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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE SOCIALIST REPUBLIC OF VIET NAM
THE MINISTRY OF ENERGY

REHABILITATION OF DA NHIM POWER SYSTEM IN THE SOCIALIST REPUBLIC OF VIET NAM

DRAFT TECHNICAL SPECIFICATIONS

Volume I of III

JUNE 1995

NIPPON KOEI CO., LTD.
TOKYO, JAPAN

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DRAFT TECHNICAL SPECIFICATION

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SECTION 1 GENERAL SPECIFICATIONS

1.1 Scope of Work

The Contract shall include the designing, manufacturing, testing before shipment, finishing, galvanizing and protective coating where specified, packing for export, insuring, shipping and delivery to the Port of Saigon of the Plant, landing, customs clearance, transport from the Port of Destination to the Site and delivery to the Site of all the following:

(1) Seal rubbers and seal clamps for four (4) sets of spillway radial gates, one (1) set of intake caterpillar gate, two (2) sets of butterfly valves of penstock with auxiliary equipment, and each thirty two (32) sets of manholes and expansion joints of the penstock.

(2) Two (2) sets of local control panel and one (1) set of remote control panel for spillway radial gates and each one (1) set of local control panel for intake caterpillar gate, intake movable trash rack and penstock butterfly valves with all necessary electrical equipment and cables.

(3) Mechanical and electrical parts for gates and valves with all necessary material for installation.

(4) Each one (1) complete set of irrigation outlet valve and its guard valve with control panel and all necessary electrical equipment and cable and replacement of sealing material of conduit expansion joint and one (1) conduit pipe

(5) Two (2) water supply pump at spillway irrigation outlet with control panel and all necessary electrical equipment and cable

(6) One (1) set of rope haulage of penstock

(7) One (1) lot of spare parts and testing equipment for existing gates and penstock

The Contract shall also include the dispatch of their installation supervisors, and the services of instruction to the project staff and the Employer's shop inspection. All shall be in accordance with these Specifications, the accompanying Drawings and Tender Schedules.

1.2 General Description of the Project

The Da Nhim Hydroelectric Power Project, which was located at about 250 km northeast of Ho Chi Minh city, was constructed in 1964 with installed capacity 160 MW (4 units x 40 MW).

The Da Nhim dam basin which feeds water to the Project has a drainage area of about 1,400 km^2 and an annual rainfall of 1,700 mm, and the Da Nhim flows through this basin for a distance of 80 km. The lower half of the river course runs through the gradually opening fields at the elevation varying between 1,020 and 960 m, with an average discharge of 36 m^3/sec at its end.

The Da Nhim basin borders on the lower plain on the east coast beyond the divide mountains, and between the basin and the plain there is a large descent of about 800 m in a distance of less than 10 km. This favored natural feature provides an ideal site for a valuable hydropower project which enables to develop huge water power at a low cost by diverting the water of the Da Nhim to the low plain through relatively short waterway.

1.3 Distribution of Electric Power

For the distribution of electric power to the electrical equipment and controls of the Plant to be supplied under the Contract, the Contractor shall design and supply all power cables in sufficient capacity and all their accessories such as conduits, cable hangers, fittings, anchors, etc., from the electrical terminal point at the dam, intake, penstock valve house and power station. Voltage drop of the power cables between the terminal points and respective equipment shall be limited to less than 2.5 percent of the rated voltage.

1.4 Works by Employer and/or Other Contractors

The Employer will arrange the necessary for the completion of the Project other than that covered by the Contract, to be executed by the Employer or other contractors. The Contractor shall cooperate with the Employer and other contractors to ensure the satisfactory completion of the Project as a whole.

1.5 Operation and Control

The gates and valves will be operated and controlled as follows:

(1) The spillway radial gates and hoists provided in the spillway will be operated and controlled by an operator with either a remote control cabinet provided in the spillway watch house at the dam or two (2) local control cabinets provided on each hoist deck.

(2) The irrigation valves will be operated and controlled by the operator with a local control cabinet provided on the hoist deck of the spillway radial gates.

(3) The water supply pump will be operated and controlled by the operator with a local control cabinet of the irrigation valves including all control of the water supply pump.

(4) The intake caterpillar gate and hoist will be operated and controlled by the operator with a local control cabinet provided in the operation chamber.

(5) The movable trash rack will be operated and controlled by the operator with a local control cabinet.

(6) The butterfly valves will be operated by the operator with a local control panel integrated into hydraulic oil unit.

1.6 Climate

Generally, the site of the Da Nhim power station is subjected to the summer and winter monsoons. The alteration of seasons is as follows:

Jan. - Mar.	:	Dry and cool season under continental winter monsoon with no rain
Apr. - May	:	Thunderstorm season with the highest temperature in all season
Jun. - Aug.	:	Summer season with west wind, accompanied by long rain
Sept. - Dec.	:	Changeable weather, some times struck by typhoon with heavy rainfalls resulting in flood

As for atmospheric temperature, this site was devided into two parts. One was the dam and tunnel sites with an altitude of more than 1,000 meters where the climate was moderate and comfortable and the other was the power station site with an altitude of about 200 meters where the climate was tropical and not so comfortable. The temperature ranged from 30 °C to 5 °C at the dam site and from 40 °C to 15 °C at the power station site. The temperature difference in a day was more than 10 °C.

The rainfall at Don Duong during period between 1980 and 1993 was 1,300 to 1,700 millimeters per annum. The rainy season begins at the end of April and ends at the end of November. The daily rainfall was frequently concentrated in a short time with intense hourly rainfall which reached approximately 80 millimeters at the maximum. At the beginning of the rainy season, it rained for 20 to 30 minutes in the afternoon at an interval of 2 or 3 days, but in an earnest period the time of daily rainfall became 2 to 3 hours and, as frequency increased, rainfall became to continue for almost whole day.

The dam site was blessed with cool breezing throughout a year, but there were sometimes a gust of wind which broke down the roof of houses.

The average humidity was 60 to 70% in the dry season and more than 70% in the rainy season. In the day time, the humidity dropped to less than 70% in any season and to less than 50% even at the hottest period at the end of dry season which saved the working staff from the hotness.

1.7 Traffic Condition

There is the railway having a track gauges of 1 meter from Ho Chi Minh to Dong Duong near the dam site in a length of about 350 kilometers. Rail shipment on the largest available rail car from Saigon was subjected to the following limitation.

Width	:	2.1 meters,	Height	:	2.5 meters
Length	:	11.1 meters,	Load	:	25 metric tons

The paved highway, National route No. 20, runs to Dong Duong from Ho Chi Minh through mountainous area in a distance of about 250 kilometers, and the highway No. 11 runs in about 350 kilometers along east coast, passing near the power house and penstock site. The highways were 6 meters in width, with bridge capacity of 12 metric tons in general, in which the middle 4 meters portion in paved with asphalt. The steepest grade of the highway was 6

percent except 10 percent in the mountainous areas where the smallest radius of curve is about 20 meters.

The daily air service was available between Ho Chi Minh airport and Lien Khang airport which is about 30 kilometers apart from the dam site. The required time of air traveling between the two air ports was approximately 50 minuets.

1.8 Construction Power Supply

The Employer will provide the electric power required for the Contractor's supervisors and site installation work.

1.9 Telephone Facilities

The Employer will provide the telephone facilities for the Contractor's supervisors.

At least 2 circuits of telephone line will be, but not necessarily exclusive use, available to the Contractor at terminals of the telephone facilities. The Contractor shall provide and install all wiring and telephone receivers at his own cost and expense, from such terminals.

The Contractor will use the telephone line free of charge until completion of the Works. However, for use the public telephone line the Contractor shall pay necessary telephone charge to the Telephone Authorities of the Socialist Republic of Viet Nam.

1.10 Instruction to Project Staff

During the period from commencement of erection work at the Site and until one month after the date of issue of the last Taking-Over Certificate, the Contractor shall instruct those employees, designated by the Employer, who will subsequently be responsible for the adjustment, operation and maintenance of the Plant. The course of instruction shall be carried out to the satisfaction of the Employer and the Engineer and shall be given in the English language.

1.11 Completion Schedule

(1) Construction Time Schedule

A Construction Time Schedule for the whole works of the Project has been prepared by the Employer as shown on Figure 5.18. The Construction Time Schedule is shown to assist the Tenderers and the Contractor in preparing their detailed construction time schedules.

(2) Approved Work Program

Within one (1) month after the Commencement Date, a work program shall be prepared and submitted by the Contractor for the Engineer's approval in the form of a Critical Path Network Diagram or other form, covering the design, manufacture, delivery, recommended erection and testing of the Plant, in sufficient detail to define the various sections of the Work in fifteen (15) copies, namely six (6) for the Employer and nine (9) for the Engineer. Upon approval of the program by the Engineer, it should thereafter be referred to as the approved Work Program and shall be a part of the Contract.

(3) Monthly Status Report

The monthly status report shall be prepared by the Contractor. The said monthly status report shall be submitted in three (3) copies to the Employer and a copy to the Engineer.

(4) Weekly Report and Schedule

One copy each of brief report and schedule for the construction work at the Site shall be submitted weekly or fortnightly by the Contractor to the Employer and the Engineer.

(5) Meeting on Time Schedule, etc.

From time to time during the execution of the Contract, the Engineer is empowered to call for meetings, either in his home office or at the manufacturer's offices or the Employer's office or at the Site, as he deems necessary, for the purpose of control of the Contract. As required by the Engineer, responsible representatives of the Contractor shall attend such meeting at his own expense.

In keeping the Approved Work Program of this Contract, the Contractor shall cooperate with the Employer and other contractors at the Site in order to effect the completion of the Project as a whole. The Engineer shall coordinate the schedules of work of all the contractors and shall have the final jurisdiction and control, in case of dispute, of the program of work. It is therefore in the Contractor's best interest that he shall prepare a detailed and accurate schedule and indicate clearly the space and facilities which he will use to execute his work.

1.12 Units of Measurement

In all correspondence, in all technical schedules and on all drawings, Metric units of measurement shall be employed.

1.13 Working Stresses and Design

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

All parts which will have to be dismantled or which might have to be dismantled, for purposes 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.

All design shall be such that the installation, replacement and general maintenance may be undertaken with the minimum of time and expense. The tolerances used for dimensions and finishes shall be selected with due consideration to the particular properties and functions of the parts and the corresponding accuracy required to obtain proper operation and tight sealing.

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 to the concrete foundations all loads imposed by the various parts of the equipment. Such bases or frames shall be supplied complete with suitable anchor bolts and shall be so proportioned that the bearing loads imposed on the concrete foundations will not exceed 60 kgf/cm^2.

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

Complete information regarding the design assumptions, loading and operating conditions, deflections and unit stresses used in the design shall be provided with the appropriate drawings by the Contractor to the Engineer.

The Contractor shall be deemed to have examined the Specifications and Drawings for Tender herewith and to have concurred with the design and layout of the Works, as being sufficient to ensure reliability and safety in operation, free from undue stresses, adequate drainage and other essentials for a satisfactory working plant.

It should be noted that the Drawings for Tender show only the general type of equipment and the principal dimensions and are not intended to define the exact details of the equipment to be furnished. Alternative details and arrangement will be considered. The said alternatives shall be listed up in the tender proposal. As the Drawings indicate the outline of the structure in which the equipment is to be installed, special attention shall be paid to the arrangement of the equipment so as to make optimum use of the available space. Any recesses required in this structure for alignment and grouting of embedded parts shall be determined by the Contractor.

1.14 Permanent Electricity Supplies

The power for the Plant shall be alternative current of;

3-phase, 4-wire, 50 Hz,	
Voltage between phases	380V
Voltage between phase and neutral	220V
Voltage variation	± 10%
Frequency variation	± 5%
Neutral point	Solidly grounded

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

1.15 Tropicalization

In choosing materials and their finishes due regard shall be given to the humid tropical conditions under which the power plant and equipment will be called upon to work. The Contractor shall submit details of his practices which have proven satisfactory and which he recommends for application on the parts of the Work which may be affected by the tropical and local conditions. The materials and finishes used shall be approved by the Engineer. All control cubicles shall also be vermin proof and the minimum thickness of steel plate of them shall be 2.3 mm.

1.16 Grounding

All electrical equipment in the Plant shall be substantially grounded to system provided by the Employer in the vicinity of the respective structures. Adequate size of copper grounding conductor, based on the maximum ground fault current and the protection in the circuit, shall be used for these connections and the minimum size of them shall be 8.00 mm^2.

1.17 Change to Material or Equipment

The Contractor shall not make any changes to the equipment or in the materials to be incorporated in the equipment from that specified or implied by these Specifications without the written approval of the Engineer. Such changes or alternations shall in no way be detrimental to the interests of the Employer and shall not result in any increase to the Contract Price.

1.18 Labels and Plates

The Contractor shall supply and install at least one name plate made of bronze or corrosion-resisting steel in approximately 500 mm wide by 400 mm high, for each Plant to be provided under this Contract. All duty labels and instruction plates on cubicle and equipment, including above name plates, shall be in Vietnamese language. The Contractor

shall submit sentences and letters in English of all duty labels and instruction plate to the Employer. Translation from English to Vietnamese will be made by the Employer.

Unless otherwise required by the Employer or the Engineer, all data and names plates on equipment and Plant shall be in English.

1.19 Drawings and Documents to be Supplied by the Contractor

Award of Contract does not imply the approval of drawings and documents prepared for and submitted with the Tender.

Immediately after concluding the Contract Agreement, the Contractor shall firstly submit a master list of drawings and documents to be provided under the Contract for approval of the Engineer, clearly indicating title (to always contain the Employer's name, Project name, Contract No., Work Division, etc.), numbering method, size and quantity of drawings, dimensions and form of title block and bibliography, etc.

The Contractor shall include in his Tender the cost for preparation of the drawings, documents and others to be provided under this Contract.

(1) Drawings and Documents for Approval

Prior to commencement of manufacturing the Plant, the Contractor shall submit the design criteria, calculations, specifications, dimensioned and traced drawings and diagrams showing all details of the Plant and materials to be used as well as all arrangements related to the other contractor's works, for approval of the Engineer and the Employer simultaneously. These drawings and data with stamp of "FOR APPROVAL", "DATE OF SUBMISSION" and "CONTRACTOR'S SEAL" shall be submitted within the times mentioned hereunder reckoned in calendar month from the Commencement Date. The Contractor shall allow a period of at least six (6) weeks for such approval procedure and another one (1) week for return mail after receipt by the Engineer. One copy of them submitted will be returned to the Contractor by the Engineer with one of the marks tentatively planned as "APPROVED" or "APPROVED EXCEPT AS NOTED" (authorizing the Contractor to proceed with the contractual works taking account of the Notes) or "RETURNED FOR CORRECTION AND RESUBMISSION". In any case these shall be submitted in sufficient time to permit 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. Claims or extensions of

time will not be permitted on account of the late submission of drawings and documents to the Engineer or for delays caused by drawings and documents being not approved by the Engineer.

It is to be understood, however, that approval of drawings and documents will not relieve the Contractor of any responsibility in connection with the Work.

All drawings and documents to be submitted for approval or sent to the Employer or the Engineer for any other reason shall be sent by registered airmail or by hand.

The title of the drawings, the signature of the Contractor's responsible engineer, the date prepared, the drawing number, etc., shall appear in the bottom right-hand corner of the drawing. The size of drawings shall be as follows:

A1	594 mm x 841 mm
A3	297 mm x 420 mm
A4	210 mm x 297 mm

A blank in 200 mm wide by 100 mm high shall be kept unoccupied above the title block of drawing for the Engineer's comments.

(2) For-Work-Drawings

After approval of the drawings and documents by the Engineer, the Contractor shall supply copies of the approved-drawings with stamp of "FOR WORK DRAWING", "DATE OF APPROVAL" and "CONTRACTOR'S SEAL" to the Employer and the Engineer.

