6	Installation	M-9

SECTION-2: CONGUILLO INLET

Subsection N	Conguillo Inlet, Outlet Facilities	N-1
N.1	General	N-1
N.2	Outlet Valves	N-2
N.3	Guard Valves	N-5
N.4	Steel Pipes	N-6
N.5	Drain Pump and Water Level Detectors	N-8
N.6	Diesel Engine Generator Set	N-10
N.7	Control System and Controls	N-12
N.8	Shop Assembly and Test	N-14
N.9	Installation	N-15

SECTION-3: POZA HONDA INLET

Subsection	O	Poza Honda Inlet, Outlet Facilities	O-1
	O.1	General	O-1
	O.2	Inlet Fixed Transhrack.....	O-2
	O.3	Outlet Valves.....	O-4
	O.4	Guard Valves	O-5
	O.5	Steel Pipes.....	O-7
	O.6	Drain Pump and Water Level Detectors.....	O-8
	O.7	Diesel Engine Generator Set	O-10
	O.8	Control System and Controls.....	O-10
	O.9	Shop Assembly and Test.....	O-12
	O.10	Installation.....	O-13

PART - I

GENERAL SPECIFICATIONS

PART-1

GENERAL SPECIFICATIONS

GS.1 GENERAL

GS.1.1 General Description of the Project

The Water Transbasin Project for Chone-Portoviejo River Basin is planned to supply water for domestic and irrigation water to Chone and Portoviejo river basins.

The main schemes of the project are involved in three (3) water transbasin schemes, as summarized below.

Transbasin	Capacity	Remarks
Daule Peripa to La Esperanza	18 m ³ /s	Gravity flow
La Esperanza to Poza Honda	16 m ³ /s	Pumping up
Poza Honda to Mancha Grande	4 m ³ /s	Gravity flow

The first transbasin scheme from Daule Peripa to La Esperanza is necessary to increase substantially the water resources to meet all the water demands in the project area. The second transbasin scheme from La Esperanza to Poza Honda is indispensable to meet water demand mainly for water supply and irrigation in the Portoviejo river basin, in addition to the Poza Honda dam. The third transbasin scheme from Poza Honda to Mancha Grande is also needed to meet water demand in the Chico river basin, mainly to supply El Ceibal water treatment plant and the Chico irrigation system.

Seyerino pumping station and its power supply by the transmission line from Daule Peripa hydroelectric power station are provided for this Project. Severino pumping station has six (6) units of 3.2 m³/sec. - 2,400 kW pumping equipment, control equipment and switchgear.

For receiving the electricity through the said transmission line, the outdoor substation including two (2) banks of transformers and switchgear are provided in the vicinity of the pumping station. The transmission line is 138 kV single overhead circuit, total length in about 34 km and transmission capacity in 20 MW. Outlet facilities are provided at both Conguillo and Poza Honda Inlets.

GS.1.2 Scope of Works

This Contract Package 3 shall include the designing, manufacturing, supplying, testing before shipment, finishing, painting, packing for export, insuring, shipping, delivering to the ports of destination, landing, custom clearing, transport to Site, site storing, erecting, installing, testing and cooperation in the commissioning and maintaining of all following works, but not limited to:

- (a) Six unit of 3.2 m³/sec. - 2,400 kW pumping equipment including main pumps and motors, valves, transformers, static condensers, switchgear and control equipment, and ancillary equipment for Severino pumping station, along with extension of outdoor switchgear and control equipment at the Daule Peripa hydroelectric power station.
- (b) One set of power line carrier telephone equipment between the Daule Peripa hydroelectric power station and the Severino pumping station.
- (c) One circuit of 138 kV transmission line on a single circuit tower approx. 34 km in length between the Daule Peripa hydroelectric power station and the Severino pumping station.
- (d) Intake trash racks and rake, intake gates and gantry crane and discharge penstocks for the Severino pumping station.
- (e) Outlet facilities at both Conguillo and Poza Honda Inlets.

All shall be in accordance with these Specifications in Volume-III, Drawings for Tender in Volume-IV and Forms of Tender and Schedules in Volume-II.

All works incidental to this Contract Package-3 whether specified in detail or not shall be carried out by the Contractor in accordance with these Specifications and the Conditions of Contract in Volume-I herein.

GS.1.3 Works to be Executed by The Employer or Other Contractors

The Employer will arrange for the following necessary works for the completion of the Project, other than those covered under the Contract, and which are to be executed by the Employer or other Contractors:

- (a) Access roads with maintenance therefor.
- (b) Civil and Architectural Works (Contract Package-1 for Daule Peripa-La Esperanza Transbasin and Contract Package-2 for others for the Severino Pumping Station and the Conguillo and Poza Honda Inlet Structures), including provision of foundations, openings, blockouts for anchors and trenches, floor concrete filling and associated metal works for the Pumping Station and Inlet Structures, such as part of coverings, floor plates, sleeves,

embedded metal works including pipes for building works except as specifically provided in the Specifications hereinafter.

- (c) Construction and/or installation of other works such as land formation for the Contractor's stock yard, camp, office and store house, and permanent camps for the Employer and the Engineer, etc.
- (d) Other associated works.

GS.1.4 Contract Terminal Points

The Contract terminal points between this Contract Package 3 and Contracts Packages 1 & 2 and others shall be as mentioned below.

- For Civil Works:

See those in Clause GS.6.5 of the General Specifications.

- For Distribution Lines to permanent camp:

Up to receiving Station in the permanent base camp near the Severino Pumping Station.

- For Transmission Line:

From the termination of 138 Kv double bus of the Daule Peripa Hydropower Station vide the Technical Specifications and the Drawings for Tender attached.

- For Electrical Works at both Inlet Structures:

From the termination of no-fuse breaker of the switch panel to be provided in each control room by civil contractors (However power supply therefor to be provided by portable generators under this Contract).

GS.1.5 Instruction to Project Staff

(a) Instruction to Local Staff

The Contractor shall provide the services by the qualified instructors who will instruct Employer's employees as they will subsequently be responsible for the operation and maintenance of the Plant. The course of instruction shall from time to time be carried out during the erection period for at least three (3) months.

(b) Operation and Maintenance Instruction

At the option of the Employer, the Contractor shall provide the services by two men who are fully skilled in operation and maintenance of machines, controlling equipment and the Plant supplied under the Contract for a period of six (6) months after the date of issue of the Total Provisional Reception Certificate. Such instructors of the Contractor shall assist and advise the Employer's employee on the routine operation and maintenance of the Plant.

(c) The costs of those instruction services shall be quoted in Schedule-V of Volume-II according to the instructions therein.

GS.1.6 Access to Site

The Contractor shall make his own investigation of the prevailing conditions of available public and/or private roads and of clearances, restrictions, bridge-load limits, and other limitations that affect or may affect transportation and ingress/egress at the Site.

The Contractor shall use every reasonable means to ensure that all loading limits and other limitations on roads are observed, and in the event of it being necessary to move any extraordinary load of equipment or pre-construction unit or part of the Works, the Contractor shall before moving such extraordinary load obtain all necessary permits and approvals from authorities and comply with all other lawful requirements.

The Contractor shall abide by all limitations, laws and regulations relating to the use of public transportation routes. The Contractor shall make any necessary repair or replacement as the case may be to any structure on route which is damaged by the Contractor as the result of his own negligence. Such repair or replacements shall be satisfactory to the appropriate government authorities.

The following are information for reference only;

(a) Air Ports

- There are three air ports around the Project site(s), named Manta, Portoviejo and Guayaquil, which are linking with Quito; the capital of Republic of Ecuador.

(b) Sea Ports

- There are two sea ports at Pacific Ocean side named Manta and Guayaquil Ports.

(c) Roads

- There is no restriction due to road tunnel and clearance maximum high for truck in 4.0m. Asphalt-paved roads limiting vehicle's weight of 24.6 tons are available from both Manta and Guayaquil Ports to the Project site(s).
- Distance from Manta Port to the site (Severino Pumping Station): Approx. 93 km, and from Guayaquil Port to the site (Severino Pumping Station): Approx. 213 km via Pichincha, and 257 km via Portoviejo respectively.
- Width of the road: 3.35 m and shoulder in 2.0 m.
- Bridges: Several bridges exist on the route, design loads of which are approx. 32.0 tons

GS.1.7 Climatic Conditions

The Project site is situated in an area having tropical or semi-tropical climate. A year will be divided into dry and wet seasons, lasting from June to December and January to May respectively.

For the convenience of Tenderers, a climatological summary will be given as follows;

(a) Rainfall

Mean monthly precipitation in millimeter at Dos Bocas meteorological gauge station where locates in the catchment area of La Esperanza Dam is as follows:

Dry :	June to Dec.	Max.	454 (Dec.)
		Min.	0.0
Wet :	Jan. to May	Max.	754 (Jan.)
		Min.	0.0 (May)
Annual Total :		Max.	3,600
		Min.	611
		Ave.	1,518

(b) Temperature

Mean monthly, mean monthly max. and min. atmospheric temperatures in degree Celsius at Daule Peripa has been reported as below:

	Mean	Max.	Min.
Jan	27.3	34.3	19.6
Feb.	26.1	34.3	18.8
Mar	26.9	34.9	19.5
Apr.	27.0	34.5	19.6
May	26.7	34.2	19.9
Jun.	25.6	34.4	20.1
Jul.	25.1	34.6	18.9
Aug.	26.1	35.2	17.2
Sept.	26.3	35.5	17.8
Oct.	25.9	36.0	19.1
Nov.	25.9	35.3	18.5
Dec.	26.0	35.0	19.5

(c) Humidity

Mean annual relative humidity is 87 percent at Daule Peripa and mean monthly relative humidities vary from 70 percent on July to 97 percent on December.

(d) Wind velocity

The annual average wind velocity at Daule Peripa is 1.7 m per sec. and the maximum and minimum wind velocities are 3.5 m/s and 0.1 m/s respectively.

GS.1.8 Water Conditions

The existing water quality in the reservoirs near Project sites are below for reference;

Existing Water Quality Parameters in the Reservoirs

Parameter	Unit	Daule Peripa	La Esperanza	Poza Honda
Total Coliforms	/100 ml	2,320	1,320	144
Fecal Coliforms	/100 ml	+	+	+
BOD	mg/l	10.01	6.20	8.95
Dissolved Oxygen	mg/l	2.6	7.15	5.47
PH	unit	7.5	7.4	7.7
Chlorides	mg/l	18	23.16	14.67
Fluorides	mg/l	0.0	0.0	0.0
Color	units	2.66	3.50	3.00
Turbidity	units	8.16	7.98	6.67
Total Dis. Sol.	mg/l	96.66	356.16	211.13
Total Hardness	mg/l	52.00	182.00	116.00
Borum-Total	mg/l	-	-	-
Manganese-Total	mg/l	0.0	0.0	0.0
Iron as Fe	mg/l	0.15	0.25	0.15
Sodium	mg/l	15.83	38.65	14.67
Sulphate	mg/l	0.0	53.00	14.00
Nitrates	mg/l	0.90	1.22	1.04
Cadmium	mg/l	0.0	0.0	0.0
Calcium	mg/l	17.03	44.16	26.10
Potassium	mg/l	0.0	4.0	0.0
Magnesium	mg/l	6.83	17.48	11.00
Conductivity	Umohs/cm	102.26	494.22	342.60

Note: Data from water quality analysis (table 1), in the original Laboratory report. JICA/CRM-1994

GS.2 DRAWINGS AND MANUALS

GS.2.1 Drawings

(1) General

The Contractor shall understand that the award of Contract does not imply the approval of drawings/documents prepared for and submitted with the Tender unless otherwise incorporated into the Contract.

(2) **Tender Drawings**

Tender Drawings are for tendering purpose only. Provided that after the Contract Agreement was concluded, the Contractor may use the Tender Drawings including those adjusted at the time of Contract negotiation, for preparing Drawings for approval as provided hereunder.

(3) **Drawings for approval**

Before manufacturing the equipment and site construction works are to commence, the dimensioned drawings and diagrams in A1 size indicating English Language at lower line of main Spanish Language, and showing all details of the equipment and materials to be used as well as all arrangement related to the Works shall be submitted to the Engineer for approval and to the Employer simultaneously. A blank in 200 mm wide by 100 mm high shall be kept unoccupied above the title block of drawings for the Engineer's Comments. In any case, these drawings shall be submitted in sufficient time allowance to permit corrections and/or modifications to be made, if such are deemed to be necessary and/or are instructed by the Engineer, without delaying the completion of the Works. The drawings which are required to be modified as necessary by the Engineer shall be resubmitted for approval.

When the Contractor prepares the Construction Programme as required in Clause GS.3.3, he shall make allowance for and indicate on the schedule, the time for approval of drawings by the Engineer. A period of at least four (4) weeks after receipt by the Engineer should be allowed for such approval and another one (1) week for return mail. Claims or extensions of time shall not be permitted on account of the late submission of drawings to the Engineer or for delays caused by drawings being returned not approved but for resubmission by the Engineer.

(4) **Approved Drawings and Reference Drawings for Works**

Upon approval by the Engineer, the drawings shall be submitted to the Engineer and the Employer, indicating stamp as For Work Drawings. The Contractor will be required to submit back connection wiring diagrams for reference in the same manner as the Approved Drawings. Only approved drawings can be used for manufacturing or assembly purpose.

Should any modification is required with the drawings, however, the Engineer may instruct the Contractor to do so and the drawings so modified shall be resubmitted.

It shall be understood that approval of the drawings by the Engineer will not exonerate the Contractor from any of his liabilities under the Contract.

