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SECTION 11395

SLUICE GATE (PENSTOCKS), STOP LOGS AND WEIRS

1 GENERAL

1.1 Scope of Work

A. Furnish all labor, materials, equipment and incidentals required and install complete, sluice gates, weirs, stop logs, operators, operating systems and appurtenances as shown on the Drawings and as specified herein.

1.2 Submittals

A. Submit to the Engineer, shop drawings and product data showing materials of construction and details of installation for:

1. Complete description of all materials.
2. Certified shop and installation Drawings showing all details of construction, dimensions and anchor bolt locations.
3. Descriptive literature, bulletins and/or catalogs of the equipment.
4. 4. Description of surface preparation and shop prime painting of gates and accessories.

B. In the event it is not possible to conform to certain details of this Section, describe completely all non-conforming aspects.
C. Design Data: Calculations showing operating thrust and stem design.
D. Operation and Maintenance Data: Operating and maintenance instructions for each type of equipment shall be furnished to the Engineer as provided.

1.3 Reference Standards

A. American Society for Testing and Materials (ASTM).
B. National Electrical Manufacturers Association (NEMA).
C. British Standards (BS).

1.4 Quality Assurance

A. The sluice gates, weirs, stop logs operators, operating stems and appurtenances specified under this Section shall be furnished by manufacturers who are fully experienced, reputable and qualified in the manufacture of the equipment furnished with minimum 10 years' experience. The sluice gates, weir gates, stop plates, operators, operating stems and all related equipment shall be designed, constructed and installed in accordance with the best practices and methods.

2 PRODUCTS

2.1 Sluice Gates (Penstocks) Stop Logs and Weir

A. General: Provide sluice gates of the wall mounted type unless otherwise approved.

1. Spindle Nut: Machine cut from high molecular weight polyolefin having low coefficient of friction.

2. Seals: Provide sealing to door faces and side guides in high molecular polyolefin and provide backing strips in expanded neoprene.
3. Fasteners: Stainless steel.
4. Grout: Non-ferrous type.

B. Materials:

5. Door: Provide door comprising a core of rigid cellular polymer, sandwiched between two (2) sheets of a rigid compressed composite plastic of high tensile and impact strength, and which is stabilized against ultra-violet light. Door shall be totally enclosed in a stainless steel AISI 304matrix.
6. Operating equipment: sluice gates shall be provided with cast iron pedestal with handwheel, crank operated enclosed gear single speed. Provide motorized actuators where indicated of approved manufacture, adequate for the operation indicated and as specified hereafter.
7. Frame and Spindle: Frame and spindle shall be of stainless steel AISI 304 and unless otherwise approved, the spindle shall be rising type.
8. Spindle Nut: Machine cut from high molecular weight polyolefin having low coefficient of friction.
9. Seals: Provide sealing to door faces and side guides in high molecular polyolefin and provide backing strips in expanded neoprene.
10. Fasteners: Stainless Steel.
11. Grout: Non-ferrous type.

2.2 Motorized Actuators

A. General: Sluice gates shall be manually operated or shall be provided with motorized actuators as shown on the bills of quantities.
B. Actuators shall be special reduction gear boxes, driven by a motor and suitably provided with torque and limit switches. The torque cut-out switches shall be such that they can be set over a wide range of torques. Manual operation and mechanical position indicator shall also be furnished. Actuator motors installed within enclosures for odor control shall be explosion proof.
C. The interchangeable driving gears, worm gear and output shaft shall be mounted in a best quality, sealed, oil bath, grey iron case. The design shall be such to permit the gear case to be opened for inspection or disassembled without releasing the stem thrust or taking the valve out of service. The worm shall be of alloy steel with threads carbonized, hardened and round for high efficiency and long life; the worm gear shall be cast from the highest quality nickel bronze, whereas helical gear and pinion forming first reduction shall be of heat-treated alloy steel with teeth hobbed and finish shaved for accuracy. All shafts shall run in ball or needle bearings of high quality.
D. Electrical equipment shall be fitted in a separate compartment and sealed off from the totally enclosed gearing. Electric motors shall be of the totally enclosed fan cooled type especially designed for valve control.
E. The contactor which starts and stops the motor shall be operated by a push-button control circuit which shall include a torque switch closing" direction only; limit switch for "opening" and "closing"; "blinker" switch to indicate "running" and terminal box. The travel limit switch may be combined with the torque switch to provide additional safety. If a foreign body gets under the valve seat, the torque valve seat, the torque switch shall cut out before the travel limit is reached and a warning light shall indicate "fault". Also, the equipment shall be arranged to halt the valve at any required intermediate position.

F. For manual operation a lever shall separate the drive motor from the gearing and shall connect the hand wheel which is of heavy steel directly with the output shaft. One turn of the hand wheel shall equal one revolution of the output shaft. If during manual operation the motor is engaged by remote control, the hand wheel shall be automatically disconnected.
G. Actuators shall be provided with a protective system according to accepted electrical standards.
H. Each actuator shall be supplied with a startup kit comprising installation instructions, wiring diagram and sufficient spare cover screws and seals.

2.3 Stop Logs

A. Stop logs shall be of aluminum to BS 1474 or other light corrosion resistant material and shall be securely embedded into the structure. All frames shall be AISI 304 L, suitable lifting facilities shall be provided. Stop boards (stop logs) shall be to the dimensions shown on drawings. Provide guides and inverts of stainless-steel construction and neoprene seal and EPDM Gasket on the frames.

2.4 Weirs, Plates and Adjustable Weirs

A. Weirs shall be of stainless steel 304 L. The weirs shall be fixed to the adjoining structures by stainless steel bolts.
B. Adjustable or variable weirs shall be stainless steel AISI 304 and shall be varied in height mechanically by a motorized system linked to a local control panel with transmission to main control panel.

3 EXECUTION

3.1 Installation

A. Installation of all gates and guides shall be done in a workmanlike manner. Handle, store and install the equipment specified in this Section in strict accordance with the manufacturer's drawings and recommendations. Frames and guides shall be installed in a true vertical plane and shall be installed with 90-degree corners.
B. Gates with embedded guides and inverts shall be installed in accordance with the recommendations of the manufacturer subject to the Engineer's approval.
C. Stainless steel chemical bolts shall be used for fixing of guides and inverts to concrete structures.

3.2 Field Testing

A. After installation, all gates, stop logs and weirs shall be field tested at maximum differential head to ensure that all items of equipment are in compliance with the specifications, including the leakage requirements.

    1. Maximum allowable leakage for sluice gates and stop plates shall be 0.375 liters per minute per 300 mm of perimeter under the design seating head.

B. In the event that any unit fails to meet the above requirements, the necessary changes shall be made and the unit re-tested. If the unit remains unable to meet the test requirements to the satisfaction of the Engineer, it shall be removed and replaced with a satisfactory unit at no cost to the Owner.

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SECTION 11420

CENTRIFUGE

1 GENERAL

1.1 Work Included

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of centrifuges, including ancillary equipment.

1.2 Related Work

1.2.1 Supplies and Works Included Under This Section Shall Comply With:

a) Section VII – A: General requirements;
b) Section 01010 - Corrosion protection;
c) Section 01020 - Basic mechanical requirements;
d) Section 01030 - Basic electrical requirements;
e) Section 14100 – Pipes and fittings;

1.2.2 Works Under This Section Shall Be Co-Ordinated With:

a) Concrete works covered by the Civil and Building Works Section;

1.3 System Description, Characteristics and Operating Conditions

1.3.1 Description

The centrifuges shall be installed in order to dewater the sludge.

The characteristics are detailed in the Employer's Requirements.

Moreover, the Contractor shall provide characteristics of the proposed equipment in the Technical Schedules under Part 1.

1.3.2 Control and Monitoring

The operation mode of the centrifuge should have both:

1. Manual control and PLC automatic control.
2. Local control and distance control.

A local control box, including a manual emergency stop button, shall be set up close to the centrifuges. It will be IP 55 protected.

The box will be composed at least of the following controls and instructions, for each equipment:

3. Manual / auto commutator
4. Lighted button "ON"
5. Lighted button "OFF"
6. Defaults presentation:

The Contractor shall provide a detailed document explaining the control and regulation system he wants to install, concerning the machines control and the way this equipment will be connected to the general computer. Moreover, the following detectors shall be installed and connected to the PLC:

1. High and low levels detection soundings in chambers.

2. Malfunctions and alarms.

1.3.3 Design Criteria

All equipment and constructional arrangements for which the Contractor is responsible under the terms of the Contract must be sufficient to achieve the treatment levels indicated in the Employer's Requirements.

Unless otherwise specified, all the electrical equipment will be water proof registered IP54.

1.4 Quality Assurance

1.4.1 Shop Tests and Inspection

1. Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
2. Inspection and testing of standard products: the Contractor shall supply certificates of routine tests.
3. Workshop inspections and tests:
   a) The seals and the embedded parts shall be presented separately and unpainted for checking.
   b) The surface appearance of embedded parts shall be examined and their dimensions checked. Rolling, sliding and plate sealing surfaces shall be perfectly flat and smooth.
   All dimensions shall be checked.
   c) Welds: Refer to Section 01020 – Basic mechanical requirements.

1.4.2 Submittals

The supplier should submit the following documents (non-exhaustive list):

1. Detailed Ichnography and section diagram and specification for equipment, showing all functional dimensions and space necessary for maintenance, operation and installation…
2. Detailed performance specification of equipment and drawings of all parts
3. Process detailed calculation notes justifying that design criteria are respected.
4. Installation, maintenance and operation manuals with requirements of accuracy
5. Manufacture and quality assurance measures
6. Protective coating list of all parts
7. Commissioning tests list.
8. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.
9. Internal wiring diagrams and control principle drawing of control box.
10. Weight and material of each component.

1.5 Dimension Tolerances

The requirements of Section 01020 – Basic mechanical requirements – will apply

2 PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1 Materials

Centrifuging machine:

- Chassis: 304L stainless steel

- Cover: polyester
- Metal parts in contact with the sludge: 316L stainless steel

2.2 Fabrication

2.2.1 Centrifuging Machine

- Dual motor with relative variable speed drive regulated by the extraction torque,
- One impeller with 304L stainless steel extraction screw and bowl,
- Casing of effluent and sediment outlets made of 304L stainless steel,
- Complete assembly mounted on anti-vibration blocks,
- High-pressure impeller,
- Torque reading system with electronic control module,
- Continuous relative speed control device on conveyor torque measurement,
- Safety system on conveyor torque and hydraulic start-up coupler for alarm shut-down,
- System for recovering braking energy from the drive shaft,
- One outlet hopper for centrifuged sludge made of 304L stainless steel,
- One degassing device connected to the draining network and to the waste air extraction network,
- Special tooling for machine maintenance,
- One sampling offtake with stop valves (2) for automatic and manual sampling of supernatants.

2.2.2 Removal of Supernatants

The supernatants will be conveyed by gravity flow to the all-water station.

2.3 Operation

2.3.1 General

Operation of the centrifuges shall be totally automatic, including the shut-down and rising phases.

A) Centrifuging Machine

Constant performance of the machines (dryness level of dehydrated sludge) is achieved by maintaining a constant conveyor torque, which is itself achieved by automatic adjustment of the differential speed. The automation systems will also allow the feed flow rate to be controlled (limitation of flow rate in the event of an abnormal rise in torque).

The machines and their associated equipment are fastened to the civil structures through anti-vibration devices.

B) Miscellaneous

The installation includes:

- rinsing water offtakes at all levels in the various circuits,
- the industrial water inlet for washing, with back-up drinking water supply (inlet protected by a disconnector),
- the rehandling pipes for supernatants with visual monitoring of the product and sampling system, (quarter-turn tap and manholes or gutters connected to the drain network),

- the thickened sludge supply pipes with sampling system (quarter-turn tap and manholes or gutters connected to the drain network),
- a washing water removal system.

All the pipes connected to the machine are fitted with Dilatoflex-type flexible joints. The control and monitoring equipment of the installation includes;

- measuring instruments (flow-meters) on each line and on all the circuits (sludge, polymer, supernatants),
- a local start-up control with total parameter definition (in addition to the control system from the centralized control room),
- automatic reading and monitoring of the resistance torque for instantaneous protection against feed overloads (adjustable thresholds for tripping and alerts),
- reading, monitoring and adjustment of the relative speed,
- a bearing temperature monitoring system,
- a vibration monitoring system.

The control cabinet(s) for the machines is (are) installed away from potential projections of water or sludge, in a closed, well-lit and ventilated room.

C) Handling

It must be possible to remove the machines from the building using the handling equipment installed at fixed stations, so that they can be handled outdoors without difficulty.

2.4 Spare Parts

The Contractor shall indicate the volume of spare parts and tools required for an operating duration of three years.

3 EXECUTION

3.1 Inspection Before Erection

The Contractor shall check the setting and alignment of pre-embedded parts as well as the dimensions and setting of recesses in the civil works for embedded parts.

3.1.1 Inspections Before and After Concreting

1. The following inspections shall be carried out before and after concreting:
   a) Holes position
   b) Flatness, verticality, horizontality of the embedded parts,
2. Erection tolerances:

Refer to Section 01020 and paragraph 1.6.2.

3.1.2 Dry Tests

1. Examination of paintwork.
2. Machine must run for two hours without water and without any noticeable problem (noise, axial position…).

3.1.3 Commissioning Tests

1. Examination of paintwork.

2. Checking of operation parameters.
3. 3Checking of operation conditions for nominal flow and during 24 hours. The sludge flow shall remain nearly constant during these 24 hours testing operations;
4. If the test results cannot satisfy technical requirements, the supplier has to make rectification, changing equipment or taking improvements until the requirements in tender documents are reached. All relative rectification expenses will be undertaken by the supplier.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 11600

LABORATORY EQUIPMENT AND SUPPLIES

1 GENERAL

1.1 Scope of Work

A. Furnish all labor, materials, equipment and incidentals required and supply all laboratory equipment as specified herein and install in the existing laboratory, as directed by the Engineer.
B. The laboratory shall be suitably equipped to enable a monitoring of the parameters of the plant influent, the effluent and the composition of the wastewater at various plant stages including sludge and odors, and shall cover, but not be limited to the parameters as described in the technical specifications.

1.2 Submittals

A. Submit to the Engineer, complete lists of equipment and supplies including catalog cuts, data sheets and other pertinent information.
B. Furnish at the time of delivery of materials four copies of the manufacturer's printed instructions for operation and maintenance of equipment, where applicable.

1.3 Delivery, Storage and Handling

A. Deliver materials in manufacturer's original unopened and undamaged packages in a manner to prevent damage from environment and construction operations. Handle in accordance with manufacturer's instructions.

2 PRODUCTS

2.1 Laboratory Equipment and Supplies

A. The laboratory equipment shall be furnished, assembled and located as directed by the Engineer.
B. Laboratory Furniture: The furniture for the laboratory shall comprise adequate number of refrigerators and ovens for storing of samples at different temperatures, working tables, fume hoods, cupboards for acids, alkalis and solvent, and safety cabinets, dish-washers, etc. in order to meet all requirements for a proper execution of all necessary works. The furniture and equipment have to be approved by the Engineer.
C. Laboratory Equipment and Consumables: The laboratory equipment, tools and chemicals to be supplied shall comply with the requirements of the technical specifications, shall be in an adequate number and quality to the approval of the Employer's Representative, and shall consist of, but not be limited, to the following:

1. Branches
2. Sinks
3. Fume cupboards
4. Gas supply
5. Bunsen Burners
6. Instant balances

7. Standards Laboratory equipment
8. Standards tools
9. Standard chemicals

D. List of additional Equipment for laboratory

1. Ultra Sonic Cleaning Bath:
    a. Laboratory Model about 15-liter capacity, 316 L stainless steel construction, 300-watt output power ultrasonic generator.
    b. With variable speed and temperature control.
    c. Tank provided with full line and drain.
2. Water Bath:
    a. Complete with removable perforated shelf (6 positions).
    b. Constant level device fitted with element safety cut off.
3. Oil and Grease Testing Equipment:
    a. To measure trace of oil in water with built in extractor.
    b. Measuring Range 0-200 mg/l.
    c. Resolution 0-99.9 mg/l accuracy 0.01 mg/l digital display.
    d. Also, solvent reclamation system for the above.
4. COD – analysis equipment
5. BOD analysis equipment:
    a. BOD incubator, temperature control at 20°C.
    b. Capacity for 100 bottles.
    c. BOD instantaneous measuring device
6. PH Meter:
    a. Which can measure conductivity salinity and total dissolved solids.
    b. Laboratory Type.
    c. Measuring range 0 - 14 PH.
    d. Accuracy 0.01 PH.
    e. Provided with Printer.
    f. Necessary Electrodes, Electrolytes and Calibration solutions and other accessories.
7. Redox meter
8. Spectrophotometer:
    a. Laboratory model complete set for accurate colorimetric determination.
    b. Variable speed Blender:
        1. 1 or 2-liters capacity with variable speed controller
        2. Reagent Kit for tests
9. Incubator Culture – for microbiology:
    a. Culture incubator for routine incubation
    b. Small working load for tubes and Petri dishes for coli form and other pathogen incubation, temper controller in the range of 5 to 80°C with uniformity 0.25°C.
10. Refrigerator Spark Free:
    a. For sample storage
11. Sedimentation Cone: One set
12. Color Comparator – Lovibond:

a. For Field test – chlorine & Amm – N with necessary accessories.

13. TKN – Digesdahl HACH digestion distillation apparatus:
14. Dimensions 14 x 16 x 33 cm approximately.
15. Corrosion resistant
16. Variable 25 – 250 watts.
17. Analytical Electro Mechanical Weighing machine up to 210g
18. Microscope-eyepiece tube binocular (40x – 100x).
19. Oxygen Microprocessor meter.
20. Magnetic heating sterile.
21. Suspended Solids meter (portable type).
22. Rotary vane vacuum pump, flow rate 0.9m³/h
23. Forced draft oven up to 220ºC
24. Muffle oven up to 1100ºC
25. Consumable materials for Laboratory during the specified maintenance Period.
26. All necessary Furniture
27. Any other equipment needed to perform the tests required as per Employer requirement.

3 EXECUTION

3.1 Installation

A. All equipment shall be uncrated when directed, assembled as required and tested, where applicable, all to the satisfaction of the Engineer.
B. All equipment shall be assembled and installed in accordance with the manufacturer's printed instructions with all nuts, bolts, washers, clips and other hardware required to complete the assembly and installation.
C. After satisfaction assembling, testing and cleaning, install and store equipment in the locations directed by the Engineer.

3.2 Product Shelf Life, Warranty and Service

A. Product shelf life of perishable supplies and reagents and time-dated equipment shall not be exceeded on any item at the time of acceptance of the project.
B. Manufacturers of equipment items which include authorized installation in the purchase of their products shall furnish a written statement that the installation of the components will be performed at a time to be designated by the Engineer.
C. Manufacturers of equipment items which include guarantees, warranties, service contracts and / or customer training in the purchase of their products shall furnish a written statement that the time period of these services will start upon installation of the equipment to the satisfaction of the Engineer.

