

TECHNICAL SPECIFICATIONS
CHAPTER 3
MECHANICAL WORKS

CHAPTER 3 MECHANICAL WORKS

	Page
30100 GENERAL	
30101 Scope of Work	MC- 1
30102 Standard and Regulations	MC- 2
30103 Schedule	MC- 2
30104 Standard of Quality	MC- 2
30105 Equipment Guarantee	MC- 3
30106 Certification	MC- 3
30107 Drawings	MC- 4
30108 Routing of Pipelines	MC- 8
30109 Patents	MC- 9
30110 Materials	MC- 9
30111 Equipment	MC-10
30112 Lubrication	MC-11
30113 Equipment Bases and Bedplates	MC-12
30114 Anchor Bolts	MC-12
30115 Safety Guards	MC-12
30116 Reduction Gears	MC-12
30117 Motor	MC-13
30118 Nameplates	MC-15
30119 Equipment Tags	MC-16
30120 Vibration Control	MC-16
30121 Sample Cocks, Meters and Gauges	MC-16
30122 Equipment Protection	MC-16
30123 Painting System	MC-16
30124 Equipment Installation	MC-22
30125 Inspections and Tests	MC-23
30126 Accessories and Spare Parts	MC-24
30200 PLANT WATER PUMP	
30201 Scope of Work	MC-25
30202 References	MC-25
30203 Schedule of Plant Water Pumps	MC-26
30204 General Arrangements	MC-27
30205 Materials and Workmanship	MC-27
30206 End Suction Centrifugal Pump	MC-28
30207 Valves and Flexible Joints	MC-30
30208 Performance Tests	MC-31
30209 Installation	MC-31
30210 Accessories and Spare Parts	MC-31

30300 AIR SCOURING BLOWER

30301	Scope of Work	MC-33
30302	Schedule of Air Blower Units	MC-33
30303	General Arrangements	MC-34
30304	Construction and Materials	MC-35
30305	Appurtenances	MC-37
30306	Performance Tests	MC-39
30307	Installation	MC-39
30308	Accessories and Spare Parts	MC-40

30400 ALUM DOSING SYSTEMS

30401	Scope of Work	MC-41
30402	References	MC-41
30403	Schedule of Alum Dosing System	MC-42
30404	Equipment Manufacturer	MC-44
30405	Alum Solution Mixer	MC-45
30406	Alum Dosing Pumps	MC-46
30407	Bridge Walkway and Drive Platform	MC-47
30408	Process Piping and Valves	MC-47
30409	Motors	MC-48
30410	Accessories and Spare Parts	MC-48
30411	Certification	MC-49

30500 LIME DOSING SYSTEMS

30501	Scope of Work	MC-50
30502	References	MC-50
30503	Schedule of Lime Dosing System	MC-51
30504	Equipment Manufacturer	MC-54
30505	Lime Solution Mixer	MC-54
30506	Lime Dosing Pump	MC-54
30507	Lime Injection Pump	MC-54
30508	Lime Dosing Injector	MC-55
30509	Bridge Walkway and Drive Platform	MC-55
30510	Process Piping and Valves	MC-55
30511	Motors	MC-56
30512	Accessories and Spare Parts	MC-56
30513	Certification	MC-58

30600 CHLORINATION SYSTEM

30601	Scope of Work	MC-59
30602	References	MC-59
30603	Equipment Manufacturer	MC-60

	<u>Page</u>
30604	Manufacturer's Service MC-60
30605	Schedule MC-61
30606	Removal and re-installation of existing equipment MC-64
30607	Chlorinator MC-65
30608	Weigh Scale MC-66
30609	Booster Pump MC-66
30610	Chlorine Container MC-66
30611	Chlorine Container Grab MC-67
30612	Process Piping and Valves MC-68
30613	Protection Against Corrosion MC-69
30614	Motor MC-70
30615	Accessories and Spare Parts MC-70
30616	Certification MC-73

30700 FLUSH WATER PUMPS

30701	Scope of Work MC-74
30702	References MC-74
30703	Schedule of Pumps MC-75
30704	General Arrangements MC-76
30705	Materials and Workmanship MC-76
30706	End Suction Centrifugal Pump MC-76
30707	Valves and Flexible Joints MC-76
30708	Performance Tests MC-76
30709	Installation MC-76
30710	Accessories and Spare Parts MC-77

30800 PORTABLE SUBMERSIBLE SUMP PUMP

30801	Scope of Work MC-78
30802	Schedule of Pumps MC-78
30803	Submersible Sump Pumps MC-78
30804	Accessories and Spare Parts MC-80

30900 VENTILATING SYSTEM

30901	Scope of Work MC-82
30902	References MC-82
30903	Schedule MC-82
30904	General Arrangements MC-82
30905	Tests MC-83
30906	Propeller Fans MC-84

31000 CHAIN HOISTS

31001	Scope of Work MC-85
-------	-------------------------------

31002	References	MC-85
31003	Schedule of Chain Hoists	MC-85
31004	General Arrangements	MC-86
31005	Hand Operation Chain Hoists	MC-86
31006	Portable Gantry Frame	MC-87

31100 PIPE WORK FOR ELEVATED TANK

31101	Scope of Work	MC-88
31102	Schedule of Pipe Work	MC-88
31103	Piping and Valves	MC-89

CHAPTER 3 MECHANICAL WORKS

30100 GENERAL

30101 Scope of Work

The Contractor shall provide all labor, materials, equipment and incidentals to furnish and install the complete mechanical work as shown on the drawings and/or as specified herein. It is the intent of these specifications, that when completed the mechanical work shall be suitable in every respect for the service intended, and the Contractor shall, at no extra cost, supply all the materials and do all the work which may be reasonably implied as being incidental to the work.

The Contractor shall be responsible for all piping, and testing and placing in satisfactory operation the complete mechanical work to the approval of the PMO/Engineer.

The work under this Contract shall not interrupt the operation of the existing treatment works and shall keep the normal condition of the present operation. In case of a work necessitating the plant operation to be stopped, all temporary works, equipment, materials, labour and testings needed shall be installed and furnished to keep the operation present conditions by the Contractor without additional cost.

The Contractor shall be deemed to have included in his Contract, price for all items necessary such that the installations are complete in all respects and left in a satisfactory working order.

All work, equipment, materials and others are to be of the best quality approved by the PMO/Engineer and strictly in accordance with the Specification.

In the event of any portion of the work or materials failing to pass the tests specified herein, or set forth in the Manufacturer's list for that particular item, the PMO/Engineer may at his discretion, reject that portion of the work or material entirely.

The work shall include but not be limited to the following.

- a) Plant water pump system
- b) Air-scouring blower system
- c) Alum dosing system
- d) Lime dosing system
- e) Chlorination system
- f) Flush water pumps system
- g) Ventilation fans system
- h) *Removal works and re-installation works of existing system*
- i) Other miscellaneous works

30102 Standard and Regulations

The mechanical works, all equipment, materials and fabrication shall conform to the latest applicable following standards or equivalent national standards.

- a) IEC : International Electrotechnical Commission
- b) ISO : International Organization for Standardization
- c) ANSI : American National Standards
- d) BS : British Standards
- e) DIN : Deutsche Institute fur Normung
- f) JIS : Japan Industrial Standards
- g) MS : Mauritian Standards
- h) NF : Norme Francaise
- i) SSPC : Standards of Steel Structure Painting Council

30103 Schedule

The completeness of the schedule in each section is not guaranteed and the omission of a electrical system in the schedule needed to complete the work shall not relieve the Contractor from his responsibility for installation of the work complete.

30104 Standard of Quality

Where items of equipment are specified by the name of a manufacturer, it is for the purpose

of establishing a standard of quality, construction, and acceptable experience. Substitute equipment will be acceptable if it can be demonstrated to the PMO/Engineer that the substitute is in accordance with the specifications and equal in quality to those models specifically named.

Manufacturers listed as "equal" have been determined by the PMO/Engineer to style and model. However, this shall not relieve the named Manufacturer from the responsibility of meeting all specified requirements.

All mechanical equipment and materials furnished shall be new and of current design.

30105 Equipment Guarantee

The Contractor shall guarantee all equipment supplied against defects in workmanship or materials for a period of two years, unless stipulated otherwise, following acceptance of the completed project.

Under this guarantee the Contractor agrees to correct without delay at his own expense any failure of such parts due to faulty materials, construction, or installation or to the failure of any such equipment to successfully perform within the limits of the specifications and further shall make good any damage to any part of the work caused by such failure.

Any work installed contrary to or without approval by the PMO/Engineer shall be subject to change as directed by the PMO/Engineer, and no extra compensation will be allowed to the Contractor for making these changes.

The PMO/Engineer will give prompt written notice of observed defects. If the Contractor after notice, fails to proceed promptly to comply with the terms of this guarantee, the Contractor will be held liable for all expenses incurred.

30106 Certification

The Contractor shall submit a certificate to the PMO/Engineer from the manufacturer stating that the installation, checking, adjusting and coordinating each equipment item are satisfactory, that all equipment is ready for service and that the operating personnel have

been suitably instructed in the operation and care of the equipment.

30107 Drawings

(1) Interpretation of Drawings

Process requirements for piping, valves and fittings are shown on the drawings and are specified. Any deviation from these requirements shall be considered a substitution and shall be submitted in accordance with the specified procedures for substitutions.

The drawings indicate the desired configuration of piping, valves and fittings. The drawings shall not be construed as being complete assembly plans, but rather as guidelines to be followed in order to provide the necessary piping, valves and fittings shown on the drawings. In addition, any piping or appurtenances not shown on the drawings which are required for a complete and operable system shall be furnished.

The Contractor shall obtain in the field all information relevant to the placing of electrical work and in case of any interference with other work, shall proceed as instructed by the PMO/Engineer. The locations of all equipment, fixtures, similar devices and piping routes shown on the drawings are approximate only. Exact locations shall be as approved during construction.

(2) Shop drawings

Prior to fabrication, the Contractor shall obtain from the Manufacturer, shop drawings for all equipment. Shop drawings shall include fabrication, assembly, foundation drawings, piping diagrams and materials used, power drive, assembly, parts, devices, and other accessories forming a part of the equipment to be furnished.

After checking the shop drawings for accuracy and suitability, the Contractor shall submit six (6) copies of the shop drawings and material lists to the PMO/Engineer for approval as outlined in the General Conditions.

All shop drawings shall be checked by the Contractor for accuracy and the Contract requirements before submittal. Shop drawings shall bear the signature of the

Contractor and date checked and shall be accompanied by the statement that the shop drawings have been examined for conformity to the specifications and drawings. This statement shall also list all discrepancies with the specifications and drawings.

Shop drawings, not so checked and noted by the Contractor shall be returned to him without approval. The PMO/Engineer's check shall be only for conformity with the design concept of the project and compliance with the specifications and Contract Drawings.

The PMO/Engineer's approval shall in no way relieve the Contractor from the responsibility of, or the necessity of, furnishing materials and workmanship required by the Contract drawings and specifications which may not be indicated on the shop drawings.

The Contractor shall be responsible for all dimensions to be confirmed and correlated to the job site and for coordination of his work with the work of all other trades.

Approval by the PMO/Engineer for the shop drawings shall neither relieve the Contractor of his obligations under this Contract nor relieve him from correcting any error found subsequently in the approved working drawings.

Where required, the Contractor shall submit to the PMO/Engineer samples of materials he proposes to install and approval before installation.

(3) Record Drawings

The Contractor shall keep on site at all times a complete set of the drawings relative to this Contract, and as the Contract works are proceeded with, indicate in red colour on such drawings, any variations to the Contract works as executed from those shown on the Contract drawings.

(4) As Built Drawings

After the completion of work, the Contractor shall deliver a complete set of "As built drawings" showing the complete installation including all alterations and modifications. The set of the drawings shall include but is not limited to all floor plans and diagrams.

The "As built" drawings shall be provided. Any cost related to this work is deemed to be covered by the Contractor's rates.

(5) Certified Test Curves

The Contractor shall submit six (6) copies of certified performance or certified test curves for all pumps specified herein. The Contractor shall notify the PMO/Engineer eight (8) weeks prior to any testing to allow the PMO/Engineer to witness the tests.

(6) Certified Reports

The Contractor or his authorised representative, shall submit a notarized written report with respect to his equipment certifying that ;

- a) the equipment has been properly installed and lubricated under his supervision
- b) the equipment is in accurate alignment,
- c) he was present when the equipment was placed in operation,
- d) he has checked, inspected, and adjusted the equipment as necessary,
- e) the equipment is free from any undue stress imposed by connecting piping or anchor bolts,
- f) the equipment has been operated under full load conditions and operated satisfactorily, and
- g) the equipment is fully covered under the terms of the guarantee.

(7) Operation Manual

The Contractor shall submit four (4) sets of operation and maintenance manual specified in Sub-Clause 6.13 in Conditions of Contract.

The operation manual written for use by the plant operator shall contain but not be limited to the following.

- a) Process description for complete treatment works including raw water intake, receiving tank, rapid mixing tank, flocculation and sedimentation tank, filters, chemical dosing system, plant water system, and others, with references to flow and line diagrams.

- b) List of plant alarms, giving possible causes for alarm initiation, and sequence of remedial actions to be taken.
- c) Procedures for setting up chemical dosage rates on dosing equipment for calculating the rate and dosing pump stroke and speed settings from specified doses giving worked examples with cross references to pump calibration curves, where applicable.
- d) Calibration of metering and dosing equipment.
- e) Step by step account of plant start-up and shut-down procedures.
- g) Instructions on monitoring of treatment performance and sample log sheets for each treatment item, to be filled by operators on a routine basis.
- h) Safety precautions to be taken in plant operation, in the handling of hazardous chemicals, action to be taken on chlorine liquid or gas leaks, and chemical spillages, including first aid instructions.
- i) Basic maintenance procedures such as flushing of pumps, and chemical delivery lines, cleaning of tanks after use and washing down of spillages.
- j) 'Do's' and 'Don'ts' in plant operations. Operators' attention shall be drawn to all operations considered to be dangerous to operators or likely to cause damage to the Work.
- k) Trouble-shooting chart containing symptoms, probable causes, and remedies that should be included.
- l) A3 size copies of all drawings, folded to A4 size referred to in the operation manual.

Operation manual shall be simple and written in either non-technical or semi-technical language. Wherever possible, the operation manual shall be presented in a tabulated and easy to understand form.

(8) Maintenance Manual

Maintenance manual shall include but not be limited to the following.

- a) Checking, testing and replacement procedures to be carried out on all mechanical plant items on a daily, weekly and monthly basis or at longer intervals to ensure trouble-free operations. This information shall be presented in a tabulated form with hard and thick paper and bound in hard plastic files.
- b) Fault location and remedy charts to facilitate tracing the cause of malfunctions or breakdown and correcting faults.
- c) A complete list of recommended lubricants and lubrication charts for individual facility. The charts shall include at least three trade names of the products, which are available in the city of Mauritius.
- d) A spare schedule which shall consist of a complete list of itemized spare for all mechanical plant items with ordering references and part numbers.
- e) A complete manufacturers and suppliers list which shall include address, telephone numbers, facsimile numbers and telex addresses of manufacturers, suppliers and local agents. The list shall be tabulated in alphabetical order giving the name of manufacturer and supplier.
- f) A complete list of manufacturers instructions for operation and maintenance of all bought-out equipment. The list shall be tabulated in alphabetical order giving the name of the manufacturer, supplier identification of the plant item giving the model number and the literature provided including instruction leaflets and drawing numbers.

30108 Routing of Pipelines

It is the responsibility of the Contractor to route all piping. Piping shall be routed in such a way so as not to interfere with other piping, equipment, instrumentation, electrical work or structures. Pipeline routing shall be in accordance with the guidelines presented in the

Drawings.

Minor changes due to differences in equipment, size or configurations will be permitted provided that such changes do not interfere with other work. Any major deviations from the layouts shown on the Drawings will be considered substitutions and shall require approval as such. All piping layouts shall be subject to approval by the PMO/Engineer prior to installation.

All exposed piping shall be located against walls, under ceilings, or in floor trenches. If floor trenches are used, gratings shall be installed to cover the trench. Piping shall not be routed under floor slabs unless specifically shown as such on the Drawings. In no case shall piping be located so as to interfere in any way with traffic or access to equipment. Minimum head room shall be 2 metres unless specifically shown otherwise on the Drawings.

All piping running below concrete structures shall be encased in concrete even if not specifically shown on the Drawings. Unless specifically shown on the Drawings or approved by the PMO/Engineer, no wall penetrations shall be made underwater.

30109 Patents

The Contractor shall assume all costs of patent fees or licenses for equipment or processes and shall safeguard and save harmless the Employer and the PMO/Engineer from all damages, judgements, claims and expenses arising from license fees or claimed infringement of any letters, patents, or patent rights or because of any royalty or fee for the use of any equipment or process, structural feature or arrangement of the component parts of the installation. The price stipulated for payment under this Contract shall be deemed to include payment for all such patent fees, licenses or other cost pertaining thereto.

30110 Materials

Materials to be used for manufacturing and installation of the equipment herein specified shall be selected from the best available for the purpose of use considering strength, ductility, durability, and on the basis of the best current engineering practice. Materials shall be (1) New, unused and of first quality, (2) Free from defects and (3) Suitable for the application and not overstressed mechanically or electrically.

Uniformity of type and manufacture of fittings or accessories is to be preserved as far as practicable throughout the whole work.

Wherever, in this specification, an article, material, apparatus, equipment, or process is called for by trade name or by the name of patentee, manufacturer, or dealer, it shall be understood as intending to mean and specify the article, material, apparatus, equipment, or process designed, and equal hereto in quality, finish, design, efficiency, and durability and equally serviceable for the purposes for which it is intended.

The Contractor shall if required by the PMO/Engineer submit samples of materials for their approval before placing an order.

The Contractor shall be responsible for all materials, apparatus and equipment furnished by him in connection with his work, and shall take all special care to protect all parts of finished work from any damage until these are handed over to the Employer.

All materials shall at all times during construction be adequately protected against mechanical injury or damage by water. If any apparatus has been damaged, such damage shall be repaired by the Contractor at his own cost and expense.

If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through a special dielectric test as directed at the cost and expense of the Contractor or shall be replaced by the Contractor at his own expenses.