(3) Final Drawings and Documents

After all items of the Work have been manufactured, erected and commissioned, a complete set of the negatives of the drawings previously approved and/or corrected during site works are to be submitted to the Employer and the Engineer.

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

The reduced size of drawings into A3 size shall be bound in A3 size covers and be submitted to the Employer and the Engineer.

(4) Required Numbers of Drawings and Documents

Numbers of the drawings and documents to be submitted to the Employer and the Engineer shall be as follows:

	To the Employer	To the Engineer
Within times mentioned		
Drawings and documents for approval	6 copies	9 copies
For-work-drawings and documents	- do -	4 copies
Within two(2) months upon Completion of the Work		
Complete set of negatives of drawings and documents	1 set	NIL
Complete set of microfiche of drawings and documents	1 set	1 set
Complete set of bound print of drawing and documents		
Full size	6 sets	NIL
Reduced size (A3 size)	4 sets	2 sets

Further copies of particular drawings and documents are to be provided at the Contractor's own expense if so requested by the Engineer or the Employer.

(5) Target on Submission of Drawings and Documents

(a) Within five (5) months

The detailed drawings and documents related to the civil work such as the drawings showing the blockouts and foundations of the Plant and location of anchor bars and plates to be supplied and installed by the Employer.

(b) Within ten (10) months

General and shop fabrication drawings and calculation sheets.

(c) Documents for approval specifically stated in the Specifications ;

- Work program in Clause 1.11 "Completion Schedule-Approved Work Program" within one (1) month.

- Request of translation to the Employer for labels and plates in Clause 1.18 "Labels and Plates" within one (1) month after approval of drawings for main component of the Work.

- Operation and Maintenance Manuals in Clause 1.20 "Operation and Maintenance Manuals" within one (1) month after approval of drawings for main component of the Work.

- Erection Instructions in Clause 1.21 "Instruction for Erection Works" within ten (10) months.

- Qualification documents for welding procedure and for welder and welding operator's qualification in Clause 1.22.(11) "Standard and Workmanship-Welding" not later than three (3) months before commencement of fabrication work.

- Painting Specifications, color scheme and painting sample in Clause 1.24.(1) "Protection, Cleaning and Painting-General" before commencement of fabrication work.

- Test procedure at the shop and at the Site in Clause 1.28 "Test Procedure Instructions" within twelve (12) months.

- Photographic record in Clause 1.30 "Photographs" upon completion of the Work.

- Spare parts list in Clause 1.31 "Spare Parts" and maintenance equipment and special tools list in Clause 1.32 "Maintenance Equipment and Special Tools" within one (1) month after approval of drawings for main components of the Work.

(d) Within twelve (12) months

All other drawings and data other than those as above mentioned.

1.20 OPERATION AND MAINTENANCE MANUALS

The Contractor shall submit to the Engineer the general instructions concerning the correct manner of operation and maintenance of all the Plant provided under this Contract with special references to any recently developed features.

The instruction manual shall be prepared for each plant system as outlined in Clause 1.1 "Scope of Work", and shall be submitted for approval in the same manner as the drawings. It shall be finalized before delivery of the Plant to the Site, and when finally approved, ten (10) copies and two (2) copies shall be prepared and forwarded to the Employer and the Engineer, respectively. The Contractor shall ensure that the erection supervisor has a copy in his site office.

The instruction manual shall include a separable and complete section describing the normal operating procedures for the control of the Plant, and shall include easily read diagrammatic drawings of the equipment to facilitate understanding the descriptive information.

The instruction manual shall describe and illustrate in detail the method and procedure for assembling, adjusting, operating and dismantling of each component, system and machine and the use of equipment devices necessary for such works. The maintenance of each component shall be described, including the recommended frequency of inspection and lubrication.

The Contractor shall, in preparing the instruction manual, take into account the lack of experience and familiarity of the operating personnel with this type of equipment.

The manual shall include a complete list of all drawings prepared for this Contract, the approved painting specification, the tool list, the spare parts list, the parts list for each component of item of equipment with necessary catalogues, etc. The parts list shall include manufacturer's code and serial numbers and ordering instructions. The parts list shall be detailed for only the equipment supplied and shall not include general reference or description of similar equipment which is of the same model but different only in detail. The manual shall be prepared in English language.

1.21 INSTRUCTIONS FOR ERECTION WORKS

The Contractor shall submit to the Engineer for approval within ten (10) months from the Commencement Date the instruction manual for the erection work of the Plant to be executed at the Site.

The instruction manual shall be submitted for approval in the same manner as the drawings and, when finally approved, three (3) copies shall be submitted to the Employer and two (2) copies to the Engineer. The Contractor shall ensure that the erection supervisor has a copy in his office at the Site.

The instruction manual shall describe and illustrate in detail the methods and procedures for installation of the Plant, the use of the construction facilities and measurement devices together with their capacity and required number, field shop to be provided for the installation work and other necessary explanations on the installation work.

1.22 STANDARDS AND WORKMANSHIP

(1) General

All materials shall be new, the best of their respective kinds and of such as are usual and suitable for work of like character. All materials shall comply with the latest Japanese Industrial Standards (JIS) unless otherwise specified or approved by the Engineer.

All workmanship shall be of the highest class throughout to ensure smooth and vibration free operation under all possible operating conditions, and the design, dimensions and materials of all parts shall be such that the stresses to which they may be subjected 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 approved drawings. All joints, datum surfaces, and matching components shall be machined and all castings shall be spot faced for nuts. All machined finished shall be shown on the approved drawings. All screws, bolts, studs and nuts and threads for pipes shall conform to the latest standards of the International Organization for Standardization (ISO) covering these components and shall conform to the standards for metric size. The Contractor shall use exclusively the standards and size system presented in his tender and accepted and incorporated in the Contract.

(2) Standard Specifications

The Japanese Industrial Standards issued by the Japanese Standards Association of Japan have been used throughout these Specifications. Other national or international standards may be accepted provided that the requirements therein are, in the opinion of the Engineer, equivalent to or better than the current issue of the Japanese Industrial Standards.

Unless otherwise specified, design and fabrication of the equipment shall conform to the applicable provisions of "Technical Standards for Water Gates and Penstocks" as issued by the Hydraulic Gate and Penstock Association of Japan.

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

All electrical equipment, material and details of installation shall comply with the requirements and the latest revisions of the following Standards and codes where applicable:

(a) Japanese Industrial Standards (JIS),
(b) Standard of the Japanese Electrotechnical Committee (JEC),
(c) Standards of the Japan Electrical Manufacturer's Association (JEM),
(d) Japanese Cable-makers Associations Standards (JCS),
(e) International Electrotechnical Commission (IEC),
(f) International Organization for Standardization (ISO), and
(g) Standard of local regulatory bodies having jurisdiction over and installation.

(3) Material Inspection and Testing

Materials, parts and assemblies thereof, entering into the Work shall be tested, unless otherwise directed, according to the best commercial method for the particular type and class of work. When the manufacturer desires to use stock material not manufactured specifically for the equipment furnished, satisfactory evidence that such material conforms to the requirements herein stated, shall be furnished, in which case tests on these materials may be waived. Certified mill test reports of plates and sections will be acceptable. In addition to the mechanical tests required by the Specifications, all materials shall be examined in the shop for laminations and imperfections before incorporating them into the Work and any defective material shall be rejected.

Witness tests and inspection of material may be made at the place of manufacture by the Inspector appointed by the Engineer, unless otherwise specified. Such witnessing and inspecting will be conducted so as to interfere as little as possible with manufacturing operation. The Contractor shall however comply with any reasonable request made by the Inspector concerning the method of test or correction of defective workmanship.

All castings weighing 226.8 kg (500 pounds) or more shall have test coupons attached from which test specimens may be prepared. The number, size and location of the test coupons shall be to the approval of the Engineer. Faulty material or materials found to be inferior to that specified shall be rejected and removed at once, and shall not be used in any part of the Work.

Test pieces of other structural materials shall be provided as required by the Engineer.

The ultimate strength, limit of elasticity, ductility, hardness, etc., will be determined from such test pieces.

The Contractor shall furnish, free of charge, all test pieces, blankets, etc., cut and machined to the sizes, shapes and dimensions as directed by the Engineer. The testing of the specimens will be carried out by the Contractor at his own expense, and shall be performed as directed by the Engineer.

Test pieces which represents rejected material shall be preserved and become the property of the Employer. Copies of all test reports shall be mailed to the Engineer.

Waiving of inspection by the Engineer shall not relieve the Contractor of the responsibility for supplying material and workmanship acceptable to the Engineer.

(4) Shop Assembly

All items of equipment shall be assembled in the shop prior to Shipment and tests shall be performed by the Contractor as may be required to demonstrate to the satisfaction of the Engineer the adequacy of the equipment and its component parts. All tests should be simulated to normal operating conditions as closely as possible. All dismantled parts shall be properly matchmarked and doweled to ensure correct assembly in the field.

(5) Castings

All castings shall be dense, sound and true to pattern, of workmanlike finish and of uniform quality and condition, free from blowholes, porosity, hard spots, shrinkage defects, cracks or other injurious defects, and shall be satisfactorily cleaned for their intended purpose. All castings shall be checked for defects before final machining.

Casting shall not be repaired, plugged, or welded without permission 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 or 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.

Surfaces which do not undergo machining and are exposed in the final installation shall be dressed to provide a satisfactory appearance so that they will not require surface smoothing at site prior the painting.

(6) Forging

The ingots from which the forging are made shall be case 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 or 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.

(7) Steel Plates, Bars, Pipes, etc.

Steel plates, bars, pipes, etc., for the equipment shall be of the steel materials or better in accordance with the specified standards.

(8) Floor Plate

Checkered type floor plate shall be of an approved raised pattern. All edges of plate shall be planned and joints shall be cut so as to maintain continuity of pattern.

(9) Walkways, Ladders and Handrails

Adequate walkway, ladders, and safety handrails and guards shall be provided on and around each unit, where necessary, 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.

(10) Machine Work

(a) General

All tolerances, allowances and gauges for metal fits between plain cylindrical parts shall conform to the Japanese Industrial Standards or other approved equivalent standards for the class of fit as shown on otherwise required. Sufficient machining stock shall be allowed on locating pads to ensure true surfaces of solid material. Bearing surfaces shall be true and exact to secure full contact. Journal and sliding surfaces shall be polished and all surfaces shall be finished with sufficient smoothness and accuracy to ensure proper operation when assembled. Parts entering any machine shall be carefully and accurately machined. All drilled holes for bolts shall be accurately located and drilled from templates.

(b) Finished Surfaces

Surface finished shall be indicated on the Contractor's drawings and shall be in accordance with the Japanese Industrial Standards or other approved equivalent. Compliance with specified surface will be determined by sense or feel and by visual inspection of the work compared to standard roughness specimens, in accordance with the provisions of the above stated standards.

(c) Unfinished Surfaces

So far as is practicable, all works shall be arranged to obtain proper machining of adjoining unfinished surfaces. When there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground smooth, or machined, to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown on the drawings and shall be chipped or ground

free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in approved manner.

(d) Pins and Pin Holes

Pin holes shall be bored to gauge, smooth and straight, and at right angles to the axis of the member. The boring shall be done after the member is securely fastened in position. Pins shall be of hardened and ground steel and positively held in position. Wheels or rollers for use in gates shall be mounted on removal pins and have self-lubricating bushings or self-aligning roller bearings and brass washers.

(e) Lubrication

Before assembly, all bearing surfaces, journals, and grease and oil grooves shall be carefully cleaned and lubricated with and approved oil or grease. After assembly, each lubricating system shall be filled with an approved lubricant. Self-lubricating bearings shall be cleaned with clean rags, and greased with an approved lubricant before assembly. Solvent shall not be used on the self-lubricating bearings. The specification of all approved lubrications shall be mentioned in the Operation and Maintenance Manuals.

(f) Balancing

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

(11) Welding

All welding shall be done either manually by the shielded metallic arc process or automatically by the shielded arc or submerged arc method.

The Contractor shall develop and submit a welding procedure for the approval of the Engineer. After the welding procedure has been approved, the Contractor shall record it on a special drawing which shall thereupon become one of the drawings of the Contract. Weld sizes and types shall be shown on all Contractor's drawings where welding is required.

Non-destructive examination such as radiographic or ultrasonic, or magnaflux or dye-penetrated inspection shall be carried out by the Contractor when required by the standards, these Specifications or the design criteria employed. All important weld 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 or Inspector, do not appear to conform to the welding standards, shall be non-destructively tested when required by the Engineer.

Suitable meters shall be provided to show the welding current and the arc voltage at all times during the welding operations. Unless otherwise specifically stated, welded parts requiring machine finished shall be completely welded before being finished.

Plates to be joined 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 joined 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 for a distance of 25 mm from the edge to be welded shall be thoroughly cleaned of all rust, grease and scale, to bright metal.

(a) Qualification of Welding Procedure

The technique of welding employed, the appearance and quality of the welds made and the methods used in correcting defective work, shall conform to the American Welding Society (AWS) Standard D.1.1, or other approved equivalent standard.

(b) Qualification of Welders and Welding Operators

All welders and welding operators assigned to the Work shall have passed a qualification test, within the preceding six (6) months, for welders and welding operators, in accordance with JIS Z 3801 and/or Z 3841 or AWS D.1.1 or other approved equivalent standard. The Contractor shall furnish the Engineer with certified copies of reports of the results of physical tests of specimens welded in the qualification tests. If, in the opinion of the Engineer, the work of any welder at any time appears questionable, he shall be required to pass the appropriate requalification test. All costs of qualification tests shall be borne by the Contractor.

(c) Welding Electrodes

The welding electrodes shall conform to JIS Z 3211 or Z 3212, low hydrogen type covering or other approved equivalent.

Stainless type weld metal, where used in the water passages for protection against pitting, shall be chromium nickel steel. The type, chemical composition and JIS number of welding rods for this purpose shall meet with the approval of the Engineer.

1.23 Safety Precautions and Fire Protection

(1) Safety Precautions

Prior to any of the Work being energized, the Contractor shall be responsible for supplying and fixing in prominent positions near to each item of the Work concerned, large multilingual temporary signs giving clear warning of danger in areas which might previously have been regarded as safe.

During erection and commissioning, the Contractor shall provide all temporary scaffolding, ladders, platforms with toe boards and handrails essential for safe and convenient access of workmen, inspectors and other authorized persons employed about the Works. All dangerous openings or holes in floors shall be provided with handrails or covers; preventative measures shall be taken to protect workmen from falling materials.

The maximum possible safety must be rendered to personal directly engaged on this Contract or those who frequently are in the working area or those who in the normal course of their occupation find it necessary to utilize temporary works erected by the Contractor.

(2) Fire Protection

The Contractor shall be responsible for the fire protection of his buildings, Plant and equipment and shall provide portable fire fighting equipment as nominated by the Engineer within one (1) month of such nomination. The equipment shall be available on the Site at all times and shall be kept available as directed by the Engineer.

The Contractor shall maintain the fire fighting equipment in a condition satisfactory to the Engineer and shall recharge extinguisher after use regardless of by whom they were discharged. Adequate stocks of fresh chemical charges for use in extinguisher shall be kept in readiness on the Site. Fire fighting equipment shall be left on the Site for the full period from the commencement of site works until taking over the Works.

1.24 Protection, Cleaning and Painting

(1) General

The painting of the Plant shall include the preparation of the metal surfaces, paint application, protection and drying of the paint coatings, as well as the supplying of all tools, labors and materials necessary for the entire painting work.