(5) Manner of submission

All drawings submitted for approval or sent to the Employer or the Engineer for any other reasons shall be sent by registered mail with quickest possible means.

The Engineer will return one copy marked and signed with one of the following classifications.

"APPROVED"

"APPROVED WITH MODIFICATION AS MARKED IN RED"

"RESUBMIT AFTER MAKING CORRECTIONS"

"DISAPPROVED FOR REASONS NOTED"

Upon receipt of drawings and documents which have been marked "APPROVED" and "APPROVED WITH MODIFICATION", the Contractor will be authorized to proceed with the Works covered by such drawings and documents which may be subject to making any correction(s) if indicated thereon by the Engineer. All approved Drawings shall be maintained at the Contractor's respective site office in proper order.

When the returned drawings and documents have been marked "RESUBMIT" or "DISAPPROVED", the Contractor shall make the necessary corrections and/or revisions to the drawings and documents in timely manner and shall resubmit them to the Engineer. When the returned drawings and documents have been resubmitted for approval, the Engineer will try to complete his review and/or approval of the drawings and documents within fifteen (15) working days, however, this will depend on the number and complexity of the corrections/revisions which have to be checked. This procedure will continue until the drawings and documents have eventually been marked as shown in "APPROVED" or "APPROVED WITH MODIFICATION", at which time they will become part of the Contract Documents.

After all items of the Works have been manufactured and erected, bound prints and negatives of drawings As Built for the Project shall be submitted to the Employer and the Engineer before issuance of the Total Provisional Reception Certificate.

Negatives of drawings to be submitted to the Employer shall be of "Mylar film" or other approved permanent transparent materials, and those to be Engineer shall be of microfilm.

(6) Schedule for Submission of Drawings

The Contractor shall submit the following drawings for the Engineer's approval within the times stated hereunder, reckoned in calendar months from the Date indicated in the Commencement Order in each case.

(a) Three (3) months

(i) Pumping and Hydromechanical Equipment

- General layout drawings of all Plant
- Detailed drawings and data related to Civil Works such as pipes, anchors for the plant, traverser rails of overhead and gantry cranes, etc. to be embedded in the first stage concrete. These drawings shall also include the foundations of the Plant, and locations and sizes of all blockouts required in the concrete work.

(ii) Transmission line

- Check survey results with a sag template and the tower site cross section for the transmission line
- Design drawings for transmission line towers
- Detailed specifications and drawings of conductors, groundwires, insulator sets and their fittings for transmission lines
- Temperature-tension-sag table for transmission lines

(b) Six (6) months

(i) Pumping and Hydromechanical Equipment

- Arrangement drawings of the Plant and their ancillaries including water, oil and air pipework
- Single line diagrams of all Plant
- Diagrams of all piping system

(ii) Transmission Line

- Soil investigation results at tower locations
- Design calculations of each foundation
- Drawings of foundation
- Table of volume of excavation and concrete of foundation
- Weight list of reinforcement bars for foundation

(c) Eight (8) months

(i) Pumping and Hydromechanical Equipment

- Dimensioned drawings showing the construction details of all main components.
- Elementary circuit diagrams in A4 size (210 mm x 297 mm) of all electrical equipment under the Contract.

GS.2.2 Test Procedure Instructions

The Contractor shall submit to the Engineer for approval, during or immediately following the submission of drawings, test procedure instructions for each test item to be performed during manufacture and Test on Completion. Instructions shall define sequence of tests, equipment to be used, operation procedures to be followed and detailed procedures for conducting the tests, and as far as applicable shall contain performance guarantees, design values, technical particulars or any other standard data for testing to be treated as the criteria for evaluation of each test. Instructions shall be submitted for approval and distributed in the same manner for drawings as set out in the previous clause.

GS.2.3 Instruction Manuals

The Contractor shall submit to the Engineer for approval the instruction manuals for erection before the delivery of the Plant and operation and maintenance manuals within six (6) months before the commission of the respective equipment.

Instruction manuals shall describe in detail erection procedure and use of all erection equipment and measurement devices. Procedure for assembling, adjusting, operating and dismantling of each component system and machine shall be described and illustrated.

Maintenance of each component shall be described in detail including the recommended frequency of inspections and lubrication. The instruction manuals shall include easily readable diagrammatic drawings of the equipment to facilitate understanding the descriptive information. The Contractor shall, in preparing the instruction manuals, take into account the lack of experience and familiarity of the Employer's operating personnel with those types of equipment.

The instruction manuals shall include a complete list of all drawings and documents prepared for this Contract, spare parts list, and parts list for each item of equipment. The parts list shall include manufacturer's code and serial numbers and ordering instruction, and shall be detailed as far as possible for only the equipment supplied.

GS.2.4 Number of Document Submission

Number of drawings and instruction manuals to be submitted to the Employer and the Engineer shall be as follows:

	To the Employer	To the Engineer
• <u>During the course of Construction work</u>		
- Drawings for approval	2 copies	5 copies
- Approved drawings	3 copies	3 copies
- Test Procedure Instruction for approval	2 sets	5 sets
- Approved Test Procedure	3 sets	3 sets
- Manuals for approval	2 sets	5 sets
- Approved manuals in complete sets of bound prints	5 sets	2 sets
• <u>After Completion of the Works</u>		
- Complete set of negatives of drawings	1 set for prototype	1 set for microfilm
- Complete sets of bound prints of drawings, reduced to A3 size (297 mm x 420 mm)	4 sets	1 set

Further copies of particular drawings in the course of construction work are to be provided, if required.

GS.3 SCHEDULE AND REPORTS

GS.3.1 Commencement, Carrying Out and Completion of Works

- (a) The Contractor shall start and/or complete the respective works from and/or within the number of months specified herein, counting from the Date indicated in the Commencement Order.

Works

Targets

(1) Severino Pumping Station

- | | |
|---|-------------------------|
| -Start of installation of dewatering pipes, balance pipes, drain pipes, etc. where embedded into concrete (continue stepwise according to concrete lift schedule) | From end of 7th months |
| -Start of installation in 3-months of penstocks where locate beneath ground EL.70.0m. | From end of 13th months |
| -Start of installation of overhead travelling cranes | From end of 23rd months |
| -Start of dry tests in 2-months, after having finished all individual tests, etc. | From end of 38th months |
| -Start of tests on completion in 2-months under watery condition, following dry tests. | From end of 40th months |
| -Ready for handing over the works | Within 42 months |

(2) Conguillo Inlet

- | | |
|--|-------------------------|
| -Completion of installation and dry tests | By end of 34h months |
| -Start of tests on completion in 1-month under watery condition, after having finished all related civil works | From end of 36th months |
| -Ready for handing over the Works | within 37 months |

(3) Poza Honda Inlet

- | | |
|--|-------------------------|
| -Completion of installation and dry tests | By end of 37th months |
| -Start of tests on completion in 1-month under watery condition, after having finished all related civil works | From end of 41th months |
| -Ready for handing over the works | Within 42 months |

- (b) For preparing the construction Schedule, the Contractor shall assume the periods or progress rates required by the Contractor for civil and other contractors referring a tentative time schedule shown on the attached Construction Schedule with note that the periods or progress rates given here are approximate and no claim for additional payment shall be made by the Contractor as long as such periods or progress rates are changed not so as to affect adversely to the Works of the Contractor.

- (c) Test filling of water into pumping equipment through suction pondage shall be done as directed by the Engineer under cooperation with other contractors.

The test filling will include subsequent dewatering for inspecting the performance of the said waterway structures, and rewatering thereto, on which the programme will be intimated by the Engineer.

The Contractor shall, as and when called upon by the Engineer in writing, carry out the said test filling, dewatering, inspection and rewatering, and give assistance required by the Engineer to fulfill the test filling programme.

GS.3.2 Liquidated Damages

Should the Contractor have failed to complete any Section of the work and to complete the whole of the works within the period as specified in Clause GS.3.1 or each other period or the dates for the respective works as may be allowed pursuant to Clause II.1.6 (Period of Completion) of the Draft Contract in Volume-I, there shall be deducted from the Contract Price, as liquidated damages and not or by way of penalty, one third of one per thousand per day of such Section or Sections of the Contract Price or the amount specified elsewhere in the Contract, for each calendar day between the dates set forth in Clause GS.3.1 for the Section or Sections of the Works and actual date of completion.

However, the total accumulation of the liquidated damages for delay, in any case, shall not exceed five (5) percent of the Contract Price.

For further details, see Clause II.1.7 of the Draft Contract and Clause II.2.10 of the General Dispositions; both in Volume-I.

GS.3.3 Construction Programme

The Contractor shall within one (1) month from the Date indicated in the Commencement Order submit the Construction Programme to the Engineer for his approval in five (5) copies and to the Employer in two (2) copies.

The Contractor shall pay his full attention on the Works by the Contractor for other contractor's works, intimately related with the Works under the Contract, and shall clearly indicate them on the Construction Programme.

The Contractor shall also describe the conditions of working shifts, if necessary to execute in night works and/or Saturday & holiday works, to be applied in the respective works progress of his Construction Programme.

The Construction Programme to be prepared in the form of CPM network shall be compiled in such manner so that activities shall consist of not only actual work operations but also include time allowances for the preparation and approval of drawings and samples, procurement and shipping of materials and equipment, installation of all items, taking into account possible delays caused by flood and inclement weather, religious customs and holidays, etc. The critical path shall be clearly marked on the CPM network.

The CPM network shall be closely monitored and kept current. In addition, it shall be formally updated bi-monthly by the Contractor, or as directed by the Engineer, and submitted to the Engineer for review and comments.

GS.3.4 Progress Reports

The Contractor shall, before the tenth (10) day of each calendar month, submit five (5) copies of monthly progress report; three (3) to the Employer and two (2) to the Engineer in a format acceptable to the Engineer detailing the progress of the works accomplished during the preceding month. The report shall contain general description of major activities, percentage progress of each main activity, local and expatriate manpower, etc.

GS.3.5 Photographic and Video Documentaries

The Contractor shall, according to Clause II.2.5.5 of the General Dispositions of Volume-I and throughout the contractual period, submit to the Engineer colour photographs and video documentaries which clearly show the work progress being made. They shall be taken during manufacturing and erection of each major component of the Works and as directed by the Engineer. The photographs shall be submitted to the Employer and the Engineer, attaching to the monthly progress report in Clause GS.3.4 (Progress Report).

Upon completion of the Project, the Contractor shall submit two (2) sets to the Employer and one (1) set to the Engineer, of colour photographs adequately edited in a booklet form and video documentary in a few volumes showing the entire sequence of the Works from the start up to the completion.

GS.3.6 Weekly and Monthly Work Schedules During Erection

The Contractor shall submit a required number of copies of a written weekly and monthly schedule in a form approved by the Engineer for the main work items in schedules vs. progress. Each schedule shall contain appropriate comments in regard to the works on each major activity.

GS.3.7 Joint Progress Meeting

A regular meeting among the key personnel of the Engineer and the Contractor may be held once a week or fortnight as agreed among the parties concerned to discuss the progress made, the works to be done and any problem having a direct bearing on the work activities. The Employer may attend such meetings or hold separate meetings whenever necessary.

GS.4 GENERAL PROVISIONS AND TEMPORARY FACILITIES

GS.4.1 Cooperation with Other Contractors

The Works on the Site will also be undertaken by other contractors. The Contractor shall not have exclusive occupancies of the affected localities at the Site. The Contractor shall cooperate with other contractors for smooth execution and progress of the Project Works. Any discrepancies or conflicts, which may arise between the Contractor and other contractors with regard to their respective works, will be resolved by the Employer and Engineer, and whose decision shall be final and binding on all parties concerned.

When ordered by the Engineer, the Contractor shall make available to other contractors his own plant and equipment whenever practicable at the same rate and conditions as would be charged to the Employer.

GS.4.2 Bench Marks

The Employer/Engineer will establish bench marks and reference survey pegs at the each work site. The Contractor may establish additional temporary bench marks in each work site and transmission line for his own convenience but each temporary bench marks so established shall be in a location approved by the Engineer, and shall be accurately related to the bench marks established by the other contractors.

GS.4.3 Sanitary Arrangements and Clearing of Site

The Contractor shall keep the Site in a clean and sanitary condition and shall provide and maintain sanitary conveniences for the use of persons employed in the Works to the extent and in the manner and at such places as approved by the Engineer and by any local or other authority concerned, and all persons connected with the Works shall be obliged to use these conveniences.

The Contractor shall also post notices and take such other precaution as may be necessary to keep the Site clean.

Clearing of Site by the Contractor shall not be made without the written approval of the Engineer and shall be kept to a minimum particularly over streams and drains.

GS.4.4 Precautions for Safety

(a) General

The Contractor shall take all necessary precautions against risks of loss of life or of injury to any person employed on the Works or to employees of the Employer and the Engineer or of others or to visitors or to persons having good and sufficient reasons to be about the Works and to this end shall properly safeguard the Works to the satisfaction of the Engineer.

The Contractor shall furthermore take all necessary precautions against damage to the property of the Employer or of others located at or adjacent to the Site.

The Contractor shall at all times comply with any accident prevention regulations and any safety regulations peculiar to the various trades employed on the Works and any safety regulations published by the Government of Ecuador, including the Employer.

The Contractor shall report promptly to the Engineer all accidents involving death of or serious injury to any person, on the Site or resulting from the Contractor's operations.

The Contractor shall appoint a person in charge for Safety. The person in charge shall be qualified in safety and familiar with the type of work being performed, whose assignment shall include initiation of measures for the protection of health and the prevention of accidents and who shall see, by personal inspection, that all safety rules and regulations are enforced.