30111 Equipment

All equipment furnished under this Contract shall be new and guaranteed free from defects in materials, design and workmanship. It shall be the Contractor's responsibility to determine the conditions and service under which the equipment will operate and to warrant that operation under those conditions shall be successful. All parts of the equipment shall be amply proportioned for all stresses that may occur during fabrication, erection, and intermittent or continuous operation.

All equipment shall be designed, fabricated, and assembled in accordance with the best modern engineering and shop practice. Individual parts shall be manufactured to standard size and gauges so that repair parts, furnished at any time, can be installed in the field.

Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests. Materials shall be suitable for service conditions.

30112 Lubrication

A complete schedule of recommended lubricants which shall be available in Mauritius and the name of manufacturers and suppliers and comparable products shall be submitted to the PMO/Engineer for approval. The number of different types of lubricants shall be kept to a minimum.

Equipment lubrication systems shall be provided that require attention no oftener than weekly during continuous operations, do not require attention during start-up or shut-down, and do not waste lubricants.

Grease lubrication systems shall preferably be of the pressure type. Grease application points shall be easily accessible and where needed, extension piping shall be provided. When a number of such points can be grouped, they shall be brought to a rigidly constructed battery plate and each point shall be clearly labelled. A permanently labelled grease gun shall be supplied for each type of grease required and each type of nipple fitted.

Oil lubrication shall preferably be of the recirculating reservoir type which automatically maintains the correct oil level and shall be designed for continuous normal operation for long periods. Sight glass level indicators shall be fitted on all oil reservoirs, and the levels shall be easily read over the maximum operating range. The level indicators shall be simple to dismantle for cleaning, clearly marked with the minimum, normal and maximum oil levels at normal running temperature, and shall show the normal oil filling level at design ambient temperature. The sight glass shall be protected against mechanical damage.

The Contractor shall provide lubricants of types approved by the PMO/Engineer in quantities sufficient for consumption up to and including completion, testing and final acceptance. A two-year supply of each lubricant shall also be provided.

30113 Equipment Bases and Bedplates

Equipment assemblies shall be mounted on a single heavy cast iron or welded steel bedplate unless otherwise shown or specified. Bases and bedplates shall be provided with machined support pads, tapered dowels for alignment or mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits. Seams and contact edges between steel plates and shapes, shall be continuously welded and welds shall be ground smooth. Bedplates to support machinery or piping shall not be used other than that which is factory installed.

30114 Anchor Bolts

The Contractor shall furnish anchor bolts, nuts, washers, and sleeves of adequate design as required for proper anchorage of the bases and bedplates to the concrete bases. Anchor bolts, nuts, washers and sleeves used under submerged or intermittently submerged conditions shall be stainless steel.

30115 Safety Guards

Belt or chain drives, fan blades, couplings, exposed shafts and other moving or rotating parts on all sides shall be covered with safety guards conforming to all local safety codes and regulations and conform to the most restrictive requirements. Guards shall be designed for easy installation and removal, complete with necessary supports, accessories, and fasteners, all hot dip galvanized. Outdoor service guards shall be designed to prevent entrance of rain and dripping water, and provide drainage for condensation.

30116 Reduction Gears

Reduction gear to be specified under these specifications shall be of cycle reduction gear or equivalent. The cycle type reduction gear shall be fully enclosed in an oil tight casing. Mechanism of this reduction gear shall be of a combination of a planet gear and a fixed-internal sun gear. Wear resistance parts shall be in rolling contact. The reduction gear shall consist of casing, ring gear housing, low speed and high speed shafts, low speed shaft roller and shaft pin, and cycloid discs. The cycloid disc namely planet gear shall have

cycloidal-shaped teeth, and sun gear circular pin teeth. The torque transmitting components of the gear shall be made of high carbon chromium bearing steel. The lubrication shall be in accordance with the current practice of the manufacturer.

30117 Motor

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

(1) References

The following standards are referred to.

- a) IEC 34 : Rotating electrical machines
- b) BS 4999 : General requirement for rotating electrical machines
- c) JIS C 4210 : Low-voltage three-phase squirrel-cage induction motors for general purpose

(2) Type and Rating

- a) Type : Horizontal or vertical, totally enclosed type
- b) Cooling method : Self-ventilation
- c) Number of phases : Three(3)-phase, four(4)-wire
- d) Rated frequency : 50 Hz
- e) Rated voltage : 400 AC or 230V AC
- f) Class of rating : Continuous
- g) Class of insulation : E class
- h) Limited temperature rise : 75 deg.C (resistance method)
- i) Ambient temperature : 40 deg.C
- j) Voltage variation : 10% over and under the rated value, at the rated frequency
- k) Frequency variation : 5% over and under the rated value, at the rated voltage
- l) Momentary excess current : 150% of rated current for not less than 15 seconds

- m) Momentary excess torque : 160% of rated torque
- n) Overspeed : 120% of the maximum rated speed
- o) Power frequency withstand voltage (r.m.s.)
 - less than 1 kW : 500V + 2E (1,000V min.)
 - less than 10,000 kW : 1000V + 2E (1,500V min.)

(2) Construction

Squirrel cage induction motors for exterior service shall be of weather proof design suitable for continuous service in a tropical environment.

Minimum output shall be as shown on the specification schedule and the mechanical drawings.

The motors for the driven equipment except pumps shall be capable of developing the motor power required by the units under all specified operating conditions without overload, and shall develop adequate starting torque for the driven equipment.

The motors for the driven pump shall have a rating that will not be exceeded with the pump operating at any point on its characteristic curve and in addition shall have a service factor of at least 1.15.

The motors shall be designed for full voltage starting. Locked-rotor current shall not exceed 600%.

All motors shall be run without injury in normal service, when under a load equal to the rated output, irrespective of a terminal voltage variation of 10% over and under the rated voltage, at the rated frequency.

Motor torque characteristics shall be equal to the requirements of the pumps being furnished. The motor shall have sufficient torque to start and synchronize with the discharge valve opened.

Bearings shall be sleeve type. Each bearing shall be furnished with bearing temperature relays.

Space heaters shall be installed and arranged to be automatically energized when the motor is at rest and to automatically maintain a pre-determined motor temperature.

Motors shall be free of objectional noise and vibration. Maximum vibration at any speed or load shall not exceed two mils peak-to-peak.

(3) Tests

The squirrel cage induction motors shall be completely assembled at the factory and field. The squirrel induction motors shall be subject, unless otherwise noted, to the following tests by the Contractor.

- Construction tests
- Measurement of resistance
- No-load tests
- Calculation of full load characteristics and breakway torque
- Calculation of minimum starting torque
- Tests for starting input characteristic
- Temperature tests
- Withstand voltage tests
- Noise tests
- Vibration tests

30118 Nameplates

Equipment nameplates shall be engraved or stamped on metal plates and fastened to the equipment in an accessible location. Nameplates shall indicate :

- a) Name of manufacturers;
- b) Type of unit and model number;
- c) Serial number; and
- d) Rated capacity, voltage, or other pertinent information.

30119 Equipment Tags

Each item of mechanical equipment shall be tagged with permanent, legible Tags readily visible after installation. Tags shall be of stainless steel plate, minimum thickness 1.0 mm and shall be provided with anchoring chain. Minimum size of Tag shall be 120 mm x 60 mm. Each tag shall be engraved with at least following.

- a) Name of equipment
- b) Equipment identification number
- c) Others as directed by the PMO/Engineer.

30120 Vibration Control

All rotating and reciprocating machinery shall be statically and dynamically balanced to eliminate excessive vibration. Where necessary, special vibration isolators shall be utilized.

30121 Sample Cocks, Meters and Gauges

Sample cocks shall be provided on the discharge of each pump installed under this Contract. Meters and gauges shall read in metric units as approved by the PMO/Engineer.

30122 Equipment Protection

All equipment shall be boxed, crated, or otherwise completely enclosed and protected for overseas shipment, handling and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times. Pumps, motors, electrical equipment, and other equipment having antifriction or sleeve bearings shall be stored in weathertight storage facilities such as warehouses.

30123 Painting System

Painting system to be applied under this Contract shall be specified as follows and surface preparation specified hereinafter shall conform to SSPC.

(1) System A (Alkyd Resin Paint System)

ITEM	NAME OF PAINT	MINIMUM DRY FILM THICKNESS (Microns)
a) Surface preparation	: SSPC-SP-6 or SP-3	
b) Primer	: Etching primer	20
c) First coat	: Red lead or lead suboxide primer	35
d) 2nd coat	: Ditto	35
e) 3rd coat	: Long oil alkyd resin paint	35
f) Finish coat	: Ditto	35

Etching primer shall conform to JIS K5633 class 2 or other applicable standard approved equal.

First coat of red lead and lead suboxide primer shall conform to JIS K5622, Class 1 and JIS K5623, Class 1 respectively or other applicable standard approved equal.

2nd coat of red lead and lead suboxide primer shall conform to JIS K5622, Class 2 and JIS K5623, Class 2 respectively or other applicable standard approved equal.

(2) System B (Chlorinated Rubber Paint System)

ITEM	NAME OF PAINT	MINIMUM DRY FILM THICKNESS (Microns)
a) Surface preparation	: SSPC-SP-6 or SP-3	
b) Primer	: Organic zinc rich primer	20
c) First coat	: Ditto	40
d) 2nd coat	: Chlorinated rubber paint	40
e) 3rd coat	: Chlorinated rubber middle coat	35
f) Finish coat	: Chlorinated rubber finish	35

(3) System C (Epoxy Resin Plug Urethane Paint System)

ITEM	NAME OF PAINT	MINIMUM DRY FILM THICKNESS (Microns)
a) Surface preparation :	SSPC-SP-10	
b) Primer :	Inorganic zinc rich primer	75
c) First coat :	Epoxy primer	60
d) 2nd coat :	Ditto	60
e) 3rd coat :	Poly-Urethane resin paint	30
f) Finish coat :	Ditto	30

(4) System D1 (Epoxy Resin Paint System)

System D1, epoxy resin paint system shall be suitable for drinking water service and paint shall be certified by recognized public health Authorities for linings in potable water. The Contractor shall submit certification of paint which is suitable for drinking water service.

ITEM	NAME OF PAINT	MINIMUM DRY FILM THICKNESS (Microns)
a) Surface preparation :	SSPC-SP-10	
b) First coat :	Epoxy resin	125
c) 2nd coat :	Ditto	125
d) Finish coat :	Ditto	125

(5) System D2 (Epoxy Resin Paint System)

ITEM	NAME OF PAINT	MINIMUM DRY FILM THICKNESS (Microns)
a) Surface preparation	: SSPC-SP-10	
b) Primer	: Inorganic zinc rich primer	75
c) First coat	: Epoxy primer	60
d) 2nd coat	: Ditto	60
e) 3rd coat	: Epoxy resin paint	50
f) Finish coat	: Ditto	50

(6) System E1 (Tar Epoxy Resin Paint System)

System E1, tar epoxy resin paint system shall be suitable for drinking water service and paint shall be certified by recognized public health Authorities for linings in potable water. The Contractor shall submit certification of paint which is suitable for drinking water service.

ITEM	NAME OF PAINT	MINIMUM DRY FILM THICKNESS (Microns)
a) Surface preparation	: SSPC-SP-3 or SP-10	
b) First coat	: Tar epoxy resin paint	200
c) 2nd coat	: Ditto	200
d) Finish coat	: Ditto	200

(7) System E2 (Tar Epoxy Resin Paint System)

ITEM	NAME OF PAINT	MINIMUM DRY FILM THICKNESS (Microns)
a) Surface preparation	: SSPC-SP-3 or SP-10	
b) Primer	: Organic zinc rich primer	40
c) First coat	: Tar epoxy resin paint	200
d) 2nd coat	: Ditto	200
e) Finish coat	: Ditto	200

(8) System F (Paint System for Galvanised Surfaces)

a) Surface preparation and primer

Surface shall be free from moisture, dust or other contaminants with use of solvent cleaning. Damaged galvanised area shall be cleaned by using hand or power tool, and surface shall be finished as SSPC-SP3 and painted with etching primer, minimum dry film thickness of 20 microns.

b) Coat

After finishing surface preparation, painting system A, B, C, D1, D2, E1 or E2 shall be applied unless otherwise specified.

(9) Area of Application

Painting systems specified in the previous section shall be applied to the following area and items.

AREA AND ITEMS	PAINTING SYSTEM
a) Ungalvanised ferrous metal, outdoor service, except buried, submerged and other surfaces specifically included elsewhere.	System A

AREA AND ITEMS	PAINTING SYSTEM
b) Ungalvanised ferrous metal, indoor service, except special areas specified, buried, submerged and other surfaces specifically included elsewhere.	System B
c) Ungalvanised ferrous metal, outdoor service, specially specified, except buried, and submerged.	System C
d) Ungalvanised ferrous metal, indoor service, corrosive environment.	System D2
All steel surfaces in chemical building, chlorine building, utility duct and other areas specified, including doors and door frames, control panels, piping, mechanical equipment and miscellaneous metal work.	
e) Galvanised ferrous metal, outdoor service, except buried, submerged, and other surfaces specifically included elsewhere.	System F plus System A
f) Galvanised ferrous metal, indoor service, except buried, submerged and other surfaces specifically included elsewhere.	System F plus System B
g) Galvanised ferrous metal, indoor service, corrosive environment.	System F plus System D2
All galvanised steel surfaces in chemical building, chlorine building, utility duct and other area specified .	
h) Ungalvanised ferrous metal, submerged.	
- All steel work, submerged or intermittently submerged in or water, potable water production process	System E1 or System D1
- All steel work, submerged or intermittently submerged in water, especially the filter process	System D1

AREA AND ITEMS	PAINTING SYSTEM
- All steel work, submerged or intermittently submerged in water, except the potable water production process	System E2
i) Galvanized ferrous metal, submerged.	
- All galvanised steel work, submerged or intermittently submerged in water, and potable water production process	System F plus System E1 or System D1
- All galvanised steel work, submerged or intermittently submerged in water, specifically the filter process	System F plus System D1
- All galvanised steel work, submerged or intermittently submerged in water, except the potable water production process	System F plus System E2

Painted surface shall be protected against impact, abrasion, discolouration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of the PMO/Engineer.

30124 Equipment Installation

The Contractor shall install all equipment specified herein in full accordance with the Drawings, Specifications, equipment manufacturer's recommendations and good practice.

All parts to be installed shall be cleaned thoroughly. All packing compounds, rust dirt, grit and other foreign matter shall be removed. All holes and grooves for lubrication shall be cleaned. All enclosed chambers or passages shall be examined to make sure that they are free from injurious materials.

For major equipment items specified hereinafter the equipment manufacturer's factory trained service personnel shall be on-site to supervise the installation.

The Contractor shall have an experienced, competent, and authorized representative of the

manufacturer or supplier of each major item of equipment visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment manufacturer's representative shall be present when the equipment is placed in operation. The Contractor shall have the equipment manufacturer's representative revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the PMO/Engineer.

Prior to being placed in operation, equipment shall be inspected by the manufacturer's factory-trained personnel. All defects discovered during this inspection shall be corrected prior to initial equipment start up. Internal coatings applied at the factory shall be removed if required. Lubricant shall be applied in the proper places and levels shall conform to the manufacturer's recommendations. If required, full load tests shall be performed and results of such tests shall be recorded. Unsatisfactory performance shall be corrected and tests shall be repeated until the equipment performance meets the Specifications.

30125 Inspections and Tests

The Contractor shall notify the PMO/Engineer at least thirty (30) calendar days prior to the manufacture's factory tests. The inspector appointed by the PMO/Engineer reserves the right to witness all tests.

The Contractor shall furnish the service of the manufacture's serviceman, all special tools, temporary materials, electricity, fuel, assistance, labor, apparatus and instruments as may be requisite and as may reasonably demanded to carry out such shop and field tests efficiently.

The Contractor shall provide a safe working environment for shop and field test. Sufficient data shall be obtained during shop and field tests to permit the inspection and to plot characteristic curves for various specified operation conditions.

The results of all the tests shall be recorded on test certificates to be signed by the Contractor and submitted to the PMO/Engineer for record purposes.

The Contract works shall not be considered complete until all tests have been completed to the satisfaction of the PMO/Engineer and the 'As built drawings' have been approved.

Each item of equipment shall be inspected for damage, defects, completeness, and correct operation before installing. Previously installed related work shall be inspected and verify that it is ready for installation of equipment.

The PMO/Engineer shall be notified in event that any equipment or material is damaged. Repairs to damaged products shall not be made without prior approval by the PMO/Engineer.

Prior to installing equipment, installation areas shall be clean and concrete or masonry operations completed. The areas shall be maintained in a broom-clean condition during installation operations. Equipment shall be cleaned, conditioned and serviced in accordance with the approved Instruction Manuals and requirements in other Sections of these Specifications before installing.

30126 Accessories and Spare Parts

(1) Accessories

For all equipment and panels, all essential and desirable accessories for installation, operation and maintenance shall be furnished and installed, which shall include but not be limited to the items specified hereinafter.

(2) Spare Parts

All spare parts shall be properly preserved and packaged for a long period of storage before use, in hot and humid climate and shall be properly marked in the English language on the outside to permit easy identification of the contents without opening and exposing the contents to the atmosphere.

(3) Tools

The Contractor shall furnish all standard and special tools that may be required for the installation, testing and servicing of the equipment. These tools shall be properly packed in a suitable steel box with the contents listed on the outside in neat lettering in contrasting color, in the English language. Each tool box shall be provided with a lock and keys. Hinges for the tool box shall be of the continuous hinge type.

30200 PLANT WATER PUMP

30201 Scope of Work

The work specified herein shall include the furnishing following electric motor driven pumping units together with all valves, flexible joint and other necessary and desirable accessory equipment and auxiliaries and appurtenances, whether specifically mentioned in this specification or not, as required for an installation incorporating the highest standards for the type of service, and including field testing of the entire installation.

The work specified shall also include executing supervisory service for installation of pumping units, valves and flexible joints final checking of pumping units installed, field test and instruction of the regular operating personnel in the care, operation and maintenance of all equipment.