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SECTION 13241

AIR BLOWERS

1 GENERAL

1.1 Work Included

1.1.1 Scope of Supply

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of air blower system equipment, including but not limited to:

1. Air compressors,
2. Step-up gear,
3. Motor,
4. Check valve,
5. Diffuser at delivery end,
6. Filter at inlet,
7. Silencer at delivery end,
8. Vent silencer,
9. Acoustic enclosure,
10. Control cabinet,
11. Pipes,
12. Pre-embedded parts

The pre-embedded parts (steel plates, continuous sections, etc.) to which will be attached the adjustment rods of the permanent embedded parts, shall be supplied, fitted and anchored in the primary concrete under Civil Works Section as will be shown on the civil construction drawings.

13. Embedded parts

Embedded parts are steel parts anchored either in the secondary concrete or primary concrete and which may be subject to operating loads.

The embedded parts (anchors, support parts, etc.) shall be supplied and installed by the Contractor under the present section.

Concreting of the embedded parts shall be covered by Civil Works Section.

14. Covers above the slots shall be provided by the Contractor.

1.2 Related Work

1.2.1 Supplies And Works Included Under This Section Shall Comply With:

A) Section VII – A. General Requirements;
B) Section 01010 - Corrosion protection;
C) Section 01020 - Basic mechanical requirements;
D) Section 01030 - Basic electrical requirements;

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A) Concrete works covered by the Civil Works Section;
B) Electrical works covered by the Electrical Equipment Section;
C) Section 17200 – Instrumentation.

1.3 System Description, Characteristics and Operating Conditions

1.3.1 Operating Conditions

Air blowers are mainly used in the biological treatment to guarantee the amount of oxygen needed for the bacteria to remove organic pollution. An air flow at certain pressure shall be provided at the bottom of the biological tanks. This incoming air shall be homogenously distributed by the air diffusion systems.

Compressed air is provided thanks to an air compressor located near the biological tank. Each compressor shall operate with one tank.

Air pipes shall be equipped with manual ball valves and solenoid valves.

The Contractor shall design air compressors and pipes dimensions and parameters, according to the biological tanks designs. He shall provide a calculation note to ensure the efficiency of his overall aeration system, particularly concerning involved flows and levels.

Moreover, the Contractor shall provide characteristic curves of proposed compressors in the Schedules of Particular:

- Pressure increasing in bars
- Input flow in m^3/min
- Absorbed power in kW

In addition, the following items shall be précised in his bid:

- Rotating speed in rd/min
- Nominal power of the driving motor
- Weight of the overall equipment and of each main part
- Input and output ports diameters
- Main operation loads, particularly when they are in relation with Civil works fastenings.

In addition, the Contractor shall specify the maximum reaction force at the delivery end with a view to designing the delivery end piping anchoring device. He shall also specify the maximum forces on the delivery end flange.

The Contractor's bid shall include:

- performance guarantees
- the simplified installation drawings of the proposed equipment
- the characteristics of the equipment
- the nature of the proposed materials
- the technical data sheets or manuals for the coatings used
- the coating procedure

1.3.2 Control and Monitoring

The operation mode of air compressors should have both:

1. Manual control and PLC automatic control.
2. Local control and distance control.

Air compressor local control facilities shall be located close to the biological chambers.

The box will be composed at least of the following controls and instructions, for each equipment:

3. Manual / auto commutator
4. Lighted button “ON”
5. Lighted button “OFF”
6. Defaults presentation.

The Contractor shall provide a detailed document explaining the control and regulation system he wants to install, concerning both machines control and the way these equipment will be connected to the general computer. He shall particularly describe the automatic operation principle he wants to install for the air blowing control.

Moreover, the following detectors shall be installed and connected to the PLC:

7. Malfunctions and alarms.

1.4 Quality Assurance

1.4.1 Codes and Standards

A) BS 2009/ASME PTC 10 Performance tests
B) ISO 1940 Balancing
C) VDI 2055 Vibrations

1.4.2 Design Criteria

See performance specifications.

1.4.3 Shop Tests and Inspection

A) Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
B) Inspection and testing of standard products: the Contractor shall supply certificates of routine tests.
C) Workshop inspections and tests:
   a) The seals and the embedded parts shall be presented separately and unpainted for checking.
   b) The surface appearance of embedded parts shall be examined and their dimensions checked. Rolling, sliding and plate sealing surfaces shall be perfectly flat and smooth.

All dimensions shall be checked.

   c) Welds:

Refer to Section 01020.

1.5 Submittals

The supplier should submit the following documents (non-exhaustive list):

1. Detailed Ichnography and section diagram and specification for equipment, showing all functional dimensions and space necessary for maintenance, operation and installation…
2. Detailed performance specification of equipment and drawings of all parts
3. Hydraulic and process detailed calculation notes justifying that design criteria are respected.

4. Installation, maintenance and operation manuals with requirements of accuracy
5. Manufacture and quality assurance measures
6. Protective coating list of all parts
7. Commissioning tests list.
8. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.
9. Internal wiring diagrams and control principle drawing of control box
10. Weight and material of each component

1.6 Guarantee

1.6.1 Performances

The Contractor shall provide a calculation note proving that the equipment he intends installing have an efficient capacity to aerate the biological chambers, for a Qmax flow (of far future) and during 5 hours.

Air compressor noise shall not exceed 80 dB at a distance of 1 meter from the equipment.

Vibrations amplitude shall not exceed values specified by the VDI 2055.

1.6.2 Dimension Tolerances

The deviation of the plane position shall be less than □ 20 mm. The elevation deviation shall not exceed ± 10 mm.

2 PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1 Fabrication

2.1.1 Air Compressor

The air compressor should be equipped with appropriate:

1. Inlet dust filter,
2. Silencer,
3. Discharging pressure valve,
4. Pressure protection device,
5. Pipe flexible joints.
6. Motor
7. Acoustic housing
8. Control box

2.1.1.1 Characteristics of Step-Up Gears

The step-up gear mechanism shall be single-stage helical. The shafts and gears shall be machined out of forged steel and the profiled teeth gears shall comply with the requirements of AGMA 11-13 (American Gear Manufacturers Association) or equivalent.

The slow-speed bearings shall be of the roller bearing type, and the high-speed bearings shall be of the oscillating sole plate bearing type.

The bearings shall be lubricated by pressurized oil from the lubrication plant.

The step-up gear housing shall be of 250-grade cast iron according to standard BS 1452, with a horizontal joint plane to simplify maintenance.

The shafts and gears shall be made of forged steel.

2.1.1.2 Motor

The motor shall be:

1. IP23 protected
2. 240 Volts,
3. 50-Hertz
4. Class F insulation.

The motor system should be installed on a public assembly type of steel foundation, and it shall be equipped with driving belt adjustable device, as well as the protection cover for the belt and the wheel.

The electric motors shall comply with the relevant standards and publications of the UTE and the IEC.

2.1.1.3 Driving Head

Gear box will be made of 250-graded cast iron according to BS1452.

Shafts and gear-wheels shall be made of stainless-steel A 316 L.

2.1.1.4 Wheel

Wheel shall be made of wrought aluminum.

2.1.1.5 Volute

Volute will be made of 250-graded cast iron according to BS1452.

Blades will be made of stainless-steel A 316L.

2.1.1.6 Control Cabinet and Instrumentation

The booster pump assembly shall be controlled by a PLC during the start-up, shutdown and monitoring phases.

All alarm, tripping, indicator and monitoring functions shall be displayed on a local control board.

2.2 Pipes

Inlet and outlet pipes shall be made of stainless steel 316L.

2.3 Soundproofing

An acoustic chamber shall cover the volute, the step-up gear and the motor in order to reduce noise 1 m away from the unit to 85 dB□ in a non-reverberating environment with four compressors in operation.

The installation will include a silencer system at the delivery end and a vent system.

2.4 Handling

The Contractor shall design and provide a mobile handling device with hoist and chain able to supply each blower.

They shall allow the gathering of equipment in a common assembling area.

2.5 Spare Parts and Special Tools

The contractor shall supply the spare parts which are necessary according to the manufacturer.

The Contractor shall specify and supply the special tools required for equipment maintenance and for 2 years of operation.

3 EXECUTION

3.1 Inspection Before Erection

The Contractor shall check the setting and alignment of pre-embedded parts as well as the dimensions and setting of recesses in the civil works for embedded parts.

3.2 Field Quality Control

3.2.1 Inspections Before and After Concreting

A) The following inspections shall be carried out before and after concreting:

a) Equipment position
b) Flatness, verticality, horizontality of the embedded parts,

B) Erection tolerances:

Refer to Section 01020 and paragraph 1.6.2.

3.2.2 Dry Tests

C) Testing of all operation characteristics during 24 hours and without water:

c) For each compressor taken individually,
d) For each compressors combination eventually necessary to get the overall installation flow.

During these tests, vibrations, temperature increasing and noise shall particularly be checked.

D) Examination of paintwork.

3.2.3 Commissioning Tests

Before the tests, the Contractor shall submit the detailed test procedure to be used to the Engineer for approval. This will notably include how he intends to measure the flows, pressures, powers, etc. indicating the type, brand, measuring range and precision class of the instruments he undertakes to use on the site.

1. Examination of paintwork.
2. Checking of operation conditions for nominal flow and during 24 hours. During this test, the vibration amplitude and heating shall be checked.

The amplitude of the vibrations will be measured. It will not exceed the threshold values set by the applicable standard.

3. Checking of the operating characteristics of the units individually and of any combination used to obtain the total flow rate of the installation.
4. The supplier shall provide effectiveness testing report, taking samples from upper, middle, lower, left, middle and right part of sections of incoming and outgoing water ditches, in order to check the effectiveness of aeration. Each aeration system shall fit individually with requirements.
5. If the test results cannot satisfy technical requirements, the supplier has to make rectification, changing equipment or taking improvements until the requirements in tender documents are reached. All relative rectification expenses will be undertaken by the supplier.
6. Leakage shall not be observed out of the pipes.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 14100

PIPES AND FITTINGS

1 GENERAL

1.1 Work Included

This specification applies to the supply, assembly and testing of pipes and fittings.

1.2 Related Work

1.2.1 Supplies and Works Included Under This Section Shall Comply With:

A) Section VII – A. General Requirements;
B) Section 01010 - Corrosion protection

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A) Civil Engineering works and Building works;
B) Section 08200 – Painting;
C) Section 13241 – Air blowers;
D) Section 14150 – Valves, Gates & Appurtenances;
E) Section 14270 – Dosing pumps;
F) Section 14300 – Miscellaneous pumps;

1.3 Quality Assurance

1.3.1 Standards

Preference shall be given to ISO Standards (International Standards Organization).

Other standards such as EN (European Committee for Standardization/CEN), BS (British Standards Institution/BSI), AFNOR (Association Française de Normalisation), DIN (Deutsche Standards für Normung), ASTM (American Testing and Material Standards), ANSI (American National Standards Institute), ACI (American Concrete Institute), AWWA (American Water Works Association), API (American Petroleum Institute) can only be used either if they are compatible and better than the relevant ISO Standards or when no ISO Standard covers the product, based on the Engineer's satisfaction.

All standards and references shall in any case be deemed to include the latest edition available 28 days before the deadline for submission of Bids.

All units of weight and measurements shall be based on the Metric System of Weights and Measurements.

1.3.1.1 PVC Pipes and Fittings

- ISO/R 161/1: Thermoplastics pipes for the conveyance of fluids - Nominal outside diameters and nominal pressures - Part 1: Metric series.
- ISO 264: Unplasticized polyvinyl chloride (PVC) fittings with plain sockets for pipes under pressure - Laying lengths - Metric series.
- ISO/R 265: Pipes and fittings of plastics materials. Socket fittings with spigot ends for domestic and industrial waste pipes. Basic dimensions: metric series.
- ISO/R 1133: Plastics. Determination of the melt flow rate of thermoplastics.

- ISO 2035: Unplasticized polyvinyl chloride (PVC) moulded fittings for elastic sealing ring type joints for use under pressure. Pressure-resistance test.
- ISO 2044: Unplasticized polyvinyl chloride (PVC) injection-moulded solvent-welded socket fittings for use with pressure pipe - Hydraulic internal pressure test.
- ISO 2507: Unplasticized polyvinyl chloride (PVC) pipes and fittings. Vicat softening temperature. Test method and specification.
- ISO 2536: Unplasticized polyvinyl chloride (PVC) pressure pipes and fittings, metric series - Dimensions of flanges.
- ISO 3114: Unplasticized polyvinyl chloride (PVC) pipes for potable water supply. Extractability of lead and tin. Test method
- ISO 3126: Plastics pipes - Measurement of dimensions.
- ISO 3127: Thermoplastics pipes - Determination of resistance to external blows.
- ISO 3473: Unplasticized polyvinyl chloride (PVC) pipes. Effect of sulphuric acid. Requirement and test method
- ISO 3606: Unplasticized polyvinyl chloride (PVC) pipes. Tolerances on outside diameters and wall thicknesses,
- ISO 4065: Thermoplastic pipes. Universal wall thickness table,
- ISO 4422: Unplasticized polyvinyl chloride (PVC) pipes and fittings for water supply. Specification,
- ISO/TR 7074: Performance requirements for plastics pipes and fittings for use in underground drainage and sewage,
- ISO/TR 7473: Unplasticized polyvinyl chloride pipes and fittings. Chemical resistance with respect to fluids,
- NFT 54003: PVC tubes to convoy fluids.
- NFT 54016.II: Characteristics of PVC tubes.
- NFT 54028: Plastics. Unplasticized PVC pipe elements. Assembling with adhesive. Dimensional characteristics
- NFT 54039: tests to be used for sealing-ring assemblies,
- NFT 54041: Elastomer sealing rings,
- BS 2494: - Elastomeric seals for joints in pipework and pipelines
- BS 3505: – Specifications for unplasticized polyvinyl chloride pressure pipes for cold potable water.
- BS EN 1452 - - Joints and fittings for use with unplasticized PVC pressure pipes (including hydraulic pressure tests).
- BS 4514: uPVC soil and ventilating pipes, fittings and accessories
- BS 4660: Unplasticized PVC underground drain pipe, fittings for drainage and sewer pipes. Nominal size 110 and 160.
- BS 5255: Thermoplastics waste pipes and fittings
- BS 8301: Code of Practice for building drainage
- NF EN 681-2: Elastomeric seals - Specification for materials for joint seals on pipes used in the field of water and drainage - Part 2: thermoplastic elastomers.

1.3.1.2 Ductile Iron Pipes and Fittings

- ISO 9001: Total quality Assurance System
- ISO 2531: Ductile Iron Pipes, Fittings, accessories and their joints for water application.
- BS EN 545 (or NF EN 545 – 2010): Ductile iron pipes, fittings, accessories and their joints for water pipelines — Requirements and test methods.
- ISO 4179: Ductile iron pipes & fittings for pressure and non-pressure pipelines – cement mortar lining.
- EN14901: Ductile iron pipes fittings and accessories – epoxy coating (heavy duty) – requirements and test methods.
- ISO 10804: Restrained Joint System for Ductile iron Pipelines-Design Rules and Type Testing
- NF EN 598: Pipes, connections and fittings.
- NF A 48-870: Standard joints.
- ISO 4633 / NF EN 681: Joint rings.
- EN 1514: Gasket
- EN ISO 4016 / EN ISO 4034 Bolts and Nuts

1.3.1.3 EN ISO 7091 Washers stainless Steel Pipes

- ISO 9001: Total quality Assurance System
- ISO 5252: Steel tubes Tolerance Systems ISO 1127: Stainless steel tubes - Dimensions, tolerances and conventional masses per unit length.

1.3.1.4 HDPE Pipes and Fittings

- EN 12201: Polyethylene (PE) pipes for water supply, and for drainage & sewerage under pressure-Dimensions.
- BS EN ISO 1167: Pipe tests: Hydrostatic strength testing, internal pressure test…
- ISO 3458/3459/3501/3503: Fittings test
- DIN 3543: Tapping Fittings

1.3.2 Design Criteria

All piping shall be designed for a minimum working pressure of 10 bar expect for the effluent pressure line which shall be designed for a minimum working pressure of 16 bar.

1.3.3 Shop Inspection and Test

1. Inspection

The quality of all materials, the process of manufacture shall be subject to inspection and approval by the Engineer or by an independent testing laboratory selected by the Employer. Such inspection shall be made at the place of manufacture and the pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though sample pipes may have been accepted as satisfactory.

2. Hydrostatic test

Before coating and lining each pipe with a service pressure higher than 6 bars shall be tested. The test pressure for steel pipes shall be given by the following formula:

$$P = \frac{20\,St}{D}$$

Wherein:

P = Hydrostatic test pressure in bar

S = 75% of yield point of steel used in MPa

t = Wall thickness in mm

D = Outside diameter in mm

Test pressure for PVC and concrete pipes and fittings shall be according to the applicable standards.

1.4 Submittals

1.4.1 General

In his proposal, the Contractor shall provide for all pipes and fittings all necessary guarantees concerning the nature of the materials used, the quality of execution and implementation, their stability during operation in normal conditions of use, and the interior and exterior protective linings and coatings on the pipes, as well as all supporting calculation memoranda and characteristics.

1.4.2 Certificates

The Contractor shall furnish a mill certified report, in triplicate, of the tests for each material to be utilized in the work. The certifications shall contain the result of chemical and physical tests required by these specifications for the materials.

1.4.3 Shop Drawings

The Contractor shall submit detailed working and shop drawings and schedules of all pipe, fittings and appurtenances. Shop drawings shall include but not be limited to the following:

- Lists and schedules of material, linings and coatings.
- Schedules of pipe lengths and thicknesses.
- Details of proposed joints, hardnesses and installation details.
- Names of suppliers and identification of materials and equipment to be supplied.
- Shop drawings shall show the locations of unions, bolted flanged connections or other appurtenances to permit ready dismantling of piping systems.

The work of this section shall be completely coordinated with the work of other sections. The Contractor shall verify at the site, both the dimensions and work of other sections which adjoin his materials. Field measurements shall be taken at the site and incorporated in the shop drawings, with specific notes.

1.5 Description

A) Networks materials, with appropriate protective coatings/linings shall be in accordance with the followings:

- Sewage network:
  - ~ All inlet and internal/ connection main sewage pipes shall be made of spiral welded steel for diameters greater than 800mm (Produced According to EN 10217-1 / Steel Grade S235JR to EN10025-2 with an External HDPE Coating to DIN 30670 3mm thick and an Internal Solvent Free Epoxy lining to AWWA C210 400 microns thick), Beveled Ends with a Standard Pipe Length 13.5m) and standard/restrained ductile iron for diameters up to 800mm.
  - ~ Outlet pipes for clarified water shall be made of spiral welded steel for diameters greater than 800mm (Produced According to EN 10217-1 / Steel Grade S235JR to EN10025-2 with an External HDPE Coating to DIN 30670 3mm thick and an Internal Solvent Free

Epoxy lining to AWWA C210 400 microns thick), Beveled Ends with a Standard Pipe Length 13.5m) and standard/restrained ductile iron for diameters up to 800 mm.