The Contractor shall hold regularly scheduled safety meetings at least once each month with his engineers, supervisors and foremen. When directed by the Engineer, additional meetings shall be held. The Contractor shall keep the Engineer well informed as to when these meetings are to be held and shall provide the Engineer with a copy of the proposed agenda. The Engineer and the Employer reserve the right to attend any of such meetings.

(b) Fuel

The Contractor shall make arrangement to store and handle fuel to the safe conditions for public in accordance with the laws and security regulations in force relating to the movement, handling, use and storage of fuel.

The Contractor shall obtain all necessary licenses and shall pay all fees and charges in respect of the same as may be necessary for the purpose of moving fuels from place to place and storing the same, and shall carry out all applications to obtain the approval from the authority of the Government of Ecuador.

Above-ground gasoline or liquefied petroleum gas storage tank shall not be permitted to locate within the limit of camp site or closer than 100 m of any building in the Site.

(c) Lighting

In addition to the lighting for the access road provided by the Employer, the Contractor shall provide sufficient lighting at each work site and camp area to ensure that security and safe working conditions are to be established, and further that the Works can be constructed in complete compliance with the Contract, and the complete inspection of all Works in progress can be made by the Engineer.

(d) Fire Fighting Service

The Contractor shall take every precaution to prevent fire occurring on or about the Site and shall provide suitable and adequate fire fighting equipment, for ready use of Works under construction, including his residential quarter, labour camps and ancillary buildings. The Contractor shall maintain such equipment and such additional fire fighting equipment as may elsewhere herein be defined, in efficient condition until the Plant is completed and the Works accepted by the Employer. He shall comply with the laws in force and instructions of the Engineer with respect to the prevention of fires. The Contractor shall be responsible for maintaining fire fighting crew on the Site at all times. An efficient fire alarm system shall be installed and maintained by the Contractor.

The Contractor shall fight diligently any fire which may occur on the Site wherever the fire may originate, with regard to which he shall employ all requisite equipment and manpower up to the limit of his equipment and manpower employed at the Site, including the equipment and manpower of his sub-contractors.

(e) Accident Reports

The Contractor shall, within twenty four (24) hours of the occurrence of any accident at or about the Site or in connection with the execution of the Works, report such accident to the Engineer. The Contractor shall also report such accident to the appropriate authority when it is required by the law. The Contractor shall be required to furnish monthly reports of all accidents to staff, workmen, equipment or plant involving loss of time, giving such information as may be prescribed by the Engineer.

GS.4.5 Temporary Facilities

(a) General

The Contractor shall submit for approval of the Engineer drawings and full particulars of all Temporary Works which the Contractor intends to construct at least thirty (30) calendar days before he desires to commence constructing such works. The Contractor shall also obtain any necessary approval from the Employer or other Government authorities before commencing construction.

On completion of the Works, all Temporary Works constructed by the Contractor, unless otherwise specified or directed by the Engineer, shall be removed from the Site. The Contractor shall make safe all areas affected by the Temporary Works and reinstate natural drainage.

The Contractor shall finish, reinstate, clean up and relinquish parts of the Site at the end of the Period of Maintenance or such earlier times as directed by the Engineer.

(b) Land Preparation

The Employer will according to Clause II.3.2 of Special Conditions in Volume-I allocate and provide for free use of the Contractor land areas of approx. 5,000 sq.m, 1,000 sq.m and 1,000 sq.m for Severino Pumping Station, Conguillo Inlet and Poza Honda Inlet respectively within the designated Project Area. Those required for construction of transmission line will also be provided separately as concluded as the time of Contract negotiation. The Contractor shall accommodate his work force and set up all site storage, offices, store houses, services and facilities within such land areas provided that the use of these lands shall not interfere with any section of the Works or with the works of the other contractors. Provided that if the Contractor's plan and layout are unavoidable to locate some or part of the Temporary Works referred to here above outside the said boundaries but within the designated Project Area, the Contractor shall submit for approval to the Engineer, his proposal on item of the Temporary Works, its location and the date by when such land is required, at least four (4) months prior to commencement of use of such land; the Contractor may assume that the Employer requires at least three (3) months time for arranging for such land.

(c) Construction Power Supply

All electric powers required for the Works at the Site for the Severino Pumping Station and Inlet Structures including those for camps, offices, store houses, lightings and so forth shall be supplied by the Contractor himself by means of provision of sufficient capacity of generating equipment sets at each place. The Contractor shall provide, supply and install all necessary facilities to provide electricity in 220/127 V, 3 phases, 4 wires, 60Hz system for such purposes. The generator set (s) to be provided in the

vicinity of Severino Pumping Station shall have enough capacity to drive two overhead travelling cranes which locate inside building, in addition to those required for installation/ erection of pumps, motors, valves, penstocks and so forth.

The Contractor shall pay keen attention that delay of the Works due to fault of his electric power supply system shall not cause any claim on extension of time for completion of the Works under the Contract.

(d) Water, Gas and Compressed Air Supply

The Contractor shall provide his own arrangement for water, gas and compressed air supply system against his work sites, storage yards, offices, labour camps, staff quarters, etc. at his own expense.

(e) Wireless Telephone Facilities

There will be no centralized telephone system to be installed, maintained and operated within the project area; rather by wireless telephone system of CRM which links CRM head office in Portoviejo and main office around Severino Pumping Station with other satellite offices that will locate at Conguillo Inlet, Membrillo Outlet, Poza Honda Inlet and Mancha Grande Outlet.

The Contractor shall therefore provide and install by himself for his own communication means required to execute the Works at site, though such CRM's system may be available for the Contractor in an emergency case. The Contractor shall make application to get approval on use of frequency band for wireless telephone, etc. to the authorities concerned through CRM.

(f) Medical Service

The Package-2 civil contractor will construct, operate and maintain a clinic with medical man and nurse in the base camp near the Severino Pumping Station, and also provide an ambulance car to transport personnel injured to Hospital in Portoviejo. The Contractor may also receive such service to utilize the facilities at the actual cost. However, the Contractor shall provide all necessary medical cares, at his cost, for all persons employed by him and by any sub-contractor employed by him on the Works including their dependents, in accordance with the terms of the Contract.

(g) Transportation for the Contractor's Personnel

The Contractor shall provide his own arrangement for the transportation of the Contractor's personnel employed by him on the Works at his own cost.

GS.5 STANDARDS AND DESIGN BASIS

GS.5.1 Method of Procedure for Design

As far as it is consistent with the interest of the Works and the results to be attained, orders and methods of prosecuting the Works will be left to discretion of the Contractor, with whom ordinarily the responsibility of such order and methods shall rest provided, however, that the Engineer shall at any time have right to prescribe and control such orders and methods with a view to the safety, rapidity and economy of construction of the Works, and to ensure harmony and cooperation with other contractors.

If required by the Engineer, before commencing the Works or any portion thereof, the Contractor shall furnish the Engineer with full information as to his plans and methods for carrying out the Works or any portion of the Works.

GS.5.2 Standards

American national standards, Japanese industrial standards and the other international standards such as IEC, ISO, etc. shall be used for the Works. Other national standards may be accepted provided that the requirements therein are, in the opinion of the Engineer, better or equivalent to the current issue of those standards above mentioned.

If the Contract Documents conflict in any way with any or all of the above standards or codes, the Contract Documents, upon confirmation of the Engineer, shall have precedence and shall govern.

Design and fabrication standards, all mechanical and electrical equipment, materials and details of installation and inspection shall comply with the requirements and latest revisions of the American, Japanese and International standards or codes or the approved from those given below:-

- (a) American National Standards (ANSI)
- (b) American Society for Testing and Materials (ASTM)
- (c) American Society for Mechanical Engineering (ASME)
- (d) American Institute of Steel Construction (AISC)
- (e) American Welding Standard (AWS)
- (f) National Electrical Manufacturers Association (NEMA)
- (g) Japanese Industrial Standards (JIS)
- (h) Japanese Electro-Technical Committee's Standards (JEC)
- (i) Japanese Technical Standards for Design of Water Gates and Penstocks
- (j) Japanese Technical Standard for Electrical Facilities
- (k) Japan Electrical Manufacturer Association's Standards (JEM)

- (j) Japanese Cable-makers Association Standards (JCS)
- (l) International Electrotechnical Commission (IEC)
- (m) International Organization for Standardization (ISO)
- (o) German Standards (DIN)
- (p) British Standards Institution (BS)
- (q) International Telegraph and Telephone Consultative Committee (CCITT)
- (r) Ecuadorian Standards
- (s) Other standards approved by the Engineer

GS.5.3 Units of Measurement

The metric system of measurement shall be used exclusively for this Contract. Drawings or printed pamphlets in which other units have been used, the equivalent metric measurement shall be marked in addition.

GS.5.4 Frequency

All electrical equipment shall be designed for a frequency of 60 Hz.

GS.5.5 Insulation Levels

The electrical equipment shall withstand the following voltages:

	<u>138 kV</u>	<u>13.8 kV</u>	<u>4.16 kV</u>	<u>220/127V</u>
- Full wave impulse of 1.2 x 50 micro- seconds	650 kV	110 kV	75 kV	-
- Power frequency for one minute	275 kV	34 kV	19 kV	1,500 V

GS.5.6 Auxiliary Electricity Supplies

The power for ancillary equipment and controls shall be as follows:

(a) Alternating Current

- 3-phase, 4-wire, 60 Hz
Voltage 220/127 V
- Voltage variation under rated frequency
and output continuously $\pm 10\%$
- Frequency variation under rated voltage
and output continuously $\pm 5\%$
- Neutral point Solidly
grounded

The 3-phase supply shall be used for power circuits and the single phase supply for lighting, indication, motor controls and similar small power circuits.

(b) Direct Current

125 Volts, 2-wire for essential controls, indication, alarm, emergency lighting, circuit breaker tripping and closing supplies.

All equipment and apparatus shall be capable of operating satisfactorily from minus 20% to plus 30% rated operating voltages.

GS.5.7 Grounding

The grounding systems for the Pumping Station and each inlet structure will be provided under the separate contracts package 1 and 2 as shown on the Drawing for Tender.

Grounding wiring and connections from the equipment, including for all ancillary equipment, motors, motor control centers, control boards, etc., to be installed under the Contract, to the ground studs in secondary concrete and/or the grounding grid buried in the switch yard shall be provided by the Contractor.

GS.5.8 Labels for Equipment

(a) Warning Notices

The Contractor shall provide warning notices and signs associated with the Plant in his supply. Such notices and signs will be required to be in the Spanish language and shall obtain the Employer's approval. Outdoor notices shall be of vitreous enameled steel.

(b) Device Numbers

Every electrical control switch, relay and other device shall be allocated with a device number on the Contractor's comprehensive circuit diagrams. The device number shall be in accordance with ANSI C37.2.

The Contractor shall apply a label of approved form to each electrical device, showing the device number in a legible and permanent manner.

(c) Labels

The Contractor shall provide labels in sufficient numbers, size and detail to permit rapid and positive identification to be made of all pieces of equipment for operational and maintenance purposes. Such labels shall preferably be of engraved plastic laminate.

The wording of each label shall be submitted to the Engineer for approval. The wording shall be in the Spanish language.

GS.5.9 Change to Equipment or Material

The Contractor shall not make any change to the equipment or to the materials to be incorporated in the Plant from those specified or implied in the Contract without the written approval of the Engineer. Such changes or alterations shall in no way be detrimental to the interests of the Employer and shall not result in any increase to the Contract Price.

GS.5.10 Tropicalization

In choosing materials and their finishes, due regard shall be given to the humid tropical conditions under which the Plant will be called upon to work. The Contractor shall submit, details of his practices which have proven satisfactory effect and which he recommends for application on the part of the Works which may be affected by the tropical conditions. The materials and finishes used shall be approved by the Engineer.

GS.6 MECHANICAL AND STRUCTURAL WORKS

GS.6.1 Working Stresses and Design

The design, dimensions and materials or all parts of the Plant shall be such that they will not suffer damage under the most adverse conditions nor result in undue deflections and vibrations which might adversely affect the operation of the equipment. Mechanisms shall be so constructed as to avoid sticking due to rust or corrosion.

All parts which will or may have to be dismantled for purpose of servicing or replacement shall be retained with anti-corrosive fasteners. The type, material and size of all fasteners shall be selected to safely withstand the maximum superimposed direct, alternating, kinetic and thermal loads and all loads induced by workmen when installing or removing the fasteners during the life of the equipment.

Wherever possible, all similar parts, including spare parts, shall be made to gauge and interchangeable. Such parts shall be of the same materials and workmanship and shall be constructed to such tolerances as to enable substitution or replacement from spare parts to be made easily and quickly.

Suitable structural steel bases or frames shall be provided where necessary to transmit all loads imposed by the various parts of the equipment to the concrete foundations. Such bases or frames shall be supplied complete with suitable anchor bolts and shall be so proportioned that the bearing and shearing loads imposed on the concrete foundations will not exceed 60 and 8 kgs per square centimeter respectively.

The Plant shall be designed to minimize the risk of fire and consequential damage, to prevent ingress of vermin, bird, dust and dirt, and accidental contact with electrically energized or moving parts, and shall be capable of continuous operation with minimum attention and maintenance in the exceptionally severe conditions likely to occur in a tropical climate.

Each part of the Plant shall be of such construction and design as to give long and continuous service with low maintenance costs.

Upon request by the Engineer, complete information regarding the design assumptions, loading and operating conditions, deflections and unit stresses used in the design shall be provided by the Contractor.