30202 References

The following standards are referred to :

- a) ISO 3069 : End suction centrifugal pumps--Dimensions of cavities for mechanical seals and for soft packing
- b) BS 4999 : General requirements for rotating electrical machines
- c) BS 5257 : Horizontal end-suction centrifugal pumps
- d) BS 5316 : Acceptance tests for centrifugal, mixed flow and axial pumps
- e) JIS B 8301 : Testing Methods for Centrifugal Pumps, Mixed Flow Pumps and Axial Flow Pumps
- f) JIS G 4051 : Carbon Steels for Machine Structural Use
- g) JIS G 4105 : Chromium Molybdenum Steels
- h) JIS G 5121 : Stainless Steel Casting
- i) JIS G 5501 : Gray Iron Castings
- j) JIS H 5111 : Bronze Castings

30203 Schedule of Plant Water Pumps

TABLE 2-1 PLANT WATER PUMPS

Identification	:	P-PW 1 and 2
Type	:	Horizontal, volute pump
Number	:	Two (2) units
Services	:	Plant water, finished water pumping
Rated Capacity	:	1.2 m ³ /min.
Rated Head	:	18 m
Pump Speed	:	Approx. 1,440 rpm
Pump Casing Design Pressure	:	Minimum 10.0 kg/cm ²
Pump Casing Hydrostatic Pressure	:	Minimum 15.0 kg/cm ²
Type of Motor	:	Squirrel cage induction motor
Motor Size	:	Minimum 7.5 kW
Motor Efficiency	:	More than 70.0 %
Voltage	:	400 V, three(3)-Phase, 50 Hz

TABLE 2-2 VALVES AND FLEXIBLE JOINTS

	V-PW-1	V-PW-2	CV-PW	FJ-PW-1	FJ-PW-2
Type	Sluice valve		Siring Check valve	Ball type flexible joint	
Number	2	2	2	2	2
Nominal diameter	100 mm	80 mm	80 mm	80 mm	65 mm
Applied	Pump suction	Pump discharge	Pump discharge	Pump suction	Pump discharge
Flanged joint	ISO 7005				
Material	Cast iron, ductile cast iron or stainless steel type 316				
Operation	Manual				
Accessories	Support materials				

30204 General Arrangements

The Contractor shall be responsible for the design or the complete electric motor driven pumping units, valves, flexible joints and shall guarantee the complete units to be free from harmful torsional or other vibration stresses throughout the entire operating range of speed and loads.

(1) Data Submittal

Literature, pump characteristic curves showing head capacity, horsepower, efficiency and required NPSH, detail drawings including materials, construction and parts list to indicate full conformance with the detail specifications and to show installation details shall be submitted to the PMO/Engineer.

(2) Nameplate

There shall be a metal nameplate on each pump with the serial number, size type or model, design head, capacity and speed stamped into the plate. There shall also be *an arrow indicating the direction of forward rotation.*

(3) Shop and Field Painting

The pumps couplings, motors and bed plates shall have shop and field coats. All interior ferrous and nonmachined surface of casings shall be shop painted with tar epoxy paint, Paint System E1 unless otherwise specified.

Painting shall conform to the requirements as specified in "30123 Painting System" unless otherwise specified.

30205 Materials and Workmanship

All materials shall be of the highest grade, free from defects and imperfections, of recent manufacture and unused, and of the classification and grades designated. Material not specifically described shall conform to the manufacturer's standard for the applicable part in the service intended.

All materials, supplies, and articles, not manufactured by the Contractor, shall be the products of recognized reputable manufacturers. The products of firms other than those specified herein will be accepted when it is proved to the satisfaction of the PMO/Engineer that they are equal in strength, durability, usefulness, and convenience for the purpose intended.

The Contractor shall furnish to the PMO/Engineer for his approval the names of the manufacturers of all machinery and other equipment which he contemplates incorporating in the work, together with performance capacities and other relevant information pertaining to the equipment. Equipment, materials, and articles installed or used without such approval shall be at the risk of subsequent rejection.

Workmanship shall be of the highest grade and in accordance with the best modern standard practice.

30206 End Suction Centrifugal Pump

(1) General

Pumps shall be horizontal, end suction, top vertical discharge, centrifugal pumps, directly connected to the motor with a flexible coupling and complete with shaft seals and bearings. Each pump and motor unit shall be mounted on a steel or cast iron common base plate. Suction and discharge of the pump shall be flanged end.

All essential and desirable indicators, lubrication devices, and other accessories for the pumping units shall be provided.

(2) Construction and Materials

a) Casing

The casing shall be of cast iron conforming to JIS G 5501, Class 3, FC 20 or other applicable standard with smooth waterway and fitted with wearing rings. The wearing rings shall be of bronze casting conforming to JIS H 5111, Class 6, BC 6 or other applicable standard. Casing shall be constructed so that the back casing and rotating parts shall be removed without disturbing the volute case, and the suction

and discharge piping.

b) Impeller

The impeller shall be enclosed, accurately machined, and statically and dynamically balanced. The impeller shall be made of the following materials.

- Bronze casting conforming to JIS H 5111, Class 6, BC 6 or other applicable standard
- Cast iron conforming to JIS G 5501, Class 3, FC 20 or other applicable standard
- Stainless steel, type 304

c) Shaft

The pump shaft shall be of carbon steel conforming to JIS G 4501, Class S30C or other applicable standard, precision-ground, and provided with renewable bronze or stainless steel sleeve where it passes through the stuffing box and is in contact with water.

The shaft shall be rigidly supported by at least two (2) sets of heavy-duty antifriction ball bearings conforming to JIS B 1521 or B 1522 or other applicable standard. Lubrication of bearings shall be oil or grease and in case of oil lubrication, appropriate provisions for oil level checking and an oil drain shall be provided.

d) Stuffing Box

The stuffing box shall be of such design and size as to ensure tight packing without excessive wear or friction on the shaft sleeve. Dimensions of stuffing box shall conform to ISO 3069.

The stuffing box shall be provided with at least five (5) square packing rings with a lantern ring. An easily removable gland shall be provided for the stuffing box. The gland shall be of bronze casting, stainless steel or cast iron.

e) Shaft Coupling

The shaft coupling between pump and motor shall be the flexible type and shall conform to JIS B 1452 or other applicable standard, couplings shall be provided with guards.

30207 Valves and Flexible Joints

(1) Sluice Valves

Sluice valves shall be provided and installed in the water inlet and discharge pipes to each plant water pump as shown on the Drawings.

All valves shall be of cast iron or ductile cast iron. The specification described in the Sub-Section 10503 Valves, in "CHAPTER 1 CIVIL WORKS", shall be applied.

(2) Check Valves

Check valves shall be provided and installed in the air discharge pipes to each plant water pump as shown on the Drawings.

Wafer check valves shall be dual plate, two spring-loaded, semicircular plates type. The valves shall be designed and manufactured in accordance with internationally accepted standards.

Valves shall be designed to fit between two pipe flanges and for a working pressure of 10.0 kg/cm².

Valve body and plates shall be of cast iron or ductile cast iron. Hinge pin, stop pin and springs shall be of type 316 stainless steel. Valves shall have resilient seating in the valve body unless otherwise specified. Seat materials shall be Buna-N (NBR).

Spring action shall be designed to close each plate independently.

(3) Flanged Joints

Flanged joints shall be provided and installed in the water inlet and discharge pipes to each plant water pumps as shown on the Drawings.

The specification described in Sub-Section (3) Jointing of Section 10504.3 Pipelaying and Jointing of Pipes, and Sub-Section 10504.4 Protection of Pipes and Joints, in "CHAPTER 1 CIVIL WORKS" shall be applied.

30208 Performance Tests

The Contractor shall submit six (6) copies of the performance test report of pumps conducted in a factory of the manufacturer in accordance with the applicable provisions of JIS B 8301 and JIS B 8302 or other applicable standards.

30209 Installation

The Contractor shall be required to install the pumps and check the operation condition under the supervision of pump specialist. After checking pump installation, the Contractor shall submit a certificate to the PMO/Engineer from pump manufacturer stating that the installation of pump units is satisfactory; that the units are ready for acceptance field testing.

30210 Accessories and Spare Parts

(1) Accessories

For each pump, all essential and desirable accessories for an installation and operation shall be furnished and installed, which shall include but not be limited to the following:

- a) Two (2) Sets of common base plates
- b) Two (2) Sets of anchor bolts and nuts
- c) Two (2) Sets of couplings with guard
- d) Two (2) Sets of casing drain valves

- e) Two (2) Sets of priming funnel with valve
- f) Two (2) Sets of pressure gauges with cocks for pump suction and discharge

(2) Spare parts

The following spare parts shall be furnished for each pump.

- a) Two (2) Complete sets of gland packing
- b) Two (2) Complete sets of oil seals
- c) Two (2) Complete sets of sleeve
- d) Two (2) Complete sets of bearings
- e) Two (2) Complete sets of wearing rings
- f) Two (2) Complete sets of all gaskets
- g) Three(3) Complete sets of all packing required for the pump
- h) Two (2) Lantern rings
- i) Two (2) Complete sets of all special bolts, screws and nuts
- j) Two (2) Complete sets of special tools required for maintenance of the pump

30300 AIR SCOURING BLOWER

30301 Scope of Work

The work specified herein shall include the furnishing following air-blower units together with all other necessary and desirable auxiliaries appurtenances, whether specifically mentioned in this specification or not, as required for an installation incorporating the highest standards for the type of service, and including field testing of the entire installation.

The work specified shall also include executing supervisory service for installation of pumping units, final checking of pumping units installed field test and instruction of the regular operating personnel in the care, operation and maintenance of all equipment.

(1) References

The following standards are referred to.

- | | | | |
|----|------------|---|--|
| a) | JIS B 1453 | : | Geared Type Shaft Couplings |
| d) | JIS B 8341 | : | Testing methods for Displacement Compressors |
| e) | JIS G 5121 | : | Stainless Steel Casing |
| f) | JIS G 4051 | : | Carbon Steels for Machine Structural Use |
| g) | JIS G 4105 | : | Chromium Molybdenum Steels |
| h) | JIS G 5501 | : | Gray Iron Casting |
| i) | JIS H 5111 | : | Bronze Castings |

30302 Schedule of Air Blower Units

The schedule of air-blower units specified above is summarized in the following Tables.

TABLE 3 AIR SCOURING BLOWERS SCHEDULE

Identification	:	AB-AS 1 and 2
Type	:	Roots type rotary blower Belt-coupled with motor
Number	:	Two (2) units
Services	:	Filter air scouring
Rated Capacity	*1	: 31.8 m ³ /min
Outlet Pressure	:	4,000 mm Aq G
Speed	:	Not exceeding 900 rpm
Blower Noise	*2	: Less than 85 dB(A)
Type of Motor	:	Squirrel cage induction motor
Motor Size	:	Minimum 30 kW
Motor Starting	:	Star-delta method
Motor Efficiency	:	More than 92.5 %
Voltage	:	400 V, three(3)-Phase, 50 Hz

Notes *1: Discharge capacity will be controlled and adjusted with use of blow-off valve.

*2: 1 m from the blow and 1 m above bed plate.

30303 General Arrangements

The Contractor shall be responsible for the design or the complete electric motor driven blower units, and shall guarantee the complete units to be free from harmful torsional or other vibration stresses throughout the entire operating range of speed and loads.

(1) Data Submittal

Literature, blower characteristic curves showing head capacity, horsepower, efficiency and detail drawings including materials, construction and parts list to indicate full conformance with the detail specifications and to show installation details shall be submitted to the PMO/Engineer.

(2) Nameplate

There shall be a metal nameplate on each blower with the serial number, size type or model, design head, capacity and speed stamped into the plate. There shall also be an arrow indicating the direction of forward rotation.

(3) Shop and Field Painting

The blowers, couplings, motors and bed plates shall have shop and field coats. All interior ferrous and nonmachined surface of casings shall be shop painted with tar epoxy paint, Paint System E1 unless otherwise specified.

Painting shall conform to the requirements as specified in "30123 Painting System" unless otherwise specified.

(4) Materials and Workmanship

All materials shall be of the highest grade, free from defects and imperfections, of recent manufacture and unused, and of the classification and grades designated. Material not specifically described shall conform to the manufacturer's standard for the applicable part in the service intended.

The products of firms other than those specified herein will be accepted when it is proved to the satisfaction of the PMO/Engineer that they are equal in strength, durability, usefulness, and convenience for the purpose intended.

The Contractor shall furnish to the PMO/Engineer for his approval the names of the manufacturers of all machinery and other equipment which he contemplates incorporating in the work, together with performance capacities and other relevant information pertaining to the equipment. Equipment, materials, and articles installed or used without such approval shall be at the risk of subsequent rejection. Workmanship shall be of the highest grade and in accordance with the best modern standard practice.

30304 Construction and Materials

The blowers shall be positive displacement, single stage, vertically split case, roots type rotary blower directly coupled with motor suitable for continuous service. Blower speed, head and capacity characteristics shall conform to the requirement listed in the "Schedule" and capacity can be adjusted to change the pulleys. All essential and desirable indicators, lubrication devices, and other accessories for the blower units shall be provided.

(1) Casing and Head Covers

The casing shall be vertical split type the suction and discharge flanges type. The casing shall be provided with eye bolts, and there shall be pipe tap connections for drain at the bottom of the lower casing as drain and drain valve shall be provided.

Both the exterior and the interior surface shall be finished smooth. No plugging, welding or other repairs to casting will be permitted. The casing and head covers shall be of cast iron conforming to JIS G 5501, Class 3, FC-20 or better.

(2) Rotor

The rotor shall be ductile iron or high tensile cast iron of the straight lobe involute type and shall operate without rubbing, or liquid seals, or lubrication, and shall be positively timed by a pair of accurate machined, heat treated chromium molybdenum steel timing gears.

(3) Shaft and Bearings

The shafts shall be of heat treated carbon steel. Each impeller shaft assembly shall be supported by two (2) bearings at timing gear side and one (1) bearing at opposite side. Each bearing shall be provided with a positive oil seal to prevent oil leakage into the blower casing. Bearing temperature detectors shall be provided on each bearing and designed for remote and local direct reading.

(4) Lubrication System

A pressure lubrication system for bearings and timing gears shall be built-in and shall include a shaft driven oil pump, oil reservoir, pressure gauge, water cooled oil cooler with tubing, low oil pressure shut-down switch and control, suction oil strainer and necessary piping.

(5) Bed Plate

The anti-vibration type bed plate shall be fabricated steel or cast iron box with web reinforcing so designed that they can be grouted after alignment and leveling.

(6) Shaft Coupling

Coupling between the blower and the drive motor shall be the flexible type and shall have sufficient capacity to develop the full strength of the shafting which they connect. The shaft coupling shall be provided with guards.

30305 Appurtenances

Appurtenances specified herein shall be furnished and shall be manufactured by the same manufacturer of the blower specified the above. All appurtenances shall be designed for use on a rotary blower and shall be the standard product of a manufacturer regularly engaged in the design and fabrication equipment.

(1) Intake Filter – Silencers

Each blower shall be provided with a combination filter and chamber type inlet air filter silencer designed for indoor installation. The filter element shall be of the reusable metallic type that can be cleaned with solvent and recoiled for additional use.

A removable cover plate shall be provided on the side of the filter–silencer and the size number of the filter elements shall be in accordance with the manufacturer's commendations for the blower capacity required.

The filter silencers shall provide sound attenuation of not less than 15 decibels for frequencies in the 125 and 250 cycles per second bands and not less than 18 decibels for frequencies between 250 and 4000 cycles per second.

The filter–silencers shall be welded steel construction and shall have flanged ends, and shall be supported.

(2) Discharge Silencers

Each blower shall be provided with a discharge air silencer of the two chamber type with an acoustic absorption section on the inlet tube. The units shall be welded steel construction with flanged ends, and shall be supported. The silencers shall provide sound attenuation of not less than 15 decibels at all frequencies between 250 and

2000 cycles per second. The acoustic absorption material shall be copper wool. The silencers shall be either the externally packed type or the chamber type. The exterior of silencers shall be insulated for protection of operating personnel.

(3) Pressure Relief Valves

A pressure relief valves shall be provided with each blower. The valves shall be the weight-loaded type, constructed of cast iron with flanged connection. The relief system shall have a capacity of not less than that of the blower when operating. The valves shall be the standard product of the same manufacturer of the blower.

(4) Rubber Expansion Joints

Expansion joints shall be provided and installed in the air inlet and discharge pipes to each blower as shown on the Drawings. The joints shall be flanged molded rubber, designed for installation between pipe flanges. The joints shall be suitable for discharge air temperatures of up to 110 degrees C and gauge pressures up to 1 kg/cm². Each joint shall be equipped with steel retaining rings.

Joints on the discharge line from each blower shall be equipped with control unit to limit expansion of the joint due to pressure. Each joint shall have two control units. Each control unit shall consist of two steel plates, one bolt and nut and two rubber and two steel washers.

Each plate shall have two holes to fit over two holes in the steel flanges on the pipe at each end of the expansion joint. The plates shall extend beyond the outside diameter of the flanges and be provided with a hole for the tension bolt to be installed through the two plates.

(5) Check Valve

Check Valves shall be provided and installed in the air discharge pipes to each blower as shown on the Drawings. Check valves shall be dual plate, two spring-loaded, semicircular plates type. The valves shall be designed and manufactured in accordance with internationally accepted standards.

Valves shall be designed to fit between two pipe flanges and for a working pressure of 10.0 kg/cm².

Valve body and plates shall be of cast iron, ductile iron or type 316 stainless steel. Hinge pin, stop pin and springs shall be of type 316 stainless steel. Valves shall have resilient seating in the valve body unless otherwise specified. Seat materials shall be Buna-N (NBR).

Spring action shall be designed to close each plate independently.

(6) Sluice Valves

Sluice valve shall be provided and installed in the discharge pipes to each air scouring blower as shown on the Drawings.

Sluice valves shall be cast iron or ductile cast iron. The specified described in the Sub-Section 10503 Valves in "CHAPTER 1 CIVIL WORKS", shall be applied.

30306 Performance Tests

Each blower shall be tested in the factory to demonstrate compliance with the specifications. Tests shall include operation at full rated speed and other speeds during which the capacity and horsepower shall be measured. Test reports shall be approved by the PMO/Engineers prior to shipment of equipment.

The Contractor shall be required to consult with Employer about field test and to inform appropriate procedure of field test considering site condition. Each blower unit will be field tested and the Contractor shall be also required to send the engineer/s from blower manufacturer to the site for supervising service of field test.

30307 Installation

The Contractor shall be required to install the blowers and check the performance under the supervision of specialist of blower installation.