- Industrial water network: HDPE.
- Sludge network: Ductile Iron or Steel.
- Chemical networks: HDPE.
- Fire Protection: HDPE
- Draining / Raining Water: reinforced concrete water canal (Refer to Tender Drawings) / pipe (Class III-Wall according to ASTM C76 and AASHTO M 170).
- Pressurized air system: 316L stainless steel

B) Steel pipes will not be allowed for outdoor purposes.

2 PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1 Fabrication

2.1.1 Stainless Steel Pipes

A) General specifications

- The general characteristics of stainless-steel tubes must comply with the international standards in force.
- Pipes should be designed with smooth internal surfaces to minimize the potential for biological build-up (biofouling).
- Regular inspection and maintenance for pipes and joints should be incorporated into the operational procedures to monitor any potential localized corrosion that may occur over time.

B) Assembly

Pipes shall consist of 316L (or higher-grade alloys) stainless steel tubes and connections welded together.

Welds more than 1.5 mm thick should preferably be done with filler metal.

Welds inside pipes shall be protected by injecting argon or nitrogen into the pipe.

All welds must be cleaned mechanically or chemically (e.g., pickling, passivation…). A flushing system may be required for periodic cleaning.

Air shall be used for cooling, with. controlled cooling applied based on material thickness and welding process used to prevent unwanted thermal stresses or cracks.

The Contractor shall use parts prefabricated in the factory for bends and tapers.

All supports, fixing accessories and screws shall also be made of 316L stainless steel or higher-grade material matching the pipe grade.

2.1.2 Checking of Welds

Welds shall be prepared, carried out, checked and repaired in accordance with the specifications of NF and ISO standards.

Welds shall be prepared with hollow chamfers, V-shaped for single-side welds and X-shaped for double-side welds.

A straight root face at the base of the chamfer is only permitted if it is of regular height and small enough not to hamper penetration.

V-shaped welds will normally have chamfers opening outwards. They shall be repeated backwards after chipping.

The Contractor's checks shall include the following operations:

A) The appearance of all welds must be checked

The Contractor shall check that all welds are regular and properly connected to the part. Their width end-to-end must be no more than 1.8e + 5 mm, with e being the thickness of the sheet in the case of a V-shaped chamfer or half its thickness in the case of an X-shaped chamfer.

Average build-up is between the following limits:

$$\left(0{,}5+\frac{e}{20}\right)\text{mmet}\left(2+\frac{e}{10}\right)\text{mm}$$

Maximum difference in level is:

$$\left(\frac{e}{20}+1\right)\text{mm}$$

The length "a" of an apparent continuous defect (groove or lack of penetration) shall be less than 30 mm, the distance separating two defects less than 3a and the sum of all "a" value over the length of the joint L less than L/10.

B) Penetrant test

All welds shall be checked by means of a penetrant test as per standard ISO 3452.

The Contractor shall carry out the penetrant tests himself.

The Engineer reserves the right to carry out additional tests if he considers it necessary. The corresponding costs shall be borne by the Engineer if the results should prove to be satisfactory and by the Contractor if not.

C) Acceptance or rejection of welds

Weld defect acceptance criteria shall be determined according to the nature, service conditions and importance of the equipment inspected, and in light of the danger and consequences involved in the event of a burst.

More generally, the criteria shall be derived from the standards in force and specific to each class of equipment.

D) Repairing welds

Defective welds shall be repaired by eliminating the defective area down to sound metal and repeating the weld. Repaired areas shall be re-inspected.

If the new inspection reveals unacceptable work, an additional inspection shall be carried out on either side of the area in question.

If this new inspection does not reveal any defect leading to rejection of the weld, only the area concerned by the first inspection shall be repaired. If not, a complete inspection shall be performed.

A welded area cannot be repaired more than twice in order to avoid changes in the structure of the metal resulting from repeated heating, unless specified to the contrary.

2.1.3 HDPE Pipes

A) General

The general characteristics of HPDE pipes must comply with the international standards in force.

B) Assembly

1. Pipe Preparation

HDPE pipes shall be sawn perpendicular to the center line and cleanly to avoid sharp edges, burrs and roughness.

The area shall be completely scraped and the surface cleaned with solvent.

2. Welding Methods

Welds shall be made:

- either by butt fusion (Butt fusion: An electrically heated mirror shall be used to reach a plasticizing temperature, at the pipe ends, of 200°C ± 10°C. The weld shall be made by pressing the pipe ends together under a pressure of 1.5 to 2 kg/cm² to obtain a single continuous length,
- or by welding, particularly in the case of shaped parts:
  - with a hot steel torch (controlled temperature and air flow) and HDPE filler rod,
  - with a heated wedge device, using HDPE filler wedges,
  - by extension to all HDPE parts.

3. Connectors (couplings, Tees…)

Polyethylene connectors will also be joined by profusion, either by butt fusion or, in the case of fittings with a socket, by means of a heating sleeve or incorporated electrical heating resistance activated by an automatic welding device.

4. Connection to other materials

Connections to pipes made of traditional materials (steel, ductile iron, etc.) shall be made by means of a molded HDPE collar polyfused to the end of the HDPE tube and by a coated backing flange connected to the other material.

5. Connection to manholes

For HDPE pipe connections to manholes, neoprene holes will be added to the end of the tube or manhole access fittings shall be provided, with a welded HDPE collar and gusset assembly embedded in the concrete.

6. Pipe Testing

Pipes shall be tested in accordance with articles 76, 78 and 79 of section 71 of the French General Technical Specifications. The test pressure shall be equal to the service pressure plus 50% (article 76.5).

2.1.4 Ductile Cast Iron Pipes and Connections

A) General

All ductile iron pipes and fittings to be supplied under this Specification shall be obtained from an approved manufacturer having an ISO 9001: 2000 TOTAL QUALITY ASSURANCE system based on the latest version of the ISO 9001 standard.

The general characteristics (size, pressure classes, thickness, lengths, physical properties, test and coatings…) of ductile iron pipes, connections and fittings must comply to the latest international standards in force

A calculation note concerning concrete anchor blocks shall be submitted to the Engineer for approval.

In tight spaces, the use of restrained joints should be considered to eliminate the need for concrete thrust blocks.

B) Connection of pipes

Pipes shall be joined by socket joint and possibly elastomer seals or restrained joint. Non-buried pipes shall be joined by flanges.

C) Lining

Socket jointed pipes shall be protected with an appropriate lining suitable for exposure to salty environment and other harsh conditions (e.g., centrifuged high alumina cement mortar for the pipe and sockets with red epoxy paint), and as recommended by the manufacturer. and approved by the Engineer.

D) Coating

Appropriate external protective Coatings shall be applied (such as layer of electrolytic zinc and epoxy paint on all pipes and Red-brown epoxy powder for flange connections and connecting parts) for ductile iron pipes and connecting parts, and as recommended by the manufacturer and approved by the Engineer:

2.1.5 PVC Pipes

A) General

The general characteristics of PVC tubes intended to convey fluids are described in standard NF T 54-003.

This complies with international standards ISO/161/1, ISO/3606 and ISO/3126.

PVC tubes for pressurized or buried pipes: the characteristics of the tubes shall comply with the specifications of standard NF T 54-016.II

B) Assembly

All pipes shall have appropriate sealed joints based on the exposed environmental conditions.

The dimensional characteristics of sealing-ring assemblies of pressurized pipe elements shall comply with the specifications of standard ISO 2045.

Pipe elements include:

- PVC tubes
- Ductile iron fittings with appropriate corrosion resistant coating

Standard NF T 54-039 describes the tests to be used for sealing-ring assemblies.

Elastomer sealing rings shall comply with standard NF T 54-041.

2.1.6 Dismantling Joints

These joints should enable all valves and other fittings on the pipes to be dismantled and reassembled.

They shall be made of ductile iron or steel, and sized in accordance with the diameter of the pipes and maximum service pressure.

They must be internally and externally coated with an appropriate thickness, in line with the relevant updated standards and the manufacturer’s recommendations and to the satisfaction of the Engineer

They shall consist of two sleeves sliding into one another and fitted with an assembly flange at each end. Watertightness at the point of sliding shall be guaranteed by a rubber seal compressed by an intermediate companion flange.

The dismantling joint shall be assembled on the pipe and fittings by means of threaded rods.

It shall be of "free" type if the pipe is not submitted to longitudinal stress, and otherwise of "self-abutting" type.

2.1.7 Flanges

Flanges shall be determined in accordance with standardization rules depending on the diameter of the pipes and the service pressure.

They shall be of flat type, made of steel or stainless steel, to be welded on to pipes with a perpendicular face and drill holes.

The seal bearing surface may be raised, with concentric grooves 8 mm apart and 0.4 mm deep, without rough edges, in order to improve the adherence of the seal and prevent it from slipping.

The sealing surfaces of the flanges shall be coated. Careful attention must be paid to the angular position of the flanges.

2.1.8 Seals

Seals shall be fitted between flanges; they shall be of flat type and adapted to the characteristics of the flanges.

Seals shall be made of webbed rubber or synthetic rubber.

2.1.9 Dielectric Insulating Seals

All fittings of a different nature shall be mounted between flanges with dielectric insulating seals.

These insulating seals shall be made of an insulating material such as bakelite. They shall be fixed with appropriate bolts, nuts and washers.

2.1.10 Bolting

All assembly screws, bolts, pins, threaded rods, nuts and washers shall be made of Z2CN 18-10 L stainless steel and comply with standardization regulations with regard to the diameters and cutting of threads, which must not offer resistance. Threads of screws and bolts used on parts subject to vibrations and shocks shall be locked.

2.1.11 Corrosion Protection

See technical specifications relating to corrosion in section 01010.

2.2 Special Tools and Spare Parts

Refer to Section VII – A. General Requirements

3 EXECUTION

3.1 Handling of Pipes

Pipes of all types must be handled with care during both storage and transport to prevent damage to pipe and its coating. Pipes shall be placed on the ground or laid in trenches gently, avoiding rolling them on stones or on rocky ground without first creating a runway using planks.

Any pipe accidentally dropped from any height whatever must be considered as suspect and may only be laid after further inspection. With regard to steel pipes, the coating shall be protected against friction wear by packing straw or other soft material between them. They must rest on planks and not on round timber.

For storage, the stock height and disposition should be as recommended by the manufacturer.

For transportation, the nesting (placing one pipe inside another) is not allowed. The mode and the way of transportation should respect the manufacturer recommendations.

All the above stipulations also apply to connections and fittings.

3.2 Cutting Pipes

Depending on laying requirements, the Contractor shall be entitled to cut pipes. However, all necessary precautions must be taken to ensure that this is only done in cases of absolute necessity and as infrequently as possible.

Before cutting the pipe, it is essential to measure the external diameter at the cutting point with a circumference tape or compass caliper, to check that it is compatible with the intended coupling joint dimensions.

Pipes may be cut by any process and cutting machine suited to the material in question, so as not to disturb its physical state and obtain a clean cut, without any damage (coating, excessive heat or distortion…), in accordance with the manufacturer's recommendations and to the Engineer's satisfaction.

Prepare ends according to the type of joint used and follow manufacturer's recommendations. Take care not to damage lining of other types associated with main pipes. Repair on site, minor damage, if permitted.

The Contractor shall do his utmost to ensure that the new spigot ends resulting from such operations are smooth with chamfer edges, and that they produce assemblies that are as reliable as ordinary pipe ends.

3.3 Laying Pipes

Pipe interiors shall be inspected at the time of laying and carefully cleared of all foreign bodies that may have entered them. The pipe ends shall be carefully cleaned to remove any lumps, blisters, excess coal tar, oil, grease and moisture-Care shall be taken to ensure that they remain clean during laying.

Whenever work is interrupted, pipes being laid shall be blocked with a plug to prevent foreign bodies or animals from entering. The laying shall not be proceeded if the trench bottom is muddy, frozen, or contains standing water.

Tubes and connections shall be inspected before being assembled to ensure, in particular, that the outer protective coating and possible inner protective lining are intact or restored to its original condition.

Coatings and linings must be carefully repaired whenever they have been removed or damaged.

All-pipe laying shall be carried out by experienced pipe-layers, well skilled in this work.

3.4 Jointing and Lubricate Paste

3.5 Lubricate Paste

- Ductile Iron Pipes

  A) Flexible Joint Push- in automatic standard type (Flexible) in accordance with BS EN 545 and ISO 2531,
  B) Flanged Joint according to BS EN 1092-2/BS EN 545 and ISO 7005-2/ISO 2531
  C) Self -Anchored push in Joints. according to ISO 10804-1

- HDPE Pipes

  A) Plastic / Metal compression fittings according to pipe diameter. and pressure.
  B) Butt-fusion and Electrofusion fittings according to pipe diameter.
  C) Flanged connections and tapped fittings

- Steel Pipes → Welded or Flanged or threaded or Mechanical (Bolts) Joints

- PVC Pipes → Flexible with approved rubber rings, specifically rated for the intended pressure and environmental conditions of the system, complying with BS EN 681: 2000.

3.6 Testing Pipes and Manholes

A) Preparing the tests

Testing operations on joints and pipes shall be carried out by the Contractor at his own expense in accordance with the Engineer's instructions.

Tests are carried out in conditions that allow the pipe and especially all the joints to be properly examined. In particular, the Contractor shall provide and place all blank plates, thrust blocks supply pipes and any other accessory installations (pump, valve, weirs, air compressor, pressure gauge…) required for carrying out the tests, as stipulated, and all necessary equipment.

B) Test methods

B.1) Vacuum Testing Manholes:

1. General: Test using air whenever possible prior to backfilling to assist in locating leaks. Make joint repairs on both outside and inside of joint to ensure permanent seal. Test manholes with manhole frame set in place.
2. Vacuum test in accordance with ASTM C1244 and as follows:
   a) Plug pipe openings; securely brace plugs and pipe.
   b) Inflate compression band to effect seal between vacuum base and structure; connect vacuum pump to outlet port with valve open; draw vacuum to 33.8 kPa (0.338 bar); close valve; start test.
   c) Test:
      - Determine test duration for manhole from the table below:

VACUUM TEST TABLE	
Manhole Diameter	Test Period
1.2 meters	60 seconds
1.5 meters	75 seconds
1.8 meters	90 seconds

      - Record vacuum drop during test period; when vacuum drop is greater than 3.4 kPa (0.034 bar) during test period, repair and retest manhole; when vacuum drop of 3.4 kPa does not occur during test period, discontinue test and accept manhole.
      - When vacuum test fails to meet 3.4 kPa drop-in specified time after repair, repair and retest manhole.
3. When unsatisfactory test results are achieved, repair manhole and retest until result meets criteria; repair visible leaks regardless of quantity of leakage.

B.2) Inspection and Testing Gravity Sewer Piping:

1. Visual Inspection, in which the Engineer shall inspect the section for grade, direction, line, appearance of inner surface, depth and correct jointing.
2. Air Test:
   a) Test each section of gravity sewer piping between manholes.
   b) Introduce air pressure slowly to approximately 28 kPa (0.28 bar).
      - Determine ground water elevation above spring line of pipe, for every foot of ground water above spring line of pipe increase starting air test pressure by 3.0 kPa; do not increase pressure above 69 kPa.
   c) Allow pressure to stabilize for at least five minutes. Adjust pressure to 24 kPa (0.24 bar) or increased test pressure as determined above when ground water is present. Start test.
   d) Test:
      - Determine test duration for sewer section with single pipe size from the following table. Do not make allowance for laterals.

AIR TEST TABLE	
Minimum Test Time for Various Pipe Sizes	
Nominal Pipe Size (mm)	**T (time), (min/ 30 m)**
75	0.2
100	0.3
150	0.7
200	1.2
250	1.5
300	1.8
375	2.1
450	2.4
525	3.0
600	3.6
675	4.2
750	4.8
825	5.4
900	6.0

- Record drop in pressure during test period; when air pressure has dropped more than 6.89 kPa (0.0689 bar) during test period, piping has failed; when 6.89 kPa air pressure drop has not occurred during test period, discontinue test and piping is accepted.
- When piping fails, determine source of air leakage, make corrections and retest; test section in incremental stages until leaks are isolated; after leaks are repaired, retest entire section between manholes.

3. Exfiltration Test:
    - Test pipe larger than 900 mm diameter with exfiltration test not exceeding 378 L for each mm of pipe diameter for each kilometer per day for each section under test. Perform test with minimum positive head of 610 mm.
4. Infiltration Test:
    - Use only when gravity piping is submerged in groundwater minimum of 1220 mm above crown of pipe for entire length being tested.
    - Maximum Allowable Infiltration: 378 L per mm of pipe diameter for each kilometer per day for section under test; include allowances for leakage from manholes. Perform test with minimum positive head of 610 mm.

B.3) Hydrostatic Testing Pressure Piping:

1. Hydrostatically test each portion of pressure piping, including valves, at 1.5 times working pressure of piping based on elevation of lowest point in piping corrected to elevation of test gauge.
2. Fill section to be tested with water slowly, expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled. Raise pressure to specified test pressure.
3. Observe joints, fittings and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.
4. Correct visible deficiencies and continue testing at same test pressure for additional 2 hours to determine leakage rate. Maintain pressure within plus or minus 34.4 kPa of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.

5. Compute maximum allowable leakage "L" by the following formula:

$$L = \frac{SD\sqrt{p}}{C}$$

Where,

"S" is the length of pipe tested, in meters;

"D" is the nominal diameter of pipe, in mm;

"P" is the average test pressure during leakage test, in kPa;

"C" is a constant equal to 22,259.

When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

6. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections and retest until leakage is within allowable limits. Correct visible leaks regardless of quantity of leakage.

B.4) Deflection Testing of Plastic Pipe:

1. Perform vertical ring deflection testing on plastic piping, after backfilling has been in place for at least 30 days but not longer than 12 months.
2. Allowable maximum deflection for installed plastic pipe limited to five percent (5%) of original vertical internal diameter.
3. Perform deflection testing using properly sized rigid ball or 'Go, No-Go' mandrel.
4. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe as determined by ASTM standard to which pipe is manufactured. Measure pipe in compliance with ASTM D2122.
5. Perform test without mechanical pulling devices.
6. Locate, excavate, replace and retest pipe exceeding allowable deflection.

C) Compliance and additional tests

The Contractor shall make good any faulty sealing observed during the tests, by immediately and at his own expense making any repairs whatsoever that the tests have shown to be necessary. However, he shall not bear the cost of replacing, supplying and placing parts not supplied by him if any weakness is shown to be due to the poor quality of the materials or faulty manufacture. The same is true of the cost of the preliminary investigations if such defects should be confirmed.

Once repairs have been made a new test shall be performed in the same conditions as those described above. However, the costs incurred by such tests shall be borne by the Engineer if repairs have been carried out as a result of a burst or deterioration arising from an intrinsic defect in a part not supplied by the Contractor.

D) Report

A report is drawn up jointly by the Engineer and the Contractor for each test.

E) Height setting

Before any backfilling operations, the height setting of the pipes shall be checked systematically by a surveyor; this work will be paid for by the Contractor and submitted to the Owner for approval.

F) Inspection

All pipes of ≥1200 mm diameter shall be inspected visually prior to filling.

All pipes of <1200 mm diameter shall be inspected by video camera prior to filling.