The finish color of all Plant shall be approved by the Engineer under the confirmation of the Employer. The Contractor shall propose a color scheme for the equipment and shall submit painted samples or color chips. A color chip shall be included with the approved color schedule for each type of finish. The color of all undercoats shall match the color of the finish coat.

Paint shall be a product of reputable manufacturer. Paint shall be delivered in the manufacturer's sealed tins, stored under cover and used within the guaranteed term of validity and by the method recommended by the manufacturer.

The Contractor shall prepare and submit the painting specifications for approval of the Engineer in the manner as stipulated in Clause 1.19 (Drawings and Documents to be supplied by the Contractor). The painting specification shall cover paint schedule, manufacturer's statement of the physical and performance characteristics for paint materials to be selected, and manufacturer's recommended procedures for the surface preparation, application, handling instructions, equipment, ambient conditions, mixing instructions, safety and storage instructions, etc. The procedures shall also include any special requirements for field repairs to the damaged coating and for the coating of field joints.

All parts which will ultimately be buried in concrete shall be cleaned and protected, before leaving the manufacturer's shop, by a portland cement wash or other approved method. Before being installed they shall be thoroughly descaled and cleaned of all rust and adherent matter.

(2) Surface Preparation

All oil, paraffin, grease and dirt shall be removed from the surfaces to be painted, by wiping the surfaces with a clean cloth dipped in mineral solvent. Following solvent cleaning, all weld spatter, slag, burrs, loose rust and mill scale and other foreign substances shall be removed by shot or grit-blasting to "Sa 2 1/2" of Swedish Standard SIS 055900 or SSPC-SP10 of Steel Structure Painting Council Manual Volume 2. Special attention shall be given to cleaning of corners and converging angles. Blast cleaned surfaces showing plate surface defects such as scabs or sharp gouges shall be repaired in an approved manner prior to painting.

After blast cleaning, the surface shall be dusted off or blown off with compressed air free of detrimental oil and water. All surfaces to be painted shall be completed dry, clean and free from moisture just prior to and during painting. If rust forms or the surface become contaminated in the interval between cleaning and painting, recleaning to the same degree shall be required.

(3) Application Procedure

The application of protective coating shall be carried out at the Contractor's shop and/or field shop, whenever possible. Painting work at erection site shall be limited to touch-up coatings for damaged areas and coatings for field welding portions.

All paint, when applied, shall provide a satisfactory film and a smooth even surface. Paint shall be thoroughly stirred, strained, and kept at the uniform consistency during application. Paint shall not be applied when the temperature of the metal or surrounding air is below 10 degrees C and that of the metal is above 50 degrees C, or when the humidity is above 90 percent, or when it threatens to rain before the painted coat gets dry. Each coat shall be protected during the initial curing period against the possibility of moisture condensation or contamination with foreign matter. Paint shall be performed by brushing and/or airless spraying.

When the coating material is applied by spraying, suitable means shall be provided to prevent segregation during the coating operation. Free oil and moisture shall be removed from the air supply lines of all spraying equipment. Each coat shall be uniform and free from runs, sags and other imperfections. The time between successive coats shall be not less than the minimum nor more than the maximum re-coating time specified by the manufacturer.

The paint shall be applied so that the thickness at any point is not less than that stipulated in the approved painting specification. Surfaces not required to be coated, but adjacent to surfaces which are to be cleaned and coated, shall be adequately protected during cleaning and coating.

Repairs to damaged areas of the coating system shall be carried out strictly in accordance with the approved painting specification.

Because of the flammable and toxic nature of the coating materials, the Contractor shall take precautions to eliminate hazard that may arise during the application of the coating. Smoking and welding shall not be allowed within 10 m of the place when painting is in progress.

Where steelwork is to be welded, only the primer shall continue over the weld area. Subsequent coats shall be kept back 100 mm from the weld and completed after welding. The primer shall be such that no toxic fumes are given off during welding. Alternatively, approved temporary protection such as taping may be provided as an alternative to priming the weld areas. The edges of shop coats exposed on removal of the tape shall be treated in accordance with the manufacturer's instructions to ensure adhesion to coats applied at Site.

Painting shall be stopped off 75 mm from the edges of interface areas for high strength friction-grip bolts. Painting over and around such bolts shall be completed as specified after assembly.

(4) Surfaces not to be Painted

Bronze, brass, machined parts surfaces of gear teeth, finished ferrous surfaces, surfaces in rolling or sliding contact after field assembly and hoist ropes shall not be painted. All corrosion-resisting steel surfaces for bearings and machinery parts shall not be painted.

On completion of cleaning, this surface not to be painted shall be coated with an approved rust preventive coating material or an adhesive plastic film to protect the surfaces from minor mechanical damage and corrosion during Shipment and storage at the Site. The coating material shall be stripped off after field erection of equipment.

Unassembled fittings, pins, bolts and nuts shall be oiled and wrapped with moisture-resistant paper or protected by other approved means.

(5) Paint Schedule

One epoxy resin zinc rich primer coat and two or three coats of coal-tar epoxy resin paint, total dry film thickness of 0.45-0.60 mm, shall be applied to the following items:

- Interior surfaces of steel pipe,
- Interior surface of outlet valves and of guard valves, and
- All parts continuously submerged in water.

One epoxy resin zinc rich primer coat, two coats of non-bleed type tar epoxy resin paint as under coats, one coat of epoxy resin micaceous iron oxide paint as an intermediate coat and two coats of chlorinated rubber paint as finish coats, total dry film thickness of 0.45-0.60 mm, shall be applied to the following items :

- Exposed surface of steel pipe,
- Exposed surface of outlet valves and guard valves, and
- Exposed surface of steel structures for rope haulage

All unfinished surfaces of ferrous metal except those above specified shall be so given one zinc rich primer coat and four coats of chlorinated rubber paint (two under coats, one intermediate coat and one finish coat) as to have the total dry film thickness of 0.15-0.18 mm.

Commercial equipment other than those above specified may be painted in accordance with the manufacturer's standard practice, subject to approval of the Engineer.

(6) Inspection

All work shall be subject to inspection by the Contractor. The inspection shall be performed in accordance with the approved test procedure prescribed in Clause 5.28 "Test Procedure Instructions".

Following the visual inspection on surfaces that have been coated, the dry film thickness of coating shall be checked at as many places as possible to prove the thickness overall to be to the specified minimum thickness by the electro magnetic

thickness meter. Further, for the purpose of measuring the continuity of coatings, coated areas shall be examined by the pin hole detector ("Holiday" detector). The peeling inspection shall also be performed for the coated areas.

1.25 Packing

Each item shall be packed properly or protected for the Shipment from the place of manufacture to the Site.

Each crate of package shall contain a packing list in a waterproof envelope and a copy in triplicate shall be forwarded to the Engineer prior to deliver. All items of material shall be clearly marked for easy identification against the packing list.

All cases, packages, etc., shall be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and the correct position of the slings and shall bear an identification mark relating them to the appropriate shipping documents.

Cases which cannot be marked as above shall have metal tags with the necessary marking on them. The metal tags shall be securely attached to the package with strong steel wire or equivalent.

The Engineer shall reserve the right to inspect and approve the equipment and the packing before items are delivered. The Contractor shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not relieve the Contractor from responsibility for any loss or damage due to faulty packing.

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.

The shipping mark shall consist of the following information in sequence and in frame commensurate with the size of package :

(a) Consignee : _____

(b) CONTRACT NO. : _____

(c) Port of Destination : _____

(d) Item number, if applicable,
package number in sequence,

	and quantity per package	:	_____
(e)	Description of contents	:	_____
(f)	Net and gross weight, cubic measurement	:	_____

1.26 Delivery

The Contractor shall deliver all materials and equipment including Contractor's Equipment supplied under the Contract to the Site in adequate time for its preparation and erection according to the Approved Work Program.

Notification of such delivery shall be given to the Employer and the Engineer in writing not later than thirty (30) days prior to the actual shipping date for any equipment to be shipped.

Each notification 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.

The Contractor shall be responsible for the reception at the Site of all deliveries for the purpose of the Contract.

The Contractor shall at his responsibility inspect the cargoes at the Site upon arrival of the cargoes and shall report in writing the particulars, quantities, conditions, damages, if any, of the cargoes to the Employer within three (3) days after arrival.

1.27 Embedded Steelworks, Opening, etc.

Unless otherwise specified, any foundation, wall and roof openings and coverings, concrete floor filling and sleeves in the foundation and wall will be provided by the Employer.

The Contractor shall design and supply as part of this Contract, all anchors, fasteners, foundation bolts and nuts, braces, posts, supports, shims, pippins, conduits, sleeves, access ladders and platforms, handrails, cover plates and curbing, hangers, hooks, gratings, traps and other miscellaneous metal works around the Plant, and all steel works as may be required for temporary or final support of anchorage of the Plant, which are indispensable for, associated with and required for the Plant to be provided and installed under this Contract, except as otherwise provided in the Specifications and Drawings for Tender.

The following items are in principle those excepted from supply under this Contract, and will accordingly be supplied and installed by the Employer in accordance with the dimensions, locations and numbers shown on the Contractor's drawings approved by the Engineer. The Contractor shall however be responsible for ensuring that they are in the correct position.

(a) Anchor bars and pad plates required for embedding into the primary concrete for fixing the anchor materials of the Plant, as noted with "by others" in the Drawings for Tender.

(b) Anchor bars and U-shaped hooks required for embedding into the primary concrete for fixing the temporary anchor materials of the Contractor's equipment for erection and installation purposes, as noted with "by others" in the Drawings for Tender or approved by the Engineer.

(c) Miscellaneous metal works around the Plant and small bore steel pipes, as noted with "by others" in the Drawings for Tender.

The Contractor shall indicate on his drawings full details of foundations, openings, blockouts and all anchors components required in both primary and secondary concrete structures and shall be responsible for the timely supply, completeness and accuracy of his drawings and the other related information which will be supplied and/or given to the Employer for further works, through approval procedure as mentioned in Clause 5.22 herein.

All adjustments to foundation levels, embedment, bedding and mortar filling of the Plant on foundations and cementing into walls and floors will be carried out by the Employer, but all leveling and adjusting of the Plant on foundations shall be carried out by the Contractor.

The primary and secondary stage concrete including its reinforcing bars will be placed by the Employer. The Contractor shall satisfy himself that this concrete has been carried out to his satisfaction.

Any steelworks which is to be built into the concrete foundations shall not be painted or coated.

During installation of all embedded steel pipes, the openings of each pipe end shall be plugged by suitable covers which shall be removed after completion.

Structural steel supports and facilities for anchors shall be supplied and installed by the Contractor to prevent displacement or uplift of the embedded component due to buoyancy or external forces that may occur during placing concrete.

1.28 Test Procedure Instructures

The Contractor shall submit to the Engineer for approval, during or immediately following the submission of drawings, the instructional test procedures, describing each test to be performed at the Contractor's shop and at the Site. The test procedures shall define the sequence of the tests, the equipment preparation and operation procedures to be followed and the detailed procedures for conducting the tests, tolerances for dimension and/or quality controls and other necessary items for the tests. The test procedures shall be separately prepared for the tests to be performed at the shop and at the Site. These procedures shall be submitted and distributed in the same manner as the drawings.

1.29 Tests

During the construction and after the installation work of each item of equipment, the Contractor shall perform the tests as described in the test procedures to establish the accuracy of assembly and to prove the adequacy of the materials and workmanship.

The tests and test procedures shall be approved by the Engineer. No part of the Work shall be considered acceptable until it has successfully complied with these tests to the satisfaction of the Engineer.

1.30 Photographs

The Contractor shall keep photographic records of the progress of the Work. Upon completion of the Work, the Contractor shall submit to the Employer three (3) sets and to the Engineer one (1) set of recorded color photographs adequately edited in a book with explanation to the Engineer's satisfaction. The Contractor shall provide himself necessary access to the Work and temporary facilities to photograph any part of the Work at any stage or construction or manufacture.

1.31 Spare Parts

The Contractor shall furnish the spare parts for the Plant.

Any spare part supplied shall be packed or treated in such a manner as to be suitably stored in the 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 purpose on the outside of the packing.

Spare parts so provided shall be delivered into such stores as may be designated by the Employer and delivery 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.

1.32 Maintenance Equipment and Special Tools

The Contractor shall furnish one lot of maintenance equipment and special tools sufficient for the proper maintenance of all the Plant provided by the Contractor. The maintenance equipment and special tools shall include, but shall not be confined to:

(a) slings and four 1-ton capacity chain blocks.

(b) two spanners of each size to fit hexagon nuts of all bolts of 25 mm diameter and over.

(c) two grease guns to suit each size of grease nipple.

(d) special spanner, tools and appliances, if required, to enable every maintenance task to be performed, including major dismantling.

(e) one electrical instrument or apparatus of each kind required for testing and maintenance of electrical equipment.

(f) any other recommendable equipment and tools.

The maintenance equipment and special tools shall be delivered with the Plant, in lockable cabinet(s) fitted internally so that the tools may be safely stored in an orderly manner.

SECTION 2 TECHNICAL SPECIFICATIONS

SUBSECTION-1
DESIGN CRITERIA

1.1 Design Load

1.1.1 General

The equipment shall be designed with the worst combination of the acting loads.

The combinations of loads for each equipment under normal and over loading conditions shall be described in detail in Subsection-4 "DETAILED SPECIFICATIONS", according to the frequency of occurrence of loads and probability of their coincidence.

The loads specified herein shall be considered as minimum requirements and the Contractor shall use additional loads and combination thereof which the Contractor considers to be applicable and necessary.

1.1.2 Valve and Rope Haulage

(1) Hydrostatic load

Hydrostatic load shall be of the water difference between upstream and downstream sides of the gate, valve and trash rack.

(2) Sedimentary load

Sedimentary load shall be of the sedimentary depth of sand in front of the gate. The load shall be calculated by using following values:

Coefficient of sedimentary pressure (Ce) : 0.4
Unit weight of sediment (W) : 1.5 tf/m^3
Density ratio of sediment (υ) : 0.3

(3) Dead weight

Reaction due to self weight.

(4) Wind load

The basic wind load of 300 kgf/m^2 for a vertical projected area shall be applied by the type of structures to be designed upon multiplying by the following corresponding factors.

- For plane surface : 1.2
- For a cylindrical surface : 0.7
- For lattice member, at front side : 1.6
- For lattice member, at rear side : 1.2

(5) Operating load

Operating load shall conform to the requirement of Clause 1.1.3.

(6) Water pressure variation and vibration force induced by flowing water shall be considered.

(7) All loads imposed during operating the valves or the rope haulage due to the overload of the hoist or wagon jammed conditions.

1.1.3 Hoist

(1) For stationary type

The stationary type hoist shall be designed taking into account of the following loads.

(a) Dead weight of the gate leaf and ballast weight if any
(b) Friction force due to rotating and/or sliding parts
(c) Friction force due to seal rubbers
(d) Friction force due to sediment if any
(e) Buoyancy
(f) Uplift force and down pull force
(g) All loads imposed during raising the gate due to the overload hoist or gate jammed conditions.

Closing force of all valves shall have an allowance of more than 25 percent against all upward forces such as friction forces and buoyancy, etc., in any valve openings under any water level but except those of the spindle hoist.

(2) For movable type

Movable type hoist shall be designed taking account of the following load in addition to the above operating loads.

(a) Horizontal inertia force and/or centrifugal force

(b) Wind load

40 kg/cm^2 under operating condition
300 kg/cm^2 at storing position

(c) Braking load and other friction loads

(d) Seismic load (seismic intensity of 0.12)

1.1.4 Steel Pipe

(1) In case of empty

The following external pressure shall be considered.

(a) The head of water equivalent to the vertical difference between center line of the steel pipe and the elevation of concrete deck

(b) Load due to the placing of concrete

(2) In case of filled with water

(a) Internal pressure

The design internal pressure shall be of the static head.