Ample factors of safety shall be used throughout and especially in the design of all parts subject to alternating stresses or impacts.

For the rotating parts of the main Plant, the maximum stresses caused by runaway speed shall not exceed two thirds of the minimum yield stress of the material.

For all part of the Plant subject to headwater pressure, the maximum stresses resulting from a pressure of 13.0 kg/cm^2 shall not exceed the values shown in the table below.

For all other load bearing parts of the Plant under the respective most severe operating conditions, the unit stresses in the materials shall not exceed the values also shown in the table below.

Maximum Allowable Stresses:

<u>Materials</u>	<u>Stress in Tension</u>	<u>Stress in Compression</u>
- Cast steel, alloy cast steel and forging	One fifth of the ultimate strength or one half of the yield strength, whichever is the smaller	One fifth of the ultimate strength or one half of the yield strength, whichever is the smaller
- Steel plate for principal, in thickness under and equal to 40mm	One fourth of the ultimate strength	One fourth of the ultimate strength

For other materials used in the construction of the Plant, the maximum stresses in tension or compression under the most severe conditions occurring under all possible operating conditions shall not exceed one-third of the yield strength nor one fifth of the ultimate strength of the materials.

Allowable shearing stresses shall not exceed 60 percent of the allowable stress in tension of materials, except that the maximum stress in torsional shear in the main shaft and spindles shall not exceed 50 percent of the allowable stress in tension.

GS.6.2 Balance

Main revolving parts of the pumps and motors shall be truly balanced both statically and dynamically so that, when running at normal speeds and any load and speed up to the maximum, there shall be no harmful vibration due to lack of such balance and the Plant shall operate with the least possible amount of noise.

GS.6.3 Workmanship and Materials

All materials shall be new, the best of their respective kinds and of such as are usual and suitable for works of like character. All materials shall comply with the latest standards for testing materials unless otherwise specified or permitted by the Engineer.

All workmanship shall be of the highest class throughout the Works to ensure smooth and vibration free operation under all possible operating conditions, and the design, dimensions and materials of the parts shall be such that the stresses to which they may be subject shall not render them liable to distortion, undue wear, or damage under the most severe conditions encountered in service.

All parts shall conform to the dimensions shown on and shall be built in accordance with the Approved Drawings. All joints, datum surfaces, and mating components shall be machined

and all castings shall be spot faced for nuts. All machined finishes shall be shown on the Approved Drawing. All screws, bolts, studs and nuts and threads for pipe shall conform to the latest standards of the International Organization for Standardization covering these components and shall either all conform to the standards for metric sizes. The Contractor shall use exclusively the standards and size system presented in his Tender and accepted and subsequently incorporated in this Contract.

(a) Shop Assembly and Tests

All items of the Plant shall, in principle and unless otherwise specified respectively, be assembled in the shop prior to shipment and tests shall be performed by the Contractor as may be required to demonstrate the adequacy of the Plant and its component parts, to the satisfaction of the Engineer. All tests should simulate normal operating conditions as closely as possible. All dismantled parts shall be properly matchmarked and doweled to ensure correct assembly on the Site.

(b) Welding

Wherever welding is specified or permitted, the approved welding process shall be used. For welding on main components, ASME Standard "Boiler and Pressure Vessel Code" section VIII and IX shall be applied. All welders and welding operators shall be fully qualified in accordance with JIS Z3801/Z 3841 or ANSI/AWS D.1.1 and their certificates shall be submitted to the Engineer. The Contractor shall submit to the Engineer necessary welding procedure instructions for approval based on the said Standards. The welding rods shall conform to AWS A5.1 or JIS Z-3211/Z3212, low hydrogen type covering

After the welding process has been approved by the Engineer, the Contractor shall record it on a special drawing which shall thereupon become one of the Drawings of the Contract.

Radiograph inspection shall be carried out by the Contractor when required by the standards or the design criteria employed. All welds which, in the opinion of the Engineer, may be subject to the full stress induced in the adjacent plate, or which, in the opinion of the Engineer, do not appear to conform to the welding standards shall be radiographed.

All defects in welds shall be chipped out to sound metal and such areas shall be magnafluxed or ultrasonically tested to ensure that the defect has been completely removed before repair welding.

Plates to be jointed by welding shall be accurately cut to size and rolled by pressure to the proper curvature which shall be continuous from the edge. Flattening in the curvature along the edges with correction by blows will not be allowed. The dimensions and shape of the edges to be jointed shall be such as to allow thorough fusion and complete penetration, and the edges of

plates shall be properly formed to accommodate the various welding conditions. The surfaces of the plates adjacent to the edge to be welded shall be thoroughly cleaned of all rust, grease and scale to bright metal. All important welding shall be stress-relieved by heat treatment before machining.

(c) Castings

All castings shall be of close grained quality and true to pattern of workmanlike finish and of uniform quality and condition free from blowholes, porosity, flaws, hard spots, shrinkage, defects, cracks or other injurious defects, and shall be satisfactorily cleaned for their intended purposes. Castings defective shall not be repaired, plugged or welded without approval of the Engineer. Such permission will be given only when the defects are small and do not adversely affect the strength, use or machinability of the castings. Excessive segregation of impurities of alloys at critical points in a casting will be cause for its rejection. The largest fillets compatible with the design shall be incorporated wherever a change in section occurs. All castings shall be stress-relieved before machining and again repair by welding.

(d) Forging

The ingots from which the forging are made shall be cast in metal molds. The workmanship shall be first-class in every respect and the forging shall be free from all defects affecting their strength and durability including seams, pipes, flaws, cracks, scales, fins, porosity, hard spots, excessive nonmetallic inclusions and segregation.

The largest fillets compatible with the design shall be incorporated wherever a change in section occurs. All finished surfaces of forging shall be smooth and free from tool marks.

The forging shall be clearly stamped with the heat number in such location as to be readily observed when the forging is assembled in a completed unit.

(e) Piping

Seamless steel pipe and/or copper pipe shall be used for all oil lines. Galvanized steel pipe or copper pipe shall be used for all air or gas lines. Steel pipe shall be used for water lines.

All necessary studs, bolts, screws, nuts, washers, gaskets, packing, supports, etc., required in connection with the field assembly of the piping system, shall be supplied by the Contractor. All gaskets and packing shall be of approved material and of a type that has proven satisfactory effect for the service conditions, to which they will be subject.

(f) Piping Installation

Piping shall be installed in the locations, elevations and to the lines shown on the Approved Drawings. All lines shall be sloped to allow drainage at the low point. Where a branch cannot be drained through fixtures, a drain valve shall be provided on an accessible location.

All piping shall be fitted and assembled to introduce the minimum of stress to the pipe and fittings, and the assembly shall conform to the best piping practice. The Engineer shall be the sole judge of the standard of workmanship. All piping shall be supported as shown on the Approved Drawings. All piping less than 75 mm diameter shall be supported at 2 meter intervals maximum.

All threads shall be accurately and clearly cut and all burrs shall be removed. The same standard of thread system shall be used throughout the Plant.

Where pipe is embedded in concrete, it shall be carefully set to the required lines and grades and securely braced and held so that no movement shall occur during concreting operations.

Copper pipes to be embedded in concrete shall be protected with suitable sleeves.

All piping to be embedded shall be tested and approved in the presence of the Engineer prior to being embedded.

Sleeves for piping in primary concrete or blockout shall be supplied by the Contractor and will be embedded under the Civil Contract where piping passes through a wall, floor or beam, according to the Approved Drawings.

All surfaces of the pipe which come in contact with concrete shall be cleaned prior to placing concrete in order to secure a satisfactory bond.

Pipe unions shall be fitted where necessary to facilitate installation or maintenance of equipment. Junction of copper to ferrous pipes shall be made with bronze adapters.

The Contractor shall schedule and arrange his works for installing pipes and pipe supports in cooperation with the contractor for Civil Work.

(g) Hangers and Supports

The Contractor shall supply and install all pipe hangers, brackets and supports required for support of piping, including drilling and caulking for expansion anchors and any work incidental to the setting of such embedded anchors or inserts in concrete.

Unless otherwise specified, pipe supports shall be spaced at 2-meter centers maximum for steel and 1-meter centers for copper. Piping hangers for copper pipe shall be copperplated and of an approved type. Vertical runs shall be supported by means of pipe clamps or collars at each floor. Hangers and supports shall be painted. Pipe supports to be embedded in concrete shall be made of material, which will not deteriorate, weaken or cause damage to the pipe.

(h) Valves

The Contractor shall provide all valves necessary for the convenient and proper operation, control, testing and maintenance of the Plant in addition to any valve specifically mentioned elsewhere in this Specifications.

The working parts of all valves shall be replaceable and those in contact with water or air shall be made of or faced with corrosion resistant material.

Seals and seats shall be positively fixed so that they cannot become loose in service. The fixing of seals and seats by an interference fit only is not acceptable.

The operating mechanisms shall have means of lubrication and, in the case of isolating valves, position indicators and means of padlocking in the open and closed positions.

All hand operated valves shall close by clockwise rotation of the handwheel which shall be marked to show the direction of closing. Valve handwheels shall be located for safe and convenient operation with extended spindles where necessary to achieve this. All hand operated valves shall be capable of being opened and closed against their maximum working pressure fully unbalanced with a force at the handwheel not exceeding 10.0 kgs/man. If necessary to achieve this, reduction gearing, ball or roller bearings or oversize handwheels shall be provided. Unless otherwise approved, all power operated valves shall also be capable of being operated by hand; if handwheels are provided for this purpose, they shall not rotate when the valve is operated by power.

As far as practicable, all valves for similar service shall be of the same maker and type and be interchangeable.

In the case of all valves having working pressures of more than 13.0 kgf/cm², the components directly subject to fluid pressure including the closing member shall be of steel.

All gate valves for water and air service shall be of a type in which the operating mechanism is not subject to the working fluid.

Valves other than needle type shall not be used permanently for throttling. For such as to adjust flow subdivision in a system, orifice plates or needle valves with fixed stops shall be provided.

Valves for water service may be gate, butterfly, ball, plug, globe or needle type, whichever is most suited to the particular service.

Valves for air service may be ball, plug, globe or needle type whichever is most suited to the particular service.

Valves for oil service may be gate, butterfly, ball, plug or needle type, whichever is most suited to the particular service.

Non-return valves shall be of a type specifically designed to avoid impact and water hammer on closure. The closing member shall be pivoted from the valve body, not from a lid or cover.

(i) **Embedded Anchorages**

The Contractor shall supply and install all embedded metalworks such as anchors, embedded metal inserts for pipe and conduit supports, embedded sleeves in secondary concrete, which are associated with and required for the Works under the Contract.

The Contractor shall design these embedded anchorages to properly transfer and distribute loads of the Plant to the foundation structures.

(j) **Walkways, Ladders and Handrails**

Adequate walkways, ladders, and safety handrails and guards shall be provided on and around each Plant, where necessary or as required in the Specifications, to afford access to and protection from all moving and electrical parts. Such items shall be designed to facilitate easy removal to permit free access to the various parts of the unit.

(k) **Tests for Piping System**

The Contractor shall test all pipe lines as directed by the Engineer and shall supply all labour, materials, pumps, plugs, gauges, etc., required to make tests. Lines may be tested in convenient sections. In the case of failure due to faulty workmanship, faulty material or leaks, he shall repair all damage and leaks, replace the faulty material including concrete if already placed, and retest piping at his own cost until the tested section becomes acceptable to the Engineer.

All tests shall be carried out in the presence of the Engineer and any local authority inspectors having jurisdiction over this class of work. All piping system shall be flushed clean prior to test. Oil piping shall be flushed clean prior to test. Oil piping shall be flushed with acid and suitable flushing oil in

an appropriate method approved by the Engineer. Prefabricated pipes will be acceptable upon approval by the Engineer and the prefabricated pipes shall be flushed with acid at the manufacturer's works. The Contractor shall provide all water, oil and the necessary equipment for test of piping system.

Before testing, all anchor blocks, thrust supports, and hangers shall be in place. If piping is tested in sections, temporary end caps shall be fitted to the approval of the Engineer. Each section shall be slowly filled with the test medium, and care shall be taken to expel air from the piping, if liquid is used. For acceptance, the test pressure shall be kept constant for the test period without pumping additional water into the section under testing. If a drop in pressure occurs, leaks shall be repaired and the pipe line retested until satisfaction by the Engineer.

(i) Hydraulic Pressure Tests

All pressure vessels, cooling coils and piping shall be pressure tested, in the presence of the Engineer, and shall meet the following requirements:-

- Parts subject to penstock line water, air and/or oil pressure:

1.5 times the maximum design pressure for 10 minutes

- All other parts:

Twice the maximum working pressure, but no less than 5 kgf/cm², for 10 minutes.

All pressures are gauge pressure. All leaks and evidence of excessive or permanent deflection shall be repaired to the satisfaction of the Engineer, and the test repeated until the test conditions are satisfied.

GS.6.4 Protection, Cleaning and Painting

All parts to ultimately be buried in concrete shall be cleaned and protected adequately against oxidation in transit before leaving the manufacturer's shop by a cement wash or other approved methods.

Before being installed they shall be thoroughly descaled and cleaned of all rust and adherent matter, or be treated according to a method approved by the Engineer. Such cleaning or treatment shall not detrimentally affect the strength, mechanical properties or final operational function of the equipment.

All machined parts or bearing surfaces shall be cleaned and protected from corrosion before leaving the manufacturer's shop by the application of an approved rust preventive lacquer,

or a peelable plastic film. Where the latter is impracticable, such parts shall be cleaned with solvent and lapped or polished bright.