30308 Accessories and Spare Parts

(1) Accessories

All essential and desirable accessories for installation of the highest quality shall be furnished, which shall include but not be limited to the following:

- a) Two (2) Sets of anti-vibration common bed
- b) Two (2) Sets of blower pulley
- c) Two (2) Sets of three kinds of motor pulley for adjust the air flow rate
- d) Two (2) Sets of v-belt
- e) Two (2) Sets of v-belt cover
- f) Two (2) Sets of discharge air pressure gauge graduated 0 to 0.70 kg/cm² (absolute) with cock
- g) Two (2) Sets of discharge air temperature thermometer for graduated 0 to 150 degrees C.
- h) Two (2) Sets of grease gun
- i) One (1) Complete set of special tools required for maintenance of the blower
- j) One (1) Lot of necessary accessories recommended by the manufacturer

(2) Spare Parts

The following spare parts shall be furnished for each blower.

- a) Eight (8) Complete sets of bearings
- b) Eight (8) Complete sets of oil seals
- c) Eight (8) Complete sets of all gaskets and seals
- d) Eight (8) Complete sets of all special bolts, screws and nuts
- e) Eight (8) Complete sets of filter elements for intake filter-silencer
- g) Twenty(20) Sets of v-belt
- h) Two (2) Lot of grease (1kg)
- i) One (1) Lot of oil (20 liters)
- f) One (1) Lot of necessary spare parts recommended by the manufacturer

30400 ALUM DOSING SYSTEM

30401 Scope of Work

The Contractor shall furnish and install equipment and materials for the alum dosing system with all necessary piping and appurtenances as specified herein.

The work specified herein includes, but is not limited to furnishing, installing, testing, placing in satisfactory operation, start-up services and maintenance services for the alum dosing system complete.

- a) Alum solution mixers
- b) Alum solution baskets
- c) Alum dosing pumps
- d) Wheelbarrow
- e) Bridge walkway and drive platform
- f) Wooden platform for storing solid alum packages
- g) All piping works in the chemical building and the chemical building to the alum dosing points
- h) Other miscellaneous works required

The alum dosing system shall consist of :

- A supply header for gravity transfer of alum solution from solution tanks to the alum dosing pumps;
- Alum dosing pumps for accurate measuring and dosing of alum solution;

The alum dosing system shall be able to dose alum solution at variable rates as needed in accordance with the raw water quantity and quality. The control and adjustments of dosing rates shall be manually set at the location of the alum dosing pumps.

30402 References

The following standards are referred to.

- a) IEC 335 : Safety of household and similar electrical appliances
- b) JIS C 0905 : Supplementary Requirements for Construction of Electrical Apparatus for Explosive Atmospheres in General Industry
- c) JIS G 3459 : Stainless Steel Pipes

30403 Schedule of Alum Dosing System

The schedules of alum dosing equipment are summarized on Tables 4.1 to 4.2.

TABLE 4-1 ALUM SOLUTION MIXERS SCHEDULE

Identification	:	MX-AL1,2
Type of mixer	:	Vertical mechanical mixer, flange jointing with drive unit
Type of Drive	:	Reduction gear
Number Required	:	2 units
Location	:	Alum solution tanks in the chemical building
Service		
- Liquid	:	10% alum agitation
- Viscosity	:	1.5 CP
- Density	:	1.05
- Temperature	:	Normal temperature
Mixing Volume	:	42 m ³
Dimensions of Tank	:	2.5 L x 2.5 B x 3.0 H (m) (Effective depth of 2.0 m)
Material	:	Stainless steel 316
Speed	:	Fixed speed as proposed
Minimum Motor	:	2.2 kw
Power Supply	:	400 V, three(3)-phase, 50 Hz

TABLE 4-2 ALUM DOSING PUMPS SCHEDULE

Identification	:	P-AL1 to 3
Type	:	Peristaltic type metering pump
Number	:	3 units
Capacity	:	0.42 to 14.0 l/min
Discharge Pressure	:	2.0 kg/cm ²
Pump Speed	:	Max. 360 rpm
Tube		
- Material	:	Marprene
- Inner diameter	:	25.4 mm
- Thickness	:	3.2 mm
Measuring range	:	An adjustable range of minimum 50 : 1
Accuracy	:	Within $\pm 1\%$ of full stroke
Motor	:	0.55 kw
Voltage	:	230V, single-phase, 50 Hz.

TABLE 4-3 ALUM SOLUTION BASKETS SCHEDULE

Identification	:	BK-AL1,2
Type	:	Cubic type
Number	:	2 units
Dimensions	:	1.2 L x 1.2 B x 1.85 H (m)
Material	:	Stainless steel 316
Accessories	:	Lifting eyes and chains

TABLE 4-4 WOODEN PLATFORM SCHEDULE

Identification	:	WF-AL1,2	WF-AL3,4	WF-AL5
Numbers	:	2	2	1
Size	:	3 x 3 (m)	3.5 x 3.5 (m)	2.5 x 3 (m)
Purpose	:	Storage of alum packages		
Material	:	Wooden		

TABLE 4-5 WHEEL BARROW SCHEDULE

Identification	:	WB-AL1
Numbers	:	1 unit
Load	:	50 kg
Purpose	:	Transferring alum packages

TABLE 4-6 PIPING SCHEDULE

Service	Nominal diameter	Pipeline materials	Remarks
(1) Alum solution tanks			
Fresh water pipe	100 mm	Galvanized steel pipe	with valves
Outlet header pipe	32 mm	Steel pipe lined with PVC	with diaphragm valves and strainer units
Overflow pipe	80 mm	- do. -	
Drain pipe	50 mm	- do. -	with diaphragm valves
Flush water pipe	50 mm	Galvanized steel pipe	with sluice valves
(2) Dosing pumps			
Inlet pipe	25 mm	Steel pipe lined with PVC	with ball valves and strainer unit
Outlet pipe	25 mm	- do. -	with ball valves
Fresh water pipe	25 mm	Galvanized steel pipe	with ball valves
(3) Dosing pipe			
To the rapid mixing tank	32 mm	Steel pipe lined with PVC	with ball valves
To the end of sedimentation tank	32 mm	- do. -	with ball valves

30404 Equipment Manufacturer

All alum dosing equipment shall be fabricated by a manufacturer regularly engaged in the production of alum dosing system of similar requirements for at least five (5) years. The units shall be of such design and constructed so that it will operate satisfactorily under the proposed operating conditions.

30405 Alum Solution Mixer

(1) Design Conditions

Each mixer shall consist of a single impeller mounted on a vertical shaft and suspended from a pedestal, a drive unit with motor, shaft bearings, flange coupling, a one unit type base for all support, and a hatchway cover. Each mixer shall be so assembled that it can be lifted from the tank as a complete unit unless otherwise noted.

The mixer assemblies shall be capable of blending and mixing continuously the chemicals specified, or water, in a manner which will promote the formation of a uniform solution and concentration throughout the tank.

(2) Construction and Materials

a) Impeller and Shafting

The impeller shall be as recommended by the mixer manufacturer as to the number of impellers, type, size and vertical location on the shaft.

The length and diameter of each shaft shall be sufficient to drive the impeller for proper mixing without undue noise vibration and whipping under all operation conditions required.

Antifriction type thrust and guide bearings shall be located above the water line for supporting and guiding the shaft and impeller and to resist all hydraulic loading on the shaft. Easy access for bearing maintenance shall be provided above the operation floor of the mixer.

For impeller and shaft shall be made of type 316 stainless steel and stainless steel casting.

b) Drive Assembly

Gear speed reducer assembly shall be designed and built for continuous service 24 hours a day, and shall be of ample capacity for furnishing the required power and

torque output. All the drive assembly shall be suitable for use out-of-doors and shall be of splash-proof construction, so protected that dust and dirt will not interfere with its proper operation.

All gears shall be finished in a manner to ensure accurate meshing and shall run quietly. Pedestal for mixer units shall be cast iron with sufficient section to withstand the full load encountered in the operation.

All bearings shall be of the antifriction type with adequate provisions for lubrication. Steel safety guards shall be firmly bolted to the equipment to prevent any contact with moving parts.

30406 Alum Dosing Pumps

(1) Construction and Materials

The alum dosing pumps shall be peristaltic type manually variable over a 50:1 speed range, triple-feedback-loop pulse-width-modulated controller, metering tubing rolled pumps. The marprene tube's inner sizes shall be 25.4 mm, thickness 3.2 mm.

Appurtenances specified herein shall be furnished and installed as shown on the Drawings. They shall be manufactured by the same manufacturer of the alum dosing pumps as specified above.

The pressure relief valves shall be spring loaded, relieve pressure adjustable type and shall be designed to relieve pressure in excess of a preset pressure and the blowdown pressure shall be adjustable.

(2) Field Calibration Tests

As soon as convenient after the equipment is installed, each unit shall be field tested to demonstrate that each unit will be able to measure the alum liquid specified accurately within the full measuring range. For each pump, 3 times of field calibration test with pump speed of 20%, 40%, 60%, 80% and 100% shall be executed.

All instruments required for reading and required quantity of alum liquid having chemical strength of 10% Alum shall be furnished by the Contractor at no additional cost to the Employer.

Full details of test procedure will be determined or approved by the PMO/Engineer based on conditions existing in the field at time of test. The Contractor will submit six (6) copies of all results arranged and neatly presented for the approval of the PMO/Engineer. In the event equipment fails to meet requirement specified, the Contractor shall, at his own expense, replace it with new one.

30407 Bridge Walkway and Drive Platform

The 0.75 metre wide walkway and the 1.8 metre wide drive platform shall be supported by steel I-beams and shall be designed to safely withstand all normal operating loads. They shall consist of structural supports, standard I-beam and shall have handrails of double-row, 40 mm in diameter steel pipe, 1.0 metre high.

The drive platform shall be an expanded section surrounding the drive unit of the mixer and provide easy maintenance access. Bridge walkway and drive platform shall be covered with galvanized checkered plate, with a minimum thickness of 4.5 mm. Minimum requirement of the bridge walkway and drive platform shall be as shown on the Drawings.

30408 Process Piping and Valves

(1) Process Piping

All necessary alum process piping to the points of dosing shall be furnished and installed so as to complete the alum dosing system as shown on the Drawings.

All pipes to be used for alum dosing shall be polyethylene (PE) pipe as specified in Sub-Clause 10502.3 in Chapter 1 Civil Works.

The pipe installed aboveground shall be supported with brackets at intervals not exceeding the values specified herein.

Bracket Interval	
Horizontal pipeline	Vertical pipeline
13D	25D

D: diameter nominal

The Contractor shall furnish all necessary materials for pipe supporting and neatly install the pipe to prevent the horizontal pipeline from sagging.

The maximum bending radius shall not exceed 20D for both underground and aboveground piping.

(2) Valves

All valves to be used for the alum dosing system shall be made of type 316 stainless steel.

30409 Motors

Output of motors to be provided with alum dosing pumps shall be not less than the kilowatt rating specified in each schedule. All motors shall be the squirrel cage induction type with totally enclosed, fan-cooled enclosure.

30410 Accessories and Spare Parts

For alum dosing system, all essential and desirable accessories for an installation and operation shall be furnished and installed, which shall include but not be limited to the following.

(1) Accessories for each alum dosing pump

- a) One (1) Set of steel frame base
- b) One (1) Set of anchor bolts and nuts

- c) One (1) Lot other necessary accessories recommended by the manufacture
- (2) Spare Parts for each Mixer
- a) One(1) Complete set of bearings
 - b) One (1) Lot other necessary spare parts recommended by the manufacture
- (3) Spare Parts for each alum dosing pump
- a) One (1) Complete assembled set of peristaltic pump
 - b) Twenty(20) Meters of marprene tube
 - c) One (1) Complete set of bearings
 - d) Two (2) Complete sets of valves with valve seats
 - e) Two (2) Complete sets of packing
 - g) Two (2) Complete sets of gaskets
 - h) One (1) Complete set of coupling cushion
 - i) One (1) Complete set of cams
 - j) One (1) Complete set of inner race for bearing
 - k) One (1) Lot of other necessary spare parts recommended by the manufacturer

30411 Certification

The Contractor shall submit a certificate to the PMO/Engineer from the manufacturer stating that the installation of the equipment is satisfactory; that the units are ready for operation; and that the operating personnel have been suitably instructed in the operation, lubrication and care of the units.

30500 LIME DOSING SYSTEM

30501 Scope of Work

The Contractor shall furnish and install equipment and materials for the lime dosing system with all necessary piping and appurtenances as specified herein.

The work specified herein includes, but is not limited to furnishing, installing, testing, placing in satisfactory operation, start-up services and maintenance services for the lime dosing system complete.

- a) Lime solution mixers
- b) Lime dosing pumps
- c) Lime injection pumps
- d) Lime dosing injectors
- e) Wheelbarrow
- f) Bridge walkway and drive platform
- g) Mixers installation beams and checkered plates
- h) Wooden platform for storing solid lime packages
- i) All piping works in the chemical building and to the lime dosing point
- j) Other miscellaneous works required

The lime dosing system shall consist of :

- a) A supply header for gravity transfer of lime solution from solution tanks to the lime dosing pumps;
- b) Lime dosing pumps for accurate measuring and dosing of lime solution;

The lime dosing system shall be able to feed lime solution at variable rates as needed in accordance with the raw water quantity and quality. The control and adjustments of feed rates shall be manually set at the location of the lime dosing pumps.

30502 References

The following standards are referred to.

- a) IEC 335 : Safety of household and similar electrical appliances
- b) JIS C 0905 : Supplementary Requirements for Construction of Electrical Apparatus for Explosive Atmospheres in General Industry
- c) JIS G 3459 : Stainless Steel Pipes

30503 Schedule of Lime Dosing System

The schedules of lime dosing equipment are summarized on Tables 5.1 to 5.6.

TABLE 5-1 LIME SOLUTION MIXERS SCHEDULE

Identification	MX-LM1,2
Type of mixer	: Vertical mechanical mixer, flange jointing with drive unit
Type of Drive	: Reduction gear
Number Required	: 2 units
Location	: Lime solution tanks in the chemical building
Service	
- Liquid	: 10% lime milk
- Viscosity	: 5 CP
- Density	: 1.1
- Temperature	: Normal temperature
Mixing Volume	: 4.2 m ³
Dimensions of Tank	: 1.5 L x 1.5 B x 3.0 H (m) (Effective depth of 2.0 m)
Material	: Stainless steel 316
Speed	: Fixed speed as proposed
Minimum Motor	: 1.5 kW
Power Supply	: 400 V, three(3)-phase, 50 Hz

TABLE 5-2 LIME DOSING PUMPS SCHEDULE

Identification	:	P-LM1,2
Type	:	Peristaltic type metering pump
Number	:	2 units
Capacity	:	0.42 to 15.0 litre/min
Discharge Pressure	:	2.0 kg/cm ²
Pump Speed	:	Max. 360 rpm
Tube		
- Material	:	Marprene
- Inner diameter	:	25.4 mm
- Thickness	:	3.2 mm
Measuring range	:	An adjustable range of 50 : 1
Accuracy	:	Within $\pm 1\%$ of full speed
Motor	:	0.55 kw
Voltage	:	230V, single-phase, 50 Hz.

TABLE 5-3 LIME INJECTION PUMPS SCHEDULE

Identification	:	P-LMB1,2
Type	:	Horizontal, volute pump
Number	:	2 units
Services	:	Finished water pumping
Rated Capacity	:	0.15 m ³ /min.
Rated head	:	25 m
Pump Speed	:	Approx. 1,440 rpm
Pump casing design		
- Design pressure	:	Minimum 10.0 kg/cm ²
- hydrostatic pressure	:	Minimum 15.0 kg/cm ²
Motor size	:	2.2 kW
Power Supply	:	400 V, three(3)-Phase, 50 Hz

TABLE 5-4 LIME DOSING INJECTORS SCHEDULE

Identification	:	IJ-LMB1,2
Number	:	2 units
Services	:	10 % lime milk
Capacity		
- Primary	:	0.15 m ³ /min.
- Secondary	:	15 l/min
Material	:	Stainless steel 304

TABLE 5-5 WOODEN PLATFORM SCHEDULE

Identification	:	WF-LM1	WF-LM2
Numbers	:	1	1
Size	:	3.5 x 3.5 (m)	1.2 x 3 (m)
Purpose	:	Storage of lime packages	
Material	:	Wooden	

TABLE 5-6 WHEELBARROW SCHEDULE

Identification	:	WB-LM1
Type	:	
Numbers	:	1 unit
Load	:	50 kg
Purpose	:	Transferring lime packages

TABLE 5-7 PIPING SCHEDULE

Service	Nominal diameter	Pipeline materials	Remarks
(1)Lime solution tanks			
Fresh water pipes	100 mm	Galvanized steel pipe	with sluice valves
Outlet pipes	25 mm	- do. -	with ball valves and strainer units
Overflow pipes	80 mm	- do. -	
Drain pipes	50 mm	- do. -	with ball valves
Flush water pipes	50 mm	- do. -	with sluice valves
(2)Dosing pumps			
Inlet pipes	25 mm	Steel pipe lined with PVC	with valves
Outlet pipes	25 mm	- do. -	with valves
Flush water pipe	25 mm	Galvanized steel pipe	with ball valves
(3)Injection pumps			
Suction pipes	50 mm	Galvanized steel pipe	with sluice valves
Discharge pipes	50 mm	- do. -	with sluice valves
(4)Dosing pipe			
Dosing pumps to the rapid mixing tank	63 mm	Abrasion materials or reinforced rubber hose	with valves and quick coupling
Dosing pumps to the filtered water effluent pit	75 mm	- do. -	with valves and quick coupling

30504 Equipment Manufacturer

All lime dosing equipment shall be fabricated by a manufacturer regularly engaged in the production of lime dosing system of similar requirements for at least five (5) years. The units shall be of such design and constructed so that it will operate satisfactorily under the proposed operating conditions.

30505 Lime Solution Mixer

(1) Design Conditions

The specification described in **Sub-Section 30405 Alum Solution Mixer** shall be applied.

(2) Construction and Materials

The specification described in **Sub-Section 30405 Alum Solution Mixer** shall be applied.

30506 Lime Dosing Pump

(1) Construction and Materials

The specification described in **Sub-Section 30406 Alum Dosing Pump** shall be applied.