All these inspections shall be recorded and sent to the Engineer. The cost of such inspections shall be borne by the Contractor

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 14150

VALVES, GATES AND APPURTENANCES

1 GENERAL

1.1 Scope of Work

This specification applies to the supply, assembly and testing of hydraulic equipment of water pipeline to be executed by the Contractor unless otherwise required by Employer's Requirements.

1.2 Related Works

Supplies and works included under this section shall comply with all other sections of the Specifications, and particularly:

a) Section 01010 – Corrosion protection
b) Section 01020 – Basic electrical requirements
c) Section 02215 – Trench excavation
d) Section 02350 - Concrete structures
e) Section 14100 – Pipes and fittings
f) Section 17200 – Instrumentation.

1.3 System Description, Characteristics and Operating Conditions

1.3.1 Main Characteristics

The type of valves, the diameters, the materials and the corrosion protection shall be compliant with the ones described on the Drawings approved by the Engineer or the Bill of Quantities.

Actual location and level of interface with existing pipe/connection point, if any, must be checked on site in coordination with the Employer and the Engineer.

1.3.2 Operating Conditions

All valves and gates shall be designed and constructed for the Maximum Operating Pressure (MOP) and the Maximum Allowable Working Pressure (MAWP) and the fluid.

1.4 Standards and Regulations

With reference to the General requirements of the Employers Requirements, the main particular Standards to be used are as follows. This list is not exhaustive.

1.4.1 Standards

- ISO 185: Grey cast iron,
- ISO 1083: Spheroidal graphite cast iron,
- ISO 5208: Industrial valves – pressure testing for valves,
- ISO 5210: Industrial valves – multi-turn valve actuator attachments
- ISO 5211: Industrial valves – Part-turn actuator attachments
- ISO 6708: Pipe components – definition of nominal sizes,
- ISO 7005-2: Metallic flanges – part 2: cast iron flanges,
- ISO 7268: Pipe components – definition of nominal pressure,
- ISO 7259: Predominantly key-operated cast iron gate-valves for underground use,

- ISO 10497: Testing of valves – Fire type-testing requirements
- EN 1563: Founding – Spheroidal graphite cast irons
- EN 14901: Ductile iron pipes, fittings and accessories - Epoxy coating (heavy duty) of ductile iron fittings and accessories – Requirements and test methods
- EN 1074 –part 1 to 6: Valves for water supply – Fitness for purpose requirements and appropriate verification tests – Part 1: general requirements, part 2: isolating valves, part 3: check valves part 4: air valves, part 5: control valves, part 6: hydrants
- EN 1171: Industrial valves – Cast iron gate valves
- EN 558-1: Industrial valves, Face-to-face and center-to-face dimensions of metal valves for use in flanged pipe systems - PN and Class designated valves
- BS 5153: Check valves
- BS 5163: Gates valves
- BS 5155: Butterfly valves
- NF E 29 323 / NF E 327: Gates valves
- NF E 29 430: Butterfly valves
- ISO 5752: metal valves for use in flanged pipe systems - Face-to-face and center-to-face dimensions
- EN 10 088- Part 1 to 5: Stainless steels – part 1: list of stainless steels; part 2: technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes; part 3: technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes; part 4: technical delivery conditions for sheets/plate and strip of corrosion resisting steels for construction purposes; part 5: technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes.
- AWWA C 504: Standard for Rubber-Seated Butterfly Valves
- AWWA C508: Standard for Swing-Check Valves for Waterworks Service

1.4.2 Design Criteria

a) Unless otherwise specified, all valves and gates shall be butterfly valves type for diameters from 400 mm and above and seal gate valves type for diameters less than 400 mm.
b) Unless otherwise specified, the supply and fixing of a valve with nominal diameter less than the diameter of the pipe is not allowed.
c) The valves shall be self-supported without link to the supports of the pipes.
d) The equipment shall be the product of an established and reputable manufacturer who has had experience in the manufacture of the type of equipment herein specified.
e) All valves of the same type shall be from the same manufacturer.
f) All valves, except the air valves, must be able to handle the pressure tests of the pipeline, i.e. 1.5 time the Maximum Operating Pressure MOP).

1.4.3 Shop Tests

a) Performance Tests

Each valve, gate and appurtenance shall be operated three times from the fully closed to the fully opened position and the reverse, under a no flow condition to demonstrate that the complete assembly is workable.

b) Hydrostatic Test

Valves specified shall be hydrostatically tested as follows:

- Upstream/downstream Leak tightness test at 1.1 times the maximum admissible working pressure at 20˚C.
- Body strength test at 1.5 times the maximum admissible working pressure at 20˚C.

1.5 Submittals

The Contractor shall submit detailed shop drawings and working drawings with relevant calculation notes or type test evidences.

a) Hydraulic calculation notes and Working drawings,
b) Technical documents

The Contractor shall provide documentary evidence of the performances of the valves for the service as required, including QA documentation of the supplier.

c) Shop drawings

Shop drawings shall include but not limited to the following:

- Lists and bill of materials of valves.
- Dimensions and materials.
- Instructions for installation.
- Structural calculation according to standards
- Detailed drawings of the installation with reference to the surroundings (Concrete, steel structure, electrical equipment, pipes...)
- Results of the shop tests

2 PRODUCTS

2.1 General

a) Construction

All valves of the same type shall be from one manufacturer.

All valves shall have following markings and they shall be designed cast in raised letters upon some appropriate part of the body or written on a plate fixed to the body:

- name of mark of manufacturer,
- year of manufacturing,
- working pressure,
- arrow direction for valves designed for one way flow only.

Valve ends shall be flanged ends except where otherwise specified. Where flanged ends are used, mating dimensions and drilling shall be in accordance with the pipe and fitting flange as specified in the Specifications.

Thickness of flanges shall be determined as based on the working pressure specified and shall conform to internationally accepted standards.

All materials which will be specified hereunder shall conform to ISO, EN, AFNOR, ASTM, BS, DIN or other internationally accepted standards.

Valves shall be equipped with hand lever, hand wheel, manual actuator, pneumatic actuator or electric actuator as shown on the drawings or as required for the operation.

Actuators shall have arrows cast thereon to indicate the direction of rotation for opening the valve.

Valves 50 mm in size and smaller shall be all bronze, unless otherwise specified, except for hand wheels which shall be of cast or malleable iron, and provided with screw ends.

The minimum working pressure of valve shall be as specified herein unless otherwise shown in the valve schedule.

b) Corrosion protection

All valves, gates and appurtenances, unless otherwise specified shall be shop primed in compliance with Section 01010 Corrosion protection.

2.2 Gate Valves

All gate valves shall have screw and yoke rising stem or non-rising stem depending on design and Engineer's instructions.

2.2.1 Gate Valves

Gate valves shall be designed and manufactured in accordance with ISO 5752 or EN 1074-2 and EN 1171 or EN 558-1 series 14 or 15, or other internationally accepted standards.

The valve body and bonnet shall be of DIN 1693 or EN1563 grade GGG40 or GGG50 ductile cast iron.

The stuffing box shall be the same materials of the body as specified above and shall be tight in the open position. The depth of the stuffing box shall be not less than the diameter of the valve stem. Packing for the stuffing box shall be made of suitable materials approved by the Engineer. Asbestos shall not be used. O ring stem seals may be used, subject to the approval of the Engineer and these seals shall have a minimum of two (2) "O" ring seals, of which at least one (1) shall be above the stem collar and replaceable under full working pressure while the valve is in the fully open position.

Valve stem shall be stainless steel, DIN 17 440 grade I-4462 or EN 10 088-2 grade 1.4021 (X20 Cr13).

2.2.2 Resilient Seated Gate Valves

Resilient Seated (RS) gate valves shall be used only for diameters below 300 mm and pressures under 16 bars.

Resilient seated gate valves shall NOT be used as scour valves for wash out: metallic gate valves shall be used instead.

RS gate valves shall be designed and manufactured in accordance with AWWA C509 or other internationally accepted standards.

RS type gate valves shall be DIN 1693 or EN1563 grade GGG40 or GGG50 ductile cast iron body resilient seated gate valves with non-rising stems (NRS). Valves shall be designed to provide an unobstructed waterway having a diameter of not less than the full nominal diameter of the valve when in the open position.

For stem seals, either gland packing or O rings included other pressure actuated stem seal shall be provided. The stuffing box or O rings packing plate shall be the same materials of the valve body. Gland packing for the stuffing box shall be made of suitable materials approved by the Engineer. Asbestos shall not be used. O ring seals shall be designed to have a minimum of two O ring seals, of which at least one shall be above the stem collar and replaceable under full working pressure while the valve is in the fully open position.

Valve stems shall be stainless steel DIN 17 440 grade I-4462 or EN 10 088-3 grade 1.4021 (X20 Cr13).

All valves shall be equipped with handwheels.

Resilient seats shall be applied to the gate and shall seat against a corrosion resistant surface. The surface shall be of EPDM rubber coating in a manner to withstand the action of line fluid and operation of the sealing gate under long term service. Resilient seats shall be bonded or mechanically attached to the gate. All exposed mechanical attaching devices and hardware used to retain the resilient seat shall be of corrosion resilient material.

Bolts and nuts to be used for bonnet, packing plate, gland and others shall be stainless steel unless otherwise noted.

All interior and exterior ferrous parts of the valve except for finished or seating surfaces shall be finished with fusion bonded epoxy protective coating conforming to AWWA C213 or EN 14901. Total dry film thickness on the interior and exterior surface shall be not less than 250 microns.

Resistance and water tightness of the valves shall conform to ISO 5208.

2.2.3 Bronze Gate Valves

Bronze gate valves shall be designed and manufactured in accordance with standard approved by the Engineer. Valves shall be equipped with either screw ends or flanged ends. Valves in size 50 mm and smaller shall be bronze body, screw bonnet, gate valves having a solid wedge, inside screw and rising stem.

Valves in size 65 mm and 80 mm shall be bronze body, flanged bonnet, gate valves having a solid wedge, inside screw and non-rising stem.

The body shall be bronze casting having tensile strength not less than 196 N/mm². Disc shall be bronze casting specified above or copper having tensile strength not less than 314 N/mm². Stem shall be copper specified above.

Resistance and water tightness of the valves shall conform to ISO 5208.

2.2.4 Stainless Steel Gate Valves

Stainless steel gate valves shall be solid wedge disc type gate valves with outside screw and yoke rising stems and designed for handling acids or other chemicals. Valves shall have hand wheels and flanged ends.

Unless otherwise specified, major parts of the valve such as body, bonnet, stem, disc, gland with gland bolts and nuts, bonnet bolts and nuts and other parts which may contact with handling liquid shall be made of AISI 316 stainless steel and stainless-steel casting.

Resistance and water tightness of the valves shall conform to ISO 5208.

2.3 Butterfly Valves

2.3.1 Flanged Butterfly Valves

Tight closure butterfly valves and shall be designed and manufactured in accordance with EN 593 and EN 1074-2. Valves shall be designed for a maximum non-shock shut off pressure according to the design pressure value.

Flanges shall conform to ISO PN 10, 16, 20, 25, 40 or more depending on the working pressure and flange to flange dimensions shall conform to ISO 5752 series 14.

Valves body shall be ductile iron and shall conform to DIN 1693 or EN1563 grade GGG40 or GGG50.

Valve shafts shall be made of minimum AISI 316 stainless steel or EN 10 088-3 grade 1.4401 (X20 Cr13). Valve shafts shall be a one-piece unit extending completely through the valve disc, or of the "stub shaft" type, which comprises two separate shafts inserted into the valve disc hubs. If of "stub shaft" construction, each stub shaft shall be inserted into the valve disc hubs for a distance of at least 1.5 times the shaft diameter.

Elastomer seats shall mate with a stainless-steel seat AISI 316 L or EN 10 088-3 grade 1.4021 –X20 Cr13) or with the following seat surfaces complying with AWWA C504: Stainless steel, Monel or bronze. Sprayed or plated mating seat surfaces shall not be used. Deposit seat surfaces may be acceptable if approved by the Engineer.

Elastomer seat for valves, shall be clamped, mechanically secured, bonded, or vulcanized to the valve body.

All clamps and retaining rings for elastomer seats shall be of fusion bonded epoxy coated steel, or stainless steel or plated with corrosion resistant material with a maximum zinc content of 16 per cent and a maximum aluminum content of 3 per cent. All nuts and screws used with clamps and retaining rings shall be of stainless steel, and shall be secured with resin.

Valve disc shall be of a cast or fabricated design with no external ribs transverse to the flow. Valve discs shall be of ductile iron, or stainless steel. They shall conform to these as specified below:

- Ductile iron: DIN 1693 or EN1563 grade GGG40 or GGG50.
- Stainless steel: AISI 316 L minimum or other type approved by the Engineer.

Shaft seals shall be provided wherever shafts project through the valve body. Shaft seals shall be preferably designed for standard O ring seals. O ring seals shall be contained in a removable corrosion resistant recess.

Resistance and water tightness of the valves shall conform to ISO 5208.

2.3.2 Wafer Butterfly Valves

Wafer butterfly valves for water shall meet the applicable requirements specified in 2.3.1 above for flanged butterfly valves except as otherwise specified herein.

Valves shall be designed to fit between two pipe flanges and for the maximum non-shock shut off pressure according to the design pressure value.

Valves shall be either seat in body and have elastomer seat which shall be designed to lap over both faces of the valves, or designed in compliance with water-tightness specifications of ISO 5208.

2.4 Check Valves

Check valves shall comply with BS 5153

2.4.1 Ball Check Valves

Ball check valves shall be used only for drainage or wastewater applications for diameters below 300 mm and when water hammer effects are not significant. Flanges shall conform to ISO PN 10, 16, 20, 25, 40 or more depending on the working pressure.

The valve body shall be made of cast iron or ductile iron with epoxy coating internally and externally. The ball shall be encapsulated in molded elastomer.

The valve body shall have a removable bonnet enabling the replacement of the ball without removing the check valve of the pipe.

2.4.2 Flap Valves

Flap valves shall be used only for drainage or wastewater applications.

a) Flap Valves (General purpose)

The seat shall be one-piece cast iron conforming to BS EN 1561 Grade 250 with a raised section around the perimeter of the waterway opening to provide the seat. The raised section shall provide a seating plane diverging, top to bottom, from the plane of the mounting flange to assist in positive closure of the water. The seat shall be shaped to provide two bosses extending above the top of the

waterway opening, for mounting the top pivot lugs. Pivot lug bosses shall be drilled and tapped for mounting studs.

The flap shall be designed to be either butted to the face of a wall or to the outlet flange of a discharge pipe.

The cover shall be one-piece cast iron conforming to BS EN 1561 Grade 250 with necessary reinforcing ribs, with a lifting eye for manual operation, and with bosses to provide a pivot point connection with the links. Bosses shall be designed to place the hinge bolts in double shear when gate is assembled.

Each pivot lug shall be one-piece cast iron. Lugs shall have double bosses to place the top hinge bolts in double shear when they are assembled through the links. The lugs shall be adjustable in the horizontal plane without removal of the cover from the gate links. The adjustment shall allow the top pivots to be moved toward the gate seat for reduce the sensitivity of the cover, or moved away from the gate seat to provide opening with a minimum differential head. Two studs shall be used to connect each pivot to the gate seat.

The links connecting the cover and pivot lugs shall be one-piece heavy duty cast iron. Each link shall be provided with bronze bushing at each pivot point. The bottom of the links shall be provided with an adjusting screw to properly align seating faces on the cover with respect to the seat. The seat shall be designed to limit the double hinge action, preventing the cover from rotating sufficiently to become wedged in the open position.

All interior and exterior cast iron parts of the valve except for finished or seating surfaces shall be finished with fusion bonded epoxy protective coating conforming to AWWA C213 or EN 14901. Total dry film thickness on the interior and exterior surface shall be not less than 250 microns.

b) Flap Valves for Sea Water Applications

Flap valves frames including fixings for seawater and other aggressive applications shall be of stainless-steel conforming to BS 970. Sealing faces shall be phosphor bronze conforming to BS 2874.

Flap valves manufactured from corrosion resistant materials will also be acceptable for general-purpose applications.

Doors shall be of reinforced natural rubber compound of sufficient flexibility to maintain an efficient seal under minimal seating head conditions.

Door hinges shall be continuous across the full width of the door and manufactured from homogeneous polypropylene, polyurethane or similar non-ageing material.

2.4.3 Swing Check Valves

Swing check valves shall be DIN 1693 or EN1563 grade GGG40 or GGG50 ductile cast iron body and disc, and bronze seating type. The valves shall be designed and manufactured in accordance with AWWA C508 or EN 1074-3. Flanges shall conform to ISO PN 10, 16, 20, 25, 40 or more depending on the working pressure and flange to flange distance shall conform to ISO 5752 series 14 or series 48.

Valves shall be suitable to operate in a horizontal or vertical position with flow upward and when fully open, valves shall have a net flow area not less than the area of a circle with a diameter equal to the nominal pipe size.

Valve shall be furnished with hinge arms, levers and springs or weights and when necessary, furnished with a bypass pipe and by pass valves.

2.4.4 Split Disc Wafer Check Valves

Split disc wafer check valves shall be dual plate, two spring loaded, semicircular plates type. The valves shall be designed and manufactured in accordance with API 594, or other internationally accepted standards.

Valves shall be designed to fit between two pipes flanges.

Valve body and plates shall be of cast iron, ductile iron or AISI 316 stainless steel. Bronze casting plates may be permitted. Hinge pin, stop pin and springs shall be of AISI 316 stainless steel. Valves shall have resilient seating in the valve body unless otherwise specified. Seat materials shall be EPDM or high content nitrile (BUNA "N") elastomer.

2.4.5 Bronze Swing and Lift Check Valves (50 mm and Smaller)

Bronze swing and lift check valves shall be designed and manufactured in accordance with standard approved by the Engineer. Valves shall be equipped with screwed ends.

Swing check valves shall be suitable to operate in a horizontal or vertical position with flow upward. Lift check valves shall be suitable to operate in a horizontal position with flow upward when fully open. Both of swing and lift check valve shall have a net flow area not less than the area of a circle with a diameter equal to the nominal pipe size.

Valves shall be bronze body, screwed bonnet and disc. Valves shall be designed to have bronze seating or resilient seating. Resilient seats shall be made of Teflon.

The body shall be bronze casting, and bonnet and disc shall be of bronze casting or copper. The said bronze casting and copper shall conform to the requirements specified in 2.2.3 above.

2.4.6 Axial Spring-Loaded Check Valves

The axial spring-loaded check valves shall be low stroke, low inertia check valve consisting of a body in the form of concentric rings supported by spacers and a mobile sealing assembly incorporating a similar arrangement of concentric rings to those in the body. Valves shall be equipped with flanged ends. The body shall be cast iron conform to ASTM A48 64 35B or EN 1563 grade GGG40 or GGG50. The sealing assembly shall be made of polyurethane. The spring shall be stainless steel conform to AISI 316L or equivalent.

2.5 Plug Valves

Plug valves shall be DIN 1693 or EN1563 grade GGG40 or GGG50 ductile cast iron body, non-lubricated, resilient faced eccentric plug type valves.

Port areas of valves shall be at least 80% of the full pipe area.