All parts other than machined or galvanized parts, which will be exposed and submerged after erection, shall be thoroughly cleaned and in principle given with best quality approved zinc rich primer coat and four coats of tar-epoxy resin or epoxy resin paint in total 0.45 mm dry film thickness including finish coat after erection and touching up on the Site, except such apparatus as panels and instruments which will be finish painted under approved procedures. All unfinished surfaces of ferrous metal which are exposed after erection shall be by the chlorinated rubber paint for total thickness of 0.12 - 0.16 mm. The painting system shall comply with the SIS 55900 or SSPC-SP10.

Primer shall be applied to surfaces prepared in accordance with the manufacturer's instructions. The surface shall be wiped clean immediately prior to applying the paint. The primer and finish coats of paint shall be applied using the methods and equipment recommended by the manufacturer.

The internal surface of all pipelines shall be cleaned out by the approved methods before installation and again prior to commissioning to ensure freedom from dirt, rust, scale, welding slag, etc. All exposed pipes shall be colour coded for identification after erection is completed. The code system shall be approved by the Engineer.

The final colour of all Plant shall be approved by the Engineer but the Contractor shall propose a colour scheme for the Plant and shall submit colour chips or paint samples. A colour chip shall be included with the approved colour schedule for each type of finish to be applied at the Site.

Sufficient paint shall be shipped for field painting and touch-up of shop painting. Paint shall be product of reputable manufacturer and its selection shall be approved by the Engineer.

GS.6.5 Embedded Metalwork, Opening, etc.

Unless otherwise specified, any foundation, wall and roof opening and covering, concrete floor filling in the foundation, slab and wall and trench with corner angle for cabling will be provided under the separate contracts for Civil and Architectural Works.

The Contractor shall supply and install all anchors, fasteners, embedded metal works, sleeves, pipings, conduits, coverings of holes for passing bus bars, cables and pipes and sleeves associated with and required for the equipment and materials being provided and installed under this Contract, except as otherwise provided for in the Specifications.

The Contractor shall indicate the location and details of foundations, openings, blockouts and all embedded components on his drawings and shall be responsible for the completeness and accuracy of his drawings and the information supplied to others. Anchorages to be embedded in primary concrete will be installed under the contracts for Civil and Architectural Works according to the Contractor's approved drawings. The Contractor shall be responsible for the adequacy and accuracy of location of all embedded components to be

supplied by him, whether installed by himself or by the Civil and Architectural Works contractors.

The Contractor shall clearly indicate on his construction schedule when embedded components are to be installed, and shall identify and indicate the date of delivery of all embedded components to be installed in concrete. All adjustments of foundation levels, embedment, bedding and grouting of foundations and cementing into walls and floors except as specifically provided in the Specifications will be carried out under the contracts for Civil and Architectural Works, but all leveling and adjusting of the Plant on foundations shall be carried out by the Contractor.

The foundation bolts, embedded steel parts, anchors, braces, posts, supports, shims, etc., and all metalworks as may be required for temporary or final support or anchorage of the Plant, except mortar or concrete backfilling for blockout or concrete reinforcing steel in pump house and grouting around suction casing, shall be provided and installed by the Contractor as part of this Contract.

GS.7 ANCILLARY ELECTRICAL EQUIPMENT AND INSTRUMENTS

GS.7.1 Fuses

Fuses shall comply with relevant standards approved by the Engineer. All contacts in fuse carriers and bases shall be silver plated or brass, gilding material, copper.

Fuse carriers and bases for control and lighting circuits shall be of a type in which live metal is fully shrouded at all times to prevent accidental human contact.

For equipment subject to vibration in service, clips or other approved devices shall be provided to retain the fuse carriers in position.

Where a solid link is provided in a fuse carrier, as required by the control circuit diagrams approved by the Engineer, the fuse carrier and associated base shall be coloured white.

All fuses of the same current rating shall preferably be interchangeable.

GS.7.2 Motors and Contacts

All auxiliary motors shall be continuously rated for the maximum output which they are required to deliver in service.

AC machine shall be ventilated drip proof, and shall be suitable for the voltage and frequency ranges, including speed rise following load rejection by the main plant.

The dimension of motors shall conform to relevant standards approved by the Engineer.

The rated voltage, rated current and rated duty of contacts, including motor starters, shall be appropriate to the service conditions and shall in each case be subject to the approval of the Engineer.

GS.7.3 Control Devices

(a) General

The contacts in all electrical control equipment shall be adequately rated for the service conditions.

Contacts shall be silver or silver-plated except where the conditions of operation require the use of harder materials such as tungsten or where special contact assemblies are of gold type.

(b) Control Sector Switches

Control selector switches provided to select a particular mode of operation of plant shall have tee-head handles and fixed operating positions spaced about 90 deg. apart.

(c) Control Switches

Control switches provided to accurate operations of plant shall have two operating positions equally spaced at about 45 degree to either side of the neutral position and shall have springs to return the handle to the neutral position when released. Control switches for circuit-breaker OPEN and CLOSE control shall have pistol-grip handles. All other control switches shall have tee-head handles.

(d) Direction of Operation

Control devices shall be arranged to turn:

- **CLOCKWISE** - for "Raise", "Close", "Start" or "ON" positions
- **ANTICLOCKWISE** - for "Lower", "Open", "Stop" or "OFF" positions

(e) Push Buttons and Emergency Trip Buttons

Push buttons shall be of heavy duty type and constructed for definite overtravel in both directions. Except where used in air conditioned rooms, push buttons shall be dust-proof and arranged to prevent the ingress of dust into any dust-proof enclosure. Push buttons, except those installed in control rooms, shall be shrouded or recessed to prevent accidental operation.

Emergency trip buttons shall be similar to push buttons but shall each have a plastic cover with magnet. The exposed face of the flap shall be engraved and filled in red with the word "EMERGENCY".

(f) **Samples**

If required by the Engineer, the Contractor shall submit samples of control devices to the Engineer for approval.

GS.7.4 Limit Switches

Limit switches shall be provided on all power operated valves, on all actuator drives, on all manually operated valves for which monitoring of position is required or necessary for indication and control functions and at other locations as specified. The switches shall be robust and arranged so that they will not be damaged by over-travel of the drive. The electrical rating of the switches shall be adequate for the service conditions. Micro switches may be used for this purpose only if specifically approved.

GS.7.5 Auxiliary Switches

All high voltage and low voltage switchgear and control gear shall be provided with the necessary auxiliary switches for the closing and opening mechanisms and for control, indications, interlocking and other functions.

Auxiliary switches shall be mounted on the equipment and directly coupled to the operating mechanism. The switches shall be robust and arranged so that they will not be damaged by over-travel of the drive. Contacts shall be inherently self-cleaning to ensure low contact resistance at all times.

The electrical rating of auxiliary switches shall be adequate for the service conditions.

GS.7.6 Electrical Relays

Electrical relays for control and alarm purposes for protection circuits shall comply with the requirements of this clause.

Relays shall be of the plug-in type and the plugged-in connections shall be made and broken by pressure contacts. Alternatively, the Engineer may approve the use of plug-in trays containing groups of relays.

Relay shall be provided with non-flammable, dust and moisture-proof cases.

Relays contact shall be adequately rated for the service conditions. Relay coils shall be continuously rated where the control scheme requires them to be continuously energized.

At least one spare normally open contact and one spare normally closed contact shall be provided except main protective relay in addition to the contacts required by the control scheme.

If required by the Engineer, the Contractor shall submit samples of relays to the Engineer for approval.

GS.7.7 Indicating Instruments

(a) General

Instruments shall be capable of withstanding or shall be adequately protected from the vibrations which are encountered in service. Instruments and associated apparatus shall be capable of maintaining their accuracy and sensitivity without excessive maintenance. Accuracy of indicating instruments shall not be more than 1.5 percent of full scale range.

Instruments on panels shall be flush mounted and provided with narrow bezels. The bezels shall have a uniform high grade finish.

All instrument cases shall be dust-proof.

All instrument scales shall be clearly printed in black figures and divisions on a white background. The quantity measured shall be clearly marked on the instrument dial in black capital letters and abbreviated form, e.g., A for Amperes. The names or titles of the instrument manufacturers and other printing which may interfere with clear observation of the reading shall not be printed on the dials. However, initials of similar markings may be shown unobtrusively as approved. Each instrument shall be identified by means of a serial number printed at the lower side of the dial. The serial number shall be legible from the front of the instrument.

Unless otherwise specified or approved all instruments shall have circular scales with a total pointer deflection of not less than 240 degrees. Normal working indication shall be at a point corresponding to approximately 75% of full scale deflection. Scales shall be provided with red-coloured marks at points corresponding to the normal working values (or full-load current of the equipment in the case of ammeters) and as approved.

The scales for ammeters in motor circuit shall be compressed so that 60% full scale deflection (F.S.D.) occurs at about 100% full load current (F.L.C.) and 100% of F.S.D. at about 200% F.L.C. The scale shall be approximately linear in the range 0% to 60% and compressed above 60% F.S.D. to indicate two times of F.L.C. at 100% F.S.D.

Instruments shall have black bar-type pointers, except in case of instruments having more than one pointer, then only one of the pointers shall be black.

Suspension for electrical instruments shall be of the taut band type. Instruments shall be adequately damped to ensure that the pointers come to rest rapidly after being deflected from their previous positions. End stop devices shall be provided to prevent damage to movements, pointers and suspensions under transient conditions.

Devices for routine checking, zero adjustment and re-calibration shall be easily accessible from the front of the panels. Where such devices are not included in the instrument case they shall be flush mounted on the panels adjacent to the associated instruments, so that adjustments can be made conveniently while watching the indicator.

Instruments provided with integral alarm initiating devices shall be arranged so that operation of the alarm devices neither impedes nor restricts the movement of the indicating pointers over the full range of the instruments. The alarm contacts shall be adjustable.

If required by the Engineer, the Contractor shall submit samples of instruments to the Engineer for approval.

(b) Pressure Gauges

Pressure gauges shall be of the industrial concentric scale type. It is preferred that pressure gauges be of the Bourdon tube type. The following additional requirements for pressure gauges shall be adhered to:

- (i) Every gauge shall be accurate to 1.5% of full scale deflection over the whole of the scale range from 0% to 100%.
- (ii) Separate range and zero adjustments shall be provided. It shall not be necessary to bend linkage arms or other components to obtain the full range of adjustment.
- (iii) The shank, Bourdon tube and quadrant gear and pinion movement shall be solidly connected together, and not depend upon the instrument case for support. Quadrant gears shall be machined or broached.
- (iv) Where Bourdon tube gauges are provided, the gauge shall be fitted with a Bourdon tube movement of the normal size for the gauge diameter.
- (v) The dial face shall be locked to prevent rotation.
- (vi) The scale of the pressure gauges shall be nominally twice the normal working pressure.

- (vii) The dials of direct connected pressure gauges shall be calibrated to read to pressure at the tapping point, and shall be clearly marked to show the compensation made for difference in head between the tapping point and the gauge.
- (viii) Gauges for water shall be calibrated in meters with depth of water.
- (ix) Gauges for oil and air shall be calibrated in kilograms force per square centimeter.
- (x) A damping orifice and an air bleed cock and drain shall be provided for each gauge.

(c) **Thermometers**

Expansion dial type thermometers shall be calibrated in degrees Celsius and shall be equipped with alarm and shutdown contacts. Hand reset maximum indication pointers shall also be fitted. The thermometers shall be unaffected by variations in temperature of the capillaries.

Electrical resistance thermometers shall have detector resistance elements (embedded temperature detectors) of platinum wire. The indicating instruments shall be calibrated in degrees Celsius.

GS.7.8 Indicating Lamps

Indicating lamps on control panels, etc., shall be supplied from the continuously maintained 125 V, DC power supply.

Lenses shall be of translucent glass or other approved materials. Indicating lamp fittings shall be suitable for continuous operation at the nominal lamp voltage regardless of the position in which they are mounted.

Colour of indicating lamps shall conform to the following status:

<u>Colour</u>	<u>Abbreviation</u>	<u>Status</u>
Red	R	close
Green	G	open
White	W	(a) normal condition
		(b) hydraulic valve: in transit,
		(c) oil pumps, drainage pump, etc.: running.
		(d) DS: order to operate

The Contractor shall submit details of indicating lamp fittings to the Engineer for approval and shall, if required, also provide samples.

GS.7.9 Enclosures for Electrical and Control Equipment

Where enclosures including cubicles are required for switchgear, control equipment, governors, relays, control and alarm initiating devices, gauge panels, fuse boards or distribution boards, they shall comply with this clause where it is applicable.

All enclosures equipment shall be weather, dust and vermin-proof, unless they are installed in a room, where they need not be weatherproof.

Weatherproof enclosures shall be suitable to withstand rain falling, and shall be provided with holes fitted with gauze screens in the bottom to permit drainage of any water which might enter.

Enclosures shall be sealed by neoprene rubber sections or other approved means. No foam rubber shall be used.

Sheet metal enclosures shall be constructed of folded and welded sheets for the front and rear surface of panels.

The weather proof enclosures shall be of 3.2 mm thick and 2.0 mm for other parts. Rolled steel sections may be used in large cubicles for forming the frame and stiffening. Where equipment is to be mounted on a panel the thickness of the sheet steel shall be sufficient to prevent vibrations affecting the correct operation of the equipment.