(2) Field Calibration Tests

The specification described in **Sub-Section 30406 Alum Dosing Pump** shall be applied.

30507 Lime Injection Pump

The requirements for the lime injection pump shall be as specified under 30200, PLANT

WATER PUMPS.

30508 Lime Dosing Injector

The injector shall operate on the venturi principle to create a local loss of pressure at the throat of the device less than atmospheric. The injector shall also mix the lime solution milk with water for dosing. Each injector shall be made of stainless steel 304 for lime solution. Each injector shall be equipped with a positive seating diaphragm lime check valve and shall have flanged ends.

30509 Bridge Walkway and Drive Platform

The 1.5 meter wide drive platform shall be supported by the steel I-beams and shall be designed to safely withstand all normal operating loads. They shall consist of structural supports, standard I-beam and shall have handrails of double-row, 40 mm in diameter steel pipe, 1.0 metre high.

The drive platform shall be an expanded section surrounding the drive unit of the mixer and provide easy maintenance access. Bridge walkway and drive platform shall be covered with galvanized checkered plate, with a minimum thickness of 4.5 mm. Minimum requirement of the bridge walkway and drive platform shall be as shown on the Drawings.

30510 Process Piping and Valves

(1) Process Piping

All necessary lime process piping valves and support materials to the point of dosing shall be furnished and installed so as to complete the lime dosing system as shown on the Drawings.

All lime dosing flexible pipes to be used for the lime dosing pumps delivery pipe to the dosing points shall be as follows.

- a) Type : Abrasion materials or reinforced rubber hose for outdoor used type
- b) Materials
 - Inner : Chlorideprene rubber
 - Exterior : Butadiene rubber
 - Reinforcement : Duck fabric

Each set of dosing flexible pipe shall be provided with male and female, stainless steel, type 316, quick coupling which shall be connected to the flexible pipe every ten (10) meter in length.

All support materials for pipes and valves shall be mad of type 316 stainless steel.

All other pipes, PVC pipe, steel pipe lined with PVC, stainless steel pipe and galvanized steel pipe to be used for the lime dosing system shall be as specified.

(2) Valves

All valves to be used for the alum dosing system shall be made of type 316 stainless steel.

30511 Motors

Output of motors to be provided with lime dosing pumps shall be not less than the kilowatt rating specified in each schedule. All motors shall be the squirrel cage induction type with totally enclosed, fan-cooled enclosure.

30512 Accessories and Spare Parts

For lime dosing system, all essential and desirable accessories for installation and operation shall be furnished and installed, which shall include but not be limited to the following.

- (1) Accessories for each lime dosing pump
 - a) One (1) Set of steel frame base

- b) One (1) Set of anchor bolts and nuts
 - c) One (1) Lot of necessary accessories recommended by the manufacture
- (2) Accessories for each lime injection pump
- a) One (1) Set of common base plates
 - b) One (1) Set of anchor bolts and nuts
 - c) One (1) Set of couplings with guard
 - d) One (1) Set of casing drain valves
 - e) One (1) Set of ball type flexible joint
 - f) One (1) Set of check valve
 - g) One (1) Set of sluice valve
 - h) One (1) Set of priming funnel with valve
 - i) One (1) Set of pressure gauges with cocks for pump suction and discharge
 - j) One (1) Lot of necessary accessories recommended by the manufacture
- (3) Spare Parts for each Mixer
- a) One(1) Complete set of bearings shall be furnished for each mixer.
 - b) One (1) Lot of other necessary spare parts recommended by the manufacture
- (4) Spare Parts for each lime injection pump
- a) Tow (2) Complete sets of gland packing
 - b) Two (2) Sets One (1) Complete set of oil seals
 - c) Two (2) Sets One (1) Complete set of sleeve
 - d) Two (2) Sets One (1) Complete set of bearings
 - e) Two (2) Sets One (1) Complete set of wearing rings
 - f) Two (2) Complete sets of all gaskets
 - g) Three(3) Complete sets of all packing required for the pump
 - h) Two (2) Complete sets of all special bolts, screws and nuts
 - i) Two (2) Complete sets of special tools required for maintenance of the pump

- (5) Spare Parts for each lime dosing pump
- a) One (1) Complete assembled set of peristaltic pump
 - b) Twenty (20) Meters of marprene tube
 - c) One (1) Complete sets of bearings
 - d) Two (2) Complete sets of valves with valve seats
 - e) Two (2) Complete sets of packing
 - f) Two (2) Complete sets of gaskets
 - g) One (1) Complete set of coupling cushion
 - h) One (1) Complete set of cams
 - i) One (1) Complete set of inner race for bearing
 - j) Ten (10) Complete sets of dosing flexible pipe ten (10) meters in length with quick coupling
 - k) One (1) Other necessary spare parts recommended by the manufacture

30513 Certification

The specification described in **Sub-Section 30412** shall be applied.

30600 CHLORINATION SYSTEM

30601 Scope of Work

The Contractor shall furnish and install equipment and materials for the chlorination system with all the necessary piping and appurtenances as specified herein. The work specified herein includes, but is not limited to furnishing, installing, testing, placing in satisfactory operation, start-up services and maintenance services for the chlorination system complete.

- a) Chlorinators
- b) Weigh scales
- c) Booster pumps
- d) Chlorine containers
- e) Chlorine gas manifolds
- f) Chlorine gas reducing valve
- g) All piping works in the chlorination building and to the chlorine feeding points
- h) Removal and re-installation of existing equipment
- i) Other miscellaneous works required.

The chlorination system shall consist of :

- a) A supply header for high pressure chlorine gas manifold from chlorine container to the chlorinators.
- b) Chlorinators for accurate measuring and dosing of high pressure chlorine gas.

The chlorination system shall be able to feed chlorine gas at variable rates as needed by the raw water quantity and quality, and filtered water quantity. The control and adjustments of dosing rates shall be manually set in the chlorinators.

30602 References

The following standards are referred to

- a) BS 341 : Valve fittings for compressed gas cylinders
- b) JIS B 8246 : Valves for High Pressure Gas Cylinder

- c) JIS B 8241 : Seamless Steel Gas Cylinders
- d) JIS G 3454 : Carbon Steel Pipes for Pressure Service
- e) JIS Z 2241 : Methods of Tensile Test for Metallic Materials

30603 Equipment Manufacturer

All the equipment specified under this Section shall be furnished by a single manufacturer and shall be products of a manufacturer regularly engaged in the production of such equipment for at least five (5) years. The Contractor shall have the sole responsibility for the proper functioning of the systems furnished.

Any reference to a specific manufacturer or model number is for the purpose of establishing a quality or parameter for specification writing and is not to be considered proprietary. In all cases any comparable source or device is acceptable.

30604 Manufacturer's Service

The manufacturer of the equipment and accessories, furnished under this Section shall execute the following services which shall be done by a fully qualified manufacturer's service engineer(s).

- a) Supervision

Checking the installation of all components before power, water and chlorine supplies are applied.

- b) Check Out

Placing the equipment into operation and necessary adjustments.

- c) Instruction

The manufacturer shall execute at least fourteen (14) days training to instruct the Employer's personnel in the use, operation and maintenance of all the equipment and the chlorination system.

d) Certification

The Contractor shall submit a certification from the manufacturer stating that the installation of the equipment is satisfactory, that the chlorination system is ready for operation and that the operating personnel have been suitably instructed in the operation and maintenance of the system.

30605 Schedule

Schedules of the chlorination system are summarized in Tables 6.1 to 6.6.

TABLE 6-1 CHLORINATORS SCHEDULE

Identification No.	CH-CHL1 & 2	CH-CHL3
Type	Manual control, solution fed vacuum type	
Number	2 units	1 unit
Purpose	Pre-chlorination	Post-chlorination
Location	Chlorination building	
Capacity	6.0 kg/hour	5.0 kg/hour
Feed rang	Adjustable range of minimum 20 : 1	
Accuracy	Within $\pm 2.0\%$ of full scale	
Power supply	Single phase AC. 230 V, 50 Hz.	

TABLE 6-2 WEIGH SCALE SCHEDULE

Identification	WS-CHL1 & 2
Type	Platform, load cell type
Number	Two (2) units
Location	Chlorination building
Weighing Capacity	2,000 kg
Indication	0 to 1,000 kg, digital
Minimum Graduation	1.0 kg
Accuracy	Within $\pm 0.5\%$ full scale
Platform Size	Approximate 800 mm x 1,500 mm
Power Supply	Single phase AC. 230 V, 50 Hz.

TABLE 6-3 BOOSTER PUMP SCHEDULE

Identification	:	P-CHL1,2	P-CHL3
Type	:		Horizontal, volute pump
Number (unit)	:	2	1
Services	:	Newly Pre-chlorination	Newly Post-chlorination
Capacity (m ³ /min)	:	0.18	0.08
Rated head (m)	:	47	30
Pump Speed (rpm)	:		Approx. 1,440
Pump casing design pressure (kg/cm ²)	:		Minimum 10.0
Pump casing hydrostatic pressure (kg/cm ²)	:		Minimum 15.0
Type of motor	:		Squirrel cage induction motor
Motor size (kW)	:	3.7	1.5
Power Supply	:		400 V, 3-Phase, 50 Hz

Note: P-CHL4 and P-CHL5 are to be relocated from the existing installed places.

TABLE 6-4 CHLORINE CONTAINER SCHEDULE

Identification	:	CO-CHL1 to 10
Number	:	Ten (10) units
Location	:	Chlorination building
Gas capacity	:	1,000 kg
Volumetric capacity	:	840 liter
Size	:	
- Overall length	:	2,200 mm (approx.)
- Inside diameter	:	770 mm (approx.)
- Wall thickness	:	Minimum 12 mm
Maximum working pressure	:	19.9 kg/cm ²
Hydrostatic test pressure	:	37.6 kg/cm ²
Number of fusible plugs	:	Six (6)
Melting point of fusible metal	:	74 degrees C

TABLE 6-5 CHLORINE GAS MANIFOLD SCHEDULE

Identification	:	MF-CHL1
Number	:	Four (4) units
Location	:	Chlorination building
Material	:	STPG 38 Sch.80
Size	:	25 mm dia.
Hydrostatic pressure	:	Minimum 20 kg/cm ²
Accessories (each)		
- Gas pressure gauges	:	0 to 20 kg/cm ² , with high, low alarm contacts
- Supports	:	Stainless steel 304

TABLE 6-6 CHLORINE GAS REDUCING VALVE SCHEDULE

Identification	:	RV-CHL1
Number	:	One (1) unit
Location	:	Chlorination building
Capacity	:	20 kg/Hour
Hydrostatic pressure	:	Minimum 15.6 kg/cm ²
rated Pressure		
- Primary	:	4 to 9.8 kg/cm ²
- Secondary	:	2.0 kg/cm ²
Accuracy	:	Within \pm 0.5 kg/cm ²
Materials of body	:	Stainless steel 304
Accessories		
- Heater with thermostat	:	Adjust the temperature to 40 degrees C AC. 230 V, 50 Hz.

TABLE 6-7 PIPING SCHEDULE

Service	Nominal diameter	Pipeline materials	Remarks
(1)Plant water			
Inlet 1 pipe	100 mm	Galvanized steel pipe	with sluice valves
Inlet 2 pipe	40 mm	- do. -	with ball valves
Flesh water pipe	80 mm	- do. -	with sluice valves
(2)Booster pumps			
Header pipe	100 mm	Galvanized steel pipe	
Suction pipe	65 mm	- do. -	with sluice valve and flexible joint
Delivery pipe	50 mm	- do. -	with sluice valve and flexible joint
(3)Feeding pipe			
Container pipe	6 mm	Copper tube	with flexible connector
Dry gas pipe	15 mm	Seamless steel pipe (Schedule 80)	with diaphragm valves and rubber flexible joints
Chlorine solution water pipe	50 mm	Steel pipe lined with PVC	with diaphragm valves and rubber flexible joints
Exhaust pipe	25 mm	Polyvinyl chloride pipe	
Drain pipe	25 mm	- do. -	with ball valves
Diffusers	63 mm	- do. -	with brackets(SS304)

30606 Removal and re-installation of existing equipment

The following existing equipment shall be re-installed as shown on the Drawings after cleaning, checking, repairing and replacing defective parts if any. The Contractor shall remove and re-install each existing chlorine feeding set one by one to ensure un-interrupted chlorine feeding.

- (1) Chlorinator 2 sets
- (2) Booster pump 2 sets
- (3) Ventilation fan 2 sets
- (4) Chain hoist 1 set
- (5) Other necessary equipment as required by the PMO/Engineer

30607 Chlorinator

(1) Construction and Materials

The chlorinator shall be of standard manufacture and shall incorporate pressure reducing valve, safety valve, flow meter, chlorine regulating valve with heater, vacuum pressure regulating valve, vacuum breaker, injector, water inlet valve, water supply pressure gauge, diaphragm chlorine gas pressure gauge, solenoid valve and chlorine control valve.

The chlorine gas control system shall operate under vacuum and upon loss of vacuum the gas supply shall positively shut off. A vacuum pressure regulating valve shall control the vacuum across the gas metering device so that accuracy of feed will be within plus or minus two percent ($\pm 2\%$) of the indicated flow rate, regardless of varying distribution system vacuum, ejector back pressure or gas pressure.

The chlorinator mechanisms, gauges and controls shall be housed in a floor mounted cabinet fabricated from plastic reinforced with fiberglass. All components of the chlorinator shall be of materials resistant to chlorine and moisture corrosion. The housing and component parts shall be designed so that all components are readily accessible for maintenance or repair.

A chlorine gas pressure gauge, a linear flow meter of the removable type and rate setting adjustment shall be mounted on the front.

(2) Chlorine Solution Injectors

The injector shall operate on the venturi principle to create a local loss of pressure at the throat of the device less than atmospheric. The injector shall also mix the chlorine gas with water for feeding. Each injector shall be made of cast iron or fabricated from steel pipe and shall have lining, rubber lining, PVC lining or others, suitable for wet chlorine gas and chlorine solution. Each injector shall be equipped with a positive seating diaphragm gas check valve and shall have flanged ends.

30608 Weigh Scale

(1) Construction and Materials

The weigh scale shall consist of a loading platform, weighing platform, stand type indicator panel and special cable.

The weigh scales shall be of a load cell type, identical platform scales. Each weigh scale shall be designed to support and weigh one (1) standard 1,000 kilogramme chlorine cylinder, each weighing approximately 1,800 kilogrammes when full.

Each scales shall have adjustable weight alarms with auxiliary contacts for remote indication of alarm condition and shall be equipped with four (4) heavy-duty casters to support one (1) chlorine cylinder so that the cylinder can be easily rotated with the use of a handle. Each caster shall be sized approximately 400 mm long with a diameter of 150 mm minimum, and shall have a rubber sleeve.

The digital indicator shall be graduated in not greater than 1 kilogramme increments and shall be capable of full scale tare adjustment.

Tare adjustment shall not require the use of any special tools and shall be easily accessible for adjustment without dismounting the indicator. The indicator shall be not less than 4 digits.

30609 Booster Pump

The specification of booster pumps shall be applied in much the same details as specified in the "30200 PLANT WATER PUMP"

30610 Chlorine Container

The Contractor shall supply ten (10) sets of one(1)-ton chlorine container and store them in the container room of the chlorination building. The containers shall be designed, manufactured, inspected and tested by the manufacturer of the containers. The Contractor shall submit hydraulic test and radiography test records to the PMO/Engineer.

(1) Construction and Materials

One-ton chlorine containers shall be designed to contain the specified quantity of liquid chlorine. The container shall have a cylindrical shell with convex or concave heads and with two identical valves near the center of one head.

The container shall be fabricated from mild steel having a minimum tensile strength of 41 kg/mm² and a minimum yield point of 25 kg/mm². The wall thickness of the container shall be a minimum of 12 mm. Screw threads for fitting of the valves and fusible plugs shall conform to JIS B 8246 or other applicable standards. Each container shall have a steel valve protection cap.

After manufacture, each container shall be subject to radiographic examination by X-ray of longitudinal and circumferential seam welds, junction of welds, and repair welds.

(2) Marking

The following items shall be marked on the bottom end of each container in a plain and permanent manner.

- a) Name or mark of the manufacturer
- b) Name of gas (Cl₂)
- c) Identification mark and serial number
- d) Water capacity (Symbol V, unit in liters)
- e) Weight without valves, fusible plugs and protection cap
(Symbol W, unit in kg)
- f) Date of hydraulic test
- g) Hydraulic test pressure (Symbol TP, unit in kg/cm²)
- h) Thickness of cylindrical shell of container (Symbol t, unit in mm)

30611 Chlorine Container Grab

Chlorine container grab shall be furnished and shall be suitable for lifting standard 1,000 kilogram chlorine containers each weighing approximately 1,800 kilograms when full.

30612 Process Piping and Valves

(1) Process piping

All necessary chlorine process piping valves and support material to the points of dosing shall be furnished and installed so as to complete the chlorination system as shown on the Drawings.

All feeding pipes shall be steel pipe lined with PVC, and be painted according to the specification described in Sub-Section 30123 Painting System.

All flexible pipes to be used for chlorine solution water piping shall be polyethylene (PE) pipe as specified in Sub-Clause 10502.3 in Chapter 1 Civil Works.

The PE pipe shall be installed in compliance with clause 30408.

All supporting materials for pipes and valves shall be made of type 316 stainless steel.

(2) Dry chlorine gas piping

Dry chlorine gas piping shall be carbon steel pipe conforming to JIS G 3453, STPG 38, Schedule 80 and other applicable standards. Fittings shall be the suitable type for high pressure gas service.

(3) Chlorine solution diffusers

Chlorine solution diffusers shall be of steel pipe lined and covered with rubber as shown on the Drawings. The rubber lining shall cover all surfaces of the pipe, flanges and bolt holes and orifices.

The lining shall be capable of developing a rubber to metal bond of at least 56 kg/cm² and shall have a tensile strength between 168 and 281 kg/cm². Minimum lining thickness shall be 4.5 mm but the Contractor, in all cases, shall be governed by the manufacturer's recommendations.

Flanges for rubber lined steel pipe shall be of the slip-on welded forged steel type. Fittings may be of the rubber lined cast iron, flanged type. Gaskets to be used for rubber lined pipes shall be 3.0 mm thick when the flanges are bolted together.