The valves body and bonnet shall be cast iron or ductile iron or a corrosion resistant, cast-iron alloy containing 1% to 1.5% nickel. The materials specified above shall have a minimum tensile strength of 216 N/mm². If the body is cast iron, the seat shall have a welded in ever lay of not less than 90% pure nickel on all surfaces contacting the plug face. The seat face shall be machined. If the body is corrosion resistant cast iron alloy, the raised seat shall be machine finished and protected with an approved epoxy coating.

The plug shall be cast iron as specified for the body and shall have a resilient coating to provide bubble tight shutoff. The resilient coating shall be chloroprene (Neoprene).

2.6 Ball Valves

Stainless steel ball valves shall be non-lubricated and shall have stainless steel ball and body with Teflon seats. Valves shall have screwed ends. Valves shall be wrench operated.

Major parts of the valve such as body, steam and ball shall be made of AISI 304 or 316 stainless steel and stainless-steel casting.

2.7 Globe Valves

2.7.1 Angle Hose Valves

Angle hose valves shall be bronze body Y Globe valves with renewable composition disc. Valves shall have rising stem and screwed ends with stainless steel replaceable quick coupling and cap. Valves shall be designed and manufactured in accordance with standards approved by the Engineer.

Discs shall be hard but sufficiently resilient to maintain tight seal within the pressure and temperature range and have high flexural and impact strength. Discs shall be made of Teflon or other materials approved by the Engineer.

Disc holder shall be made of bronze casting or copper.

2.7.2 Hose Bibs

Hose bibs shall be bronze body globe valves with renewable composition disc. Valves shall have rising stems, screw in bonnet, screwed inlet and hose coupling outlet. Working pressure shall be 10 bar. Valves shall be designed and manufactured in accordance with standard approved by the Engineer and shall be swivel nose faucet, faucet with hose coupling or lawn faucet.

Stem with disc and disc nut shall be bronze, bronze casting or copper. Disc shall be medium soft composition as recommended by the manufacturer for the intended use.

2.8 Needle Valves

Needle valves are able to regulate pressures of flows and act then as multipurpose valves.

Needle valves shall be EN 1563 grade EN GJS 400-15 ductile cast iron body, with a nose cone on grey iron to EN 1561 grade EN GJL 250. The shutter, the shaft and the body seat shall be of stainless steel to EN 10088-3 and the shutter seat of brass. All parts subject to wear shall be accessible for repair or replacement. The pressure rating shall be adjustable without use of any special tools and while the valve is in service.

Internal and external parts shall be coated with fusion bonded epoxy having a minimum thickness of 250 microns.

They shall be able to operate under pressures specified by the design.

Two (2) manometers one for the primary side and the other for the secondary side of the pressure reducing valve shall be provided. Installation at each side on pressure gauges is permitted. Installation directly on the valve is not recommended and not permitted.

2.9 Diaphragm Valves

Diaphragm valves shall be of the weir or straightway type as noted, with cast iron body, resilient reinforced rubber diaphragm and cast-iron bonnet. They shall be fitted for spoked hand wheel operation.

The valves shall be used in water, air, and weak chemical service lines.

The reinforced rubber diaphragm shall be connected to a spindle actuated compressor so that it will be lifted to provide an adequate water way for minimum pressure loss. Further, the diaphragm shall be forced tight against the body even when the compressor is lowered. The diaphragm shall seal the bonnet compartment and working parts from the fluid stream. The diaphragm shall be capable of easy replacement without removing the valve body from the pipe line.

The valves shall be protected against corrosion with a minimum 3.0 mm thick neoprene lining suitable for the service intended and consistent with associated piping unless otherwise noted.

2.10 Over-Speed Valve

The over-speed valve shall be self-operating automatic shut-off valve consisting of:

- hydraulically controlled butterfly valve, opened by hand operated hydraulic actuator and closed by counterweight with adjustable dash-pot,
- mechanical over-speed detection system with adjustment facilities,
- shut-off mechanism ensuring irreversible closing of the valve upon over-speed condition is detected.

The valve shall be double flanged type and shall comply with the specifications related to butterfly valve as far as design and materials are concerned.

The valve shall be equipped with a set of limit switches in IP67 enclosure.

2.11 Float - Altitude Valve

The altitude valve shall be used for reservoir level control, in order to prevent the water from overflowing.

The valves shall be self-operating hydraulically actuated valves and may be proposed as an alternative to electrically operated butterfly valves inserted in a level control loop.

The valves shall consist of a globe valve or a needle valve actuated by a built-in pilot valve controlled by a level or a pressure sensor.

The valve shall be designed to keep the water level within a preset range.

2.12 Float Valves

Float valves shall be balanced piston type or membrane type closing on a rising level. They shall open when water level is below the set value and shall progressively close without creating water hammers when water level is rising up to the set value.

- Nominal Pressure depending on the design
- Body Cast iron or Stainless-steel End Flanged, faced and drilled to BS 4504
- Lever and Links Stainless steel
- Float Copper or stainless steel

Valves shall not contain brasses containing more than 5% zinc. Gunmetal (to BS 1400 Grade LG2) aluminum bronze or nickel copper alloy may be used for internal components.

The outlet of the float valve shall be fixed on a vertical PVC or stainless-steel tube in order to guide the flow at least 500 mm below the lowest position of the float and avoid turbulences at the water surface. The diameter of this tube shall be 1.5 time the ND of the float valve.

The valve piston shall be designed to avoid cavitation at high differential pressures.

2.13 Pressure Reducing Valves

Pressure reducing valves shall be DIN 1693 or EN1563 grade GGG40 or GGG50 ductile cast iron body, self-contained, direct acting, spring loaded type.

Valves shall be of the globe valve type or the needle valve type and shall have flanged ends. All parts subject to wear shall be accessible for repair or replacement without removing the valve from the line. Secondary pressure of valve shall be designed to be adjustable without any use of special tools while it is in service.

Two (2) manometers one for the primary side and the other for the secondary side of the pressure reducing valve shall be provided.

2.14 Strainers

Strainer boxes shall be designed to stop all suspended solids larger than 2 mm.

Any design is acceptable provided that the dimensions of the strainer box are compatible with the dimensions of the concrete chambers shown on the drawings, reasonable quantities of suspended solids stopped by the strainer can be stored in the strainer box without clogging the device, cleaning can be easily performed, and the head loss is not higher than specified hereafter.

The body and cover shall be of cast iron or ductile iron or steel.

The strainer shall be of stainless steel.

Head loss shall not be more than 0.1 bar, when clean, at the nominal flow rate of the control valve or water meter protected by the strainer box.

2.15 Flow Control Valves

Flow control valves shall be of the globe valve type or the needle valve type. Only in certain cases where place is insufficient, butterfly valves can be used.

The type of valve used for flow control shall be approved by the Engineer.

2.16 Extension Spindle and Surface Box

Valve extension spindles shall be compatible with the operator's equipment (T-handle key). The squares shall be of ductile cast iron with 30-micron epoxy coating and the shaft shall be of hot galvanized steel. For buried valves, the extension spindle shall be protected by a PVC or ductile cast iron tube.

Surface boxes shall be furnished with their cover, anchored at the surface and adjustable (minimum adjustability 75 mm). Surface boxes and covers shall be of ductile cast iron with a bituminous varnish coating, resistant to heavy traffic. The shape (round, square, hexagonal, etc.) shall be in accordance with the Employer's requirements.

2.17 Air Valves

2.17.1 Single Orifice Type Air Valves

Single orifice type air valves shall be DIN 1693 or EN1563 grade GGG40 or GGG50 ductile cast iron body and single float actuated air valves with flanged ends. Valves shall be designed and manufactured in accordance with EN 1074-4 or other standards approved by the Engineer, and shall be able to operate up to the Maximum Working Pressure.

Valves shall automatically operate so that they will exhaust accumulated air under pressure while the pipe is flowing full of water.

Each valve shall be furnished with integral bronze or brass casting stop valve and cast-iron flange.

Floats and balls shall be stainless steel, DIN 17 440 grade I-4301 or approved plastic material.

All air valves shall be equipped with isolation valves.

2.17.2 Double Orifice Air Valves

Double orifice air valves shall be DIN 1693 or EN1563 grade GGG40 or GGG50 ductile cast iron body and double float actuated air valves with flanged ends. Double orifice type air valves shall be designed and manufactured in accordance with EN 1074-4 or other standards approved by the Engineer.

Double orifice shall be designed to automatically operate so that they will:

- Positively open under internal pressure less than atmospheric pressure to admit air in bulk during pipeline draining operation.
- Exhaust air in bulk and positively close as water, under low head, fills the body of the valve during filling operation.
- Exhaust accumulated air under pressure while the pipe is flowing full of water.

Each double orifice type air valve shall be furnished with stop valve, same size as air valve.

Double orifice type air valves shall be used for pipelines 350 mm in diameter and larger unless otherwise specified.

Floats and balls shall be stainless steel, DIN 17 440 grade I-4301 or EPDM rubber encapsulated steel.

2.18 Pressure Relief Valves

2.18.1 Function

The pressure relief valves will limit pressure surges in the mains. The pressure relief valves shall discharge water as soon as the water pressure becomes greater than the watertightness pressure which shall be field adjustable.

2.18.2 Construction

The pressure relief valves shall consist of:

- a fixed beveled horizontal nozzle,
- a flat mobile disc,
- a steel spring working in compression and pushing the disc downwards against the nozzle,
- a metallic hood diverting the discharge flow downwards.

The disc shall have no mechanical guides and shall center hydraulically itself on the water jet. The mechanical characteristics of the valve shall be calculated in the purpose to contribute to this self-centering. There shall be no possibility of friction or jamming because of incrustations or deposits. The movement of the self-centering disc shall be perpendicular to the contact plane between disc and nozzle. Moving parts shall be of low inertia.

Water tightness shall be obtained by very careful machining of the rigid corrosion resistant metal contact surfaces.

Provision shall be made for adequate aeration of the discharge flow.

Water tightness must be obtained as soon as disc and nozzle are in contact without requiring additional compression.

Access to wear parts shall be quick and easy, and their replacement shall not require disassembling or misadjustment.

The valve shall be equipped with a connecting flange according to ISO 7005.

2.18.3 Materials And Protection

All active components such as nozzle, disc, springs, etc. shall be made of stainless steel.

The hood shall be painted with a red oxide primer and additional finishing coats.

2.18.4 Performance

The pressure relief valves shall be watertight until the sealing pressure specified in the Schedule is reached. When the valve is fully open the pressure below the disc shall not exceed the maximum

pressure specified in the Schedule for a given discharge (also specified in the Schedule) through the valve.

2.18.5 Factory Tests

The valves shall be tested at the design working pressure with the disc in the closed position to demonstrate the tightness of the disc and seats.

Leakage shall not exceed 200 ml per minute.

2.19 Valves Actuators

2.19.1 General

Actuators shall be capable of seating, unseating and rigidly holding the valve disc in any intermediate position under the maximum design unbalanced head and water velocity.

Means for holding the valves in intermediate positions shall be furnished.

The operating mechanism of butterfly valve actuators shall incorporate worm gears bronze and worms of hardened steel operating in a lubricating bath totally enclosed in a sealed water tight gear case.

All valves shall be equipped with adjustable mechanical stop limiting devices to prevent over travel of the valve disc in the open or closed position.

Actuator housing, supports and connections to the valve shall be designed with a minimum safety factor of five (5) based on the ultimate strength, of three (3), based on the yield strength, of the material used.

Each actuator shall be provided with a position indicator to show the position of the valve disc at all times. The indicators shall be read in per cent (0 100%) with minimum graduation of 5%.

Manual actuators shall require an input force of not greater than 18 daN pull on either hand wheel or crank. Hand wheels shall be of cast iron, clearly marked with an arrow and the work "open" and "close" cast in relief on the rim. Hand wheels shall be of the spoke type only. Webbed or disc type shall be used.

2.19.2 Manual Actuators

a) Manual Actuators for Gate Valves smaller than 500mmm

Manual actuators for gate valves, smaller than 500 mm and including resilient seated gates, non-rising stem type shall be wrench nuts and hand wheels type without reducing gear. Rising stem type resilient seated gate valves shall be equipped with hand wheels without reducing gear. Wrench nuts and hand wheels shall be made of cast iron or ductile cast iron.

b) Manual Actuators for Gate Valves from 500mm and above

Manual actuators for gate valves from 500 mm and above shall be bevel gear type, totally enclosed actuators. Actuators shall be equipped with hand wheel and linear position indicator which shall be read in per cent (0 100%) with minimum graduation of 5%. The hand wheel shall be cast iron or ductile cast iron, and spoke type of suitable size. Operators shall be designed so that a pull of not more than 18 daN on a hand wheel which will produce an output torque equivalent to the maximum valve shaft torque required to operate the valve under actual line pressure and velocities.

c) Manual Actuators for Butterfly Valves

Manual actuators for butterfly valves shall be essentially an integral part of a butterfly valve. The rated torque capability of each actuator shall be sufficient to seat, unseat and rigidly hold in any intermediate position the valve disc. All valves shall be equipped with an adjustable mechanical stop limiting devices to prevent over travel of the valve disc in the open and closed positions. Actuator housings, supports, and connections to the valve shall be designed with a minimum safety factor of five (5), based on the ultimate strength, or three (3), based on the yield strength, of materials used.

Each manual actuator shall have all gearing totally enclosed. Actuators shall be designed to produce the specified torque with a maximum pull of 36 daN on hand wheel. Stop limiting devices shall be provided in the actuators for the open and closed positions.

All gears actuators shall be self-locking and designed to transmit two (2) times the required actuator torque without damage to the faces of the gear teeth. Each manual actuator shall be equipped with a position indicator which shall be read in per cent (0 100%) with minimum graduation of 5%. The graduation shall be engraved on actuator cover plate.

Unless otherwise specified, the minimum number of handwheel turns to rotate the disc from the fully open to the fully closed position, or vice versa, shall be as follows:

DN (mm)	Number of turns
Under 300	25
300 to under 600	30
600 and over	50

Butterfly valves with diameter lower than 100 mm may be operated by levers.

d) Gearing

Gears shall be of ductile iron, steel, or bronze, accurately machined with cut teeth, and smooth running with suitable shafts in bronze sleeve bearings or roller bearings of ample size.

All gears and bearings shall be enclosed in a cast iron housing. Fittings shall be provided so that all gears and bearings can be periodically lubricated.

2.19.3 Electric Actuators

A- General

Two (2) types of electric actuators such as type A, integral control type and type B, standard type shall be specified hereinafter.

Each type of electric actuator shall be furnished in weatherproof construction. The motor shall operate on 380/400 volt, 3 phase, 50 hertz, service for open close service, and protected IP67.

Each type electric actuator shall be mounted by the valve manufacturer, tested and adjusted prior to shipment:

a) Type A integral control type.

Electric actuator, Type A shall be integral control type and shall include, but not be limited to, the electric motor, reversing magnetic starter, limit switches, torque switches, space heaters, valve position potentiometer if specified, pushbutton station, shop wiring, gear case and a declutch hand wheel to allow manual operation of the valve.

The valve control units shall have pushbutton stations furnished in enclosures suitable for flush panel mounting or field mounting as required. The stations shall include pushbuttons, status lights, and a selector switch all as required.

b) Type B standard type.

Electric actuator, Type B shall be standard type and shall include, but not be limited to, the electric motor, limit switches, torque switches, space heaters, valve position potentiometer if specified, shop wiring, gear case and a declutch hand wheel to allow manual operation of the valve.

B- Electric Actuators for Butterfly Valve

Gear case shall be of cast iron. Flanges for actuator attachment shall be integrally cast, fully machined, and template drilled.

Motors for electric valve actuator shall be capable of producing not less than 1.5 times the required operating torque.

Any gearing in direct association with the electric motor drive shall be totally enclosed and shall operate in a lubricant.

Actuator shall include an adjustable torque or thrust limited switch capable of stopping the power to the motor when the valve has reached the stops in the open or closed position or when an obstruction has been encountered in either direction of travel.

Torque switches shall be factory set to satisfy the calculated value corresponding to the maximum operating conditions.

Limit switches shall be geared to the driving mechanism and in step at all times whether the unit is operated electrically or manually. The switches shall be of the adjustable type capable of being set to trip at the fully open and fully closed valve positions or at any point between. All electrical interconnections between limit switches, torque switches, indicator lights, and so forth, shall be factory wired and ready for operation. All gearing used in connection with limit switches shall be factory lubricated.

Actuator shall be provided with a position indicator to show the position of the valve at all times. The indicator shall be read in per cent (0 100%) with minimum graduations of 5%.

Actuator shall be equipped with a hand wheel for manual operation. The hand wheel shall be connected so that operation of the motor will not cause the hand wheel to rotate and the operation of the hand wheel shall not cause the motor rotor to rotate. The hand wheel shall be engaged by an exterior level or an automatic clutch. The action of the lever shall also declutch the motor if there is no device to accomplish this automatically when the power supply to the motor ceases. Should the power return to the motor while the hand wheel is in use, the design of the unit shall prevent the power from being transmitted to the hand wheel.

An arrow and the word "open" and "close" shall be placed on the hand wheel to indicate direction of resultant valve movement. Lettering shall be in the English language.

2.20 Special Tools and Spare Parts

The Contractor shall specify and supply one set of special tools required for dismantling and maintenance of each valve.

The Contractor shall supply all the necessary spare parts recommended by the manufacturers for each type of valve set, at least the following ones:

- 2 sets of joints for each valve's type, whatever the joint's type.
- 2 sets of bolts, nuts and washers for each valve's type.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 14161

STOP LOGS

1 GENERAL

1.1 Work Included

This section of the specifications covers the sliding stop logs of the Plant.

The supply shall include the following main items:

1. Embedded parts including lateral guides,
2. Stop log leaf,
3. Equipment for storing and holding in position the stop log.
4. The anchoring system of the built-in parts embedded in the secondary concrete,
5. The corrosion protection work,
6. The anchoring and support parts to be held or embedded in the primary concrete.
7. The special tools and the spare parts.

1.2 Related Works

A) Supplies and works included under this section shall comply with the requirements of the following:

1. Section 01010 - Corrosion protection
2. Section 01020 - Basic mechanical requirements
3. Section 16000 – Conveying systems

B) Work under this section shall be coordinated with:

4. Civil Engineering works and Building works;

1.3 Description

1. The stop logs shall be designed for operation under balanced conditions.
2. Closure: The closure of the stop log shall be carried out under normal flow conditions.
3. The stop logs will be of the sliding type and welded construction.
4. The stop logs will be fitted with seals on three sides only, the upper part not being watertight.

1.4 Quality Assurance

1.4.1 Codes and Standards

A) DIN 19704 - Principles for computation of steel hydraulic plant.
B) DIN 19705 - Recommendation for the design, construction and erection of hydraulic steel structure equipment.
C) DIN 4114 - Steel construction - Stability analysis - Buckling - Lateral buckling - Local buckling.
D) DIN 1045 - Reinforced concrete structures: design and construction.
E) NF A 46.503 - Medium and heavy plates. Tolerances on dimension and excess weight.