Doors shall be provided where access is necessary during normal operation of the plant, e.g., for replacing fuses, resetting relays, taking equipment out of service or routine inspection of contacts, relays or similar equipment, but where access is necessary only for cleaning or repair, or to equipment such as current transformers, removable covers may be provided. Where a removable cover which is larger or heavier than that can be handled by one man working alone is provided, then hinges shall be fixed in place by captive bolts and nuts.

Doors shall be constructed of sheet metal 2.6 mm or thicker with single returned edges and additional stiffeners if necessary to prevent distortion and shall be hung on substantial hinges of the lift-off type and with provision for padlocking.

The Contractor shall ensure that a 450 mm walkway is available between any open enclosure door and adjacent walls or equipment.

The arrangement of equipment in and on the enclosures shall be such that maintenance can be carried out easily without dismantling other equipment. Equipment mounted on doors

shall be kept to a minimum and no electrical relays shall be mounted on doors or hinged panels.

Enclosures shall be arranged so that equipment requiring manual operation (e.g., control switches) is at a height between 750 mm and 1,800 mm above floor level.

Cable boxes shall withstand, without fragmentation, explosion due to an electrical fault within the cable box or alternately be provided with screens to prevent fragments of the box injuring personnel.

Anti-condensation heaters shall be provided in major enclosure located outside air conditioned rooms and having an external surface greater than 0.5 square meters (excluding the bottom). The rating of the heaters shall be 20W for each square meter of exposed surface area of the enclosure. The surface temperature rise of the heaters shall not exceed 100 deg.C. Heaters shall be mechanically protected and live parts shrouded.

Where the heat produced by the equipment during normal operation is equal to or greater than the output of the heater, the heater shall be switched off automatically when the equipment is energized or a thermostat provided to control the heater.

Luminaries shall be provided to light the inside of all enclosures large enough for a man to work inside. Luminaries shall be controlled by a manually operated switch at one end and internal on the switchboard.

Where an enclosure contains fluids under pressure, compartment shall be provided to prevent damage to equipment by fluid leakages.

Equipment contained in cubicles, cabinets or similar enclosures shall be finish painted as if it were exposed to view and the inside surface of the enclosures shall be painted gloss white. The finished surfaces of panels and switchgear cubicles shall present a first class appearance free from all blemishes.

GS.7.10 Wiring and Wiring Accessories

This clause applies to all connections within equipment enclosures and all interpanel wiring working at voltages not greater than 440 V nominal. All wiring shall be carried out in accordance with wiring diagrams so that the arrangement of the wiring is consistent throughout the Plant and identical for those parts of the Plant performing the same duties.

Wiring diagrams (to be submitted for works) shall be drawn as seen from the back or wiring side of the panel, except for front connected equipment and shall show all terminals on selector switches, relays, contacts, terminal blocks, etc., in their correct relative positions. Terminal blocks shall be arranged in vertical rows and all wiring to those blocks shall be arranged to run in numerical order from top to bottom.

Wiring shall be neatly and securely bunched or cleated, and enclosed in ducts, or conduits or supported on trays and run in the most efficient manner from point to point. The bunching

of wiring shall be kept in bunched condition by means of strips of special plastic ribbon material at suitable intervals. Lacing of wire bunches with textile or plastic cord or metal buckle type clips will not be accepted. Wherever wiring is cleated to metalwork, it shall be insulated from the metal surface and shall be cleated by means of insulated straps in an approved manner. All wiring shall be left sufficiently long and neatly looped to allow a fresh termination to be made, should the original termination device break off.

Circuits of similar nature shall be grouped together and terminal blocks in AC circuits with voltage above 120 V and DC circuits above 125 V shall be segregated and fully shrouded to prevent accidental contact with live parts.

All secondary wiring provided under the Contract shall supply conductors of minimum cross section 2.0 square millimeters with not less than seven strand of copper wire.

Current transformer secondary circuits shall be run with the conductor route length as short as possible. The burden of the leads associated with current transformers and protective relays shall be sufficiently low to ensure correct operation of the protection under all conditions and this may require a cross section of conductor greater than 2.0 square millimeters.

Insulation shall be PVC of 600 volt or higher grade appropriate to the service conditions and shall be self-coloured in accordance with a code which is the same for all of the Plant.

Each end of each wire shall be provided with an approved termination and with a numbered ferrule. Wire numbers shall be allocated by the Contractor and shown on the Contractor's final circuit diagrams forwarded for approval.

The standard phase arrangement when facing the front of the switchboard panel shall be R-S-T-N and R-N-S from left to right, from top to bottom, and front to back for AC 3-phase and single-phase circuits and shall be P-N from left to right, P-N from top to boom and front to back for DC polarity. All relays, instruments, other devices, buses and equipment involving three-phase circuit shall be arranged and connected in accordance with the standard phase arrangement where possible.

All switchboard wiring shall be coloured as follows:

Wiring Colour Codes:

<u>Wiring Circuit</u>	<u>Colour</u>
Potential transformer secondary circuit	Red
Current transformer secondary circuit	Black
AC control circuit	Yellow
DC control circuit	Blue
Grounding circuit	Green

Phase and Polarity Colour Codes:

The colour codes for phase and polarity shall be as follows:

<u>Phase and Polarity</u>	<u>Colour</u>
AC three-phase, first phase	Red
second phase	White
third phase	Blue
AC single-phase, first line	Red
second line	Blue
Neutral, insulated	Green
grounded	Black
DC positive	Red
negative, insulated	Blue
grounded	Black, Yellow

GS.7.11 Cabling

(a) General

The Contractor shall provide all supports, cleats, clamps, fixing and trays necessary to support the cabling provided under the Contract, including bolts and nuts for fixing to embedded metal inserts provided by the Contractor.

Ducts, holes and blockouts will be provided under the Civil Contract to locations in concrete where approved by the Engineer in accordance with the Contractor's requirements and the Contractor shall provide the required information for this purpose according to the requirements of Clause GS.6.5. In the event of the absence or misplacement of ducts, holes, blockouts or inserts due to lack of such information, the Contractor shall arrange alternative routes or curing of holes at his own expense. Any cutting of concrete shall be only with the prior approval of the Engineer.

All cabling for all voltages and for all purposes shall be shown on cable schedules to be prepared by the Contractor and the cable schedules shall include the following information:

- (i) Cable identification
- (ii) Termination points (e.g., cubicle designations).

(iii) Cable Construction, number of cores and rated voltage.

(iv) Route length.

Each cable shall be fitted with a cable identification label at each end.

Construction method for each type of cable and for each condition for the service shall be submitted to the Engineer for approval.

(b) Cable Conductor and Joint

The conductor shall be continuous between outlets, and no junction shall be made except within outlets or junction boxes. The conductor shall be drawn through ducts or conduits after they have been cleaned. Oil or grease shall not be used as a lubricant for the drawing operation, but an approved compound may be used for this purpose.

Joints in wiring shall be compressed and insulated with PVC tape or approved connectors may be used. Grounding conductors where required to run with other conductors shall run inside the conduit piping.

(c) Conduits

Rigid steel conduit shall be galvanized inside and outside, or enameled inside. It shall be of a minimum thickness of 2.3 millimeters and have a minimum inside diameter of 16 millimeters.

(d) Conduits Installation

Conduits shall be concealed within the walls, ceilings and floors where possible. Exposed runs of conduit shall be supported with a space of not more than 150 centimeters. It shall be installed parallel or perpendicular to walls, structural members and ceilings.

Only threaded joints shall be used. Conduit which were crushed or deformed shall not be used in the Works.

Conduit shall be installed in such a manner as to ensure that the inside remains in a dry condition. Conduit shall be securely fastened to all sheet-steel outlets, junction and pull boxes with galvanized locknuts and bushings.

Exposed conduits shall be finished with the same colour paints as the finished colour of the wall or ceiling against which the conduits are placed.

All joints and terminations shall comply with the weatherproof or explosion proof requirements as applicable.

GS.7.12 Terminal Strips

Terminal strips shall consist of double stud and two-hole solid link design with the studs molded into an insulating base. Terminal strips shall be arranged in vertical rows not less than 225 mm above floor level. Sufficient terminals shall be provided on each item of equipment to permit the connection of all incoming cable cores plus 10% spare terminals. Not more than 3, and preferably not more than two wires shall be connected to one stud.

Removable transparent insulating covers shall be provided over all terminals.

GS.7.13 Grounding of Equipment

The Contractor shall provide, on the frame of every item of electrical plant, a grounding terminal of 9 mm diameter, (or larger) brass bolt on stud complete with brass washers and nuts. The construction of all equipment, including transformers and circuit breakers, shall be such that electrical continuity of grounded metal tank, frames, enclosures, etc., is maintained to the grounding terminal.

A grounding busbar of 25 mm x 1.5 mm (or larger) copper shall be provided near the bottom of each cubicle, control board, control panel, switch board, etc.

GS.8 PARTICULAR REQUIREMENT FOR OUTDOOR ELECTRICAL PLANT

GS.8.1 General Requirements for Outdoor Electrical Plant

All outdoor electrical plant shall operate without undue vibration or excessive corona and shall be designed to ensure satisfactory operation under the atmospheric conditions prevailing in the area where the switchgear and transmission line are to be erected. The design of all steel structures, towers, conductors, groundwires, and insulators and groundwire fittings shall be such as to minimize the risk of damage due to deterioration or damage in service of any part of the outdoor switchgear and transmission line.

The design of all line conductor fittings, vibration dampers, insulator sets, etc., shall avoid sharp corners or projections which would produce high electromechanical stress under normal working conditions. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surfaces and to maintain good electrical contact under service conditions. Particular care shall be taken during manufacture of conductors and fittings and during subsequent handling to insure smooth surfaces free from abrasion.

GS.8.2 Marking

(a) Members of Towers and Outdoor Steel Structures

All members of towers and outdoor steel structures shall bear punch marks corresponding to the Approved Drawings for erection and the member lists to be used for assorting work.

The erection marks shall be punched before galvanizing and shall be clearly readable afterwards.

Bolts shall bear marks corresponding to their sizes, lengths and material qualities to facilitate assembly at site.

(b) Insulator Units

Each insulator unit shall be marked with the name or trade mark of the manufacturer, the year of manufacture and the mechanical strength.

The marks shall be impressed before firing the glaze.

(c) Others

Fittings for insulator and ground wire, clamps, joints, vibration dampers, etc., shall preferably bear the identification marks to facilitate assembly and assorting on site.

GS.8.3 Bolts and Nuts

Structural members shall be secured by means of bolts and nuts with flat and spring washers.

Bolts for all structural connections shall be of hexagonal head and shall be of M16 in the minimum size.

All bolts, nut and washers shall be galvanized. The nuts of all bolts for attaching insulator sets and groundwire fittings to the towers and outdoor steel structures shall be locked in an approved manner.

The screwed thread of any bolts or studs shall not form part of a shearing plane between members. When in position, all bolts or studs shall project through the corresponding nuts for at least three (3) full turns.

Nut shall be finger tight on the bolt and will be rejected if, in the opinion of the Engineer, they are considered to have an excessively loose or tight fit.

Five (5) percent of spare of bolts, nuts, washers, fillers, etc. shall be supplied for all tower and outdoor steel structure materials under the Contract.

GS.8.4 Galvanizing

(a) General

Unless specifically mentioned in the respective technical specifications, all iron and steel used for towers and outdoor steel structures shall be galvanized after all fabrication is completed.

The zinc coating shall be uniform, clean, smooth and as free from spangle as possible.

All iron and steel articles other than wires shall be galvanized by hot dip process and shall have the minimum average coating weight of 600 g/m² on structural steel members and 400 g/m² on bolts and nuts, and shall withstand the tests set out in JIS H8641 or equivalent.

After galvanizing, holes shall be free from nodules or spelter.

All steel wires shall be galvanized by an approved process before stranding. The zinc shall be smooth, clean, or uniform thickness and free from defects, and shall withstand the tests set out in JIS H8641 or equivalent.

The preparation for galvanizing and the galvanizing itself shall not distort or adversely affect the mechanical properties of the materials.

If any galvanized part is found to be imperfect, such part must be replaced. The whole of the expense involved in the replacement of the imperfect part shall be borne by the Contractor.

If, in the opinion of the Engineer, the extent of damage found on site to a galvanized part appears capable of repair, the Contractor may, after receiving such agreement, attempt to effect repair by approved methods. The agreement to attempt repair shall not bind the Engineer to accept the repaired part when such is offered for re-inspection.

(b) White Rust

In order to avoid the formation of white rust on the galvanized surface of iron and steel articles for structural members, the galvanized surface shall be treated with approved processes.

In the event that galvanized surfaces are found to be subject to the formation of white rust in transit or storage on site, the Engineer shall either approve a

method of scrubbing and protective painting on the Site or order to replace with new materials.

Either of the above measures shall not cause extra charge to the Employer nor extension of Time for completion.

GS.9 PACKING, DELIVERY AND STORAGE

GS.9.1 Packing

(a) General

Each item of the Plant shall be packed or bundled properly so that neither damage nor corrosion shall be sustained during transportation to the Site and by rough handling.

The contents of packing cases shall be securely bolted or fastened in position with struts or cross battens. Cases shall be opened after packing to prove no movement of the contents, if the Engineer requests.

Woodwool shall not be allowed for packing purposes.

Waterproof papers and felt linings shall overlap at seams and the seams secured together in an adequate manner, but the enclosure shall be provided with screened openings to obtain ventilation.

All cases, packages, bundles, etc., shall bear at least the identification mark relating to the appropriate shipping documents, the contents and total weight.

Such shipping marks on the outside of casings or on the metal tags attached to bundles shall be protected by shellac or varnish to prevent obliteration in transit.