(b) Stress due to temperature variation.

1.1.5 Other Equipment

(1) Footpath, balcony floor, platform, etc.

Crowded load 500 kgf/m^2

(2) Step of ladder

Vertical load 180 kgf

(3) Handrail

Horizontal load 30 kg

1.2 Lightning Protection

The Contractor shall provide lightning protection arrangement for the installations as required.

SUBSECTION-2

DESIGN STRESSES

2.1 Design Stresses for Valves and Other Steel Structures

(1) Structural steel members

(a) The allowable stresses for normal loading condition of structural steel members with a thickness of 40 mm or less shall be as shown in the following table:

	Steel material	SS400 and SM400 thickness $\leqq$ 40 mm	SM490 thickness $\leqq$ 40 mm
1.	Axial tensile stress (per net sectional area)	1,200 kgf/cm^2	1,600 kgf/cm^2
2.	Axial compressive stress (per gross sectional area)	On condition of $(l/r) \leqq 20$, 1,200 kgf/cm^2	On condition of $(l/r) \leqq 15$ 1,600 kgf/cm^2
	Compressive members	On condition of $20<(l/r) \leqq 93$, $1{,}200-7.5((l/r)-20)$ kgf/cm^2	On condition of $15<(l/r) \leqq 80$, $1{,}600-11.2((l/r)-15)$ kgf/cm^2
		On condition of $93<(l/r)$, $\frac{10{,}000{,}000}{6{,}700+(l/r)^2}$ kgf/cm^2	On condition of $80<(l/r)$, $\frac{10{,}000{,}000}{5{,}000+(l/r)^2}$ kgf/cm^2

where l : buckling length of member (cm)
r : radius of gyration of sectional area of member (cm)

	Steel material	SS400 and SM400 thickness $\leqq$ 40 mm	SM490 thickness $\leqq$ 40 mm
	Compressive splice member	1,200 kgf/cm^2	1,600 kgf/cm^2
3.	Bending tensile stress (per net sectional area)	1,200 kgf/cm^2	1,600 kgf/cm^2
	Bending compressive stress (per gross sectional area)	On condition of (l/b) $\leqq$ (9/K) 1,200 kgf/cm^2	On condition of (l/b) $\leqq$ (8/K) 1,600 kgf/cm^2
		On condition of (9/K)<(l/b) $\leqq$ 30, 1,200-11 ((Kl/b)-9) kgf/cm^2	On condition of (8/K)<(l/b) $\leqq$ 30, 1,600-16((Kl/b)-8) kgf/cm^2

where l : distance between cross-sections braced (cm)

b : width of compressive flange (cm)

$$K = \sqrt{3 + \frac{AW}{2AC}}$$

AW : sectional area of web plate (cm^2)

AC : sectional area of compressive flange (cm^2)

In case of (AW/AC)<2, K is taken as 2,

On condition that compressive flange is directly welded to skin plate, etc.	1,200 kgf/cm^2	1,600 kgf/cm^2
4. Shearing stress (per gross sectional area)	700 kgf/cm^2	900 kgf/cm^2

Note: 1) In case the thickness exceeds 40 mm, the allowable stresses for normal loading condition of the structural steel members shall be adjusted as follows:

The stress shall be 0.92 time that of the allowable stress as mentioned above in the case of steel material SS41 and SM400, and 0.94 time for steel material SM490.

2) SS400 (JIS G 3101)
SM400 and SM490 (JIS G 3106)

(b) The allowable stress in case of overloading condition and/or the combined stresses resulting from combination of biaxial stress or triaxial principal stress may be increased by 50 percent than those for normal loading condition. In no case, however, shall any stresses exceed 90 percent of the yield point strength and/or minimum elastic limit of the steel material used.

The combined stress shall be calculated with the following formula as developed by Mises, Hencky and Huber:

$$fg^2 = fx^2 + fy^2 - fx \times fy + 3fq^2$$

where,

fg : combined stress (kgf/cm^2)
fx : direct stress (tension is considered as positive) (kgf/cm^2)
fy : direct stress acting perpendicular to axis of fx (tension is considered as positive) (kgf/cm^2)
fq : shearing stress (kgf/cm^2)

(c) When steel material other than those mentioned in the table of paragraph (a) of this Subsection is used, its allowable tensile stress for normal loading condition shall not exceed 50 percent of the yield point strength of the steel material used. All other allowable stresses shall be computed in proportion to the allowable stresses given in the table of paragraph (a) of this subsection based on the yield point and/or ultimate strength of steel material used, whichever is the least.

(2) Machine parts of the hoisting equipment

All mechanical parts of the hoisting equipment subject to normal or rated capacity loading condition shall be designed with the following factors of safety (FS) against the ultimate strength of the steel material used.

Material	FS for tensile stress	FS for compressive stress	FS for shearing stress
Rolled steel for general or welded structure	5	5	8.7
Carbon steel forging	5	5	8.7
Carbon steel for machine structural use	5	5	8.7
Corrosion-resisting steel	5	5	8.7
Carbon steel castings	5	5	8.7
Gray iron casting	10	3.5	10
Bronze castings	8	8	10

Note: Unit stress shall not exceed ninety (90) percent of the yield stress of the material used under the loading resulting from the breakdown or locked-rotor torque of the hoist motor, whichever is greater.

(3) Concrete stress

The allowable concrete bearing stress shall not exceed 60 kgf/cm^2 and the allowable concrete shearing stress shall not exceed 8 kgf/cm^2 respectively.

2.2 Design Stresses for Steel Pipe

(1) Steel materials

The allowable stresses for normal loading condition of steel materials shall be as follows:

Stress	SS 400 and SM 400 thickness < ≦ 40 mm
Tensile stress	1,300 kgf/cm^2
Compressive stress	1,300 kgf/cm^2
Shearing stress	750 kgf/cm^2
Bearing stress	2,200 kgf/cm^2

(2) Finished steel pipes

The allowable stresses for normal loading condition of steel pipes shall be as follows:

Stress	STPG 370 and STPY 400
Tensile stress	1,200 kgf/cm^2
Compressive stress	1,200 kgf/cm^2
Shearing stress	700 kgf/cm^2

Note : STPG 370 (JIS G 3454)
STPY 400 (JIS G 3457)

SUBSECTION-3

DESIGN PARTICULARS

3.1 Minimum Thickness

The thickness for all structural members of the Plant shall not be less than 6.0 mm, except those of the following parts or part as approved by the Engineer:

Parts	Min. Thickness (mm)
Bar element	6.0
Steel section of structural members	5.0
Corrosion-resisting steel plate for: sealing plates	6.0
Finished steel pipe	5.0

3.2 Critical Slenderness Ratio

The critical slenderness ratio for major compressive members shall be less than 120, and 150 for secondary members. The said ratio in case of tension members shall be read as 200 and 240 respectively.

3.3 Maximum Deflection

The maximum deflection of each component of the equipment shall not exceed the following value under the full load:

Component	Max. Deflection
Structural members of the rope haulage	1/1,000 of the supporting span
Other components	1/1000 of the supporting span

3.4 Corrosion Allowance

The corrosion allowance for the equipment and structures shall be taken as follows:

Equipment/Structure	Corrosion Allowance (mm)
Shell plates for steel pipe	1.5
Valve leaf and body	2.0

3.5 Coefficient of Friction

For the purpose of designing the hoist, the coefficient of friction shall not be less than the following values.

	Static Friction (starting)	Kinetic Friction (sliding or rolling)
Metal seals	0.6	0.4
Rubber seals	1.5	0.7
Brass-faced seals	0.5	0.2
Fluoro-carbon faced seals	0.2	0.1
Self-lubricating bearings	0.2	0.1
Roller wheel bearings	0.02	0.01
Sediment between steel and sand	0.3	-
Steel on stainless steel	0.5	-

3.6 Mechanical Efficiency

For the purpose of designing the capacity of driving motor, the mechanical efficiency shall be less than the following value, or the value as approved in advance by the Engineer unless otherwise specified.

Parts	Mechanical efficiency
Sheave having plain bearing (per each)	0.95
Sheave having roller bearing (per each)	0.98

Drum	0.95
Spur gear and bevel gear	
One set of wheel and pinnion (open)	0.95
One set of wheel and pinnion (oil bath)	0.97
Cyclo speed reducer	
Reduction ratio 1/59 to 1/11	0.8 to 0.85
Reduction ratio 1/121 to 1/87	0.65 to 0.75
Sprocket by chain driving (per each)	0.95
Worm gear	
Self-lock type	0.5
Anti-selflock type	0.75
Spindle	0.2 to 0.4

3.7 Rubber Seals

Seals shall be designed and mounted in such a manner that they are adjustable, water tight and shall be readily removed and replaced.

Seals shall be moulded. Extruded seals will not be permitted. Where seals are installed curved, they shall be clamped in a jig which will form them to the proper radius before the holes are laid out and drilled, and the ends trimmed. Holes in related parts of the seal assemblies shall be carefully drilled, using a template, to assure proper matching when the seal units are assembled. Arrangements shall be made to provide effective continuity of sealing at the corners of the gates.

All adjusting screws and bolts for securing the seals and seal assembly in place shall be of corrosion resisting steel.

Seals shall be made of natural or synthetic rubber suitable for the temperature ranges and conditions at the Site and shall be of a material that has proven successful in similar applications. Joints shall be water tight and seal materials shall have the physical properties shown in Figure 5.11, as determined by tests made in accordance with the relevant Standards.

The gate seals shall be spliced at the corners by shop vulcanizing to provide a single continuous seal. The tensile strength of all shop splices shall not less than 50 percent of the tensile strength of unspliced material.

3.8 Materials

The materials used in structures of the Plant shall be new and of high quality, selected particularly to meet the duties required for the proper operation of the Plant, and indicated fully in the Contractor's detailed drawings for approval.

The materials shall be met with the requirements mentioned in the latest issue of the following standards, and in accordance with those as listed below or equivalent and/or better in quality or as approved in advance by the Engineer, unless otherwise specified.

(1)	Steel plates, bars, pipes, etc.	
	(a) Steel plates for structural main parts of the equipment	JIS G 3106, SM400B and/or SM490B, where appropriate to the design and/or JIS G 3101, SS400
	(b) Steel pipe:	
	- Steel plates for shell proper	JIS G 3106, SM 400 or JIS G 3101, SS 400
	- Finished pipe	JIS G 3454, STPG 370 or JIS G 3457, STPY 400
	- Drain and air pipes	JIS G 3454, STPG 370
	(c) Steel plates for general structures of equipment, i.e., auxiliary parts, such as ladders, platforms, covers, first stage anchors, etc., or where approved by the Engineer	JIS G 3101, SS 400
	(d) Steel sections	JIS G 3192
	(e) Steel bolts, nuts and washers	JIS B 1180, B 1181 and B1256

(f)	High-strength steel hexagon bolts, hexagon nuts and plain washers	JIS B 1186
(g)	Spring lock washers	JIS B 1251
(h)	Corrosion-resisting steel plates, bars, etc.	JIS G 4304, G 4305 G 4306, and G 4307
(i)	Corrosion-resisting clad steel plates	JIS G 3601

(2) Castings

(a)	Iron castings	JIS G 5501, FC200
(b)	Steel castings (to be fully annealed)	JIS G 5101, SC410
(c)	High tensile strength carbon steel castings and low alloy steel castings	JIS G 5111, SCMnCr 3B
(d)	Bronze castings	JIS H 5111, BC2
(e)	Phosphor bronze castings	JIS H 5113, PBC2

(3) Forging

(a)	Carbon steel forging	JIS G 3201, SF490

(4) Miscellaneous materials

(a)	Self-lubricating bearings	JIS H 5102, high strength brass casting, HBsC 4 (Min. HB 210) base with solid lubricant
(b)	Stranded wire ropes (galvanized)	JIS G 3525 6 x 37 construction

(c)	Wire rope fittings	Manufacturer's standard fittings for the type of wire rope used
(d)	Rails	JIS E 1101
(e)	Light rail	JIS E 1103
(f)	Steel conduit for electric wiring	JIS C 8305

3.9 Lubrication

Provision shall be made for lubricating all bearings, including ball and roller bearings, by a pressure gun system. All lubrication nipples shall be readily accessible.

Where accessibility to a bearing for lubricating purposes is so difficult, provision shall be made for remote control lubrication or safe access to the lubrication point.

Ball and roller bearings shall be packed with grease during initial assembly.

All bearings and gear cases shall be made oil-tight and drip pans shall be provided where necessary to prevent excess oil or grease dripping to the floor or deck.

The oil and grease shall be of a type available in Viet Nam as approved by the Engineer. The type available in Viet Nam shall be investigated by the Contractor himself.

3.10 Fabrication

The equipment shall be designed and fabricated in accordance with the relevant standards, unless otherwise specified.

Fabrication of plate and structural steel work shall be performed in accordance with the best modern practice, true to line and free from warp or twist.

The connections between each structural member shall be made by means of bolting or welding and designed in such a manner that all forces are transmitted by one of such method

of connection as bolting or welding. No sharing of specific load by two types of connection shall be accepted.

When bearing type bolts are used, they shall be so proportioned that the unthreaded parts of the bolts shall resist the load at the reamed holes of the materials together with washers having a minimum of 5 mm thick. For all sloping surfaces, beveled washers shall be provided. For high strength tensile bolt connections, lock nuts and washers shall be provided.

All edges of plates to be welded shall have edge prepared by machine or other approved method so as to be suitable for the type of weld employed. Sheared edges of all stress carrying plates shall be flattened to at least 3 mm difference.

Where damage occurs in transit, the Contractor shall specify the technique of repair and obtain written approval of the Engineer before proceeding with such repair.

3.11 Mechanical and Electrical Parts for Equipment

The mechanical and electrical parts for the equipment shall conform to the following requirements unless otherwise specifically mentioned.

(1) Gearing

All gears shall be machine cut, preferably by hobbing, from solid blanks and, wherever possible, they shall be a forced fit on their shafts. The minimum requirements for materials are as follows:

Wheels	Rolled or forged steel
Pinions	Rolled or forged steel
Worm wheels	Steel with bronze rims
Worms	Steel or forged steel

Where worm gearing is used as a first motion drive, it shall be designed to have the same load and time rating as the driving motor so as to prevent undue movement and to have oil tight removable housings with lubrication oil plug, drain cock and oil level indicator. The temperature rise of the oil bath, when measured by thermometer, shall not exceed 40 degrees centigrade from the temperature of the atmosphere.

All gear wheels and pinions shall be completely covered by steel or other metal guards, unless effectively guarded by adjacent structures.

Keys in gear trains shall be so fitted and secured that they can not work loose.

(2) Ropes, drums and sheaves

The hoisting rope, except where otherwise noted, shall be galvanized, flexible, improved plough steel wire type with fiber core and internal lubricant.

The factor of safety of the hoisting ropes to the maximum normal working load shall not be less than eight (8). The hoisting rope shall also withstands the load due to maximum hoist motor torque, without exceeding 90 per cent of the yield strength. The required breaking strength of the rope shall be specified in the Contractor's order to the rope manufacturer.

The rope systems shall be equalized and arrangements entailing reverse bends shall be avoided wherever possible.
Rope drums shall be of cast steel or fabricated steel with machined grooves. Paired rope drums shall have the same diameter to the bottom of the groove. Grooves shall be smooth machined with an adequate depth. Drums shall have sufficient length to wrap the full length of rope, and have approximately one groove spare when the gate is in the highest possible position, and three dead wraps when the gate is fully closed position.
The rope end shall be secured to the outside of the drum by means of a clamp or other approved means. The fastening shall be easily accessible to facilitate rope removal or replacement.
The minimum pitch circle diameter of rope drums and sheaves shall not be less than 19 D and 17 D for 6 x 37 construction rope respectively, where D is the diameter of the rope. The minimum pitch diameter of equalizer sheave shall be not less than 10 D.