1.4.2 Design Criteria

A) Refer to Section 01020.
B) The stop logs shall be designed to withstand without damage an MCE (maximum credible earthquake).

1.4.3 Source Quality Control

1. Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
2. Inspection and testing of standard products: the Contractor shall supply certificates of routine tests.
3. Workshop inspections and tests:
   a) At the end of manufacture, the stop log shall be presented, unpainted, for checking. The seals and the embedded parts shall be presented separately.
   b) Stop logs and embedded parts:

      The surface appearance of embedded parts shall be examined and their dimensions checked. Rolling, sliding and plate sealing surfaces shall be perfectly flat and smooth.

      All dimensions of stop log members shall be checked.

      The operation of by-pass valves shall be checked.

      The Engineer reserves the right to participate in these tests.

   c) Welds:

      Refer to Section 01020.

1.5 Submittals

Refer to Section VII – A. General Requirements

1.6 Guarantee

A) Vibration
   The operation of the stop log shall be guaranteed free of vibration. No tolerances are allowed.
B) Sealing

1. The equipment shall satisfy the guarantees specified hereunder, without any special means having to be used for sealing.
2. Local leaks and average leaks per linear meter of seal shall not exceed the following values:
   a) local leaks: 0.025 liters per second,
   b) average leaks: 0.010 liters per second.

2 PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1 Manufacture

2.1.1 Embedded Parts

1. The lower embedded parts shall include:
   a) On the downstream (or upstream) side the sliding beams and the stainless-steel sealing plates,
   b) On the upstream (or downstream) side the back rails,
   c) The sill made of a steel section fitted with a stainless-steel support plate and mating with the shape of the skin plate,

d) The lintel cross beam on the downstream (or upstream) side, fitted with a stainless-steel sealing plate. The top part of this lintel beam shall be provided with a funnel to ensure an efficient sealing contact when the stop log reaches the end of the closing operation,
e) Lateral guide rails.

2. The upper embedded parts shall include:

a) The lateral guide rails up to the top of the slot.
b) At the top of the slot, the system to store the stop log in open position. This system shall include the movable wedging pieces and their fixed supports together with anchors.
c) Above the top of the slot, the systems used for wedging the stop log during storage of the stop log in maintenance position. This system shall include the movable wedging pieces and their fixed supports together with anchors.

2.1.2 Stop Log Leaf

1. The stop log shall be of welded construction and, to facilitate transport and operation, could be in two parts.
2. The stop log shall have downstream (or upstream) skin plate and seals,
3. The leaf shall be supplied with the necessary supports for storage of the stop log in open and maintenance position.
4. The upper girder of the leaf shall accommodate the necessary lifting lugs for connection to the lifting equipment. Lifting lugs shall be in the same plane as the center of gravity of the stop log.
5. Two guide blocks shall be provided on each side of each stop log or section.

   Their location shall be such that the highest and lowest bumper plates are separated from each other as much as possible.

   The stop log shall be provided with sufficient space for sideward movement but the bumper plates shall hold the stop log in a centered position, no more than 5 mm from the centerline of travel.

   All stop log members shall have a minimum clearance from embedded parts of 10 mm.
6. The Contractor shall take the necessary steps to allow easy dismantling of the seals.

2.2 Special Tools and Spare Parts

A) The Contractor shall specify and supply the special tools required for stop log maintenance.

The Contractor shall supply the following spare parts:

1. One complete set of seals with 20% stainless steel bolts for the stop log leaf.
2. One complete set of seals for the by-pass valve.

3 EXECUTION

3.1 Inspection Before Erection

A) The Contractor shall check the setting and alignment of pre-embedded parts as well as the dimensions and setting of recesses in the civil works for embedded parts.
B) The Contractor shall check the dimensions and setting of the sluice.

3.2 Field Quality Control

A) Inspections before and after concreting

1. Inspections:

a) Position of the sill,

b) Distance between the lateral embedded parts,
c) Perpendicularity of the lateral embedded parts with the sill and the frontal beam,
d) Flatness of the embedded parts, verticality, horizontality,
e) Position of storage and maintenance systems.

2. Erection tolerances: refer to Section 01020.

B) Dry tests

1. Testing of the various operations required for sluice closure and opening (Seal friction surfaces shall be wetted),
2. Checking the position of seals with respect to lateral embedded parts and sill,
3. Checking the position of lateral guide systems with respect to lateral embedded parts,
4. Checking the position and operation of the storage system,
5. Examination of paintwork.

C) Final tests

With the normal operation water level:

1. Inspection of seals and seal leakage.
2. Testing of the various operations required for closure and opening of the sluice.
3. Examination of paintwork

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 14220

SCREW PUMPS

1 GENERAL

1.1 Work Included

1.1.1 Scope of Work

The works to be included in this section consist of the design, manufacture, delivery, off-loading, erection, testing and commissioning of the mechanical equipment for screw pumps.

The equipment shall be complete with all motors, baseplates, foundation bolts and all other items of equipment necessary to make the plant complete and perfect in every detail.

1.2 Related Work

1.2.1 Supplies and Works Included Under This Section Shall Comply With:

A) Section VII – A. General requirements
B) Section 01010 - Corrosion protection
C) Section 01020 – Basic mechanical requirements
D) Section 01030 – Basic electrical requirements

1.2.2 Works Under This Section Shall be Coordinated With:

A) Civil Engineering works and Building works
B) Section 16000 – Conveying systems
C) Electrical equipment

1.3 Quality Assurance

1.3.1 Codes and Standards

1. DIN 19704 - Hydraulic steel structures. Criteria for design and calculation.
2. DIN 19705 - Recommendation for the design, construction and erection of hydraulic steel structure equipment.
3. DIN 4114 - Steel construction

1.3.2 Design Criteria

Refer to Section 01020 - Basic Mechanical Requirements.

1.3.3 Shop Tests and Inspection

1. Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
2. Inspection and testing of standard products: the Contractor shall supply certificates of routine tests.
3. Workshop inspections and tests:

Refer to Section VII – A. General requirements:

a) At the end of manufacture, the screw pumps shall be presented, unpainted, completely erected for dimensional checking.

b) Welds:

Refer to Section 01020 - Basic Mechanical Requirements.

1.4 Submittals

Refer to Section VII – A. General requirements.

Schedules of Particular.

1.5 Guarantee

1.5.1 Vibrations

The operation of the screw pump shall be guaranteed free of vibrations.

1.5.2 Dimension Tolerances

Refer to Section 01020 - Basic Mechanical Requirements.

2 PRODUCTS - COMPONENTS - AND SUB-ASSEMBLIES

2.1 Fabrication

2.1.1 General

The Contractor shall insert in his bid details regarding the screw pumps and ancillaries. The Contractor shall submit additional information such as illustrated catalogues and drawings.

The screw pumps shall be designed taking into account the emergency T.W.L. (Top water level) in the inlet sump or channel. The pumps shall operate at this level and the eventual tendency for the rotating assembly of the pump to float shall be taken into consideration when selecting bearings and other components, and also in the design of the screw assembly.

2.1.2 Steel Trough Liner

Should the screw be mounted in a steel trough liner, this liner shall be supplied and complete with all the necessary brackets and fittings for the adequate installation of the trough.

The Contractor shall carry out the final alignment of the trough to provide the correct clearances, and for the supervision of the grouting-in of the trough.

The screw pump trough shall be a leak free, mild steel fabrication of not less than 5 mm thickness formed to give the correct clearances to the screw pump.

The trough shall extend between the pump inlet and the discharge without distortion. The Contractor shall provide all necessary end and intermediate fixing/support brackets.

The trough shall be so shaped as to avoid 'wedges' between screw and side walls and to provide for the return of any excess liquid or solids without interference with pump rotation.

In order to contain the pumped liquid on the high-water level side of the screw axis, caused by the rotation of the pump, special side profiles shall be fitted. The profiles shall be fixed to the steel trough and the channel side wall using approved stainless steel fixing bolts, to maintain a small clearance around approximately 230° of the screw circumferences.

2.1.3 Screw Assembly

The rotating screw assembly shall consist of a center tube seam welded by the tube maker with cold formed helices fillet-welded thereto and stub shaft housings at each end. The helices at the leading end of the screw shall be reinforced.

Primary and secondary stresses in the screw assembly shall be calculated in accordance with ISO 2394 and the design and fabrication shall be in accordance with ISO 2394.

Design life of the screw assembly shall be assessed in accordance with ISO 2394.

Stress calculations shall not include any allowance that might be claimed by the attachment of the helices to the center tube or to buoyancy when the screw is lifting fluid.

The material of the center tube and helices shall be weldable structural steel to ISO 9267.

Welding, with the exception of the attachment of the helices, shall be carried out by the submerged arc process with approval testing of welding procedures in compliance with BS 4870; 1981 or equivalent.

Longitudinal and circumferential welds only shall be made to the center tube except for the attachment of helices which shall be by a continuous fillet weld interrupted where it intersects center tube welds.

Circumferential welds shall not occur at a greater distance than 20% from the extremities of the finished tube and preferably at the lower end only when joining tubes.

All longitudinal and circumferential welds shall be radiographed as for the approval testing procedure.

Lifting lugs shall not be welded to the center tube. Metal protection shall be in accordance with Section 01010 - Corrosion protection.

The stub shaft housing at each end of the center tube shall affect a gradual reduction in diameter and shall be weldable steel castings, to BS 4360 or equivalent. The stub shafts shall be steel forging to BS 970 Part 1 or equivalent and the fastenings to the housings shall not under any circumstances, be subject to cyclical stressing. The stub shaft shall be readily removable from the housing prior to transport and readily replaceable at site.

2.1.4 Bearings

The bottom bearing shall be pivoted to facilitate alignment of the screw and provision shall also be made to take account of the resultant force on the screw, due to the higher water level mentioned above.

The bottom bearing housing and mounting shall be designed to withstand radial forces only, including upward forces due to buoyancy during emergency level conditions. The bearing shall be split on its horizontal center line together with the phosphor bronze renewable feather keyed bearing shell to facilitate inspection without disturbance of the stub shaft or the need to support the screw.

Lubrication shall be a light grease or oil system pressurized by an electric motor driven plunger pump or oil hydraulic reservoir in the form of a power pack. If the former is chosen the grease shall return to a suitable removable receptacle located on a bracket fixed to the external sump wall or, if the latter, a return pipe shall be provided to return oil to the reservoir via a suitable inclined 'in line' filter. Pipelines shall be stainless steel which shall run in a trough recessed. Provision shall be made for priming the system (30 secs for oil or 60 secs for light grease) prior to start-up of the pump. An adjustable pressure relief valve shall be provided for either system together with a pressure gauge, pressure switch and thermal protection.

Each half of the bottom-bearing shells shall be spirally grooved such that rotation of the journal assists the passage of lubricant through the bearing surfaces.

Seals shall be split and readily changed without the disturbance of the stub shafts or the need to support the screw.

The design of the bearing housing and shells shall provide for repositioning the bottom shell to the top position and vice versa when wear has taken place.

An external stationary shroud shall be provided to prevent detritus affecting the bearing.

The top bearing shall be designed to accommodate the entire thrust including upward forces due to buoyancy of the rotating parts of the screw together with a proportion of the radial forces. The thrust shall be transferred from the shaft to the bearing by means of a thrust ring or locknuts. A "circlip"

arrangement will not be acceptable. The bearing shall be grease lubricated with a Stauffer 'tell-tale' lubricator easily accessible. All bearings shall be provided in accordance with Section 01020 - Basic mechanical requirements.

2.1.5 Screw Pump Cover

Each screw pump will be fitted with a cover in glass reinforced plastic material. The covers will completely enclose the inclined pump channels and inlet bays. It will also include lockable access covers to the ladders and inlet bays.

2.1.6 Gearboxes

The gearboxes shall be of heavy-duty construction having the output shaft at right angles to the input shaft and shall be provided in accordance with the following.

The gearboxes shall be totally enclosed. Long life double seals on the input and output shafts shall prevent the escape of lubricant and ingress of dust, sand and moisture. Breather holes and /or pipes shall be sealed to prevent ingress of dust or contaminants.

Housing of the gearboxes shall be complete with removable inspection cover, oil filler cap and drain plug, oil levels indicators for filling indicating minimum and maximum.

Lubrication of gears and bearings shall be of splash type to suit the size and mounting arrangement of the unit. Access for inspection purposes shall be allowed for in the design of the gearbox casing.

The rated power of the gearboxes shall be supported by manufacturer calculation note, taking into account the operating and severe climatic conditions, but shall have in any case a service factor not less than 2.

A steel mounting frame assembly shall be provided incorporating a one-piece bedplate, and designed for the mounting of the gear box in the inclined position. The motor shall be mounted horizontally on a fabricated steel frame assembly, separately from the bedplate gearbox. The base of the fabrication shall be suitable for holding down onto a plain horizontal top concrete mounting plinth. The fabrication shall be stress relieved when all welding is completed and prior to machining.

The assembly shall be checked for alignment at works in the presence of the Engineer's representative and, when accepted, pilot holes shall be drilled for dowel locations to facilitate lining up when holding down bolts are tightened at site.

A backstop device to prevent reverse rotation shall be provided. However, the gearbox shall be designed to be driven at 25% of normal speed in the reverse direction.

The coupling between the motor and gearbox shall be of multiple V-belts drive and pulleys type.

The final drive coupling between the gearbox and top bearing of the screw shall be of the flexible bush and pin type adequately rated and designed to tolerate without mal-effect the deflections of the screw in addition to the torque.

Guarding shall be provided to both couplings and associated shafts to give adequate protection to all moving parts. All guards shall be removable for maintenance, as per Section 01020 - Basic mechanical requirements.

All rag bolts shall be in stainless steel and be designed to ensure a good bond between the steel and the concrete.

The gear boxes shall be guaranteed for 200 000 hours of operation.

2.2 Special Tools and Spare Parts

The Contractor shall specify and supply one set of special tools required for dismantling and maintenance of the screw pumps, gearboxes and ancillaries' equipment.

The Contractor shall supply all the necessary spare parts recommended by the manufacturers. The list of spare parts shall be submitted to the Engineers' approval.

3 EXECUTION

3.1 Inspection Before Erection

The Contractor shall check the setting and alignment of pre-embedded parts as well as the dimensions and setting of recesses in the civil works for embedded parts.

3.2 Field Quality Control

3.2.1 Commissioning Tests

3.2.1.1 GENERAL

1. The Tests on Completion shall consist of the following:

   a) (1)..... Installation inspection;
   b) (2).....Pre-commissioning tests
   c) (3)..... Commissioning tests;
   d) (4)..... Overall setting-to-work.

The Contractor shall submit to the Engineer for approval a comprehensive program and detailed proposals of the Tests on Completion.

2. The Tests and the Overall Setting-to-Work shall be carried out under the control and supervision of the Contractor. The Contractor shall provide an accredited representative and all other labor, materials, all instruments including indicators, gauges, and other measuring instruments and all other apparatus required for the Tests on Completion, together with oils and stores. All instruments shall be calibrated prior to the Tests.

3.2.2 Installation Inspection

1. When the Contractor is satisfied that the screw pump sets have been properly installed, he shall inform the Engineer who will carry out the installation inspection.
2. The screw pump sets will be inspected with regards to compliance with this Specification and approved drawings. In the event of any items of plant failing to meet the requirements of this Specification or the approved drawings, or the workmanship being defective, the Contractor shall take immediate steps to remedy the deficiency to the satisfaction of the Engineer.

3.2.2.1 Pre-Commissioning Tests

1. Pre-commissioning tests shall be carried out after any deficiencies noted during the installation inspection have been remedied to the satisfaction of the Engineer.
2. All associated instrumentation (e.g. vibration and temperature monitoring equipment) shall be checked to ensure correct functioning.
3. Miscellaneous pipework shall be checked under hydrostatic pressure; leaks shall not be accepted.
4. Lubrication system shall be checked.

3.2.2.2 Commissioning Tests

1. Tests shall be carried out on each screw pump set and shall include but not necessarily be limited to the following:

   a) performance tests to establish that the screw pump sets operate satisfactorily over the entire operating flow range and to demonstrate the dynamic ability of the screw pump set operation under all Site conditions;

b) vibration monitoring to demonstrate compliance with specified vibration severity limits;
c) simulation of power failure and emergency shutdown conditions when the screw pump sets operate at full speed.

2. Performance proving tests shall be carried out on one screw pump set at a time by pumping clean water. The Contractor shall submit to the Engineer the way he intends to carry out these tests, particularly concerning water supply and output. Performance data shall include power inputs, screw pump set efficiency curves and rotation speeds. Flow rates shall be measured using flow measuring instruments to be provided by the Contractor for testing of all the screw pumps. The flow meters may be installed at a suitable location. The contractor shall remove the flow meters from their locations after completion of all tests.

3. The purpose of the performance proving tests is to confirm the factory tested results and verify the performance of the screw pump sets under site conditions over the full operating range. In the event the proving test results are not satisfactory compared to the factory tested results, the Contractor shall immediately rectify the discrepancy.

4. The screw pump sets, associated ancillary equipment and any component of the piping or lubrication systems will be liable for rejection if they fail to achieve satisfactory performances as required by the Contract.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 14270

DOSING PUMPS

1 GENERAL

1.1 Work Included

The works to be included in this section consist of the design, manufacture, delivery, off-loading, erection, testing and commissioning of the mechanical equipment for dosing pumps.

1.2 Related Work

1.2.1 Supplies And Works Included Under This Section Shall Comply With:

A) Section VII – A. General requirements;
B) Section 01010 - Corrosion protection
C) Section 01020 – Basic mechanical requirements;
D) Section 01030 – Basic electrical requirements;

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A) Civil Engineering works and Building works;
B) Section 14100 – Pipes and fittings;
C) Section 14150 – Valves, gates and appurtenances;
D) Electrical equipment;

1.3 System Description, Characteristics and Operating Conditions

Pumps shall be diaphragm-type volumetric dosing pumps for dosing the various corrosive, abrasive, loaded or viscous reagents.

The pumps shall be completely sealed.

Dosing pumps shall be provided with required equipment such as (non-exhaustive list):

- Foot valve, when the pump is installed in suction;
- Filter, when the pump is installed with a flooded suction;
- Injection nozzle;
- Back pressure valve;
- Safety valve;
- Pulsation dampener;

1.4 Quality Assurance

1.4.1 Codes and Standards

Pumps shall comply with ISO standards or approved national or international standards, in particular the following (non-exhaustive list):

1.4.2 Design Criteria

Accuracy of dosing

- Flow rate..... < ± 1 %
- Linearity ..... < ± 2 %

The repeatability of calibration shall be < ±1%, in the range 25% - 100% of variation in stroke length and in the range 20% - 100% of variation in velocity.

1.4.3 Shop Tests and Inspection

A) Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
B) Inspection and testing of standard products: the Contractor shall supply certificates of routing tests.
C) All molded and cast parts shall be submitted for inspection.
D) Workshop inspections and tests:

Refer to Section VII – A. General requirements:

a) At the end of manufacture, the pumps shall be presented, unpainted, completely erected for dimensional checking.
b) One pump of each type with its driving motor shall be tested at the manufacturer's plant to demonstrate complete compliance with the Specifications. In case the tests are not satisfactory, necessary modifications shall be done by the manufacturer and all pumping sets will be tested.