Each case, package or bundle shall contain a packing list in a waterproof envelope and copies in triplicate shall be forwarded to the Engineer prior to despatch. All items of material shall be clearly marked for easy identification against the packing list.

The Engineer reserves the right to inspect and approve the packing before the items are despatched but the Contractor shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not exonerate the Contractor from any loss or damage due to faulty packing or rough handling.

All packing materials shall remain the property of the Contractor and shall be removed from the Site at the earliest opportunity and be disposed at the places/areas which will be instructed by the Engineer.

Required information such as name of Contractor, Contract No., description of Contract, port of destination, etc. shall also be indicated.

All crates and packages, shall show where the weight is bearing and the correct position for the slings.

In addition, large sized components such as pipes, metal structures, etc., must be identified with a steel plate with a black background and white capital letters.

(b) Members for Towers and Structures

Long pieces of steel angles shall be packed in bundles properly tied together by an approved method and care shall be taken to ensure that they are robust and not of excessive length and weight for handling in transit.

Short pieces of steel angles and steel plates shall be bolted or wired together through holes and packed in the stout timber cases.

Bolts, nuts, washers and fillers shall be bagged in sealed vinyl and packed in thin steel cans. Cans shall bear the contents and be crated together.

Packing of components of dissimilar metals together shall not be acceptable.

(c) Conductors and Groundwires

Conductors and groundwires shall be packed on drums stoutly constructed of good quality timber. Drums shall be securely battened around the primer to give maximum protection to the conductor and the groundwire and correct direction of rolling indicated with an arrow in a manner not easily removable.

The first layer of conductors or groundwires on drums shall be secured to the hub in a manner avoiding damage to subsequent layers.

All drums shall be protected from deterioration on site by termite or fungus attack by an approved impregnation treatment at the works before despatch.

(d) Insulator sets and Groundwire sets

Insulator units shall separately be crated in each five (5) pieces.

Fittings and clamps shall be packed in the stout timber cases preferably in sets.

(e) Shipping mark

To facilitate the shipping of all materials and equipment and their suitable storage in-situ, as well as to be able to easily check the integrity of the corresponding supply, all crates must be marked as indicated below:

EMPLOYER'S NAME _____

PROYECTO _____

NO. DE IDENTIFICACION _____

NO. CAJA NO. _____

PESO BRUTO _____ kg

PESO NETO _____ kg

DIMENSIONES _____ x _____ mm

MARCO (FABRICONTE)*

Note: * Denotes that single symbol previously assigned to each manufacturer shall be shown. The same symbol may be used for different manufacturer, but a different color.

The identification number shall be that which shall definitely identify the part or equipment of the Plant.

GS.9.2 Delivery

No part of the Plant and Contractor's equipment shall be delivered to the Site until approval in writing has been obtained from the Engineer for such delivery.

Each application shall include a complete shipping list of the contents of each package to be delivered and shall indicate the anticipated date of delivery and the serial number for each component to be used for identification and evidence of the insurance cost arranged for it.

GS.9.3 Storage at Site

No covered storage space will be made available on the Site for the Contractor's materials. Any storage facilities required for the Works, including maintenance thereof, shall be arranged by the Contractor at his own expenses.

The Contractor shall arrange at his own expense for covered storage or other protection of all materials and equipment against corrosion and mechanical damage. Any corrosion or damage that may occur to any item shall be made good before that item is to be installed.

The Contractor shall provide all drainage and weather protection for storage of the Plant to meet the requirements of the Engineer.

The minimum requirements are that all items shall rest on wooden blocks which elevates the base the least 150 mm above floor or ground level. No items shall rest directly on the floor or ground.

All cases containing machinery shall be placed under covered storage.

Weatherproof items and structural steel members may be stored in the open, but in all instances shall be protected to the Engineer's approval. The Contractor shall be responsible for the adequacy of all protection.

GS.10 MAINTENANCE TOOLS AND SPARE PARTS

GS.10.1 Maintenance Tools

The Contractor shall provide each one set of mandatory maintenance tools sufficient for the proper maintenance of mechanical and electrical equipment for the Project. The maintenance equipment shall include:

- (a) One set of all complete wire ropes, slings and lifting devices for assembling and dismantling of one unit of pump, motor and valve with hangers.
- (b) One complete set of high quality single-ended spanners, ring spanners, socket wrenches and standard and special tools for the pump, motor and valves, all marked with size, purposed and mounted on a suitable shadow board.
- (c) One set of all necessary lifting tackles.
- (d) Others recommended by the respective manufacturers.

The Contractor shall also provide the following mandatory maintenance tools for 138 kV transmission line.

(a) Tower Erection Tools

- (i) Grounding resistance tester : 1 set
- (ii) Torque Wrench - 2,800 : 2 sets
- (iii) Torque Wrench - 4,200 : 2 sets

(b) Stringing tools and Appliance

(i)	Steel wire rope (14 mm)	: 500 m
(ii)	Wire clips (14 mm)	: 50 pcs
(iii)	Stringing clamp set (ORIOLE)	: 10 sets
(iv)	Stringing clamp set (GSW)	: 10 sets
(v)	Wire connector (14 m)	: 20 pcs
(vi)	Turnbuckle (3.5 tons)	: 10 sets
(vii)	Turnbuckle (7.0 tons)	: 10 sets
(viii)	Hanging hook	: 2 sets
(ix)	Conductor grounding device (Roller type)	: 4 sets
(x)	Conductor grounding device (Rod type)	: 4 sets
(xi)	Insulation resistance tester	: 2 sets
(xii)	Come-along clamps (ORIOLE)	: 10 sets
(xiii)	Come-along clamps (GSW)	: 5 sets
(xiv)	Lineman's hand tool set	: 10 sets

(c) Others recommended by the manufacturer(s).

The maintenance tools shall be supplied in a lockable cabinet fitted internally so that the tools may be safely stored in an orderly manner.

For all components of the Plant greater than 100 kg in weight which are not accessible by the station or truck crane, the Contractor shall provide hand operated mechanical handling equipment suitable for bringing such components to and from positions where they may be lifted by the station or truck crane.

The Tenderer shall set out the list with prices of the mandatory maintenance tools in Schedule III-A "Mandatory Maintenance Tools" and those recommended in Schedule III-B of Volume - II.

GS.10.2 Spare Parts

The Contractor shall furnish the mandatory and recommended spare parts as listed in Schedule II-A and II-B of Volume-II in the Tender Documents.

Any spare part supplied shall be packed or treated in such a manner as to be suitably stored in the tropical climate at the Site for a period of not less than two (2) years, and each part shall be clearly marked with its description and purposes on the outside of the packing.

Spare parts so provided must be delivered into such stores as may be designated by the Employer. Delivery of spare parts will not be deemed to be complete until the packages

have been opened by the Contractor, their contents checked by a representative of the Employer and the articles reprotected and repacked by the Contractor to the satisfaction of the Employer, or assembled into units at the Employer's option. The method of package and package materials shall be suitable for the satisfactory re-package.

GS.11 TESTS AND INSPECTIONS

GS.11.1 Tests at Shop

Tests for the Plant to be supplied under the Contract shall be performed at the Contractor's shop prior to shipment in accordance with the requirements of the relevant clauses of the Technical Specifications, where appropriate.

GS.11.2 Tests at Site

(a) Commissioning Tests

In the course of and after the installation/erection of each item of the equipment, control device, piping system, etc., due individual tests shall be performed, as specified herein, to establish the accuracy of the assembly and to prove the adequacy of the materials and the workmanship. All tests shall be conducted in accordance with the previously approved Test Procedure Instructions, vide Clause GS.2.2 herein.

The Contractor shall perform the following commissioning tests in association with the other contractor, as applicable to ensure that all equipment have been correctly installed, all necessary adjustments and settings are made, and are in sound condition to operate under load.

- (i) Insulation tests and drying out of equipment, if required.**
- (ii) Ground continuity tests.**
- (iii) Circuit continuity tests.**
- (iv) Testing and setting up of all relays and other protective equipment.**
- (v) Hydrostatic tests on all piping, cooling coils and pressure tanks.**
- (vi) Operation tests, which shall include operating auxiliary equipment.**
- (vii) Pump alignment or mechanical run test, when coupled to the motor, to measure the throw of the shaft at the guide bearing and impeller clearances.**

- (viii) Operation of the pump and motor, to check bearing operation, running clearances.
- (ix) High voltage test.
- (x) Any additional tests required by the Engineer to ensure the safety of the equipment when operated.

(b) Performance Tests

After the ancillary and control equipment has been installed, tested and approved and each pump unit is fully installed, adjusted and successfully completed its mechanical run, the Contractor shall conduct operation tests in the presence of the Engineer to demonstrate that all performance guarantees and technical particulars shall meet to those listed in the relevant Schedules and further that the entire works are properly installed, free from objectionable leakage and correctly adjusted to operate as specified. The tests shall be carried out in such a manner and for such duration as may be required by the Engineer to demonstrate that all requirements of the Contract have been met.

The Contractor shall make all final adjustments to the controls and detection devices in association with the other contractor.

The Contractor shall be responsible for the operation of all units during the tests.

The performance tests shall include, but shall not be limited to:

- (i) Performance tests of auxiliary equipment.
- (ii) Pump unit discharge test including measurements of head and calculation of pump efficiency.
- (iii) Sudden input rejection test.

The performance tests of auxiliary equipment shall be performed to check that the auxiliary equipment has sufficient capacity to meet the specified requirements.

The pump discharge test shall be made when water level in suction poundage is situated at the weighted average WL. 58.5 m and/or MOL 47.0 m or near. The discharge shall be measured by the flow meter provided in the main discharge penstock. All tests shall be carried by the Contractor at his full responsibility and costs including all necessary testing equipment and instruments, manpower and so forth.

Required electric power for conducting due tests will be supplied free of charge by the Employer. The final results of all tests including tests run by the Contractor shall be subject to acceptance by the Engineer and shall verify

that the performance guarantees and technical particulars given in Schedules VI and VII of Volume - II have been fully fulfilled.

After all equipment have been tested and finally adjusted to the satisfaction of the Engineer, the Engineer shall issue duly a Total Provisional Reception Certificate.

The Contractor shall perform and observe for all routine maintenance, i.e., lubricating and adjusting of all equipment until the conclusion of the performance tests and the issue of the Total Provisional Reception Certificate.

Whenever the tests indicate that the performance of the Plant under the Contract is below than those guaranteed by the Contractor, the Contractor shall carry out at his own expense such measures as may be approved by the Engineer to rectify the deficiency.

Notwithstanding this requirements, the Employer shall have the option of making a reasonable adjustment in the Contract Price in respect of any residual deficiency in the performance at the time of issue of the Total Provisional Reception Certificate, the basis of which will be the value multiplying by selling rate of water per cubic meter and water volume discharge due to deficient efficiency than the guaranteed.

(c) **Transmission Line**

- (i) Inspection and tests shall be carried out in accordance with the requirements of Subsection - I of the Technical Specifications.

GS.11.3 Test Reports

All test and inspection reports shall be submitted to the Engineer in six (6) copies within thirty (30) days after completion of each test.

Within three (3) months after the date of the Total Provisional Reception Certificate, the Contractor shall submit the test report of all inspection and tests at Site in bound print to the Engineer in two (2) copies and to the Employer in three (3) copies.

GS.11.4 Employer's Shop Inspection

The Contractor shall invite four (4) persons of the Employer's personnel for sixty (60) men-days in total (4 persons x 15 days) for the purpose of witnessing performance tests of pump-motor assemblies in the manufacturer's shops. All necessary expenses, such as round trip air ticket charge between the Republic of Ecuador and the manufacturer's country, accommodation charge as well as inland travel charges in the manufacturer's country,

personal expense at rate equivalent to US Dollar 100.0 per day, etc. shall be borne by the Contractor, vide Schedule-IV in Volume-II herein.

The Contractor shall give notice at least four (4) weeks in advance to the Employer with the test procedure and schedule of the items above, to which the Employer's personnel will witness.

PART - II

TECHNICAL SPECIFICATIONS

PART - II

TECHNICAL SPECIFICATIONS

SUBSECTION - A

MAIN PUMPS AND VALVES

A.1 GENERAL

A.1.1 Scope

This Subsection covers the design, manufacture, testing before shipment, transportation to the Site, installation/erection, commissioning and performance tests at the Site of the following:

- (1) Six (6) vertical shaft, single stage volute pumps consisting of five (5) on-duty units and one (1) stand-by duty unit, each complete with suction pipe, short pipes and enlarging pipe with loose flange connections and other necessary accessories for their satisfactory and efficient operation.
- (2) Six (6) by-pass system incorporated slow closing type non-return valves, each complete with necessary accessories for their satisfactory and efficient operation.
- (3) Six (6) electric motor driven butterfly type guard valves, each complete with necessary accessories for their satisfactory operation.

It is not the intention of these Specifications to specify in complete details of the various parts of the equipment, that are being left to the experience and practice of the Contractor to furnish the equipment which shall meet in all respects the requirements of the Employer in regard to performance, reliability and satisfactory operation.

The details of the equipment, not specified herein, will be left to the Contractor, but subject to the approval of the Engineer.

The arrangement of the main pumps, valves and pipes shall be as shown on Drawings for Tender, Nos. 3-I-004, 005, 007 and 3-I-013.