All pipes to be rubber lined shall be new and straight, free from undue roughness on the inside, porosity, grease band oil. Rust and scale shall be removed by shot blasting before the lining is applied. The use of any filter or cement is strictly prohibited. All rubber lining shall be inspected visually and spark tested by the manufacturer using a test apparatus developing a minimum of 25,000 volts. Any pipe or fitting found to be defective shall be replaced.

(4) Valves

a) Valves for chlorine service

Valves in pipelines handling high pressure chlorine gas shall be suitable globe valve for the service intended complete with all safety features to prevent dangerous leaks.

The body and one-piece bonnet and yoke shall be of carbon forged steel or carbon steel. The valves shall have wide deep stuffing boxes with teflon packing.

b) Strainer

Strainers to be used between high pressure chlorine gas manifold of chlorine container to manifold of the chlorinators shall be designed to have a removable bracket type. Size of mesh shall be suitable for the application required and approved by the PMO/Engineer. All parts of the strainer shall be of polyvinyl chloride, PVC.

30613 Protection Against Corrosion

All ferrous surfaces of equipment such as chlorinators, weigh scales, chlorine containers, and others shall be shop painted with the epoxy resin paint conforming to Paint System D2.

All ferrous surfaces shall be painted with the epoxy resin paint conforming to Paint System D2.

All paint systems stipulated shall be as specified in **Sub-Section 30123** Painting System.

30614 Motor

Output of motors to be provided with booster pumps shall be not less than the kilowatts specified in the schedule and all motors specified shall be the squirrel cage induction type with totally enclosed, fan-cooled enclosure.

30615 Accessories and Spare Parts

For each equipment, all essential and desirable accessories for installation and operation shall be furnished and installed, which shall include but not be limited to the following.

(1) Accessories for chlorinators

- a) Three(3) Complete sets of self contained compressed air breathing apparatuses. Each set of apparatuses shall comprise but not be limited to an air cylinder, pressure reducing valve, demand valve, panoramic vision full face mask, by pass valve, harness, and waist strap. The apparatuses shall incorporate a warning whistle in the pressure gauge line to indicate approaching exhaustion of the cylinder. The cylinder shall have 4 liters capacity charged to 150 kg/cm² G. Each apparatus shall be capable of accepting an additional face mask complete with its own demand valve and supply hose in an emergency.

- b) Three(3) Sets of spare air cylinders as specified above.

- c) Two (2) Complete sets of PVC protecting clothing consisting of :
 - Jacket with set in sleeves, all purpose out inside storm front, stand-up corduroy collar, welded buttons (medium size).
 - Pants, single bib, elastic suspenders, nylon slide, roomy crotch, welded buttons, full length leg (medium size).
 - Hood suitable to fit over air mask.

- Pair of black rubber, acid resistant gloves.
 - Rubber boots, knee high with puncture-proof sole and steel toe.
- d) Two (2) Complete sets of first aid medicine kits with hard plastic carrying case. Contents of medicine kits shall be approved by the PMO/Engineer.
- e) Two (2) Complete sets of an emergency repair kit with hard plastic carrying case. Contents of emergency repair kits shall be approved by the PMO/Engineer.
- f) Eight(8) Sets of rupture disks.
- g) One (1) Lot of other necessary accessories recommended by the manufacturer
- h) One (1) Set of cabinet shall be the self-stand steel cabinet type with full sized double diamond glass front.
- (2) Accessories for each booster pump
- a) One (1) Set of common base plates
 - b) One (1) Set of couplings with guard
 - c) One (1) Set of casing drain valves
 - d) Two (2) Set of ball type flexible joint
 - e) One (1) Set of check valve
 - f) Two (2) Set of sluice valve
 - g) One (1) Set of priming funnel with valve
 - h) One (1) Set of pressure gauges with cocks for pump suction and discharge
 - i) One (1) Lot of other necessary accessories recommended by the manufacturer
- (3) Spare Parts for chlorinators
- a) Three(3) Complete sets of chlorine gas pressure reducing valve
 - b) Three(3) Complete sets of vacuum pressure regulating valve
 - c) Three(3) Complete sets of chlorine gas flow meter
 - d) Three(3) Complete sets of chlorine gas pressure regulating valve

- e) Three(3) Complete sets of vacuum switch
- f) Three(3) Complete sets of ejector
- g) Three(3) Complete sets of water supply pressure gauge
- h) Three(3) Complete sets of chlorine gas pressure gauge
- i) Three(3) Complete sets of compound pressure gauge
- j) Three(3) Complete sets of fresh water inlet valve
- k) Three(3) Complete sets of chlorine solution water outlet valve
- l) Three(3) Complete sets of chlorine gas outlet valve
- m) Three(3) Pieces of solenoid valve
- n) Six (6) Sets of "O" rings and gaskets
- o) Six (6) Sets of rupture disks.
- p) Thirty(30) Pieces of bulbs for indicator lamp
- q) One (1) Lot of other necessary spare parts recommended by the manufacturer

(4) Spare Parts for weigh scale

- a) Twelve(12) Pieces of fuses
- b) One (1) Lot of other necessary spare parts recommended by the manufacturer

(5) Spare parts for booster pumps

- a) Three(3) Complete sets of gland packing
- b) Three(3) Complete sets of oil seals
- c) Three(3) Complete sets of sleeve
- d) Three(3) Complete sets of bearings
- e) Three(3) Complete sets of wearing rings
- f) Three(3) Complete sets of all gaskets
- g) Three(3) Complete sets of all packing required for the pumps
- h) Three(3) Lantern rings
- i) Three(3) Complete sets of all special bolts, screws and nuts
- j) One (1) Lot of special tools required for maintenance of the pumps

(6) Spare Parts for containers

- a) Ten (10) Pieces of auxiliary valve
- b) 1000 Pieces of gasket for container
- c) Four (4) Sets of cooper tube with connecting fittings on both ends

- d) One (1) Lot of other necessary spare parts recommended by the manufacturer
- (7) Spare Parts for piping
- a) Twenty(20) Pieces of gasket for chlorine gas piping
 - b) Twenty(20) Pieces of gasket for chlorine gas strainer cover
 - c) One (1) Set of chlorine gas pressure reducing valve
 - d) Two (2) Sets of globe valve
 - e) Ten (10) Sets of ball valve
 - f) Two (2) Complete sets of gas pressure reducing valve
 - g) Two (2) Complete sets of chlorine gas header with three connections and three chlorine manifold header valves.
 - h) Two (2) Complete sets of header supports as detailed on the drawings.
 - i) Ten (10) Meters of ϕ 6 copper tube
 - j) One(1) Lot of other necessary spare parts recommended by the manufacturer

30616 Certification

The Contractor shall submit a certificate to the PMO/Engineer from the manufacturer stating that the installation of the equipment is satisfactory; that the units are ready for operation; and that the operating personnel have been suitably instructed in the operation, lubrication and care of the units.

30700 FLUSH WATER PUMPS

30701 Scope of Work

The work specified herein shall include furnishing the following electric motor driven pumping units together with all other necessary and desirable accessory equipment and auxiliaries and appurtenances, whether specifically mentioned in this specification or not, as required for an installation incorporating the highest standards for the type of service, and including field testing of the entire installation.

The work specified shall also include executing supervisory service for installation of pumping units, final checking of pumping units installed, field test and instruction of the regular operating personnel in the care, operation and maintenance of all equipment.

30702 References

The following standards are referred to.

- a) ISO 3069 : End suction centrifugal pumps—Dimensions of cavities for mechanical seals and for soft packing
- b) BS 4999 : General requirements for rotating electrical machines
- c) BS 5257 : Horizontal end-suction centrifugal pumps
- d) BS 5316 : Acceptance tests for centrifugal, mixed flow and axial pumps
- e) JIS B 8301 : Testing Methods for Centrifugal Pumps, Mixed Flow Pumps and Axial Flow Pumps
- f) JIS G 4051 : Carbon Steels for Machine Structural Use
- g) JIS G 4105 : Chromium Molybdenum Steels
- h) JIS G 5121 : Stainless Steel Casting
- i) JIS G 5501 : Gray Iron Castings
- j) JIS H 5111 : Bronze Castings

30703 Schedule of Pumps

The schedule of pump equipment is summarized in Table 7-1.

TABLE 7-1 FLUSH WATER PUMP

Identification No.	:	P-FW1,2
Type	:	Horizontal, volute pump
Number (unit)	:	Two (2) units
Services	:	High pressure water for sedimentation washing
Rated Capacity (m ³ /min)	:	1.0
Rated head (m)	:	30
Pump Speed (rpm)	:	Approx. 1,440
Pump casing design pressure (kg/cm ²)	:	Minimum 10.0 kg/cm ²
Pump casing hydrostatic pressure (kg/cm ²)	:	Minimum 15.0 kg/cm ²
Motor size (kW)	:	7.5
Power Supply	:	400 V, three(3)-Phase, 50 Hz

TABLE 7-2 VALVES AND FLEXIBLE JOINTS

Identification	V-FW-1	V-FW-2	CV-FW	FJ-FW-1	FJ-FW-2
Type	Flanged sluice valve	Flanged sluice valve	Swing type check valve	Ball type flexible joint	Ball type flexible joint
Number	3	2	2	2	2
Nominal diameter	125 mm	100 mm	100 mm	80 mm	65 mm
Applied	Pump suction	Pump discharge	Pump discharge	Pump suction	Pump discharge
Flanged joint	ISO 7005				
Material	Cast iron, ductile cast iron or stainless steel type 316				
Operation	Manual				
Accessories	Support materials				

30704 General Arrangements

The general arrangements of the flush water pumps shall be applied in much the same details as specified in **Sub-Section 30204** General Arrangements of 30200 PLANT WATER PUMPS.

30705 Materials and Workmanship

The materials and workmanship of the flush water pumps shall be applied in much the same details as specified in **Sub-Section 30205** Materials and Workmanship of 30200 PLANT WATER PUMPS.

30706 End Suction Centrifugal Pump

The specification described in **Sub-Section 30206** End Suction Centrifugal Pump of 30200 PLANT WATER PUMP shall be applied.

30707 Valves and Flexible Joints

The specification described in **Sub-Section 30207** Valves and flexible Joints, 30200 PLANT WATER PUMP, shall be applied.

30708 Performance Tests

The specification described in **Sub-Section 30207** Performance Tests of 30200 PLANT WATER PUMP, shall be applied.

30709 Installation

The specification described in **Sub-Section 30208** Installation of 30200 PLANT WATER PUMP shall be applied.

30710 Accessories and Spare Parts

(1) Accessories

For each pump, all essential and desirable accessories for an installation and operation shall be furnished and installed, which shall include but not be limited to the following:

- a) Each one(1) Set of common base plates
- b) Each one(1) Set of anchor bolts and nuts
- c) Each one(1) Set of couplings with guard
- d) Each one(1) Set of casing drain valves
- e) Each one(1) Set of priming funnel with valve
- f) Each one(1) Set of pressure gauges with cocks for pump suction and discharge
- g) Two (2) Complete set of special tools required for maintenance of the pumps
- h) One (1) Lot of other necessary accessories recommended by the manufacturer

(2) Spare parts

The following spare parts shall be furnished for each pump.

- a) Two (2) Complete sets of gland packing
- b) Two (2) Complete set of oil seals
- c) Two (2) Complete set of sleeve
- d) Two (2) Complete set of bearings
- e) Two (2) Complete set of wearing rings
- f) Two (2) Complete sets of all gaskets
- g) Two (2) Complete sets of all packing required for the pump
- h) Two (2) Complete sets of all special bolts, screws and nuts
- i) One (1) Lot of other necessary spare parts recommended by the manufacturer

30800 PORTABLE SUBMERSIBLE SUMP PUMP

30801 Scope of Work

The work specified herein shall include furnishing the portable submersible sump pumps together with all other necessary and desirable accessory equipment and auxiliaries and appurtenances.

30802 Schedule of Pumps

The schedule of pump equipment is summarized in Table 8-1.

Table 8-1 SUBMERSIBLE SUMP PUMPS

Identification No.	P-SP 1,2
Type	Portable Submersible Sump Pump
Number	Two (2) units
Service	Portable service
Rated Capacity (l/min)	500
Rated Head (m)	10.0
Type of Impeller	Semi - open
Driver Type	Submersible Motor
Rated Output (KW) (Minimum)	2.2
Electric Power	400 V, 3-phase, 50 Hz
Speed (rpm)	Approx. 1,450

30803 Submersible Sump Pumps

(1) General

Pumps shall be heavy-duty submersible sump pumps and shall be a suitable type for the service specified. Pump discharge connection system shall be quick coupling system for flexible pipe.

All essential and desirable motor protection devices, including overload protection, lubrication devices and other accessories for the pumping units shall be provided.

Portable pumps shall be furnished and transported to the storage house as directed by the PMO/Engineer. Each pump shall be provided with strainer.

(2) Construction and Materials

(a) Pumps

The casing shall be the enclosed or non-clog centrifugal type. The impeller shall be enclosed, semi-open or open, non-clog type. The casing and impeller shall be made of cast iron conforming to JIS G 5501, Class 2, FC 20 (grey iron) or better.

For all pumps, replaceable wearing rings shall be provided between the impeller and casing. Wearing rings shall be bronze casting conforming to JIS H 5111, Class 6 or other materials approved by the PMO/Engineer.

Shaft shall be stainless steel, type 420 or other types of stainless steel approved by the PMO/Engineer. For each pump, at least one (1) set of mechanical seal and oil seal shall be provided. All mechanical seals shall be removable and replaceable.

Bearings shall be anti-friction ball or roller type. For each pump, upper and lower bearings shall be provided.

The pumps shall be provided with a suction strainer. The strainer shall be made of cast iron, stainless steel and aluminium.

(3) Painting

All ferrous surfaces of the pump shall be shop painted with tar epoxy paint, Paint System E1.

Painting shall conform to the requirements as specified in "30123 Painting System" unless otherwise specified.

(4) Motors

The motors shall be directly connected to the pump casing and completely sealed for submersion in water. Motors shall have sufficient rating to operate the pump at any head on its curve without overloading and not less than that indicated on the SCHEDULE.

The motor shall be designed and manufactured in accordance with JIS B 8325 Submersible Motor Pumps for Sumps or JIS A 8604 Submersible Pumps for Construction.

The built-in thermal overload protection with auto-cut relay shall be provided for the motors, of motor output 7.5 KW and smaller.

30804 Accessories and Spare Parts

(1) Accessories

For each pump, all essential and desirable accessories for an installation and operation shall be furnished and installed, which shall include but not be limited to the following:

- One (1) Set of discharge connection of quick coupling
- Two (2) Sets of 5 m long stainless steel lifting chain with three (3) shackles
- Three (3) Sets of 10 m long flexible pipe
- One (1) Set of power supply cable of 20 m long

(2) Spare parts

The following spare parts shall be furnished for each pump.

- Two (2) Complete sets of mechanical seals
- Two (2) Complete sets of oil seals
- Two (2) Complete sets of wearing rings if applied
- Two (2) Complete sets of bearings
- One (1) Complete set of automatic air release valve if required

Two (2) Complete sets of gaskets and packing

30900 VENTILATING SYSTEM

30901 Scope of Work

The Contractor shall furnish and install the ventilating fans as shown on the drawings and specified herein.

30902 References

The following standards are referred to.

- a) JIS B 8330 : Testing Methods for Turbo-Fans and Blowers
- b) JIS H 4000 : Aluminium and Aluminium Alloy Sheets and Plates, Strips and Coiled Sheets

30903 Schedule

TABLE 8 VENTILATING SYSTEM

Identification	EF-FIL1 & 2
Type	: Roof fan, exhaust
Number	: Two (2) units
Location	: Filter pipe gallery
Capacity	: 80 m ³ /min
Pressure	: 10 mm Aq
Noise	: Less than 56 dB
Motor Output	: 0.2 kW
Type of Motor	: totally enclosed
Power Supply	: 400 V, three(3)-phase, 50 Hz

30904 General Arrangements

The contract drawings indicate the extent and general arrangement of the ventilating fans. The Contractor shall be responsible for installing the proposed system as indicated, without violation of specification requirements. Except where dimensions are shown to locate duct

work or equipment, the drawings show duct size and arrangement only.

Equipment and duct work arrangements shall fit into the space as indicated, and shall allow adequate and approved clearances for entry, servicing and maintenance.

Rotating parts, so located that personnel can come in close proximity thereto, shall be fully enclosed or properly guarded.

Materials and equipment shall conform to the requirements specified herein and as shown on the drawings and shall be the products of manufacturers regularly engaged in the manufacture of such products.

30905 Tests

(1) Factory Tests

Unless otherwise specified, all fans shall be tested at the manufacturer's plant to demonstrate complete compliance with these specifications. Six (6) copies of test data including flow and pressure characteristic curve, required power, current and others shall be submitted for approval prior to shipment.

Factory performance tests for propeller fans specified shall be executed in accordance with JIS B 8330 or other standards approved by the PMO/Engineer.

(2) Field Tests

Upon completion, and prior to acceptance of the installation, the Contractor shall subject the ventilating systems to such operating tests as may be required by the PMO/Engineer to demonstrate satisfactory functional and operating efficiency.

Operating tests shall cover a period of not less than six(6)- hours for each fans, and all tests shall be conducted at such times as the PMO/Engineer may direct. If tests do not demonstrate satisfactory operation of the ventilating fans deficiencies shall be corrected and tested.

30906 Propeller Fans

Propeller fans shall be exhaust and high pressure industrial types. Fan shall be three blade type and blades shall be designed to ensure low noise, high volume of air flow and high efficiency. Fan shall be directly coupled with motor and fan and motor shall be supported by heavy metal frames.

Fan shall be fabricated from steel sheets conforming to JIS G 3141, Class SPCC or other applicable standards. Frame shall be fabricated from steel sheets specified above. Fixed louvers and outdoor rain hoods shall be provided by the same manufacturer as that of fans unless otherwise specified. Fixed louvers shall be parallel-blade type and fabricated from aluminium sheets. Outdoor rain hoods shall be of type 304 stainless steel and shall have enough opening area.

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with epoxy resin paint of manufacturer's standard.

31000 CHAIN HOISTS

31001 Scope of Work

The Contractor shall furnish and install hand operation chain hoists as shown on the drawings and as hereinafter specified.

31002 References

The following standards are referred to.