Number of wound layer of the hoisting rope per one drum shall be less than two layers.

Fleet angles for grooved rope drums and sheaves shall not exceed 4 degrees for the first layer of wound wire rope and 2 degrees for the second layers.

Rope sheaves shall be Vee-grooved with an included angle of 52 degrees and groove depth equal to 1.5 times the rope diameter. The groove diameter shall be slightly in

excess of the rope diameter to prevent pinching.

Slack rope detecting switches shall be provided where there is the possibility of inadvertent jamming of the load during lowering.

(3) Couplings

Flexible gear type coupling with means for field adjustment shall be provided where drive shafts are required to be connected.

(4) Bearings

Bronze bushed bearings shall be used for all low speed shafts, and high speed ball or roller bearings shall be used for all other locations.

Shafts and bearings shall be proportioned so that the length does not exceed one and one half times the shaft diameter for bronze bearing not so as to exceed an allowable bearing stress at the projected area.

(5) Keys and keyways

Keys and keyways shall be designed in accordance with the relevant standards. Where taper keys are used, they shall be provided with a gib head or other suitable provisions to facilitate withdrawal. Feather keys shall be secured in position by means of counter-sunk screws through the key.

(6) Dowels

Gear boxes and bearings which have to align accurately shall be retained in position by means of fitted dowels during assembly.

(7) Hand operation devices

Hand operation device shall be furnished. Operation of the handle shall be performed under the disconnecting condition from electrical system and the operation force on the handle shall be less than 10 kgf per man, at the handle with a diameter of 300 to 600 mm which shall be located within 600 to 800 mm in height from the base.

(8) Screwed spindles

The screwed spindles having a minimum diameter of 50 mm shall be made of

corrosion resisting steel which shall be machine-cut with square or trapezoidal thread at the necessary length.

(9) Mechanical position indicators

The mechanical type position indicators shall be mounted on each mechanism, and shall be of an easily readable dial type to rotate about 300 degrees for full travel. The dial plate shall be of stainless steel or brass with engraved marking, and main parts of the indicators shall be made of anti-corrosive materials which shall be housed in a dust-tight and weatherproof enclosure. The indicators shall be capable of reading accurate vertical height of the equipment opening by 10 cm.

(10) Oil Pump

The oil pump shall be of the rotary type having a flange suitable for aligning the pump with the motor. The pump shall be suitable for pumping light hydraulic oil. The pump shaft shall be provided with suitable bearings and shall be adequately packed or sealed to prevent leakage.

(11) Four-Way Valve

The four-way valve shall be suitable for use of light hydraulic oil having the characteristics specified in the Specification. The operation of the valves shall be arranged so that the pressure can be directed to either of two outlet ports.

(12) Relief Valves

The relief valve shall be suitable for use of light hydraulic oil having the characteristics specified.

(13) Flow Control Valves

The flow control valves shall have controlled flow in one direction and integral check valve to allow free flow in the opposite direction. The valves shall have steel socket welding flanges and shall be suitable for incorporation into the piping assembly.

(14) Oil Filter

The oil filter shall be of the removable filter-unit type. The filter shall be suitable for use of light hydraulic oil having the characteristic specified.

(15) Pressure Switches

The pressure switches shall have independent outside adjustments with locking device for setting the cut-in and cut-out pressures, and the pressure setting shall be shown on calibrated dial.

(16) Hydraulic Oil

The hydraulic oil to be used for the control system shall be capable of working efficiently over the temperature range 0°C to 60°C.

The hydraulic oil shall have good stability, anti-floating, anti-oxidant, anti-corrosion and anti-wear properties. Sludges and slurries shall not be formed under any working conditions.

The Contractor shall supply reputable manufactures having RWS viscosity of 91 to 50°C or equivalent. The characteristics and properties of the hydraulic oil shall be approved by the Design Engineer.

(17) Motors

All motors shall be of horizontal shaft, high starting torque, low starting current, squirrel cage, induction type, designed for full voltage starting, weatherproof and totally enclosed. Wound rotor motor will be accepted only if a squirrel cage type would not be satisfactory for the duty.

The insulation for the motor shall be decided by the capacity in accordance with JIS C 4210 or other approved equivalent standard, and continuous or thirty (30) minutes rating as approved by the Engineer for nature of the equipment, at the 40 degrees centigrade ambient temperature. The cable terminal boxes shall be provided with stud-type connectors.

The capacity of motor shall be examined with the following equation, and the rated motor capacity shall be more than 100 percent of that calculated based on the maximum hoisting loads, which will occur during starting, opening and closing operation of the gate or equipment. The starting and maximum torque of the motor shall be more than 200 percent, but less than 300 percent of its rated torque respectively.

$$Qp = \frac{W \times V}{6.12 \times \eta}$$

where, Qp : Output of motor (kW)

W : Maximum hoisting load (tf), selected under the most adverse combination of loads which shall be conservatively calculated with the given friction coefficients and operating conditions

V : Hoisting speed (m/min)

η : Total efficiency of mechanical parts

Windings and connections shall be suitably impregnated to render them moistureproof, nonhygroscopic and unaffected by conducting dust.

All motor bearings shall be of the ball or roller type with an inner grease seal to prevent grease from entering the winding. Bearing housing shall be fitted with a "ball in head" grease fitting and a removable plug for the escape of grease.

(18) Motor brakes

The brakes mounted on motors shall be spring-applied and A.C. solenoid released type. The rated capacity shall not be less than 150 percent of the rated full load torque of the motor. The brake shall be arranged for automatic application, when the motor power supply is cut off, and release when the motor is energized. The brake enclosure shall be weather-proof with the convenient access for maintenance.

(19) Electric cables and wiring

The Contractor shall be responsible for wiring, laying and furnishing of control and power cables and/or wires which are necessary for the required operation.

All wiring in the control cabinets shall be of PVC insulated stranded copper conductor, formed neatly into groups and properly supported. There shall be no splices in the wires or cables and all connections shall be made only at terminal blocks or studs.

All external wiring between the control cubicles, motors, limit switches, etc., shall be with multicore copper, cross-linked polyethylene insulated, PVC sheathed (Type CV), 600-volt grade cable.

The Contractor shall also supply and install all conduits and materials necessary for the Works.

All power and control cable conductors shall be of copper and have a minimum cross-sectional area of 2.0 mm^2. Single strand conductor shall not be accepted.

Compression type terminal shall be used and ring number identification shall be put at both ends of the cables.

(20) Motor starters

All starters shall be suitable for direct-on-line starting of motors, provided with 3-phase induction type over current relays for overload phenomenon with manual resetting, open-phase relays and undervoltage release feature. Overcurrent relays shall be field adjustable to correspond with the rated full load currents of the motors. Backup protection shall be provided with high rupturing capacity enclosed fuses or moulded case circuit breakers. The control voltage shall be 230-volt, AC.

(21) Control cabinets and panels

Control cabinet and panel shall be of sheet steel with minimum thickness of 2.3 mm, of rigid, self-supporting construction and supplied with channel bases.

All indicators such as meters and lights shall be visible from outside without opening the doors and/or windows which shall have integral lock and master key. Cabinets and panels shall be of weather, dust and vermin-proof construction, completely enclosed.

Removable gland plates shall be supplied and located to provide adequate working clearance for the termination of cables. Under no circumstances the floor/roof plate shall be used as a gland plate.

Space heating elements with thermostatic control shall be included in each cabinet/panel.

The instrument and control wiring including all electrical interlocks and interconnecting wiring between sections, shall be completely installed and connected to terminal blocks by the Contractor.

The arrangement of control and protection devices on the panels and the exterior finish of the panels shall be subject to the approval of the Engineer.

The interior of all cabinets and panels shall have a matted white finish unless otherwise specified.

(22) Power Distribution Panel

Power distribution panel shall be of sheet steel with minimum thickness of 2.3 mm, of rigid, self-supporting construction and supplied with channel bases.

The panel shall be of weather, dust and vermin-proof construction, completely enclosed.

The cables and wiring shall enter from bottom side or top as approved or directed by the Engineer.

Space heating elements with thermostatic control shall be included in each panel.

The power distribution panel shall contain adequate capacity of the moulded case circuit breakers in numbers required for the equipment, including one (1) spare feeder with the moulded case circuit breaker.

The source pilot light shall be visible from outside without opening the doors and/or windows which shall have integral lock and master key.

(23) Conduits

Rigid steel conduit shall be galvanized inside and outside. It shall be of a minimum thickness of 2.3 mm and have a minimum inside diameter of 16 mm.

(24) Enclosures

Motor enclosures shall be weatherproof and totally enclosed. Enclosures for all other equipment shall in general be dustproof, weatherproof and verminproof where required.

(25) Convenience outlets

Convenience outlets shall be of 2-pin with scraping earth or 3-pin type rated for 15 amps at 230 volts, suitable for English pattern plug used inside the power plant. Outlets shall be in weatherproof enclosure or suitably protected from weather.

(26) Limit switches

The limit switches shall have weatherproof enclosure and shall be mounted suitable for easy adjustment and protection from vandalism, and for rigidly locking in position after being adjusted. They shall be of heavy-duty rating and shall have corrosion-resisting steel rotating part and permanently lubricated bearings. They shall allow the arm to be fully deflected by the operator without damage to the switch.

(27) Indicating lights

All indicating lights shall be of filament with colored plastic lenses type for long life service under conditions of shock, vibration and rough handling. All indicating lights on outdoor cubicles shall be visible under daylight.

(28) Lighting fixtures

The lighting fixtures shall be complete with lamps. Fluorescent lighting fixtures shall be equipped with complete fittings for A.C. 230-volt, 50-Hz sources and a ballast or ballasts of high power factor.

Incandescent lighting fixtures shall have lamp holders in accordance with the local standards.

Mercury flood lighting fixtures shall be equipped with a screwed base lamp holder suitable for high-pressure mercury lamp, and appropriate stabilizer of high-power factor for stable operation.

The lighting fixtures for outdoor use shall be weatherproof type.

Special care shall be exercised on selection of fixtures so that illumination of the lamps is not obstructed by accumulation of insects and dust.

(29) Electrical relays

Electrical relays for control and alarm purposes and auxiliary relays for protection circuits shall be of the plug-in type and the plug-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.

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

Relay contacts shall be adequately rated for the service conditions. Relay coils shall be continuously rated whether the control scheme requires them to be continuously energized or not.

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

(30) Terminal strips

Terminal strips shall be of double stud and 2-hole solid link design with the studs moulded into an insulating base. Pinch-type terminal blocks and slotted links are not acceptable. Studs shall be of brass and 6 mm diameter except that studs of 4.7 mm diameter in corrosion-resisting steel or phosphor-bronze may be approved.

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 percent spare terminals.

Removable transparent insulating covers shall be provided over all terminals. An insulating barrier shall be provided between adjacent pairs of studs.

(31) Analog type indicating instruments

All analog type indicating instruments and meters shall have approximately 110 mm dial, shall be of heavy-duty, industrial type suitable for extreme shock and severe vibration applications. Instruments and associated apparatus shall be capable of maintaining their accuracy and sensitivity without excessive maintenance.

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

All instrument cases shall be dust-proof.

All instruments scales shall be of wide angle type clearly printed in black figures and divisions on white background. The quantity measured shall be clearly marked on the instrument dial in block capital letters. The names or titles of the instrument manufacturers and other printing which may interfere with the clear observation of the

reading shall not be printed on the clear observation of the reading shall not be printed on the dials. Initials or similar markings may however be indicated unobtrusively on them, for which the drawings showing in details all markings to be made on the dial shall be submitted to the Engineer for approval.

Unless otherwise specified or approved all instruments shall have circular scales with a total deflection of not less than 240 degrees.

Normal working indication shall be at a point corresponding to approximately 75 percent 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 circuits shall be compressed so that 20 percent of full scale deflection (F.S.D.) occurs at about 40 percent full load current (F.L.C.) and 90 percent of F.S.D. at about 120 percent F.L.C. The scale shall be approximately linear in the range 40 percent to 120 percent and compressed above 90 percent F.S.D. to indicate 6 times F.L.C. at 100 percent F.S.D.

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

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

(32) Equipment wiring and wiring accessories

This paragraph applies to all connections within equipment enclosures and all intercabinet wiring working at voltages not greater than 600 V nominal. All wiring shall be carried out in accordance with wiring diagrams so that the arrangement of the wiring is consistent throughout the equipment and identical for those parts of the equipment performing the same duties.

Wiring diagrams shall be drawn as seen from the back (i.e., wiring side) of the cabinet (except for front connected equipment) and shall show all terminals on selector switches, relays, contractors, terminal blocks, etc., in their correct relative positions.

Terminal 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 or wire bunches with textile or plastic cord or metal buckle type clips will not be accepted. Wherever wiring is cleated to metal surfaces, it shall be insulated straps in an approved manner. All wiring shall be left sufficiently long and neatly looped to allow a fresh termination to be made in case of original termination device being broken off.

Circuits of similar nature shall be grouped together and terminal block terminals in A.C. circuits shall be segregated and fully shrouded to prevent accidental contact with live parts.

All secondary wiring shall employ conductors having a minimum cross-sectional area of 2.0 mm^2 and consisting of tinned copper wire. Internal wiring of miniaturized and solid state equipment may use flexible conductors having a minimum size of 50/0.18 mm where wiring is made off to clamping type terminals and 30/0.18 mm where the termination is made by soldering.

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 mm^2.

The standard phase arrangement when facing the front of the panel shall be R-S-T-N, and R-N-S from left to right, from top to bottom, and front to back for A.C. three-phase and single-phase circuits and N-P from left to right, P-N from top to bottom and front to back for D.C. 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 wires shall be coloured as follows:

Circuit	Colour
Voltage transformers	Red

Current transformers	Black
A.C. circuit	Yellow
D.C. circuit	Blue
Grounding circuit	Green with yellow stripe

Following coloured ferrules shall be provided on each wire in order to identify phase and polarity.

Phase and Polarity		Colour
A.C., three phase,	first phase	Red
	second phase	Yellow
	third phase	Black

Phase and Polarity		Colour
A.C., single-phase,	first line	Red
	second line	Yellow
Neutral		Black
Grounded		Green with yellow stripe
D.C., positive		Red
negative		Blue

Samples of the secondary wiring, terminations and terminal blocks shall be submitted by the Contractor for approval before commencement of the works, if requested by the Engineer.

3.12 Weld Inspection

Non-destructive test such as radiographic, dye-penetrated, magnafluxed, ultrasonical tests or other type of inspection for the welded parts shall be performed in the presence of the Engineer or the Inspector. All radiographic films and data shall become the property of the Employer. All welds shall be subject to visual inspection together with the said tests.

If the workmanship is not satisfactory to the Engineer, the welding shall be chipped out to sound metal, tested and repair welded. The Work shall be 100% inspected again by the method used first to determine such faulty work.

3.13 Water Leakage Test

Water leakage test shall be performed concurrently with the watery test. Jetting or concentrated leakage at any localized point shall not be permitted, even if less than the permissible water leakage rate. The seals at such locations shall be adjusted necessary.

The maximum permissible water leakage for each gate and valve irrespective of the hydraulic pressure shall be given as follows:

(1) The maximum water leakage rate any one meter of seal shall be 0.2 l/sec. for each gate other than intake gate provided in the regulating pond, however, the total permissible water leakage shall be 5 l/sec.

(2) The maximum water leakage rate any one meter of seal shall be 0.1 l/sec. for the intake gate provided in the regulating pond, however, the total permissible water leakage shall be 2 l/sec.