A.1.2 Levels and Heads

- (1) Water Levels in Suction Pit (SWL) Vs. Operation Modes

The pump operation water levels in the suction pit will be changed between minimum operation level (MOL) at EL.47.000 and HWL EL.66.000. In principle, $Q=3.2 \text{ m}^3/\text{sec./unit}$

by max. 5 units operation will be executed above averaged SWL at 58.5 m up to HWL 66.0 m, while $Q=2.67 \text{ m}^3/\text{sec.}/\text{unit}$ by max. 6 units including one stand-by unit between SWL 58.5 m and MOL 47.0 m.

(2) Water Levels in each Head Tank against two Discharge Penstock Lanes

- Design high water level (HWL) : EL.114.020 m
(for 3 on-duty pump operation in each $3.2 \text{ m}^3/\text{sec}$ at above SWL 58.5 m)
- Design low water level (LWL) : EL.113.610 m
(for 1 on-duty pump operation in $2.67 \text{ m}^3/\text{sec}$ at above MOL 47.0 m)
- Ogee crest level : EL.113.300 m

(3) Level of Pump Center

The pump center shall be set at EL.46.000 m when the pumps are installed in the pumping station.

(4) Heads for Pump Design

Each pump shall be capable of discharging water in the designed $Q=3.2 \text{ m}^3/\text{sec.}$ with maximum pumping efficiency when the pumps are operated under the following conditions of the water levels.

- Water level averaged in suction pit : EL. 58.500 m
- Design high water level in one head tank : EL.114.020 m

In addition to the requirements above, six (6) pump units in total including one (1) stand-by duty unit shall also be capable of discharging water in total $Q=16 \text{ m}^3/\text{sec.}$ ($Q=2.67 \text{ m}^3/\text{sec.}$ each), even when SWL locates between MOL 47.0 m and the averaged SWL at 58.5 m.

A.1.3 Water Discharge Requirements

The monthly water discharge requirements for this Pumping Station will be fluctuated as below:

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Water Requirements (MCM)	16.3	8.3	11.8	11.4	10.3	11.4	14.8	14.8	27.2	34.0	25.7	26.6

Note : MCM=Million cubic meter

A.1.4 Expected Discharge Control

Discharge control by pump units and guard valves against the variable water demands will be expected as follows.

- (1) No discharge control by any guard valve, and
- (2) Discharge control will be done in principle in combination with number of pump units and pump operation hours.

A.2 MAIN PUMPS

A.2.1 Type and Rating

The pumps shall be of vertical shaft, single stage volute type pump and rating of each pump shall be as follows, referring also to the requirements in Clause A.1.2 above.

- (1) Actual Head : 55.52 m
- (2) Loss Head : 4.48 m (from the suction pipe inlet up to the head tank)
- (3) Rated Total Head for Pump Design : 60.0 m
- (4) Discharge

The discharge of one pump shall be designed for 3.2 m³/sec when it is operated at the rated total head of 60 m with maximum pumping efficiency.

- (5) Efficiency

The pumping efficiency of the pump shall be more than 88 per cent when the pump is operated at the rated total head of 60 meters and discharge of 3.2 m³/sec.

A.2.2 Speed

The pumps shall be directly coupled with the motors and their rotation direction shall be clockwise when viewed from above. The synchronous speed of motor shall be 600 RPM with 12 poles. The Contractor shall exercise special care in the design of pumps to avoid any cavitation under all range of the water level conditions given in Clause A.1.2, without any discharge control by the guard valves.

A.2.3 Check of the Design for the Tender

Tenderer shall calculate and submit a design head diagram in his Tender, showing design internal pressures along the given pipeline profile in case of happening of pump trip phenomena, which shall be made in combination with the pump/motor characteristic curve (overall efficiency vs. shaft power vs. discharge at the entire operation range vs. pump/motor flywheel effects), the given pipeline profile condition, and each function of non-return valves and one-way surge tanks to be employed for the Works.

As soon as the Contract becomes effective, the Contractor shall commence overall detail designs and subsequently justify the designs submitted in the Tender as above and incorporated into the Contract, otherwise further works shall never be proceeded with. Any change which may arise out during this process shall be full responsibility of the Contractor at no claim on extra cost nor extension of time to CRM.

A.2.4 Structure General

Each pump shall be capable of operating safely and satisfactorily under any condition of loads and water levels set out in Clause A.1.2.

The pump design must include all provisions necessary to prevent damage resulting from 125 per cent reverse rotation which may occur in the event of back flow at the pump trip phenomena.

Corrosion allowance in 2.0 millimeters shall be added to the surfaces of the pump parts exposed in water.

Adequate provision shall be made for convenient handle of all parts during assembly or disassembly of the pump.

A.2.5 Impellers

The impellers shall be made up in one piece by 13 per cent chrome 1 per cent nickel stainless steel casting or better.

All surfaces of the impeller shall be finished smooth and shall be reasonably free from hollows, depressions, projections or other surface imperfections that might cause local cavitation or pitting. The impeller shall be uniform and properly shaped in accordance with the manufacturer's best practice and the finished impeller shall be accurately balanced statically and dynamically. Before delivery to the Site, the static balance of the impeller shall be demonstrated to the satisfaction of the Engineer.

The impeller shall be securely keyed and locked to shaft. An impeller cap shall be attached to guide water. All impellers shall be interchangeable.

A.2.6 Shafts

The pump shafts shall be made of carbon steel forgings or other alloy steel forgings properly heat-treated. It shall be designed to operate safely in combination with the motor shaft at any rotating speed without detrimental vibration or distortion.

The upper end of the shaft shall be arranged for suitable direct coupling to the motor shaft.

The shaft shall be accurately machined throughout its length, polished where it passes through the guide bearing and gland packings.

The shaft shall have a removable and renewable sleeve where it passes through the stuffing box. The sleeve shall be made of corrosion resistant steel, which shall be split, securely fastened to the shaft, and accurately machined and polished.

A lifting device which may be bolted to the shaft or impeller shall be supplied for handling the shaft and impeller assembly.

A.2.7 Spiral Cases

The spiral cases shall be made of spherical graphite iron castings or welded-steel plate with flanged and bolted sections, and shall have the least number of sections practicable for shipment and handling, if necessary. The spiral case shall be so designed to safely withstand the maximum internal pressure of 13 kgf/cm² which will result from the maximum design head of the pump assuming during which pressure rise due to water hammer will occur.

The inside surfaces of the case shall be finished smooth and shall be reasonably free from hollows, depressions, projections or other surface imperfections that might cause local cavitation or pitting. The case shall be water pressure tested with 1.5 times design pressure for not less than 30 minutes for observation of any leakage or other defect at the manufacturer's shop or at the Site.

At least two (2) inspection holes are to be provided for periodical inspection of impeller at each spiral case. The details of size and structure of the inspection holes shall be made by the Contractor for approval of the Engineer.

If the case is made of welded-steel plate, full non-destructive inspection for welds shall be executed in accordance with the direction of the Engineer. The case will be fully or partially embedded in concrete and, therefore, shall be supplied with anchors sufficient to ensure that no movement will occur during concrete placing and/or permanent operation.

A.2.8 Bearings

The pump bearings shall be of the self-oil-lubricated - oil-bathed type, and shall consist of bearing support or housing and removable bearing shell. The bearing lining shall be of suitable high grade anti-friction metal securely anchored to the shell, grooved for lubricant circulation, and accurately bored for proper fit on the shaft.

The pump bearing shall be water cooled and complete with oil bath and water cooling tubes. Cooling tubes shall be manufactured of copper tubing and plate.

The cooling tubes shall be separated into at least two banks so that cleaning of one bank may be undertaken while the cooling requirement is being carried by the other.

The lubrication oil system for the bearing shall be designed to use the same oil and cooling system as for the motor bearing.

Adequate provision shall be made for maintenance and replacement of the bearing shell and for adjustment of bearing shell position.

A.2.9 Suction Pipes

A steel suction pipe which shall be of elbow type, shall be provided for each pump as shown on Drawing for Tender, Nos. 3-I-004, 005 and 3-I-007.

Each suction pipe shall have connection outlets for a water filling pipe and a drain pipe to sump pit. Each pipe which shall be of welded steel plate structure, shall be designed for respective internal and external water pressures and connected to the pump inlet by means of flange connection. The thickness of pipe shell shall not be less than 9 millimeters including corrosion allowance of 2.0 millimeters and the factor of safety for buckling of the pipe against the external pressure shall be over 1.5.

A manhole in 0.4 m wide by 0.6 m high shape shall be provided for maintenance of pump at each suction pipe. The details of size and curve radius of the suction pipes shall be made by the Contractor for approval of the Engineer. The suction pipe shall be delivered with the least number of sections practicable for shipment and handling. In order to maintain the accuracy of roundness of the suction pipe sections, internal spider shall be provided in the sections immediately upon completion of fabrication to prevent any deformation during transportation. Pad plates, tack weld jigs, etc. for site girth welding shall be supplied by the Contractor, if necessary. After field welding, 100 percent of the entire girth joint including all T-joints in the pipe shell shall be radiographed, and the welding defects shall be repaired.

A.2.10 Short and Enlarging Pipes with Flange Connections

The Contractor shall provide the following pipes and connections at the completely assembled condition.

- (1) Six (6) steel short pipes in 0.8 m diameter, coupling with pump outlets and enlarging pipes by means of flange and loose flange connections.
- (2) Six (6) steel enlarging pipes in 0.8 m to 1.0 m diameter, coupling with 0.8 m diameter short pipes and non-return valves by means of flange connections.
- (3) Six (6) steel short pipes in 1.0 m diameter, coupling with non-return valves and guard valves by means of flange and loose flange connections.

These pipes and connections shall be designed for internal water pressure of 13 kgf/cm². The contact surfaces of the joints shall be machine-finished to ensure complete water tightness when they are connected.

A.2.11 Accessories

The following accessories shall be supplied by the Contractor for the pumps:

- (1) Six (6) complete sets of steel water filling pipe with valve and flange connection in 1 50 mm diameter.
- (2) Six (6) complete sets of anchor bolt and nut.
- (3) Six (6) complete sets of pressure gauge.
- (4) All necessary temperature detectors.
- (5) All necessary oil level detectors.
- (6) All necessary cooling water flow relays.
- (7) One (1) complete set of erection and maintenance tools.
- (8) All platforms, ladders, guards, handrails, foundations, checkered plates, etc. where required for the pump structure and safe operation.
- (9) Other necessary accessories.

Note : Indicators for above items (3), (4), (5) and others required shall be furnished on the control board of Subsection E.

A.2.12 Spare Parts

The following spare parts shall be furnished by the Contractor for the pump units, according to the Forms of Schedules in Volume-II.

- (1) Six (6) sets of gland packing or seal for shaft.
- (2) Two (2) sets of pump bearing.
- (3) Six (6) sets of gasket in each type employed
- (4) A quantity equivalent to 20% of all fasteners, bolts, nuts and washers over 25 mm in diameter.
- (5) Two (2) complete sets of pressure gauge.
- (6) Two (2) sets of temperature detectors for pump bearing metal.
- (7) Two (2) sets of temperature detectors for pump bearings oil.
- (8) Two (2) sets of oil level indicators for pump bearing.
- (9) Two (2) sets of cooling water flow switch.
- (10) Two (2) sets of wearing ring and sleeve, where supplied.
- (11) One (1) complete impeller.
- (12) Other necessary spare parts recommended by the manufacturer.

A.2.13 Tests at the Contractor's Shop

- (1) General

Each pump shall be completely assembled in the Contractor's shop and properly oriented by reference lines, match-marked and doweled to ensure correct assembly and alignment at the Site. Before shipping of the goods from the Contractor's shop, the pumps shall pass such test as are prescribed in the relevant codes and standards and necessary in the opinion of the Engineer to prove compliance with the Specifications. The tests shall include material test on all important parts, dimensional inspection, hydrostatic test, balancing test of impeller, assembly and operation test, painting and packing inspection.

(2) Hydrostatic Tests

- (a)** Hydrostatic testing for the spiral cases shall be as required by JIS B8301 or other standard. The test pressure shall be 1.5 times the design pressure in accordance with the said standard.
- (b)** Hydrostatic testing and inspection shall be completed before any paint is applied. Gaskets used for testing shall be of the same material and design as specified for the finished product. Where mechanical gasket joints are broken following tests, new gaskets shall be furnished with the pump unit.
- (c)** The hydrostatic test pressure shall be held for not less than thirty (30) minutes.

(3) Performance Test

- (a)** All pumps coupled with due testing motors shall be tested by the Contractor to establish that the performance guarantees and technical particular requirements in the Schedules of Volume-II have been fulfilled. The performance test shall be made for the pump coupled with motor assembly as an operating unit to simulate installation at the Site. The Engineer reserves the right to witness the tests, and the Contractor shall notify the Engineer four (4) weeks in advance of possible date of the tests to be witnessed.
- (b)** The tests shall be conducted in accordance with the previously accepted testing procedures, unless otherwise specified. The procedures and instruments to be used shall conform to the latest applicable standards specified.
- (c)** Test data and reports shall include at least the following information, but not limited to :
 - (i)** Determination of the rated head.
The rated head shall be considered as sum of the design actual head of 55.52 m and total head losses of 4.48 m.
 - (ii)** Determination of quantity of water pumped up in cubic meters per second, in more than five (5) different points including those at the rated head and shut-off point.
 - (iii)** Measurement of horsepower input to the pump.
 - (iv)** Determination of overall efficiency
The overall efficiency shall be defined as the ratio of the water horsepower delivered by the pump to the electrical horsepower supplied to the pump motor, using the values of total head, quantity of water pumped up and horsepower input to the motor.
 - (v)** Preparation of characteristic curves showing overall efficiency, horsepower input versus discharge throughout the entire range.