The Contractor shall submit the results of workshop tests.

1.5 Submittals

The Contractor's proposal shall include:

- guaranteed performance levels,
- outline drawings for the proposed equipment,
- the characteristics of the equipment, and in particular the stage-discharge curves, efficiency, power consumption and requisite NPSH of the proposed pumps,
- the type of materials proposed,
- technical data sheets or manuals for the paints used,
- the painting procedure,
- the test procedure.

2 PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1 Fabrication

The materials used must take into account the characteristics of the fluids to be pumped. The Contractor shall propose materials suited to the fluid being pumped for each component of the dosing pump.

The dosing diaphragm shall be coated with a layer of Teflon to ensure optimum resistance at all times to the liquid (sulphuric acid, permanganate, aluminum sulphate, polymer, lime, etc.).

Other parts in contact with the liquid shall be made of non-corrodible materials such as inert materials (polypropylene, PVC, etc.) or stainless steel.

2.2 Special Tools and Spare Parts

The Contractor shall specify and supply one set of special tools required for dismantling and maintenance of the dosing pumps and ancillaries.

The Contractor shall supply all the necessary spare parts recommended by the manufacturers. The list of spare parts shall be submitted to the Engineers' approval.

3 EXECUTION

3.1 Inspection Before Erection

The Contractor shall check the setting and alignment of pre-embedded parts as well as the dimensions and setting of recesses in the civil works for embedded parts.

3.2 Setting

Dosing pumps shall be installed according to normal codes of practice and the manufacturer's instructions.

3.3 Field Quality Control

3.3.1 Commissioning Tests

3.3.1.1 General

a) The Tests on Completion shall consist of the following:

1. Installation inspection;
2. Pre-commissioning tests
3. Commissioning tests;
4. Overall setting-to-work.

The Contractor shall submit to the Engineer for approval a comprehensive program and detailed proposals of the Tests on Completion.

b) The Tests and the Overall Setting-to-Work shall be carried out under the control and supervision of the Contractor. The Contractor shall provide an accredited representative and all other labor, materials, all instruments including indicators, gauges, and other measuring instruments and all other apparatus required for the Tests on Completion, together with oils and stores. All instruments shall be calibrated prior to the Tests.

3.3.1.2 Installation Inspection

a) When the Contractor is satisfied that the pump sets have been properly installed, he shall inform the Engineer who will carry out the installation inspection.
b) The pump sets will be inspected with regards to compliance with this Specification and approved drawings. In the event of any items of plant failing to meet the requirements of this Specification or the approved drawings, or the workmanship being defective, the Contractor shall take immediate steps to remedy the deficiency to the satisfaction of the Engineer.

3.3.1.3 Pre-Commissioning Tests

a) Pre-commissioning tests shall be carried out after any deficiencies noted during the installation inspection have been remedied to the satisfaction of the Engineer.
b) All associated instrumentation (e.g. vibration and temperature monitoring equipment) shall be checked to ensure correct functioning.
c) Hydrostatic pressure test shall be carried out on each pump body and discharge pipework to check for leaks. The test pressure shall be the pump shut-off head.

3.3.1.4 Commissioning Tests

a) Tests shall be carried out on each pump set and shall include but not necessarily be limited to the following:

- ~ performance tests to establish that the pump sets operate satisfactorily over the entire operating flow range and to demonstrate the dynamic stability of the pump set operation under all Site conditions;
- ~ vibration monitoring to demonstrate compliance with specified vibration severity limits;
- ~ simulation of power failure and emergency shutdown conditions when the pump sets operate at full pump speed.

b) Performance proving tests shall be carried out on one pump set at a time by dosing clean water. The Contractor shall submit to the Engineer the way he intends to carry out these tests, particularly concerning water supply and output.

c) The accuracy, linearity and repeatability of dosing shall be tested in a range of 20%-100% of the maximum flow rate.

d) Dosing rates shall be measured using suitable flow measuring instruments to be provided by the Contractor for testing of all the pumps. The flow meters may be installed at a suitable location. The contractor shall remove the flow meters from their locations after completion of all tests.

e) Pressure measurements shall be taken at a number of locations as directed by the Engineer. Sufficient measurements shall be taken to enable the performance of the pumping system to be evaluated.

f) The purpose of the performance proving tests is to confirm the factory tested results and verify the performance of the pump sets under site conditions over the full operating range. In the event the proving test results are not satisfactory compared to the factory tested results, the Contractor shall immediately rectify the discrepancy.

g) The pump sets, associated ancillary equipment and any component of the piping system will be liable for rejection if they fail to achieve satisfactory performances as required by the Contract.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 14300

MISCELLANEOUS PUMPS

1 GENERAL

1.1 Work Included

1.1.1 Scope of Work

The works to be included in this section consist of the design, manufacture, delivery, off-loading, erection, testing and commissioning of the mechanical equipment for the miscellaneous pumps to be designed by the Contractor.

The equipment shall be complete with all base plates, foundation bolts, heat exchanger and all other items of equipment necessary to make the installation complete and perfect in every detail.

1.2 Related Works

1.2.1 Supplies And Works Included Under This Section Shall Comply With:

A) Section VII – A. General requirements;
B) Section 01010 - Corrosion protection
C) Section 01020 - Basic mechanical requirements;
D) Section 01030 - Basic electrical requirements;

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A) Civil Engineering works and Building works;
B) Section 14100 – Pipes and fittings;
C) Section 14150 – Valves, gates and appurtenances;
D) Section 16000 – Conveying systems;
E) Electrical equipment;

1.3 Description

1.3.1 Types of Pumps

The following types of pumps shall be specified hereinafter and the units shall be complete with electric motor or engines, starters, automatic controls where specified or shown, base plates and all other necessary appurtenances:

- End Suction Centrifugal Pumps.
- Multistage Centrifugal Pumps.
- Horizontal Radial Pumps.
- Vertical Centrifugal Sump Pumps.

a) End suction centrifugal pumps

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.

b) Multistage centrifugal pumps

Pumps shall be horizontal, side suction, top connected discharge, multistage centrifugal pump, directly connected to the motor with 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.

c) Horizontal peripheral pumps

Pumps shall be horizontal single stage peripheral multivane turbine impeller type, directly connected to the motor with 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.

d) Vertical centrifugal sump pumps

Pumps shall consist of an electric motor directly connected, by means of an enclosed shaft, to a vertical centrifugal type pump having a bottom suction and separate steel discharge pump column to a flanged side outlet near the motor. Bearing guiding to enclosed shaft shall be oil or grease lubricated.

1.3.2 Main Characteristics

a) All pumps shall be driven by electric motors in accordance with the requirements of the electrical specifications.
b) The direction of rotation of all the pumps shall be clockwise when viewed from the motor end of the pump set assembly.
c) All pumps of same type shall be identical in design and construction in all respects including performance, parts, mountings, connecting flange dimensions and materials.
d) The Contractor shall design the pumps to meet the performance requirements and construction requirements specified elsewhere in this Specification. Particular emphasis shall be placed on their performance, robustness and reliability.
e) The pumps shall be sufficiently robust to withstand all forces under the most arduous conditions associated with normal and abnormal operations. These shall include:
   - ~ Normal starting and stopping against an open delivery valve.
   - ~ Starting against closed valve without overheating.
   - ~ Reverse rotation due to backflow in case of flap valve failure.
   - ~ Transients due to power failure and emergency shutdown.
f) The pump rotating assembly design shall be such that the first critical speed of the pump with its motor and the transmission assembly, when running as one system, is at least 150 percent of the maximum operating speed of the pump.
g) Each component casting of the water pump body shall have a wall thickness of 10mm minimum over and above that required to meet the strength requirements, to compensate for the corrosive and abrasive action of the sewage.
h) The design and construction of the rotating assembly shall take into account the possibility of uplift forces caused by the pressure transients during pump start-up or shut-down. The Contractor shall show how this force is counteracted.
i) The pumps shall be capable to work for long periods continuously without cleaning or attention and special precautions shall be taken to avoid wear on working surfaces dues to grit.

1.3.3 Operating Conditions and Performance Requirements

1.3.3.1 Pump Duties

a) The Contractor shall determine the number of pumps he intends to use as duty and as standby for each type of pump.
b) Each of the pumps shall be capable of operating continuously without damaging effects due to cavitation (if any); If the Contractor considers that additional measures or controls are necessary to protect the Plant from any long-term damaging effects, then all such equipment and controls

shall be provided and shall be deemed to have been included in the contract price. The details shall be submitted with the Tender.

1.3.3.2 Pump Suction Ability (NPSHR)

The pump shall be capable of operating satisfactorily in the specified operating range. The pump NPSHR shall be less than the NPSHA under any operating condition at Site to avoid cavitation. If the pump requires any increase of the system head so as to achieve satisfactory operation at any point in the specified operating range, then this shall be clearly stated in the Tender. The method and details of creating the additional system head shall be stated and drawings showing any changes required in the civil layout shall be submitted. Where such requirements affect the hydraulics of the complete system, hydraulic calculations shall be carried out and included in the Tender. If the change implies higher energy cost during operation of plant, then this will be taken into account during tender assessment.

1.3.3.3 Pump Rated Speed (NR)

The maximum rated speed of the pumps shall be designed by the Contractor.

1.3.4 Head-Flow Characteristics

The pump "Head-Flow" characteristics in the specified operating range shall be stable so that a tangent drawn at any point on the curve will be downwardly directed in the direction of increasing flow.

1.3.4.1 Pump Shaft Power and Pump Efficiency

The pump shaft power characteristics shall be stable within the duty range and shall be non-overloading at the pump operating speed. The pump efficiency at the design operating point shall be not less than 85%.

1.3.4.2 Reverse Rotation Capability

Under shut down conditions, reversal of the pump rotation will take place and the pump, motor and shafting shall be designed accordingly.

1.4 Quality Assurance

1.4.1 Standards

A) NFE 44111 44121 or equivalent
B) DIN 24255 24256 or equivalent
C) ISO 2858

1.4.2 Design Criteria

1. Design of Pumps

Pumps shall be designed for the specified performance and shall operate without overheating, excessive vibration, or strain. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the work to be done.

2. End Suction Centrifugal Pumps

Unless otherwise specified, relation between pump suction diameter and pole number of drive motor shall be as specified in the following table:

Pole number of drive motor	Pump suction diameter (mm)
2	50, 65, 80, 100 and 125
4	40, 50, 65, 80, 100, 125, 150 and 200

Rated discharge flow of the pump shall be as specified in the following table unless otherwise specified.

Pumps suction Diameter (mm	2 pole drive motor m^3/min	4 pole drive motor m^3/min
40	-	Less than 0.16
50	0.10 to 0.32	0.10 to 0.32
65	0.20 to 0.63	0.20 to 0.63
80	0.40 to 1.25	0.40 to 1.25
100	0.80 to 2.50	0.63 to 2.00
125	1.25 to 6.30	0.80 to 3.15
150	-	1.60 to 5.00
200	-	2.50 to 10.00

3. Multistage Centrifugal Pumps

Rated discharge flow of the pump shall be as specified in the following table unless otherwise specified.

Pumps suction diameter (mm)	Rated discharge flow (m^3/min)
40	Less than 0.20
50	0.16 to 0.32
65	0.25 to 0.50
80	0.40 to 0.80
100	0.63 to 1.25
125	1.00 to 2.00
150	1.60 to 3.15

1.4.3 Shop Tests and Inspection

1. Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
2. Inspection and testing of standard products: the Contractor shall supply certificates of routing tests.
3. Workshop inspections and tests:

Refer to Section VII – A. General requirements:

a) At the end of manufacture, the pumps shall be presented, unpainted, completely erected for dimensional checking.
b) One pump of each type with its driving motor shall be tested at the manufacturer's plant to demonstrate complete compliance with the Specifications. In case the tests are not satisfactory, necessary modifications shall be done by the manufacturer and all pumping sets will be tested.

The Contractor shall submit the results of workshop tests.

1.5 Submittals

In addition to submittals required under Section – A. General requirements, the Contractor shall provide the following curves for each pumping unit in the Schedules of Particular:

- Lifting head (m)
- Efficiency (%)
- Horsepower (kW)
- Required NPSH (m)

Moreover, the Contractor shall determine in his bid the:

- Rotating speeds (tr/mn),

- Power of the associated motors (kW),
- Weights of the units and of each essential component,
- Wheel diameters,
- Input and output diameters.

Literature, detail drawings including materials, construction and parts list to indicate full conformance with the detail specifications and to show installation details shall also be submitted to the Engineer.

2 PRODUCTS – COMPONENTS AND SUB-ASSEMBLIES

2.1 Fabrication

2.1.1 End Suction Centrifugal Pumps

a) Casing

The casing shall be cast iron Ft 25 or equivalent, with smooth waterway and fitted with wearing rings. Wearing rings shall be provided for pumps running more than 1000 hours a year. The wearing rings shall be of bronze casting CuSn 12 or equivalent. Casing shall be constructed so that the front casing and rotating parts shall be removed without disturbing the volute case or the 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 CuSn12 or equivalent.
- Cast iron Ft 20 or equivalent.
- Stainless steel, AISI 304 or equivalent

c) Shaft

The pump shaft shall be of Cr Mo low alloy steel 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. Lubrication of bearings shall be done with grease.

d) Stuffing boxes

Stuffing boxes 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 tight 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 of the flexible type and shall be provided with guards.

2.1.2 Multistage Centrifugal Pumps

a) Casing

The casing shall be cast iron Ft 25 or equivalent, with smooth waterway and each split casing shall be fitted with wearing rings. The wearing rings shall be of bronze casting.

b) Impeller

The impeller shall be enclosed, accurately machined, and statically and dynamically balanced. The impeller shall be made of bronze casting CuSn 12 or equivalent.

c) Shaft

The pump shaft shall be of Cr Mo low alloy steel precision ground, and provided with renewable bronze sleeve where it passed through the stuffing box and is in contact with water. Both sides of the shaft shall be rigidly supported by heavy duty antifriction ball or roller type bearings. Lubrication for ball or roller bearings shall be done with grease.

d) Stuffing boxes

The stuffing boxes shall be of such design and size as to ensure tight packing without excessive wear or friction on the shaft sleeve. The stuffing box shall be provided with at least three (3) square tight packing rings with a lantern ring. An easily removable gland shall be provided for the stuffing box. The gland shall be of bronze casting.

e) Shaft coupling

The shaft coupling between pump and motor shall be the flexible type and shall be provided with guards.

2.1.3 Horizontal Radial Pumps

a) Casing

The pumps shall be split vertically and shall have a removable casing cover so designed that the pump can be entirely disassembled for repairs or inspection without disturbing discharge or suction piping. Front and back casing guide rings shall be provided. Casing and casing cover shall be of cast iron Ft 25 or equivalent casing guide rings shall be of leaded tin bronze casting.

b) Impeller

The impeller shall be bronze casting CuSn 12 or stainless steel. The shaft shall be stainless steel having a stainless-steel sleeve and supported by two (2) sets of ball bearings with grease lubrication.

c) Stuffing boxes

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

d) Shaft coupling

The shaft coupling pump and motor shall be the flexible type and shall be provided with guards.

2.1.4 Vertical Centrifugal Sump Pumps

a) Casing

The casing shall be cast iron accurately machined to provide uniform clearance for impeller and rigid connection to the supporting plate through a steel pipe to ensure positive alignment. A strainer of corrosion resistant material shall be securely attached to the suction side of the casing. Casing shall be provided with bronze wearing rings, for pumps running more than 1000 hours a year.

b) Impeller

The impeller shall be cast iron of either the open or semi enclosed non clogging type, accurately machined and finished to produce high efficiency. Impeller shall be capable of passing any solids which can pass through the strainer and shall be securely attached to the drive shaft by a key and lock nut with provision for easy removal and replacement.

c) Shaft

The pump shafts shall be carbon steel, turned and ground and of sufficient diameter to transmit the power of the motor and operate at maximum speed without vibration. Suitable oil seal or stuffing box shall be provided where the shaft passes through the pump supporting plate.

d) Bearings

The upper bearing shall be a combined radial and thrust type antifriction bearing, grease lubricated. The lower bearing shall be bronze of leaded tin bronze casting bushing and lubrication for lower bearing shall be oil or grease. Suitable oiler or grease cup shall be provided.

e) Pump support plate

Each pump shall be supported by a steel plate mounted on the sump cover plate. The pump discharge shall pass through and be rigidly supported by the supporting plate.

f) Sump cover plate

The square sump opening shall be provided with a steel angle frame and steel cover plate of the dimensions indicated. Sump cover plate shall be provided with manhole and cover plate and holes for installation of the pumps and studs for bolting down the pump supporting plates and manhole cover plate. Sump cover plate shall be bolted down to the angle frame with stainless steel nuts on stainless steel studs welded to the angle frame.

2.1.5 Motors

The motors for driven pumps except horizontal peripheral pumps shall have sufficient rating to operate the pump at any point on its characteristic curve without overloading and in addition shall have a service factor of at least 1.15 at the rated operation point.

The motor for the driven horizontal peripheral pump shall have sufficient rating to operate the pump at any point on its characteristic curve without overloading and in addition shall have a service factor of at least 1.10 at the shutoff point. Unless otherwise specified, motors shall be totally enclosed, fan cooled type. All motors shall be as specified under Electrical requirements sections.

2.1.6 Nameplate

Brass of stainless-steel nameplate giving the name of the manufacturer, the rated capacity, head, speed, model and serial number and other pertinent data shall be attached to each pump. Similar nameplates giving pertinent motor data shall be attached to each electric motor.

2.1.7 Shop and Field Painting

The pumps, couplings, motor and bed plates shall have shop and field coats. All interior ferrous and non-machined surface of casings shall be shop painted with tar-epoxy paint. Painting shall conform to the requirements as specified in the Section 01010 – Corrosion protection.

2.2 Spare Parts and Tools

Spare parts and tools shall be supplied for a two years operation period.

The Contractor shall also supply all the necessary spare parts recommended by the manufacturers.

The list of spare parts shall be submitted to the Engineer's approval.

3 EXECUTION

3.1 Inspection Before Erection

The Contractor shall check the setting and alignment of pre-embedded parts as well as the dimensions and setting of recesses in the civil works for embedded parts.

3.2 Field Quality Control

3.2.1 Commissioning Tests

3.2.1.1 General

a) The Tests on Completion shall consist of the following:

1. Installation inspection;
2. Pre-commissioning tests
3. Commissioning tests;
4. Overall setting-to-work.

The Contractor shall submit to the Engineer for approval a comprehensive program and detailed proposals of the Tests on Completion.

b) The Tests and the Overall Setting-to-Work shall be carried out under the control and supervision of the Contractor. The Contractor shall provide an accredited representative and all other labor, materials, all instruments including indicators, gauges, and other measuring instruments and all other apparatus required for the Tests on Completion, together with oils and stores. All instruments shall be calibrated prior to the Tests.