(3) The total permissible water leakage from the outlet valve shall be 200 cc per 30 minutes

(4) The total permissible water leakage from the seal of guard valve shall be 200 cc per 30 minutes.

SUBSECTION-4

DETAILED SPECIFICATION

4.1 Seal Rubbers and Seal Clamps of Gates, Valves, Expansion Joints and Manholes

4.1.1 General

All the seal rubbers and seal clamps for the following gates, valves, expansion joints and manholes shall be designed and supplied by the Contractor.

(i) Four (4) sets of spillway radial gate leaves
(ii) One (1) set of intake caterpillar gate leaf
(iii) Two (2) sets of 2,000 mm diameters butterfly valves and air valves of penstock
(iv) Thirty two (32) sets of expansion joints of penstock
(v) Thirty two (32) sets of manholes of penstock

The Contractor shall make necessary arrangement to dispatch their engineers for supervising the installation of the seal rubbers and seal clamps.

After completion of the replacement of seal rubbers for the butterfly valves, the Contractor shall carry out all necessary operation test of valves to confirm overall valve operational condition as a result of the replacement work and rectify unreasonable condition which might be detected during the operation test. The Contractor shall also make necessary arrangement to dispatch their engineers for such works.

The Contractor shall exercise special care in the design of seal rubbers and seal clamps to any water leakage under the closed condition of the gates and the valves and the design condition of penstock.

The arrangement of seal rubbers and seal clamps shall be as shown on Figure. 1.8 to 1.11.

4.1.2 Design Stresses

The design stresses shall conform to those specified in Subsection-2 " Design Stresses".

4.1.3 Design Conditions

The design data for each gate, valve, expansion joint and manhole shall conform to the following Figures.

(i)	Spillway radial gates	:	Figure 1.8
(ii)	Intake caterpillar gate	:	Figure 1.9
(iii)	Butterfly valves and air valves:		Figure 1.9
(iv)	Expansion joints of penstock	:	Figure 1.10
(v)	Manholes	:	Figure 1.11
(vi)	Specification of seal rubber	:	Figure 1.12

4.1.4 Detail Requirement

The detail requirement of the seal rubber and seal clamps not specified herein will be left to the Contractor, subject to approval of the Engineer.

(1) Seal rubber for gates

The gate seal rubbers shall be of the moulded rubber shape clamped to the upstream face of the gate by means of steel bars and corrosion resisting steel bolts, nuts and washers. The side seals and the bottom seal of radial gate and the bottom seal of intake caterpillar gate shall be of a plain bar type seal rubber.

(2) Seal rubber for butterfly valves and air valves

The valve leaf seal shall be of a plain bar type seal rubber clamped by means of steel bars and corrosion resisting steel bolts, nuts and washers. The seal of air valve shall be of the moulded rubber shape. For complete water - tightness of the valve, the edge of the valve leaf shall completely contact with the seat ring of the valve body when the valve has been closed. The seal of the valve leaf shall be renewable.

(3) Expansion joints and manholes

The seal of expansion joints shall be of round rubber packing type seal rubber and shall be renewed along with the lubricated flax packing for movement of the expansion joint.

The seal of manholes shall be plain bar type seal rubber.

4.1.5 Shop Assembly and Test

The seal rubbers and seal clamps shall be completely shop fabricated and tested for smooth and proper performance. All dimensions of the seal rubbers and seal clamps shall be checked and any error and misalignment discovered shall be corrected. Parts shall be clearly matchmarked before disassembling for the shipment.

4.2 Control Panels for Gates, Movable Trash Rack and Valves

4.2.1 General

The control panels for the following gates, movable trash rack and valves shall be designed and supplied with all necessary power and control cables and wires by the Contractor.

(i) Two (2) sets of local control panel and one (1) set of remote control panel for spillway radial gates
(ii) One (1) set of local control panel for intake movable trash rack
(iii) One (1) set of local control panel for intake caterpillar gate
(iv) One (1) set of local control panel integrated in the oil unit for 2,000 mm diameters butterfly valves of penstock

The Contractor shall make necessary arrangement to dispatch their engineers for supervising the installation of the control panels.

The Contractor shall exercise special care in the design of the control panels with all necessary power cable and wire for safe and proper operation of gates and valves.

4.2.2 Design Conditions

The design condition of the control panels for each gate and valve shall conform to those mentioned in the following Figures.

(i)	Spillway radial gate hoists	:	Figure 1.20 to Figure 1.26
(ii)	Intake movable trash rack	:	Figure 1.41 to Figure 1.43
(iii)	Intake caterpillar gate hoist	:	Figure 1.33 to Figure 1.40
(iv)	2,000 mm diameters butterfly valves of penstock	:	Figure 1.47 to Figure 1.55

It is noted that the number of the local control panel for the spillway radial gate hoists shall

be changed to two (2) panels from one (1) panel of the existing arrangement to ensure the safety operation of each gate. Therefore, the electrical sequence for Figure 5.20 to 5.26 shall be designed by the Contractor to suit for two (2) sets of the local control panel.

4.2.3 Detail Requirement

(1) Control system

The control system for each gate and valves shall conform to the Figures mentioned in sub-clause 4.2.2.

(2) Wiring

All power and control cables and/or wires with all necessary conduits and accessories from the electrical terminal point at the spillway, the intake and the valve house at penstock to the respective electrical equipment shall be supplied by the Contractor, in accordance with the manner specified in Clause 3.11 of Subsection 3 " Design Particulars".

The Contractor shall provide a self-standing type local distribution panel for each structure in accordance with the requirements specified in Clause 1.3 of General Specification.

(3) Control panels

(a) Control panel of gates and movable trash rack

Each local control panel shall be located on the hoist deck or the concrete operation floor for each gate facilities and shall be of weatherproof construction, completely enclosed, with keyed access doors and/or windows, assembled using angle or channel structural members seam welded at the corners and finished smooth. All necessary switches, indicators, relays, transformers and other devices shall be installed within each panel. The remote control panel for spillway radial gate hoists shall be located in the spillway watch house. The remote control panel shall be adequately sized to contain the remote controls for four (4) hoists and shall be of the same construction as the local control panels except that the remote control panel need not be weatherproof.

Necessary instrument shall be mounted on or inside each local control panel and remote control panel in accordance with the above Figures.

(b) Control panel of butterfly valves

The control panel integrated in the oil unit for the butterfly valves shall be designed on the basis of the oil sequence and electrical sequence mentioned in Figure 5.47 to Figure 5.56. The external dimension of the control panel shall conform to those of the existing control panel to achieve the panel installation without any alteration of the valve house. The control panel shall be located in the valve house and shall be of weatherproof construction, completely enclosed, with keyed access doors and/or windows, assembled using angle or channel structural members seam welded at the corners and finished smooth. All necessary switches, indicators, relays, transformers, all hydraulic oil unit and other devices shall be installed within the panel.

The oil unit shall conform to those specified in Clause 3.11 of Subsection - 3 " Design Particulars".

(4) Telemetering and Supervisory Control

The Contractor shall provide the following digital transducers and indicators, and terminal units on the control panels for sending necessary signals to the power station.

(a) Telemetering item

(i) For spillway radial gates and intake caterpillar gate
- Digital type gate position indications

(ii) For butterfly valves
- Digital type valve position indications

(b) Supervisory items

The " on-off contacts " (free potential, normally opened and/or closed mechanical contacts) shall be provided to signal to the remote terminal unit for all alarms and indications at the power station.

(i) For spillway radial gates and intake caterpillar gate
- Gate fully raised indications
- Gate fully lowed indications
- Gate intermediate position indications
- Fault indications (shortage of incoming source voltage and overload condition of gate)

(ii) For butterfly valves
- Valve fully raised indications
- Valve fully lowed indications
- Valve intermediate position indications
- Fault indications (shortage of incoming source voltage and overload condition of valve)

4.2.4 Shop Assembly and Test

The control panel shall be completely shop assembled and tested for smooth and proper performance of the hoist. An operation test between the remote and local control panels shall be performed to prove specified functions.
The following items, at least, shall be checked during the said operation test.

- Voltage and current of control panel
- Insulation resistance test
- Check of accuracy of indication, limit setting and alarm signal, etc.
- Appearance, overall performance of control cabinet and panel

Any defect or improper operation discovered shall be corrected and the entire test shall be repeated to the satisfaction of the Engineer.

4.3 Mechanical and Electrical Parts of for Gates and Valves

4.3.1 General

The mechanical and electrical parts provided for the spillway gates, intake caterpillar gate, intake movable trash rack and butterfly valves shall be designed and supplied by the Contractor with all necessary material for installation.

The mechanical and electrical parts to be renewed for the gates and valves are listed as follows:

Facility Name	Mechanical parts	Electrical parts
(i) Spillway radial gates	- Wire rope hangers - Oil level gauge of gear reducer	- Auxiliary parts such as limit switches, contacts, terminals, cable/wiring for the control

(ii)	Intake caterpillar gate	-	- Auxiliary parts such as limit switches, contacts, terminals, cables/wiring for the control
(iii)	Movable trash racks	- Gear reducer	- Auxiliary parts such as limit switches, contacts, terminals, cables/wiring for the control
(iv)	Butterfly valves	- Hydraulic piping - Over velocity tripping device	- Auxiliary parts such as limit switches, contacts, terminals, cables/wiring for the control

The Contractor shall make necessary arrangement to dispatch their engineers for supervising the installation of the mechanical and electrical parts.

The Contractor shall exercise special care in the design of the mechanical and electrical parts for safe and proper operation of gates and valves.

4.3.2 Design Stresses

The design stresses shall conform to those specified in Subsection - 2 " Design Stresses".

4.3.3 Design Conditions

The design data and conditions for each gate and valve shall conform to the following Figures.

(i) Spillway radial gates
- Wire rope hangers : Figure 1.12
- Oil level gauge : Figure 1.20
- Auxiliary electrical parts : Figure 1.21 to Figure 1.23 and Figure 1.25 to Figure 1.26

(ii) Intake caterpillar gate

- Auxiliary electrical parts : Figure 1.33 to Figure 1.40

(iii) Movable trash racks
- Gear reducer : Figure 1.44
- Auxiliary electrical parts : Figure 1.38 to Figure 1.43

(iv) Butterfly valves
- Hydraulic piping : Figure 1.46 to Figure 1.52
- Over velocity tripping device : Figure 1.60
- Auxiliary electrical parts : Figure 1.51 to Figure 1.55

4.3.4 Detail Requirement

The design and manufacture of the mechanical and electrical parts shall conform to those specified in Subsection - 3 " Design Particulars".

The detail requirement of the mechanical and electrical parts not specified herein will be left to the Contractor, subject to approval of the Engineer.

(1) Mechanical parts

(i) Mechanical parts

- Wire rope hangers

The Contractor shall design and supply the wire rope hangers in accordance with Figure 1.12.

- Oil level gauges

The Contractor shall design and supply the oil level gauges which shall be suitable for the gear reducer shown on Figure 5.20.

(ii) Movable trash racks

- Gear reducer

The contractor shall design and supply the gear reducer in accordance with Figure 1.44.

(iii) Butterfly valves

- Hydraulic piping

The stainless material of hydraulic piping shall be designed and supplied by the Contractor in accordance with Figure 1.46 to Figure 1.52. The Contractor shall also design and supply all necessary material for the piping installation.

- Over velocity tripping device

The over velocity tripping device shall be designed and supplied by the Contractor in accordance with Figure 1.60.

(vi) Auxiliary electrical parts

- Auxiliary electrical parts for spillway radial gates, intake caterpillar gate, intake movable trash racks and butterfly valves

All auxiliary electrical parts for the gates and valves shall be designed and supplied on the basis of respective electrical sequences mentioned in the above Clause 4.3.3 of this subsection. The Contractor shall also design and supply all necessary material for the installation.

4.3.5 Shop Assembly and Test

The mechanical and electrical parts to be supplied shall be completely shop fabricated and tested for smooth and proper performance. All dimensions of the equipment and parts shall be checked and any error and misalignment discovered shall be corrected. Parts shall be clearly matchmarked before disassembling for the shipment.

4.4 Irrigation Outlet Facilities

4.4.1 General

The following equipment for the irrigation outlet valve facilities shall be designed and supplied by the Contractor.

(i) One (1) complete lane of surface type outlet pipe (pipe No. 2) having 0.6 m in diameter and 0.905 m in length

(ii) Each one (1) complete set of butterfly type guard valve and slide type discharge valve each having 0.6 m in diameter with motor operating devices and a control

panel

(iii) One (1) lot of new seal rubber and seal packing for the existing conduit expansion joint

The Contractor shall make necessary arrangement to dispatch their engineers for supervising the installation of the irrigation outlet facilities.

The Contractor shall exercise special care in the design of these valves to avoid noticeable vibration and noise during operation under any water head and any water leakage at the fully closed condition.

The layout and arrangement of the outlet facilities shall be as shown on Figure No. 1.13.

4.4.2 Design Stresses

The design stresses shall conform to those specified in Subsection-2.

4.4.3 Design Conditions

The outlet valve facilities shall be designed for the following conditions :

(1) Outlet pipe

(a) Internal pressure

The design internal pressure shall be the static head. The static head is of the difference between the centerline elevation of the outlet pipe and the high water level of the dam of EL. 1,042.000.

(b) External pressure

The outlet pipe shall be capable of resisting the following external pressures. The factor of safety against buckling shall not be less than 1.5.

(i) The outlet pipe shall be capable of resisting the external pressure of 2m

(ii) The Contractor shall supply sufficient exterior bracings to resist the loading due to the installation.

(c) Axial forces

The outlet pipe shall be capable of resisting the following axial forces and/or

other forces that the Contractor shall foresee as an essential element of the design.

(i) Local stress due to resisting the pipe shells expansion by the stiffener rings if provided,

(ii) Stress due to axial component of internal pressure at reducing pipes,

(iii) Stress due to axial component of internal pressure at the discharge valve at its closure,

(iv) Stress due to variation of temperature of the pipe (20^0 C during the water filling), and

(v) Stress due to Poisson's effect.

(d) To resist the loads due to handling during fabrication, transportation and field erection:

The shell thickness shall not be less than the thickness necessary for handling, as determined by the following empirical formula.

$$t = \frac{D + 800}{400}$$

where,

t: minimum shell thickness (mm), but shall not less than 6.0 mm as specified in Clause 3.1 of Subsection-3 even if the pipe is reinforced by stiffener rings, etc.

D: inside diameter (mm)

(e) Welding efficiency

The strength of the longitudinal and circumferential welds on the steel pipe shall be rated at 90 percent of the plate strength.

(f) Welding joints

Full penetration butt-weld joints shall be used for all longitudinal in the pipe shells.

(g) Tolerance of steel plate

The shell thickness for manufacturing the outlet pipe shall in no case exceed 0.25 mm in minus side than the designed thickness, provided that the width of steel plate may be varied with the recommendation of the steel mill.

(2) Guard valve

- Type	:	Butterfly valve
- Quantity	:	One (1) set
- Diameter	:	600 mm
- Design head	:	23.6 m
- Sealing method	:	Metal touch seat
- Operating device	:	Motor operating Device
- Operating Head		
Normal	:	Under balanced water head condition
Emergency	:	23.6 m
- Operating speed	:	0.3 m/min._+10%
- Operation method	:	Local
- Diameter of bypass pipe and valve	:	100 mm

(3) Discharge valve

- Type	:	Slide valve
- Quantity	:	One (1) set
- Diameter	:	600 mm
- Design head	:	23.6 m
- Valve center elevation	:	EL. 1,018.400
- Water seal	:	Metal touch seat
- Operating device	:	Motor operating device
- Operating head	:	23.6 m in maximum
- Operating speed	:	0.1 m/min. Å} 10%
- Discharge coefficient at full opening	:	0.8 or more
- Operation method	:	Local

In addition the above, the reaction load due to its own weight, all loads imposed during starting, opening or closing the valve shall be considered in the design of each valve.