- a) ISO 1834 : Short link chain for lifting purpose--General conditions of acceptance
- b) JIS B 8802 : Chain Hoists
- c) JIS B 8812 : Link Chains for Chain Hoists
- d) JIS G 3101 : Rolled Steel for General Structure
- e) JIS G 3192 : Dimensions, Weight and Permissible Variations of Hot Rolled Steel Sections
- f) JIS G 3454 : Carbon Steel Pipes for Pressure Service

31003 Schedule of Chain Hoists

TABLE 9 HAND-OPERATED CHAIN HOISTS SCHEDULE

Identification	:	C-CHE1	C-CHE2	C-CHE3	C-CHL1	C-WS1
Type (*1)	:	Chain hoist with push and plain trolley				
Number (unit)	:	1	2	1	1	2
Purpose	:	Chemical Handling			Lifting chlorine container	
Location	:	Chemical building			Chlorine building	
Lift Rating (ton)	:	1.0	1.0	0.5	3.0	3.0
Lift (*2) (m)	:	6.3	2.6	2.8	3.6	3.0
Accessories	:	Hanging nets with rope for solid chemical packages		Hanging wire of stainless steel		Hanging wire of stainless steel

Note : *1 : Monorail Tracks for all chain hoists specified above will be furnished and installed by the building work.

*2 : Clearance from operation floor to bottom of monorail track

31004 General Arrangements

The hoists shall be of such design and constructed so that it will fit the available space without alternation of the building and without change to the location of the hoist rails. Unless otherwise specified, runway beams and hoist rails with stoppers shall be supplied and installed by the Contractor.

Upon completion of the equipment, the PMO/Engineer may order a full load operating test on the equipment. The Contractor shall furnish the labor and materials required for such tests and shall at his own expense correct defects in the fabrication and erection.

All ferrous surfaces requiring painting shall be shop and field coated in accordance with the **Sub-Section 30123** Painting System.

31005 Hand Operation Chain Hoists

Chain hoist shall consist of frame, casing, reduction gear and flanged load sheave with precision roller bearings, load and operation chain, overload limiter, mechanical brake and safety latch hook.

The reduction gears shall be ample proportion and provide a positive drive between the driving shaft and the load. Pinions and spur wheels shall be made from high-grade heat-treated alloy steel, and have precision machine cut-teeth.

The brake shall be of the screw and disc type where the brake pressure and the sustaining power increases in proportion to the load on the hook. Screwed brake sleeve shall be high grade steel and mounted on a splined driving shaft.

All chains shall be electrically welded steel, heat treated, polished and accurate to pitch. Dimensions and strength of the chains shall conform to JIS B 8812, or ISO 1834 or other applicable standard.

The geared trolley shall be the gear drive type with 4 ball-bearing pressed steel wheels, equipped with life-time lubrication and hardened threads with a geared travel mechanism.

The push and plain trolley shall be of the hung-in travelling type with a forged steel bar

held between the side plates of the trolley. The push and plain trolley shall have 4 ball-bearings pressed steel wheels equipped with lifetime lubrication.

31006 Portable Gantry Frame

Portable gantry frame, which is to be used for unloading and transferring the chlorine gas containers from truck to the container storage room, shall consist of specially designed gantry leg assembly. The portable gantry frame shall be capable of easy storage and transporting, and shall be equipped with heavy duty industrial casters with four(4)-anti-friction bearing wheels. The portable gantry frames shall be fabricated from seamless steel pipe conforming to JIS G 3454, STPG38 minimum schedule of 40.

31100 PIPE WORK FOR ELEVATED TANK

31101 Scope of Work

The work specified herein shall include the furnishing following piping together with all other necessary and desirable accessory materials and auxiliaries and appurtenances, whether specifically mentioned in this specification or not, as required for an installation incorporating the highest standards for the type of service, and including field testing of the entire installation.

The work specified shall also include executing supervisory service for installation of piping, final checking, field test and instruction of the regular operating personal in the care, operation and maintenance of all piping.

31102 Schedule of Pipe Work

TABLE 10-1 PIPING SCHEDULE

Service	Nominal diameter	Pipeline materials	Joint	Painting system
Inlet pipe	125 mm	Galvanized steel	Flanged	Shop prime & field paint with system F
Outlet pipe	150 mm	- do. -	- do. -	- do. -
Back wash pipe	350 mm	- do. -	- do. -	- do. -
Drain pipe	150 mm	- do. -	- do. -	- do. -
Overflow pipe	150 mm	- do. -	- do. -	- do. -
Branch pipe for chemicals	100 mm	- do. -	- do. -	- do. -
Branch pipe for sink	16 mm	- do. -	- do. -	- do. -

TABLE 10-2 VALVES SCHEDULE

Identification	V-ET-1	V-ET-2	V-ET-3	V-ET-4	V-ET-5
Type	Sluice valve				
Number	1	2	1	2	1
Nominal diameter	350 mm	150 mm	125 mm	100 mm	16 mm
Flanged joint	ISO 7005				
Material	Cast iron as ductile cast iron				Brass or bronze
Operation	Material				

TABLE 10-3 SLEEVE JOINT SCHEDULE

Identification	SJ-1	SJ-2	SJ-3
Type	Sleeve joint		
Number	2	5	3
Nominal diameter	350 mm	150 mm	125 mm

31103 Piping and Valves

All necessary piping valves, and support materials in the chemical building shall be furnished and installed so as to complete the plant water inlet, outlets, overflow and drain piping system as shown on the Drawings.

(1) Steel Pipe

All pipes and support material shall be used with galvanized steel, and shall be painted by the system F and A with field prime.

Galvanized coating on the inside and outside of pipe with zinc shall conform to ISO 1461 or JIS H 9124. Thickness of galvanized coating shall be not less than 550 g/m².

Field cutting with flame and field welding of galvanized steel pipes will not be permitted.

The specification described in 10500 PIPE WORKS of CHAPTER 1 CIVIL ENGINEERING WORKS, shall be applied.

(2) Sluice Valves

The specification described in Sub-Section 10503.1 Sluice Valves of 10503 Valves, shall be applied.

(3) Sleeve Joint

For jointing sleeve joint, the Contractor shall take account of the manufacturer's instructions and recommendations as to the methods and equipment to be used in assembling the joint.

In particular the Contractor shall render the end of each pipe perfectly smooth so as to allow the middle ring to slide freely and where necessary the pipe ends shall be recoated with the epoxy system or coal tar epoxy paint system as specified in Sub-section 30123 Painting System.

TECHNICAL SPECIFICATIONS

CHAPTER 4

ELECTRICAL WORKS

CHAPTER 4 ELECTRICAL WORKS

	Page
40100 GENERAL	
40101 Scope of Work	EL- 1
40102 Standard and Regulations	EL- 2
40103 Schedule	EL- 2
40104 Standard of Quality	EL- 3
40105 Equipment Guarantee	EL- 3
40106 Certification	EL- 4
40107 Drawings	EL- 4
40108 Workmanship	EL- 7
40109 Instructions on Site	EL- 7
40110 Handing Over	EL- 7
40111 Maintenance and Defects Liability Period	EL- 8
40112 Equipment	EL- 9
40113 Painting System	EL-12
40114 Equipment Included	EL-12
40115 Materials	EL-16
40116 Tests	EL-17
40117 Accessories and Spare Parts	EL-20
40200 ELECTRIC POWER RECEIVING SYSTEM	EL-21
40300 LOW-VOLTAGE SWITCHGEAR	
40301 References	EL-23
40302 Schedule of Low-Voltage Switchgear	EL-23
40303 Construction	EL-24
40304 Equipment Included	EL-25
40305 Installation	EL-26
40306 Tests	EL-26
40307 Accessories and Spare Parts	EL-26
40400 EMERGENCY POWER GENERATOR SYSTEM	
40401 Work to be Performed	EL-30
40402 References	EL-30
40403 Schedule of Emergency Power Generator System	EL-31
40404 Emergency Generator	EL-34
40405 Installation	EL-39
40406 Piping	EL-39
40407 Tests	EL-40
40408 Tools, Accessories and Spare Parts	EL-41

40500 MOTOR CONTROL CENTERS AND LOCAL CONTROL PANELS

40501	References	EL-43
40502	Schedule of Motor Control Center, Auxiliary Relay Panels and Local Control Panels	EL-43
40503	Construction	EL-45
40504	Equipment Included	EL-47
40505	Installation	EL-48
40506	Tests	EL-48
40507	Accessories and Spare Parts	EL-48

40600 INSTRUMENTATION

40601	Work to be Performed	EL-51
40602	References	EL-51
40603	Schedule of Instrumentation	EL-52
40604	General Requirements	EL-56
40605	Flow Measuring Devices	EL-57
40606	Level Measuring Devices	EL-60
40607	Chlorine Gas Detection System (CGD)	EL-61
40608	Panel Mounted Instruments	EL-62
40609	Installation	EL-64
40610	Tests	EL-65
40611	Accessories and Spare Parts	EL-65

40700 MONITOR AND CONTROL PANELS

40701	References	EL-70
40702	Schedule of Monitor and Control Panel	EL-70
40703	Construction	EL-71
40704	Equipment Included	EL-71
40705	Installation	EL-72
40706	Tests	EL-72
40707	Spare Parts	EL-73
40708	Operation System	EL-73

40800 LIGHTING AND COMMUNICATION SYSTEM

40801	Work to be Performed	EL-77
40802	References	EL-77
40803	Schedule of Lighting and Communication Systems	EL-77
40804	Lighting System Equipment	EL-78
40805	Intercommunication System	EL-81
40806	Removal and Re-installation of Existing Radio Telephony System	EL-82
40807	Public-Address System	EL-83

	<u>Page</u>
40808 Tests	EL-84
40809 Accessories and Spare Parts	EL-84
 40900 WIRING SYSTEM	
40901 Work to be Performed	EL-86
40902 Reference	EL-88
40903 Materials	EL-89
40904 Installation	EL-94
40905 Field Tests	EL-99
40906 Spare Materials	EL-99
40907 Measurement and Payment	EL-100

CHAPTER 4 ELECTRICAL WORKS

40100 GENERAL

40101 Scope of Work

The Contractor shall provide all labour, materials, equipment, accessories, with necessary auxiliary devices, supervision of construction, factory and field testing, start-up work, instruction and call back service, etc., and incidentals to furnish and install the complete electrical work as shown on the drawings and/or as specified herein.

The work under this Contract shall not interrupt the operation of the existing treatment works and shall keep the normal condition of the present operation.

In case of a work necessitating the Plant operation to be stopped, all temporary works, equipment, materials, labour and testings needed shall be installed and furnished to keep the present operation conditions by the Contractor without additional cost.

The Contractor shall be deemed to have included in his Tender, price for all items necessary such that the installations are complete in all respects and left in a satisfactory working order.

All work, equipment, materials and others are to be of the best quality approved by the PMO/Engineer and strictly in accordance with the Specification.

In the event of any portion of the work or materials failing to pass the tests specified herein, or set forth in the Manufacture's list for that particular item, the PMO/Engineer may at his discretion, reject that portion of the work or material entirely.

The work shall include but not be limited to the following.

- a) Power receiving system
- b) Emergency generator system
- c) Raw water intake facilities
- d) Rapid mixing basin facilities
- e) Filter facilities
- f) Alum dosing facilities

- g) Lime dosing facilities
- h) Chlorine dosing facilities
- i) Operation building facilities
- j) Instrumentation systems
- k) Intercom and public address systems
- l) Outdoor lighting system
- m) Main-wiring system
- n) Modification, removal and delivering works of existing facilities

40102 Standard and Regulations

The electrical works, all equipment, materials and fabrication shall conform to the latest applicable following standards or equivalent national standards.

- a) IEC : International Electrotechnical Commission
- b) ISO : International Organization for Standardization
- c) ANSI : American National Standards
- d) BS : British Standards
- e) DIN : Deutsche Institute fur Normung
- f) JIS : Japan Industrial Standards
- g) MS : Mauritius Standards
- h) NF : Norme Francaise
- i) IEE : Institution of Electrical Engineers

All equipment and work under this Contract shall be installed in accordance with the requirements of the power supply company "CEB" (Central Electrical Board). The Contractor shall file the required notice with any municipal department having jurisdiction over such permits and obtain and pay for all permits required.

40103 Schedule

The completeness of the schedules is not guaranteed and the omission of an electrical system in the schedule needed to complete the work shall not relieve the Contractor from his responsibility for installation of the work complete.

40104 Standard of Quality

Where items of equipment are specified by the name of a manufacturer, it is for the purpose of establishing a standard of quality, construction, and acceptable experience. Substitute equipment will be acceptable if it can be demonstrated to the PMO/Engineer that the substitute is in accordance with the specifications and equal in quality to those models specifically named.

Manufacturers listed as "equal" have been determined by the PMO/Engineer to style and model. However, this shall not relieve the named Manufacturer from the responsibility of meeting all specified requirements.

All electrical equipment and materials furnished shall be new and of current design.

40105 Equipment Guarantee

The Contractor shall guarantee all equipment supplied against defects in workmanship or materials for a period of two years, unless stipulated otherwise, following acceptance of the completed project.

Under this guarantee the Contractor agrees to correct without delay at his own expense any failure of such parts due to faulty materials, construction; or installation or to the failure of any such equipment to successfully perform within the limits of the specifications and further shall make good any damage to any part of the work caused by such failure.

Any work installed contrary to or without approval by the PMO/Engineer shall be subject to change as directed by the PMO/Engineer, and no extra compensation will be allowed to the Contractor for making these changes.

The PMO/Engineer will give prompt written notice of observed defects.

If the Contractor after notice, fails to proceed promptly to comply with the terms of this guarantee, the Contractor will be held liable for all expenses incurred.

40106 Certification

The Contractor shall submit a certificate from the manufacturer stating that the installation, checking, adjusting and coordinating each equipment item are satisfactory, that all equipment is ready for service and that the operating personnel have been suitably instructed in the operation and care of the equipment.

40107 Drawings

(1) Interpretation of Drawings

The drawings are diagrammatic and functional only and are not intended to show exact circuit layouts, number of fittings, or other installation details.

The Contractor shall obtain in the field all information relevant to the placing of electrical work and in case of any interference with other work, shall proceed as instructed by the PMO/Engineer.

The locations of all equipment, fixtures, outlets, similar devices and wiring routes shown on the drawings are approximate only. Exact locations shall be as approved during construction.

The Contractor shall furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed by the Contractor wherever needed to conform to the specific requirements of the equipment.

The ratings of motors and other electrically operated devices, together with the size shown for their branch circuit conductors and conduits, are approximate only and are indicative of the probable power requirements insofar as they can be determined in advance of the purchase of equipment.

The ratings shown for motor branch circuit protective devices are the maximum ratings permitted. Lower ratings may be used where approved as being proper for the dynamic characteristics of the motor and its connected load.

Unless otherwise specified, all conduits, wires, cables and the support systems for the conduits and cables that are required to make the electrical connections to equipment shall be furnished and installed by the Contractor.

Surface mounted panels, boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between walls and equipment.

In addition, any wiring or appurtenances not shown on the drawings which are required for a complete and operable system shall be furnished.

(2) Shop Drawings

The Contractor shall prepare shop drawings as necessary and shall submit in the required number of copies to the PMO/Engineer for approval.

All shop drawings shall be checked by the Contractor for accuracy and the Contract requirements before submittal.

Shop drawings shall bear the signature of the Contractor and date checked and shall be accompanied by the statement that the shop drawings have been examined for conformity to the specifications and drawings.

This statement shall also list all discrepancies with the specifications and drawings.

Shop drawings, not so checked and noted by the Contractor shall be returned to him without approval.

The PMO/Engineer's check shall be only for conformity with the design concept of the project and compliance with the specifications and Contract Drawings.

The PMO/Engineer's approval shall in no way relieve the Contractor from the responsibility of, or the necessity of, furnishing materials and workmanship required by the Contract drawings and specifications which may not be indicated on the shop drawings.

The Contractor shall be responsible for all dimensions to be confirmed and correlated to the job site and for coordination of his work with the work of all other trades.

Approval by the PMO/Engineer for the shop drawings shall neither relieve the Contractor of his obligations under this Contract nor relieve him from correcting any error found subsequently in the approved working drawings.

Where required, the Contractor shall submit to the PMO/Engineer samples of materials he proposes to install and approval before installation.

(3) Record Drawings

The Contractor shall keep on site at all times a complete set of the drawings relative to this Contract, and as the Contract works are proceeded with, indicate in red colour on such drawings, any variations to the Contract works as executed from those shown on the Contract drawings.

(4) As Built Drawings

After the completion of work, the Contractor shall deliver a complete set of "As built drawings" showing the complete installation including all alterations and modifications. The set of the drawings shall include but is not limited to all floor plans and diagrams.

The "As built" drawings shall be provided. Any cost related to this work is deemed to be covered by the Contractor's rates.

(5) Operation Manual

The Contractor shall submit four (4) sets of operation and maintenance manuals.

The operation manual written for use by the plant operator shall contain but not be limited to the following.

- a) Process description for complete treatment plant including power receiving, emergency generator, motor control centre, auxiliary relay panels, local control panels, monitor panels, instrumentation, and communication system and others, with references to follow and line diagrams.
- b) The requirements for the operation manual shall be as specified in Chapter

3, MECHANICAL WORKS, 30107 Drawings (7), Operation Manual of the Specifications.

(6) Maintenance Manual

The requirements for the maintenance manual shall be as specified in CHAPTER 3, MECHANICAL WORKS, 30107 Drawings (8), Maintenance Manual of the Specifications.

40108 Workmanship

The whole of the work shall be carried out in the straight forward manner by competent workmen under skilled supervision.

The PMO/Engineer shall have the right to have portion of the work taken down, removed or undone, which is executed in an unworkman-like manner or with improper materials.

In the event of the portions of the work or materials failing to pass the specified tests, or the approval of the PMO/Engineer, the Contractor shall be required at his own expense to put right such defects.

40109 Instructions on Site

The Contractor shall be required to maintain on site, at all times during the progress of the Contract, an English-speaking Supervisor, to the satisfaction of the PMO/Engineer and who shall have a full knowledge of the installation and to whom the instructions can be given on site.

40110 Handing Over

The Contract works shall be considered complete and the maintenance and defects liability period shall commence only when the Contract works and supporting services have been tested, commissioned and operated to the satisfaction of the PMO/Engineer and officially approved and accepted by the Employer.