4.4.4 Outlet Pipe Details

(1) Appurtenance

(a) Air release pipe

A 100 mm diameter air release valve and pipe shall be provided on the drain pipe between the guard valve and discharge valve.

(b) Flanges

The Contractor shall furnish necessary flanges for connecting the outlet pipe to the guard valve and the outlet valve in accordance with Figure 1.14.

(c) Sealing materials of expansion joint

The Contractor shall furnish a new sealing materials of the expansion joint in accordance with Figures 1.11 and 1.14.

(2) Fabrication

The fabrication shall conform to the requirements of Clause 4.4.7 of this subsection as far as applicable.

4.4.5 Outlet Valve Details

(1) General

The outlet valve shall be of circular section gate valve and operated by the motor operating device. The valve shall be capable of discharging water under the specified water head condition without unacceptable vibration, cavitation and excessive wear. The valve shall be connected with the drain pipe by means of flange-connection and shall consist of valve leaf, valve body, valve seat, operating device, by-pass valve and pipe, and all other necessary components.
The details of construction of the valve not specified herein will be left to the Contractor, subject to approval of the Engineer.

(2) Valve leaf, valve body and seats

The valve leaf shall preferably be manufactured from the cast iron, but cast steel will be considered. The valve leaf, fluidway and seal seat portions of the valve shall be of robust and rigid construction so as to prevent occurrence of vibration and cavitation during the valve operation.

The valve leaf shall be fabricated firmly and its bottom edge shall be suitably formed so as not to cause vibration of the valve leaf due to jet water flow during operation of the valve.

The bronze seal plates shall be fastened with flat-head bronze screw on both the sides of the valve leaf. The bronze seal plates shall be provided in the valve body to form sealing seats and sliding way upon which the vertically moving valve leaf is supported and seated.

The mating seal seat surfaces on the valve leaf and the valve body shall be carefully machined to true plane so that they will bear uniformly. The valve body shall include a fluidway and a bonnet and shall be of heavily ribbed block construction made of cast iron or cast steel. The drain valve or cock and shot pipe shall be provided at the bottom of valve body so as to easily drain the water in the bottom, of valve body. Gasket materials, bolts and nuts shall be furnished for all flanged connections.

(3) Operating device

The operating device shall be of the motor operating device mounted on the valve body to open and close the guard valve. The device shall consist of mechanical equipment, i.e., bearing, gear reducer, shaft, shaft cover, manual operating device, mechanical position indicator, housing, etc., and electrical equipment, i.e., electrical motor, limit switches, torque switch, interlock switch, electric magnetic brake, space heater, control, etc., and all other necessary components for proper and efficient operation. The operating device shall be designed to withstand the rated load at the specified allowable unit stress and the factors of safety. The mechanical and electrical equipment shall conform to the requirements of Clause 3.11 in Subsection-3 "Design Particulars".

(4) By-pass valve and pipe

By-pass system shall be provided to equalize a water pressure between upstream and downstream sides of the guard valve for operating under the balanced water head

condition.

The by-pass system shall consist of one (1) hand operated by-pass valve of 50 mm in diameter and its by-pass pipe.

4.4.6 Guard Valve Details

(1) General

The guard valve shall be of the butterfly valve type and consist of valve body, valve shaft, gear reducer, seals, motor operating device, position indicating system and all other necessary components. The valve bodies and valve leaves shall be fabricated in suitable sized sections at the Contractor's shop in consideration of the requirement for the installation at site.

(2) Valve bodies

Each valve body shall be made of welded mild steel or cast steel construction, or combined construction thereof or other approved materials.
Each valve body shall be ruggedly built and adequately ribbed to minimize distortion under full load, and shall be capable of withstanding thrust force due to water pressure acting on the valve leaf under the fully closed condition of the butterfly valve.
The shaft bushing housings shall be integrated with the valve body. The supporting bases of the valve body shall be capable of withstanding the vertical loads due to the weights of the butterfly valve and inside water to be born and other load imposed during operation of the valve. The both upstream and downstream connections between the valve body and the penstock shall be made by means of flange-joint.
The valve body shall be provided with a seat ring made of corrosion-resisting steel at the inner circumference. When closed each valve sealing system shall be virtually drop-tight.
The seat ring shall be carefully machine-finished to provide close-fitting with the seal of the valve leaf. The valve body shall be stress-relieved prior to its machine-finishing.

(3) Valve leaf

Each valve leaf shall be made of mild steel or cast steel construction, or combined construction thereof or other approved materials.
Special consideration shall be paid in design and fabrication of each gate leaf so as to minimize head loss and turbulence caused by the valve leaf under fully-opened condition, to withstand for long periods the passage of high velocity silt laden water,

and to avoid unacceptable vibration and cavitation behind the valve leaf during any operation condition. The most suitable form of the valve leaf shall be furnished.
The valve leaf shall be stress-relieved before its machining. The valve seals shall be sufficiently robust to withstand for long periods the passage of high velocity silt laden water when open. For complete water-tightness of the valve, the seal edge of the valve leaf shall completely contact with the seat ring of the valve body when the valve has been closed. The seal edge of the valve leaf shall be renewable.

(4) Shafts and Bushings

The shafts shall be made of forged steel and shall be rigidly fitted to the valve leaf. The shafts shall be designed to have sufficient diameter and length with due consideration of the bearing pressure of the bushings and bending and shearing stresses of the shafts. Proper seals shall be provided at the outside ends of the shafts to prevent water leakage.
The bushings shall be self-lubricating of graphite free Lubricate or similar approved materials and shall be supported by the bushing housings rigidly fitted to the valve body.

(5) Operating device

The operating device shall conform to the requirements of Clause 3.11 of Subsection - 3 "Design Particulars", but the device shall be mounted on the concrete deck.

4.4.6 Control and Wiring for Valves

(1) Control system

The guard valve and outlet valve shall be operated locally by a local control cabinet located on the hoist deck of the spillway radial gates with the corresponding push button switches. Limit switches shall be so provided as to stop the guard and outlet valves at the fully opened and closed positions. The guard valve shall be capable of operating under the fully balanced head condition by means of the by-pass valve, save an emergency case in which the guard valve shall be closed fully upon overcoming all loads due to full flow of water during such operation.

(2) Wiring

All power and control cables and/or wires with all necessary conduits and accessories from the electrical terminal point to the respective electrical equipment shall be supplied

by the Contractor, in accordance with the manner specified in Clause 1.3 of the General Specifications.

(3) Control cabinet

The Contractor shall provide a local control cabinet contained the controls for operation of each valve. The construction of the cabinet shall conform to the requirements of Clause 3.11 in Subsection-3 "Design Particulars". The following instruments shall be mounted on or inside the control cabinet, but shall not be limited to. All indicators such as meters and lights shall be visible from outside without opening the keyed doors or windows.

(a) Earth leakage circuit breaker
(b) Incoming supply moulded case circuit breaker (MCCB) lockable in off position
(c) Under voltage relays
(d) MCCBs to protect the motors and other circuit
(e) Motor protection relays
(f) Source volt meter
(g) Load ampere meters
(h) Valve position Indicators
(i) Starter for motors
(j) 230V convenience outlet
(k) Space heater with thermostat and on-off switch
(l) Fluorescent light with door switch
(m) "Lamp test" push button switch for inspection for all indicating lights
(n) Trouble indication light
(o) "Guard valve open" push button switch
(p) "Guard valve close" push button switch
(q) "Guard valve stop" push button switch
(r) "Outlet valve open" push button switch
(s) "Outlet valve close" push button switch
(t) "Outlet valve stop" push button switch
(u) "Source pilot" indicating light
(v) "Guard valve opening" indicating light
(w) "Guard valve closing" indicating light
(x) "Guard valve fully opened" indicating light
(y) "Guard valve fully closed" indicating light
(z) "Outlet valve opening" indicating light
(aa) "Outlet valve closing" indicating light

(ab) "Outlet valve fully opened" indicating light

(ac) "Outlet valve fully closed" Indicating light

(ad) "Outlet valve intermediate opening position" indicating light

(ae) "Motor overloaded" indicating lights

(af) "Earth leakage" indicating light

(ag) All other necessary step-down transformers, relays, contactors, switches and miscellaneous wiring components

(4) Trouble indication light

One (1) set of trouble indication light shall be provided on the local control cabinet by the Contractor, so that due warning for the trouble could be given for the operators. The trouble indication shall be lighted when the following relays or detectors, etc., for the guard valve and the discharge valve will be actuated.

- Under voltage relays
- Motor protection relays
- Earth leakage relay
- Over torque limit switches

(5) Telemetering and Supervisory Control

The Contractor shall provide the following digital transducers and indicators, and terminal units on the control panels for sending necessary signals to the power station.

(a) Telemetering item

(For outlet valve)

- Digital type valve position indications

(b) Supervisory items

The " on-off contacts " (free potential, normally opened and/or closed mechanical contacts) shall be provided to signal to the remote terminal unit for all alarms and indications at the power station.

(i) For outlet valve

- Valve fully raised indications
- Valve fully lowed indications
- Valve intermediate position indications
- Fault indications (shortage of incoming source voltage and overload

condition of valve)

(ii) For guard valve
- Valve fully raised indication
- Valve fully lowed indication
- Fault indication (shortage of incoming source voltage and overload condition of valve)

4.4.7 Fabrication

(1) General

The Contractor shall cut the plates for the steel penstock to exact dimensions, prepare the edges for welding, press the edges for rolling, roll them to the required curvatures and make them to the complete sections at the factory of the Contractor's country or other country accepted by the Engineer. The steel materials to be used for the steel penstock shall be clearly marked for easy identification of their kinds.

(2) Cutting and bending

All plates shall be cut accurately to the dimensions shown on the For-Work-Drawings, with allowance provided for possible shrinkage during welding. All edges shall be inspected for sound metal and be free from laminations, surface cracks and other injurious defect. The cylindrical shells may be rolled or bent to true curved section, continuous to the edges, by any process that does not impair the strength of the plates and with continuous curvature between the edges.

The correction of curvature by hammering will not be permitted. For butt welding of plates of unequal thickness, the work of trimming of the thicker plate shall be done in the Contractor's shop as to have a taper of 1:4, if the difference between plate thickness is more than 3.0 mm. The orientation of the plate for fabrication shall be such that the final direction of rolling is placed circumferentially. No stamping or groove marking on the steel penstock shells shall be allowed, if it puts to the part other than cutting line for fabrication purpose or leaves on the finished steel penstock surface.

The bending of plates shall be performed by cold working as rule. If bending is made by hot working, the Contractor shall obtain the approval of the Engineer for the temperature control procedure.

(3) Welding

In addition to the welding requirements of Clause 1.22 of the General Specifications, the following shall also govern:

(a) Cleaning before welding

The surfaces of plates to be welded shall be cleaned from all scale, rust, oil, paraffin or grease, for a distance of not less than 25 mm from the welding edge. Welding grooves shall similarly be cleaned.

(b) Cleaning after welding

When the steel penstock is completely erected ready for concreting, there shall be no lugs, cover plates, saddles or other devices welded to the steel penstock shell, except where these form part of the permanent support of the steel penstock for concreting. All temporary lugs and devices welded to the outside of the pipe shell shall be carefully removed by the Contractor and dressed smooth and flush with the surrounding metal. Care shall be exercised in removing such attachments to prevent cutting, tearing or gouging into the metal of the pipe shell. After concreting is completed, all internal bracings and devices welded to the inside of the steel penstock shall be similarly removed and the inside shall be dressed smooth and flush.

(c) Lugs, saddles or brackets

All lugs, saddles or brackets which are welded to the steel penstock and which are to form part of the permanent or temporary support shall be made of the same plate material as the shell proper and the welding shall meet with all the requirements as set out herein.

(d) Reinforcement of welding metal

All welded joints on pipe shells shall be dressed smooth and the maximum reinforcement shall be limited to the following tolerances on the inside of the steel penstock. On the outside of the steel penstock, welds shall be dressed free of all flux and scale and smooth to the extent necessary to allow radiographic examination.

Plate thickness (mm)	Tolerances (mm)
Under 12	1.5

12 - 25	2.5
Over 25	3.0

(e) Tolerance on offset

The maximum offset between abutting external surfaces at any position along a butt weld joint shall not exceed the following tolerances :

Joint	Tolerance
- Longitudinal joint However, in case of plate thickness 20 mm and under	5% of plate thickness 1 mm
- Circumferential joint However, in case of plate thickness 15 mm and under	10% of plate thickness 1.5 mm.

(f) Thrust collars, seepage rings, stiffener rings, reinforcement rings for grouting holes, manholes, backing strips, etc.

Thrust collars, seepage rings, stiffener rings, reinforcement rings for grouting holes, manholes, backing strips, etc., shall be welded on the pipe shells at the Contractor's workshop or field shop, and shall be made of the same plate material with the shell proper in principle.

(g) Core wires, fluxes and welding rods

Core wires, fluxes and welding rods shall be of the most suitable materials for the base metals and welding method, and shall be kept under sufficient dry condition. The Contractor shall obtain the approval of the Engineer, in corporating their kind, characteristic, weldability and control procedure into welding procedure.

(h) Back chipping

Back chipping for welded joint shall be performed by arc-air gouging.

(i) Preheating

When preheating is part of the approved welding procedure, weld joints shall be preheated in accordance with the kind of steel materials and plate thickness. Maximum interpass temperature shall be 200 degrees C. and preheating shall be a distance of more than four (4) times that plate thickness for each side from the welding line.

(j) Stress relief annealing

(i) Furnace annealing for the welded joints shall be performed after finish of welding work, whenever the joints correspond to the following cases 1. and 2. Otherwise the joint efficiency should be reduced when no stress relieving is made.

Case 1. When the plate thickness at the welded joints in the longitudinal direction of the steel penstock exceeds 32 mm and coincides with the following equation:

$$t > 8D/1{,}000 + 12$$

where, t : plate thickness (mm)
D : pipe inside diameter (mm)

Case 2. When the effect of the residual stress is considered to be great due to concentration of welded joints like reinforcing members for bifurcation, etc.

(ii) When the stress relief annealing can not be made easily, or it is considered as not necessary for application from the viewpoint of strength against welded pipes in large diameter or large welded structures or doing repair welding work that are made respectively at site, these annealing requirements can be substituted with local annealing method or other methods considered effective in improving the characteristics of welded parts, such as preheating.

(iii) In case of such treated or special steel materials like quenched and tempered high tensile strength steel which have no possibility of brittle fracture under the normal application, or which will be adversely affected by the stress relief annealing due to their unique characteristics, it may be

allowed to omit these annealing requirements even if they fall in the category described in cases 1. and 2. of the above Item (i).

(k) Shelters

If welding work is performed under the condition of windy, wet or hot weather, suitable protecting facilities shall be provided for the welding work.

(4) Tolerances

The completed steel penstock shall conform to the dimensions shown on the drawings and to the tolerances specified herein. The tolerances of circumferential length of each section shall not exceed plus or minus 0.25 percent of the design length for that section.

The end of cylindrical sections shall be within a tolerance of plus or minus 2 mm of the plane normal to the axis of the sections. Angles of bends shown on the approved drawings shall be within a tolerance of plus or minus 10 minutes of angle. Edges of adjoining plates to be welded shall match with a maximum allowance offset at any one point of 2.0 mm. The pipe sections shall be aligned so that their centerlines are within plus or minus 5.0 mm of the true centerline. The tolerances listed are exclusive of any allowance for shrinkage or distortion provided by the Contractor to compensate for effects of welding.