If, by reason of any act or omission of the Employer or the PMO/Engineer, the Contractor shall be prevented from carrying out the test on completion, then, unless in the meantime the works shall have been approved not to be substantially completed in accordance with the Contract, the PMO/Engineer may issue a handing over certificate accordingly.

Nevertheless the Contractor shall make the said tests during the period of maintenance as and when required by the PMO/Engineer by fourteen (14) days notice in writing. Any additional expense shall be added to the Contract price.

The procedure to be followed will be as follows:

- (1) On completion of the Contract works to the satisfaction of the PMO/Engineer, the Contractor shall request the PMO/Engineer to arrange for handing over .
- (2) The PMO/Engineer shall then arrange a handing-over meeting or a series thereof at the site.
- (3) The Contractor shall arrange with the PMO/Engineer and the Employer for a complete demonstration to be carried out of each and every service, and for instructions to be given to the relevant operating staff and other representatives of the Employer.
- (4) The Contractor shall prepare approved Handing Over Certificate and check lists of all controls and items of equipment, tools, spares and the like.
- (5) In the presence of the Employer and the PMO/Engineer, handing over will take place, subject to agreement upon over the Handing Over Certificate and associated check list.

40111 Maintenance and Defects Liability Period

The Contractor shall maintain the complete electrical installation and associated equipment for a period of minimum half year from the date that the installation is handed over to the Employer.

The Contractor shall be held responsible for and shall make good all defects in materials and workmanship that appear during half year maintenance and defect liability period.

The period of liability shall not end until all defects which appear during the maintenance period have been rectified.

Any item of material found to be defective shall be replaced by the Contractor within seven (7) days of his being notified and any results of defective workmanship shall be repaired including supply of new parts if necessary immediately upon being notified.

The Contractor shall allow in his tender price for this maintenance and inspection services and shall provide for all tools, instruments, plant and scaffolding, and the transportation thereof, as required for the correct and full execution of these obligations, and the provision, use or installation of all materials.

Whether they are normal maintenance materials such as oils, grease, sandpaper, etc., and parts which are periodically renewed such as relay contacts or parts which are faulty for any reason, whatsoever excepting always Acts of God such as storm, tempest or flood, lightning and earthquakes, and civil revolt, acts of war and vandalism.

The Contractor shall undertake all modifications required by the authorities concerned in order to comply with the regulations, and produce all certificates, if any, from the authorities without extra charges.

40112 Equipment

(1) Size of Equipment

The Contractor shall investigate each space in the building through which equipment must pass to reach its final location.

If necessary, the manufacturer shall be required to ship his material in sections sized to permit passing through such restricted areas in the building.

(2) Ratings of Electrical Equipment

The ratings and characteristics of all electrical equipment, the low-voltage switchgear and panels shall be as follows.

a)	Type	:	Metal-enclosed type
b)	Number of phases	:	Three (3)-phase, four(4)-wire
c)	Rated frequency	:	50 Hz.
d)	Power supply of equipment	:	
	- Three phase motor	:	Three (3)-phase 400V
	- Single phase motor	:	Single(1)-phase 230V
	- Lighting panel	:	Three (3)-phase, four(4)-wire 400/230V
	- Lighting fixture	:	Single(1)-phase 230V
	- Receptacle	:	Single(1)-phase 230V
e)	Rated control voltage	:	
	- AC	:	230V AC \pm 15%
	- DC	:	24V DC \pm 15%
	- Instruments	:	230V AC (400/230V Transformer)
	- Level and other	:	24V DC (Battery)
f)	Signal lamps	:	
	- Annunciator	:	24V DC (Battery)
	- Switchgear	:	24V DC (Battery)
	- Graphic	:	24V AC (230/24V Transformer)
	- Panel inside	:	230V AC (With receptacle)
g)	Communications	:	
	- Intercom system	:	24V DC (Battery)
	- Public address system	:	24V DC (Battery)
h)	Rated insulation voltage	:	
	- Main circuit	:	600V AC r.m.s
	- Control circuit	:	250V AC r.m.s
i)	Rated withstand voltage	:	
	- Main circuit	:	2,500V AC r.m.s
	- Control circuit	:	1,500V AC r.m.s
j)	Rated short-time withstand current	:	More than 15kA

(3) Equipment Marking

All pieces of equipment such as switches, switchfuses, circuit breakers, signal lamps, panels, etc., shall be named with engraved plastic labels in black letters on white background.

(4) Phase Arrangement

Wires and cables used for power circuits shall be color coated as follows :

- a) Three (3)-phase, four (4)-wire circuits
 - Phase A : Red
 - Phase B : Blue
 - Phase C : Yellow
 - Neutral : Black
 - Grounding : Green with yellow stripes

- b) Single-phase, two (2)-wire circuits
 - Phase : As phase color
 - Neutral : Black
 - Grounding : Green with yellow stripes

- c) D.C. circuit
 - Positive : Red
 - Negative : Blue

- d) Control circuit
 - Voltage transformers : Red
 - Current transformers : Black
 - A.C. circuit : Yellow
 - D.C. circuit : Blue
 - Grounding circuit : Green with yellow stripes

(5) Small Wiring

All small wirings of equipment and panels shall be made with 600 V PVC insulated wire of 2.0 mm square and larger having enough flexibility for operation for long duration.

All small wirings shall run neatly, fixed securely and taken at terminal boards. Also they shall be provided with solder less terminal lugs to connect to terminal boards.

Where wiring passes through holes in metal works, protection by rubber grommets shall be provided. Permanent wire markings shall be provided according to the specifications.

(6) Water-proof type

All equipment which will be installed outdoors or installed in basement room of the buildings shall be water-proof type, and designed and manufactured in accordance with the IEC 947-1 or JIS C 0920 "Tests to Prove Protection against Ingress of Water for Electrical Equipment", grade 5.

40113 Painting System

All equipment and material shall be painted with double coats of sealing primer and surface, and not less than double coats of finish paint. Before prime-painting, surface of switchgear and panels shall be treated by sand blast or dipping with acid solution.

Painting colours shall be approved by the PMO/Engineer. An adequate supply of touch-up paint shall be supplied by the manufacturer.

Detail of painting system shall be applied as specified in "30123 Painting System" in "CHAPTER 3 MECHANICAL WORKS".

40114 Equipment Included

All equipment, switchgear, panels shall include necessary equipment as presented herein.

(1) Molded Case Circuit Breaker (MCCB)

Each MCCB shall be four or three or two poles with pole internally ganged and operated by one central toggle, auxiliary switch, and pad-lock shall be provided.

Each pole shall have a separate thermal and separate magnetic tripping mechanism, both of which shall preferably be adjustable.

The toggle assemblies of all poles shall be internally and mechanically interlinked for simultaneous isolation of all poles under fault conditions, and be so arranged that the over load tripping characteristics the calibrations of each pole shall be completely unaffected by the loading of its neighboring pole or poles.

The tripping mechanisms and calibrations shall be unaffected by fluctuating and high ambient temperature.

(2) Starters/Magnet Contractors

The starters/magnet switch shall be three or two poles, 50 Hz, 600V AC., magnetically operated, as shown on the drawings.

Starters/magnet contractors provided for installation associated with electric motors shall be of the automatic star-delta starter type or reactor starter type or auto-transformer starter type or direct on-line type with ammeter, current transformer, selector switch, control switches, signal lamps, hour-meter, overload relays single phase prevented, etc. as shown on the drawings.

Each motor starter shall have a 230V operating coil and 400V adjustable three (3)-element over load relays, with manually reset switch. Auxiliary contacts shall be provided .

Reactor starter type shall be closed circuit transition, with 55%, 65% and 80 % type. Unless otherwise, the 65 % tap shall be used.

(3) Control Transformer

The control transformer shall be indoor, dry-molded resin insulated, natural air-cooled, dead-front type and as shown on the drawings.

(4) Control Switches

Control switches shall be of twist type, push-button type or pull switch type. In each switch, the moving contact shall be made of high conductivity, water-proof and arc-proof metals with dust cover.

Each push-button shall employ double break, silver-to-silver contacts. Operator shall be without guard and shall have a red button for alarm acknowledge.

(5) Phase and Sequence Selector Switches

Phase and selector switches shall be heavy-duty, rotary type. The phase and sequence selector switches shall be near resistant type and arc-proof type, and with dust cover.

(6) Alarm Annunciators

The individual and the group annunciators shall be provided with automatic visual and audible alarms to indicate abnormal conditions in the treatment plant. Heavy faults shall be indicated by flicker lights and bell and minor faults by flicker lights and buzzer.

Pressing the "BUZZER RESET" push-button shall stop the flicker light, and silence the buzzer.

The light shall go out when the alarm condition is removed and pressing the "LAMP RESET" push-button.

All annunciator lights shall become on by the "LAMP TEST" push-button at normal condition.

Annunciator lights shall be housed in boxes and engraved fault name plate covers with black letters on a white background shall be provided.

(7) Signal Lamps

Globes and lamps shall be designed to permit easy replacement from the front of the panel. Globes shall be of round or square type and shall be made of plastic resin or glass which is not easily discoloured.

Color caps shall be made of a material which will not be softened by the heat from the lamps. Each signal light shall be provided with an auxiliary transformer.

Red signal light shall be applied for 'RUN' of a motor, green for 'STOP,' and yellow for 'OVERLOAD'.

(8) Instruments and Protection Relays

Voltmeter, ammeter, wattmeter, power factor meter and frequency meter shall not be less than 95 millimeters square, 240 degrees from zero to full scale, $\pm 1.5\%$ of full scale accuracy, panel mounted type and shall be provided with external zero adjustment screw.

Watt hour meter shall be induction disc panel mounted, non-reset, six (6) digit range type.

All protection relays shall be suitable type for operation with instrument transformer ratios and connections as shown on single line diagrams under both normal and short circuit conditions.

AC. Under voltage relay shall be three (3)-phase type.

Hour meter shall be cased, panel mounted, non-reset, and of 9,999.9 hour range.

(9) Auxiliary Relays

Auxiliary relays shall be the general purpose industrial type, and shall be the dust cover enclosed plug-in type.

(10) Terminal Block

Terminal block shall be of plastic molded type or other equal and approved. It shall have a barrier between terminals. Control terminal block shall be attached with extra terminals of more than ten (10) percent of the total number of terminals.

(11) Fuse

For panels and electrical equipment, cartridge fuse and holder, plug fuse and holder and/or current limit fuse shall be provided.

(12) Instrument Transformers

Potential transformers and current transformers shall be molded resin-rubber insulated.

Potential transformers and current transformers shall be secondary voltage and current 110V, 1A, accuracy class 1.0 class and insulation level 3 kV r.m.s.

Current transformers shall have sufficient thermal and mechanical strength to withstand, without damage, current equal to the momentary and interrupting rating of the breaker.

(13) Static Capacitors

Static capacitors for improving power factor shall be all plastic film, hermetical type, three (3)-pole, 50Hz. 400V, with discharge resistance, and shall be connected before a thermal relay.

(14) Test Terminals

Test terminals shall be furnished for the secondary circuit of the potential transformer and the current transformer. All matching test plugs shall be furnished. Test plugs and lead wires for each type of protective relay shall be furnished.

40115 Materials

All materials, fittings and accessories are to be new and in accordance with the requirements of the current rules and regulations.

Uniformity of type and manufacture of fittings or accessories is to be preserved as far as practicable throughout the whole work.

Wherever, in this specification, an article, material, apparatus, equipment, or process is called for by trade name or by the name of patentee, manufacturer, or dealer, it shall be understood as intending to mean and specify the article, material, apparatus, equipment, or process designed, and equal hereto in quality, finish, design, efficiency, and durability and

equally serviceable for the purposes for which it is intended.

The Contractor shall if required by the PMO/Engineer submit samples of materials for their approval before placing an order.

The Contractor shall be responsible for all materials, apparatus and equipment furnished by him in connection with his work, and shall take all special care to protect all parts of finished work from any damage until these are handed over to the Employer.

All materials shall at all times during construction be adequately protected against mechanical injury or damage by water. If any apparatus has been damaged, such damage shall be repaired by the Contractor at his own cost and expense. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through a special dielectric test as directed at the cost and expense of the Contractor or shall be replaced by the Contractor at his own expenses.

40116 Tests

(1) General

All electrical equipment shall be completely assembled at the factory and site. They shall be subject, unless otherwise noted, as specified herein.

All tests prescribed in the current Edition of the Standards listed in 40102 Standard and Regulations, together with all amendments as applicable, shall be carried out by the Contractor on the completed installation.

Tests may also be required during progress of the Contract for insulation resistance, continuity of all conduit and earth connections, and also the ability to withdraw all cables or any cables from conduits.

In addition to any tests required by the Manufacturer upon completion of the installation, tests for polarity, insulation resistance, earth continuity and adequate operation of all parts of the installation shall, as stated above, be carried out by the Contractor. The Contractor shall provide accurate instruments and apparatus and all labour required for such testing.

All test must be carried out in the presence of the PMO/Engineer or such other person appointed for this purpose, but the Contractor alone will be held responsible to the authorities as to the installations compliance with rules and regulations.

The Contractor will be required to give all notices or details to enable the insulation to be tested or inspected. All cost arising from the inspection and any subsequent inspection or re-testing shall be borne by the Contractor.

Duplicate copies of the results of these tests shall be provided within fourteen (14) days of the witnessed tests, and the Contractor will be required to issue to the PMO/Engineer the requisite certificate upon completion, as required under the regulations referred to above.

Any faults, defects, omissions or faulty workmanship, in correctly positioned or installed parts of the installation made apparent by such inspections or tests shall be rectified by the Contractor at his own expense.

If, during running of the tests, one or more points appear to be out by more than the specified amount, the manufacturer's field engineer shall make such adjustments or alterations as are necessary to bring equipment up to specification performance.

The Contractor shall notify the PMO/Engineer at least thirty (30) calendar days prior to the manufacturer's factory tests. The inspector appointed by the PMO/Engineer reserved the right to witness all tests.

The Contractor shall furnish the service of the manufacturer's serviceman, all special tools, temporary materials, electricity, fuel, assistance, labor, apparatus and instruments as may be requisite and as may reasonably demanded to carry out such factory tests and field tests efficiently.

The Contractor shall provide a safe working environment for factory tests and field tests.

The tests can be made at either 50 Hz. or 60 Hz. If the tests are made at 60 Hz., the manufacturer shall submit six (6) certified sets of calculations showing the equivalent 50 Hz., test parameters together with the 60 Hz. test data.

The results of all the tests shall be recorded on test certificates to be signed by the Contractor and submitted to the Employer for record purposes. The original of the Test Certificate shall be submitted to CEB together with a Completion Certificate.

The Contract works shall not be considered complete until all tests have been completed to the satisfaction of the PMO/Engineer supply authority and the "As built drawings" have been approved.

(2) Factory Tests

Factory inspection will be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations.

Approval of equipment at the factory only allows the Manufacturer to ship the equipment to the site, and does not constitute final acceptance by the PMO/Engineer.

All electrical equipment shall be completely assembled at the factory. They shall be subject, unless otherwise noted, to the following tests by the Contractor.

- a) Verification of construction
- b) Mechanical operation tests
- c) Electrical operation tests
- d) Accuracy tests
- e) Voltage, current characteristic tests
- f) Efficiency tests
- g) Temperature rise tests
- h) Withstand voltage tests
- i) Short-time current tests
- j) Short circuit current tests
- k) Acoustic sound level tests
- l) Weatherproofing tests
- m) Accessories and spare parts test
- n) Any other tests which may be required by the PMO/Engineer.

(3) Field Tests

Upon completion of the electrical installation work the installations shall be subject to the following tests.

- a) Verification of construction
- b) Mechanical operation tests
- c) Electrical operation tests (include remote)
- d) Insulation tests
- e) Withstand voltage tests
- f) Polarity tests
- g) Earth loop impedance tests
- h) Earth electrode tests
- i) Testing and setting up of all timers, alarm points, electrode length and protective relays
- j) Any other tests which may be required by the CEB or the PMO/Engineer.

40117 Accessories and Spare Parts

(1) Accessories

For all equipment and panels, all essential and desirable accessories for installation, operation and maintenance shall be furnished and installed, which shall include but not be limited to the items specified hereinafter.

(2) Spare Parts

All spare parts shall be properly preserved and packaged for a long period of storage before use, in hot and humid climate and shall be properly marked in the English language on the outside to permit easy identification of the contents without opening and exposing the contents to the atmosphere.

(3) Tools

The Contractor shall furnish all standard and special tools that may be required for the installation, testing and servicing of the equipment.

These tools shall be properly packed in a suitable steel box with the contents listed on the outside in neat lettering in contrasting color, in the English language. Each tool box shall be provided with a lock and keys.

40200 ELECTRIC POWER RECEIVING SYSTEM

- * Presently, the existing power source for the equipment in the treatment works receives from a common overhead line of CEB with each one line of 20 kV and 400 V separately.
- * Under this project, the power supply is to be performed by CEB with 400V/230V, three(3)-phase, four(4)-wire, 50 Hz.

The Contractor shall install metering equipment, and provide necessary electric flexible conduit for CEB's underground cables from the pole-mounted transformer to the low-voltage switchgear including manholes and other associated civil works.

The Contractor shall liaise with the CEB's staff during his works and submit notice of commencement and completion certificate to them for electrical works.

The Contractor shall also liaise with the Mauritius Telecommunications Corporation in the same manner for telecommunication systems.

The cost for electricity consumed before the handing over to the Employer shall be borne by the Contractor.

- (1) Before executing the work, the Contractor shall consult with the CEB and obtain approval on the design and execution.
- (2) All required documents submitted to the CEB on formal application for power receiving, shall be made up in six(6)-copies and furnished by the Contractor to the PMO/Engineer.
- (3) The Contractor shall install standard tariff meter equipment where called for on the Drawings.
- (4) After installation of the power receiving, field tests and protection relays setting for power receiving shall be done in accordance with the CEB's regulations, and the Contractor shall furnish six-(6) copies of reports on the results of tests.

- (5) The CEB will carry out the following supply and installation of;
- a) over head extension–line to the site,
 - b) poles and supports for transformer,
 - c) a power transformer,
 - d) primary and secondary cut–out switches,
 - e) service cable from the transformer to the main MCCB in the low–voltage, switchgear for the Plant use, and
 - f) metering equipment in low–voltage switchgear.