4.4.8 Shop Assembly and Test

(1) Outlet pipe

(a) Mill tests

The steel plates for the steel penstock shall pass the following mill tests in accordance with the requirements of JIS G 0303 for each thickness and each quality:

(i) Tension test,
(ii) Bend test,
(iii) V-notch charpy impact test (applicable for the material SM400 or equivalent or above), and
(iv) Chemical analysis.

Certified copies of mill test reports shall be furnished to the Engineer as soon as

possible after the tests are made. The results of the test shall be submitted in the form that provides means of determining compliance with the applicable specifications for the materials tested. When requested, al tests or trial shall be made in the presence of the authorized Inspector appointed by the Engineer and/or the Employer.

(b) Radiographic examination

100 percent of longitudinal joints and 20 percent of circumferential joints including all T-parts in the pipe shell shall be radiographed at the Contractor's shop, field shop, and at the Site. Radiographic techniques shall employ X-ray only.

Radiographs shall be in accordance with the requirements and technique of JIS Z 3104 and be passed over or equal to Grade 2. Objectionable defect in welds shall be chipped or flame or arc-gouged at least in a film length to show sound metal and the defect shall be rewelded. If the objectional defect is discovered in the girth joints, it shall be repaired in accordance with the following procedure:

(i) A film length weld line of both sides of the defect portion, shall be radiographed to examine whether there is the objectional defect therein or not.

(ii) If there is the defect therein, all weld line of joint concerned shall be radiographed and all the objectional defect shall be repaired.

(iii) If there is not the defect therein, the defect portion shall be repaired.

Welds that have been repaired shall be 100 percent radiographed again. The Contractor shall furnish all equipment, films and labours necessary to perform the radiographic tests. All original films of the radiographs shall become the property of the Employer. The Contractor shall provide proper storage for his radiographs and shall store and preserve all radiographs of welding, whether the welding is accepted or rejected. All radiographs shall be identified and an identification drawing shall be prepared.

(c) Tests of weld joint

(i) General

The Contractor shall furnish all test plates, equipment, apparatus, supplies

and labours required for the tests. The size of welding test plates shall be 400 x 300 mm minimum made up with two 400 x 150 mm plates by weld. All test plates made shall be stamped to indicate the welder and date welded.

(ii) Both-side butt welded joint

After welding, the following tests shall be carried out on every plate thickness in accordance with the requirements of the approved standard.

- Two tensile tests transverse of the weld axis
- Two root bend tests, and
- Two face bend tests.

(iii) One-side butt welded joint with backing strip

The Contractor shall provide the test plates with backing strip in accordance with the approved welding procedure and carry out the welding operator's skill tests on every plate thickness in the presence of the authorized Inspector appointed by the Engineer or the Employer.

All welders and welding operators assigned to the field joint welding works shall make three (3) tests pieces welded by flat position, vertical position and overhead position and shall pass the welding operator's skill test herein.

After welding, the full length of joint shall be radiographed at the Contractor's shop. The following tests shall be carried out on the satisfactory welding joints which verified by the radiographic examination.

- Two tensile test transverse of the weld axis
- Two side bend tests, and
- Each V-notch charpy impact test for welding plate, joint portion and heat-affected zone.

(d) Inspection

The steel penstock shall be inspected by the Engineer for welding and surface imperfections such as under cut welds, stamp, clamp or chisel marks, surface pitting in the plate and other similar surface irregularities. Faulty material and workmanship shall be made good by the Contractor to the Engineer's entire satisfaction. Material which shows defect subsequent to erection shall be rejected

and the Contractor shall replace the material with new one to the satisfaction of the Engineer.

The peeling, pinhole and thickness inspection shall be performed for the dried films of the painted materials, along with visual check at the Contractor's shop, field shop and at the Site. However, peeling inspection shall not be applied for the portions painted after site welding work.

A record shall be maintained of the location of all imperfections and the corrective measures taken to effect repairs.

(2) Guard valve and outlet valve

(a) General

The guard valve and the outlet valve shall be completely assembled in the shop and tested as hereinafter described to ensure that all parts are sound, fit and operated properly.

All tests shall be made in the presence of the Engineer. If any defect orimproper operation discovered, the retest, as directed by the Engineer, shall be made until the requirements of this Specifications are met.

(b) Guard valve

The high-pressure gate valve including operating device shall be completely assembled in the shop for inspection and to ensure that all parts fit accurately and are in proper alignment. The valve shall be opened and closed several times by means of motor operating device and the required adjustments or corrections shall be made until the valve operates properly. The seal seats of the body and leaf shall fit and be sufficiently true to plane.

Before the valve is painted, a bulkhead for water-pressure testing shall be bolted to the upstream flange of the valve body at fully closed position. All air shall be vented from the bulkhead and water pressure shall be applied and raised slowly to 1.5 times the foregoing maximum design head. The pressure shall be held not less than 10 minutes. While the water-pressure test, the body, downstream portion of the leaf are examined for leaks. Any leak discovered shall be repaired. During the test, the water leakage from the valve leaf seal shall be measured and shall not exceed 200 cc per 1/2 hours.

(c) Outlet valve

(i) Assembly

The valve may be assembled with the center line vertical, but all operating tests and checking of the needle seat contact shall be made with the valve center line in the horizontal position. During assembly of the valve, special care shall be exercised to be sure the packing are properly fitted and are not damaged.

(ii) Operating test

The Contractor shall operate the valve through several complete opening and closing cycles and check to be sure the valve operates smoothly without any evidence of sticking or binding.

(iii) Major test items

The following items, at least, shall be checked during the operation test of the guard valve and the discharge valve.

- Opening and closing speeds
- Voltage and current of electric motors
- Temperature rise of bearings and motors
- Existence of abnormal noise and vibration
- Operation of limit switches
- Accuracy of position indicator
- Normal condition of control cabinet

Any defect or improper operation discovered shall be corrected and entire test shall be repeated to the satisfaction of the Engineer.

4.5 Water Supply Pump Equipment

4.5.1 General

Two (2) sets of the water supply pump equipment including pumps, suction pipe, drainage pipe, etc. shall be provided in the pump chamber of the spillway. The pumps shall be used for supplying the water for the dam area.

The Contractor shall make necessary arrangement to dispatch their engineers for supervising

the installation of the water supply pump equipment.

The arrangement of water supply pump equipment shall be shown on Figure. 1.15.

4.5.2 Design Conditions

The water supply pump equipment shall be designed in accordance with the following conditions:

Pumps

(a)	Type of pump	:	Horizontal shaft volute type
(b)	Discharge capacity per unit at rated design head	:	2.0 m^3/min.
(c)	Rated design head	:	60 m
(d)	Diving method	:	Electric motor directly coupled with motor
(e)	Type of motor	:	Horizontal shaft induction motor
(f)	Type of bed	:	Common

4.5.3 General Requirements

The water supply pump equipment shall conform to the following requirements:

(1) Pumps

The water supply pumps shall be of horizontal shaft volute type and be provided with effective lubricating system. All sections of the pump and motor casing shall be rigidly connected to maintain correct alignment of all parts.

The impeller and shaft of the pump shall be made of corrosion resistant material and bronze casting metal shall be used to the bearings. Adequate provision shall be made in the design of the pump for preventing from the entry solid materials which are too large to pass freely through the pump.

(2) Valves

A check valve shall be provided at the outlet side of water supply pump to prevent adverse water flow when the pump stops. The check valve shall be swing type and shall withstand internal water pressure of 6 kgf/cm^2. The valve body shall be made of cast iron and the sealing surface of the valve shall be accurately machined for complete

water seal when the valve closes.

Hand operating sluice valve shall be provided for changeover of standby unit and function of the stop valve if possible to provide within the required rehabilitation area. Sluice valve shall be gate valve and shall withstand internal pressure of 6 kgf/cm^2. The valve body shall be made of cast iron and the contact surface of seal parts shall be accurately machined for sufficient water seal when the valve closes.

The connection of the valves and the pipes shall be made by flange coupling.

(3) Suction and delivery pipes

Suction and delivery pipes shall be provided for the water supply pumps. The pipe shall be carbon steel pipes for ordinary piping or equivalent and shall withstand internal water pressure of 6 kgf/cm^2. The Contractor shall connect with the existing suction and delivery pipes to the embedded pipe.

(4) Control system

Water supply pumps shall be operated by a local control panel located at the hoist deck of the spillway radial gates. The local control panel is a common use with the irrigation outlet valve. All necessary control equipment for the water supply pumps shall be integrated in the local control panel.

The Contractor shall furnish a panel, wiring material and other apparatus required for the above pump control.

4.5.4 Accessories

The following accessories shall be provided by the Contractor for the water supply pump equipment:

(1) Anchor bolts and nuts for the pumps
(2) Floor plate and frames for the pumps
(3) Oil or grease supply pipes for the pumps
(4) Shaft couplings for pumps
(5) Pressure gauges for the pumps
(6) Other necessary accessories

4.5.5 Tests

The pumps shall be completely assembled at the manufacturer's shop and tested to prove the capacity of them before shipment. After installation at the Site, the operation test for the drainage pump equipment shall be carried out and the test results shall conform to the Contract requirements.

4.6 Rope Haulage of Penstock

4.6.1 General

For the convenience of penstock maintenance work between valve house and BL. No. 8 (upper crossing), one (1) complete set of the rope haulage with a capacity of 1 ton capacity shall be designed and supplied by the Contractor. The rope haulage consists of a wagon, rail, steel bridge supports, rope sheaves, rope guide rollers and all other necessary accessories for proper operation of the wagon. The rope haulage line shall be installed along the existing penstock. A wagon of the rope haulage shall be operated by an electrically operated hoist located near the valve house and shall usually be stored near the hoist.

The wagon shall be provided with automatic brake and hand brake. The automatic brake foundations automatically when the rope tension is lost due to accidents during operation and the hand brake is operated by hand from the operator's seat of wagon.

The Contractor shall make necessary arrangement to dispatch their engineers for supervising the installation of the rope haulage.

The arrangement of the rope haulage shall be as shown on the Figure 1.17 (1/2) and 1.17 (2/2).

4.6.2 Design Stresses

The design stresses shall conform to those specified in Subsection-2.

4.6.3 Design Conditions

The rope haulage shall be designed for the following conditions:

- Type of wagon : Four (4) wheels of wagon made of steel
- Hois type : Electrically operated stationary type cable-lift hoist

- Loading capacity : 1 ton
- Operating speed : 10 m/min.
- Operation : Local
- Steepest slope : Maximum 48^{o}
- Rail gauge : 1 m
- Wagon : Four (4) wheels, 3.0 m x 1.2 m
- Length of line : Approx. 995.403 m

4.6.4 Detail Requirement for Rope Haulage

The wagon, lifting and dumping mechanisms shall be simple in design and positive in operation. The details of construction of the equipment not specified herein will be left to the Contractor, subject to approval of the Engineer.

The wagon of four (4) wheel type made of steel shall be provided and designed to carry the human along with the equipment and materials for the penstock repairing. The removal type handrail shall be provided on the wagon to facilitate loading of the equipment and materials for repairing. The Contractor shall give special care on designing the wagon to ensure the safety of the human.

Flat bottom rails shall be provided and fixed to the sloping concrete face. Packers shall be provided as necessary beneath the rails to allow for inaccuracies in the concrete level. The rail for the portion between BL. No. 5 and BL. No. 7 shall be supported with the bridge support structure. The bridge support structure shall be designed to withstand all loads due to the most adverse operation of wagon.

The hoist shall be designed to raise, lower and hold the wagon in any position between the valve house and BL. No. 8 position. The hoist shall be designed to withstand the rated hoist load at normal operation and the load due to the maximum hoist motor torque without exceeding 90 per cent of the yield strength of the materials used.

4.6.5 Control and Wiring for Rope Haulage

(1) Control system

The rope haulage shall be operated locally by local control cabinet located at hoist near the valve house of penstock with the corresponding push button switches. Limit switches shall be so provided as to stop the wagon at the fully raised and lowered positions.

(2) Wiring

All power and control cables and/or wires with all necessary conduits and accessories from the electrical terminal point at the valve house to the respective electrical equipment shall be supplied and installed by the Contractor, in accordance with the manner specified in Clause 1.3 of the General Specifications.

(3) Control cabinet

The Contractor shall provide one control cabinet for operation of the wagon. The control cabinet shall be located near hoist and shall be of weatherproof construction, completely enclosed, with keyed access doors and windows, assembled using angle or channel structural members, seam welded at the corners and finish smooth. The construction of control cabinet shall conform to the requirements specified in Paragraph (10) of Clause 3.11 of Subsection - 3 "Design Particulars".

The following instruments shall be mounted on or inside the control cabinet, but shall not be limited to. All indicators such as meters and lights shall be visible from outside without opening the keyed doors or windows.

(a) Earth leakage circuit breaker
(b) Incoming supply moulded case circuit breaker (MCCB) lockable in off position
(c) Under voltage relays
(d) MCCBs to protect the motors and other circuit
(e) Motor protection relays
(f) Source volt meter
(g) Load ampere meters
(h) Wagon position Indicators
(i) Starter for motors
(j) 230V convenience outlet
(k) Space heater with thermostat and on-off switch
(l) Fluorescent light with door switch
(m) "Lamp test" push button switch for inspection for all indicating lights
(n) Trouble indication light
(o) "Wagon raising" push button switch
(p) "Wagon lowing" push button switch
(q) "Wagon stop" push button switch
(r) "Wagon emergency stop" push button switch

(s) "Source pilot" indicating light
(t) "Wagon raising " indicating light
(u) "Wagon lowing " indicating light
(v) "Wagon fully raised" indicating light
(w) "Wagon fully lowed" Indicating light
(y) "Motor overloaded" indicating lights
(z) "Earth leakage" indicating light
(aa) All other necessary step-down transformers, relays, contactors, switches and miscellaneous wiring components

(4) Trouble indication light

One (1) set of trouble indication light shall be provided on the local control cabinet by the Contractor, so that due warning for the trouble could be given for the operators. The trouble indication shall be lighted when the following relays or detectors, etc., for the rope haulage will be actuated.

- Under voltage relays
- Motor protection relays
- Earth leakage relay
- Over torque limit switches

4.6.6 Shop Assembly and Test

The rope haulage shall be completely assembled in the shop and tested as hereinafter described to ensure that all parts are sound, fit and operated properly.

All tests shall be made in the presence of the Engineer. If any defect or improper operation discovered, the retest, as directed by the Engineer, shall be made until the requirements of this Specifications are met.

The following items, at least, shall be checked during the operation test of the rope haulage.

(i) Raising and lowering speeds
(ii) Voltage and current of electric motors
(iii) Temperature rise of bearings and motors
(iv) Existence of abnormal noise and vibration
(v) Operation of limit switches
(vi) Accuracy of position indicator

(vii) Normal condition of control cabinet

Any defect or improper operation discovered shall be corrected and entire test shall be repeated to the satisfaction of the Engineer.

4.7 Provision of Spare Parts and Testing Equipment

The Contractor shall provide the following spare parts and testing equipment to maintain the existing gate and penstock.

Description	Quantity
1. Thickness inspection of pipe shell	
Ultrasonic test equipment	2 sets
2. Paint inspection	
Pinhole detector	2 sets
Magnetic thickness meter	
3. Vibration inspection of pipe shell	
Sound level meter	1 set
Vibrometer	1 set
4. Inspection of hoist	
Thermometer (0 - 200 ^{o}C)	10 sets
Ampere - volt meter	4 sets
Insulation tester (500 V, 1000 meg. ohm)	2 sets
5. Gaskets of penstock manhole	
Gaskets for No. 1 penstock (each 2 sets)	64 sheets
Gaskets for No. 2 penstock (each 2 sets)	64 sheets
6. Communication system at site	
Transceiver	3 sets