3.2.1.2 Installation Inspection

a) When the Contractor is satisfied that the pump sets have been properly installed, he shall inform the Engineer who will carry out the installation inspection.
b) The pump sets will be inspected with regards to compliance with this Specification and approved drawings. In the event of any items of plant failing to meet the requirements of this Specification or the approved drawings, or the workmanship being defective, the Contractor shall take immediate steps to remedy the deficiency to the satisfaction of the Engineer.

3.2.1.3 Pre-Commissioning Tests

a) Pre-commissioning tests shall be carried out after any deficiencies noted during the installation inspection have been remedied to the satisfaction of the Engineer.
b) All associated instrumentation (e.g. vibration and temperature monitoring equipment) shall be checked to ensure correct functioning.
c) Hydrostatic pressure test shall be carried out on each pump body and discharge pipework to check for leaks. The test pressure shall be the pump shut-off head.

3.2.1.4 Commissioning Tests

a) Tests shall be carried out on each pump set and shall include but not necessarily be limited to the following:

~ performance tests to establish that the pump sets operate satisfactorily over the entire operating flow range and to demonstrate the dynamic stability of the pump set operation under all Site conditions;

~ vibration monitoring to demonstrate compliance with specified vibration severity limits;

~ reverse rotation of the pump set due to backflow;

~ simulation of power failure and emergency shutdown conditions when the pump sets operate at full pump speed.

b) Performance proving tests shall be carried out on one pump set at a time by pumping clean water. The Contractor shall submit to the Engineer the way he intends to carry out these tests, particularly concerning water supply and output. Performance data shall include H-Q curves, power inputs, pump set efficiency curves and rotation speeds. Flow rates shall be measured using flow measuring instruments to be provided by the Contractor for testing of all the pumps.

The flow meters may be installed at a suitable location. The contractor shall remove the flow meters from their locations after completion of all tests.

c) Pressure measurements shall be taken at a number of locations as directed by the Engineer, including the outlet flange of the discharge bend of pump. Sufficient measurements shall be taken to enable the performance of the pumping system to be evaluated, including losses in the discharge pipe work.

d) The purpose of the performance proving tests is to confirm the factory tested results and verify the performance of the pump sets under site conditions over the full operating range. In the event the proving test results are not satisfactory compared to the factory tested results, the Contractor shall immediately rectify the discrepancy.

e) The Contractor shall demonstrate the total plant losses are within the values calculated by the Contractor. In the event that the measured head losses are higher than the calculated values, the Contractor shall rectify the discrepancy immediately.

f) The pump sets, associated ancillary equipment and any component of the piping system will be liable for rejection if they fail to achieve satisfactory performances as required by the Contract.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 14633

OVERHEAD TRAVELING CRANE

1 GENERAL

1.1 Scope of Work

A. Furnish all labor, materials, equipment and incidentals to install, test and place in satisfactory operation the electric overhead traveling bridge crane with controls and appurtenances, as indicated on the Drawings and as herein specified. The work includes, but is not limited to, hoists, Hangers Bridge, tracks, end stops, trolley, drive motor, reducer, brakes, motor starters, limit switches and push button controls.

B. Design of the crane structural support system shall be performed by the crane manufacturer.

1.2 Submittals

A. Submit to the Engineer as provided in the specifications, the design of the crane structural support system, shop drawings showing details of the design, fabrication and erection of all materials and equipment furnished under this Section.

B. Operating and Maintenance Data.

1. Operation and maintenance manuals shall be submitted by the supplier
2. Design Responsibility: Certificate of Design: Complete form at end of section and submit to Engineer prior to manufacture of cranes.

1.3 Reference Standards

A. American Society for Testing and Materials (ASTM)

1. ASTM A36 Standard Specification for Structural Steel.

B. Crane Manufacturers Association of America (CMAA).

1. CMAA 70 Specification for Electrical Overhead Traveling Crane.

C. National Electrical Code (NEC).

1.4 Quality Assurance

A. Design of the overhead bridge cranes shall be in general conformance to CMAA 70, except as otherwise specified herein.

1.5 System Description

A. The system will be used for handling equipment. Rated capacity shall be as indicated on drawings.

1. Travelling speed 0.50 m/sec to 0.60 m/sec. Lifting speed 0.10 m/sec.

2 PRODUCTS

2.1 Cranes Structural Steel Work

A. Provide structural steel bracing to assure rigidity of construction and to maintain accurate gauge of the length of crane. Structural steel shall conform to requirements of ASTM A36.

B. Runway rail shall be exactly parallel and horizontal, level throughout, conforming to applicable code regarding size and performance.
C. Include all stops at ends of all crane and trolley runs. The crane manufacturer is responsible for design of stops. Furnish and install materials required for stops. All stops securely anchored and positioned to protect adjacent construction, materials, equipment or similar obstructions.

2.2 Bridge

A. Bridge shall be single girder Crane Bridge. Crane girders designed to resist all vertical, lateral and torsional forces combined as specified in CMAA 70.
B. Double flanged rolled bridge truck wheels of forged or cast steel with hardened treads. Wheels designed to carry maximum wheel load under normal operating conditions without undue wear. Diameter not less than that shown for maximum load in CMMA 70.

2.3 Hoist and Trolley

A. Single speed electric hoist with spur, helical, or herringbone friction bearings throughout, including a mechanical load brake and a separate electrically operated motor brake. Design shafts of motor drum and drum pinion to run in grease lubricated ball or roller bearings. Design gear train and bearings to be oil bath or splash lubricated.
B. Trolley wheels similar in design and construction to bridge truck wheels.
C. Trolley drive consists of fully enclosed electric motor driving through spur or worm gears driving one wheel on each side of trolley. Geared transmission completely enclosed in oil tight housing. Ball or roller bearings used throughout.
D. Steel or high-grade cast-iron drum designed to withstand combined crushing and bending loads and not less than two complete wraps of hoisting rope to remain in grooves when hook is at lowest position for lift specified and no overlapping of rope when hook is at highest point. Machined drum grooves having right and left-hand grooves for double reeving.
E. Provide limit switch at upper and lower limits of hook travel, with overload cut off to prevent application of forces greater than rated capacity of hoist including allowances for accelerating load.

2.4 Brakes

A. Brakes designed for assembly on driving motor shaft or gear train to stop rotating of armature without causing driving wheels to lock too quickly.
B. Electric brakes provided for bridge motion, trolley motion, and hoist motion.
C. Bridge and trolley motor furnished with self-adjusting disc type brakes. Hoist motor furnished with oil encapsulated disc brakes which holds load and is applied automatically on power removal. Provide mechanical load brakes for hoist motion to prevent over speeding. Brakes easily accessible for external adjustment by removing cover plates.

2.5 Motors

A. Motors for Hoists, Trolley and Bridge: Trolley enclosed, reversible, Class F insulation, induction motors especially adapted to crane service and suitable for operation on 3 phase, 50 Hertz, 400 volts alternating current. Maximum 1,800 rpm (synchronous). Single speed hoist motors.

2.6 Electrical Controls

A. Supply complete integral electrical control system with the electric bridge crane equipment (by crane manufacturer) consisting of starters, circuit breakers, overload relays, limit switches, control transformer for a 230-volt control circuit, control relays and controlling devices.

2.7 Push Button Control

A. The crane shall be pendant push button operated.
B. Crane shall be operated from a manually operated traveling pendant push button control station as a part of festooned flexible plastic coated 304 stainless steel cable messenger system suspended from anti friction bearing trolleys operating on a rigid metal track. The system shall be such that the crane, trolley, and hoist can be moved to any position when operating the unit from the operating floor level. A torque reel shall be provided to permit rising and lowering of the pendant push button station.
C. Pendant push button station shall have a grounding conductor between a ground terminal in the station and the crane.

2.8 Conductors

A. For conductor for electric current supply to traveling bridge, use safety type in which conductor is shielded by a molded plastic cover that surrounds conductor except for a slotted opening shaped to contour of collector head. Provide separate conductor for each phase. (Dual conductors in a single insulating shield will not be acceptable.)

2.9 Surface Preparation and Shop Prime Painting

A. Shop painting is specified under Section 09900

3 EXECUTION

3.1 Installation

A. Confirm dimensions prior to design and verify all dimensions and clearances in field prior to erection and be responsible for proper fitting and operation of equipment.
B. Install crane in strict conformance with recommendations of manufacturer and under direct supervision of manufacturer's representative.

3.2 Field Acceptance Tests

A. Test crane after installation is complete to ensure compliance with specification and standard. The crane shall be tested at its rated load. Furnish test load. The crane functions such as hoisting and lowering, trolley travel, bridge travel, limit switches, locking and safety devices shall be tested to determine that the equipment will perform satisfactorily and safely without failure of any parts. Any defects in the equipment indicated by the tests shall be replaced/corrected and retested.
B. Include a field test of horizontal and vertical alignment of the rails.
C. If test results are unsatisfactory to the Engineer the Contractor shall provide the services of a factory trained service representative to correct any problems at no cost to the Owner.

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SECTION 15080

ODOR CONTROL

1 ODOR CONTROL

1.1 General

a) All items described within this section shall comply with the provisions of Section 15001: General M&E Requirements.
b) The design and erection of electrical installations in explosive atmospheres shall be in accordance with Section 16680: Hazardous Area Applications Guidelines.
c) Odor problems are typically associated with the development of anaerobic conditions (septicity) in sewage or sludge resulting in the formation of a range of malodorous compounds by the action of bacteria. The main compound associated with sewage and sludge odors is hydrogen sulphide (H_2S), which is also a toxic and corrosive gas.
d) Odorous compounds cause a problem if they are released to atmosphere and if there are residential/trafficked areas close to the site that may be affected. An assessment shall be taken of the likely impact the pumping station/treatment works shall have on the locality and the deodorization requirements fitted/sized accordingly to ADSSCs approval.
e) The amount of H_2S that can be formed is dependent on the strength of the sewage (or sludge) and the retention time under anaerobic conditions. Nutrient availability and the initial concentration of sulphate limit the maximum concentration that will develop. Saline intrusion increases the sulphate concentration of the sewage, which can increase the values of sulphide developing, especially in sludges.
f) In sludges, other compounds such as mercaptans, dimethyl sulphide and volatile fatty acids (VFAs) are also formed and may be as important as H_2S in adding to the total odor. The resultant lowering of pH value in sludges in the presence of VFA enhances the release of odor.
g) Anaerobic digestion reduces the VFA content of the sludge with a consequent reduction in total odor and a reduction in the potential release of sulphide. However, the digester gas produced may contain up to 3,000 parts per million (ppm) of hydrogen sulphide, which, unless treated, will have an odor impact.
h) Oxidation of H_2S and the other malodorous products of septicity to less odorous compounds will occur during aeration in activated sludge treatment or during aerobic digestion.
i) Odorous chemicals present in sewage or sludge cause a problem only when they are released to the atmosphere. This typically occurs at effluent discharge points and weirs where odor containing sewage or sludge is turbulent and there are suitable conditions for odors to be transferred to the atmosphere. If the odorous compounds can be retained in solution, for example by retaining in pipes, they will not cause nuisance.
j) H_2S can be detected by the human nose at a concentration of 0.5 parts per billion (ppb) under laboratory conditions (the threshold odor concentration). Nuisance concentrations are typically 5 to10 times this value.
k) H_2S can cause corrosion of concrete and mortar fixtures when oxidized to sulphuric acid, e.g. on moist walls of sewers and manholes. Metalwork and electrical equipment are also vulnerable to H_2S corrosion.
l) Measures to control odors shall therefore aim to:

    1. Prevent/reduce the development of septicity.
    2. Reduce the release of odor.
    3. Contain and treat odor.

4. Locate odorous processes as far away from potential complainants as possible.

m) Specific guidelines for different stages in wastewater and sludge treatment are given in Table 1 - Odor Control Guidelines

Table 1: Odor Control Guidelines

Process Stage	Minimum Provision	Enhanced Provision	Comment
Sewerage system	Use gravity system rather than rising mains. Ensure adequate velocity to prevent deposition of grit and sediment. Minimize turbulence, sharp bends and drops. Ensure adequate ventilation of gravity sewers. Minimize length of siphon sections. Minimize length of force rising main sections. Seal manholes at discharge points. Discharge at low levels to minimize turbulent drops. Minimize retention time in sumps.	Chemical dosing. Seal manholes.	
Pumping Stations	Reduce the height of hydraulic falls into sumps. Minimize operational volume of sumps. Provide sufficient slopes and benching to help avoid accumulation of rags or sediments. Allow intermittent drain down to clear rags and sediments via pumps. Where rags and screenings accumulate, include for regular cleaning out in the operational procedures. Pumping stations shall be of the submersible type, wet well/dry well or Archimedean Screw pump type. Avoid turbulence of flow in channels and at the discharge. Cover wet well.	Provide OCU if a problem is identified.	Pumping stations can be a source of odor release due to turbulence, and odor formation if sumps are oversized or if sediments can accumulate
Inlet discharge of rising main	Do not locate near a sensitive boundary. Minimize turbulence at discharge points, including at intermediate pumping stations and all downstream locations prior to secondary treatment stage. Cover channels, sumps, detritors and screens receiving pumped sewage. Ensure materials below covers are resistant to hydrogen sulphide/sulphate attack.	Chemical dosing to upstream sewerage system, nitrate salts, or STW, iron salts. Minimize turbulence of discharge flows. Cover channels and sumps. Ensure materials below covers resistant to hydrogen sulphide/sulphate attack. Vent from below covers to OCU. Consider using gravity sewerage system with lift stations rather than long rising mains.	Sewage can become very septic in rising main sewers with consequent impact on odor at intermediate pumping stations and the discharge point. Hydrogen Sulphide will also cause corrosion and pose a health and safety risk to workers if inhaled.
Inlet discharge - gravity	Do not locate near a sensitive boundary. Avoid cascades and other areas of turbulence. Keep channels non turbulent, minimise bends.	Minimize turbulence of the discharge. Covers and OCU. Consider using gravity sewerage system with lift stations rather than long rising mains.	Sewage smells even when fresh and draws air along the sewer, which may be unpleasant. Turbulence also exacerbates the release of odor.
Imported wastes and sludges	Discharge at low level to covered sump or use close coupling. Do not locate tanker discharge point near a sensitive boundary.	Treat displaced air in OCU. Connect tanker vents to OCU if air mixing employed.	Imported wastes are generally odorous.
Grit Removal	Do not select aerated grit channels. Ensure grit is washed once removed.	Do not select aerated grit channels Cover unit Ensure grit is washed once removed. Enclose grit conveyor and classifier.	Aerated grit channels can lead to a significant release of odors
Inlet screens and screenings handling	Provide local covers and minimize turbulence as far as possible. Ensure materials below covers are resistant to hydrogen sulphide/sulphate attack. Wash screenings.	House screens in a building actively vented to OCU. Provide local covers and minimize turbulence as far as possible. Ensure materials below covers are resistant to hydrogen	

SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

Process Stage	Minimum Provision	Enhanced Provision	Comment
		sulphide/sulphate attack. Provide a gas alarm system, as high levels of H_2S could accumulate if the ventilation system fails. Discharge washed screenings to enclosed skips. Do not store full skips on site.	
Inlet channels	Ensure a reasonable slope so that there is no grit deposition but not so much that there is turbulence. Avoid drops and sharp bends. Minimize height of discharges for example of return liquors, to reduce splashing.	Cover. Ensure materials below covers are resistant to hydrogen sulphide/sulphate attack.	
Storm/Balance tanks	Ensure overflow weir is upstream of any liquors or tanker discharge. Discharge to base of storage tank to minimize splashing. Design to ensure the tank and associated channels and pipelines can be completely drained of sewage, sludges, sediments and debris. Use an effective cleaning system such as rotating jets. Use an automatic system of return. Return storm/balanced flows downstream of the overflow weir and ensure are at low level in the channel to minimize splashing	Use an effective cleaning system such as rotating jets. Operation should be stopped when the jet is exposed. Use an automatic system of return. Ensure associated feed and return channels can drain back. Cover, with air displaced during filling vented to Odor Control.	Discharges into tanks release odors unless at low level. The impact is increased if the sewage discharging to the tank contains odorous wastes or liquors. Storm/Balance tanks can cause problems if sludges accumulate or if sewage is retained for excessive periods. Cleaning is important, but jet cleaners can cause odor release when the jet is exposed
Primary tanks	Provide close-coupled pumped desludging to avoid exposure of sludges to the atmosphere. Desludge frequently and remove sludges at a low concentration to avoid excessive retention. Design arrangement so that tanks can be removed from operation at times of low flow to avoid excessive retention of sewage. Minimize the height of drop over weirs to reduce splashing.	Design without a primary sedimentation stage or Provide covers vented to Odor Control. Ensure materials below covers are resistant to sulphide/sulphate attack	Primary sedimentation is a very odorous stage allowing septicity to develop in sewage and sludges if retained for excessive periods with release mainly at PST weirs and downstream channels and from sludge withdrawal handling and treatment.
Lamella separators	Minimize need for manual cleaning of plates. Do not select systems that incorporate sludge thickening within the unit.	Provide covers vented to Odor Control. Ensure materials below covers are resistant to sulphide/sulphate attack.	The level of septicity and odors developing is in proportion to the retention time.
Activated Sludge/ MBRs/SBR	Ensure adequate aeration and mixing. Fine bubble aeration systems are preferred to mechanical surface aeration systems. Use submerged or non-turbulent inlet and outlet arrangements	Cover distribution chambers, inlet channels and anoxic zone areas. Minimize the loading rate.	At normal loadings, activated sludge has a low odor level, decreasing as the loading rate decreases. FBDA systems release less aerosol and odors than mechanical surface aerators. There also is less risk of septic pockets developing.
Conventional biological filters	Ensure correct operation. Minimize the height of drop between distributor and media surface. Use recirculation if signs of ponding. Ensure adequate ventilation.		Can be a cause of odors if overloaded and ponding.
Submerged biological aerated filters fixed or fluidized media	Fluidized media preferred to fixed media Avoid turbulence at inlet and during backwashing	Cover and vent to Odor Control	Septic areas can develop, particularly in fixed media systems.
High-rate biological filters	Cover and vent filter and effluent sump to odor treatment system. Draw air from the base of the filter. Do not co-settle sludge	Replace with an alternative system, or: Cover and vent by drawing air down to the base, i.e. in the same direction and the sewage flow. Treat the vented air. Ensure materials below covers are resistant to hydrogen sulphide/sulphate attack.	Can be a significant source of odor due to the development of thick biofilms with release of odor from the top of the filter in the ventilation.
Final	Recycle backwash waters from sand filters without		

Process Stage	Minimum Provision	Enhanced Provision	Comment
Sedimentation, Tertiary sand filter, UV treatment	storage		
Picket fence thickeners and raw sludge storage	Cover and vent tanks to OCU, passive may be sufficient. Toxic levels of hydrogen sulphide will develop below covers. Do not locate near a sensitive boundary. Non-turbulent low-level inlet, outlet and supernatant discharge. Locate motors for mixers outside tanks, use external pumps. Mix at low speed rather high speed. Minimize the number of times that sludge is handled before thickening. Minimize retention time prior to thickening, digestion and dewatering stages.	Replace with mechanical thickeners Active venting to OCU	Odor in sludges and sludge liquor strength increase with storage. PFTs can be a significant source of odor formation with release of odors from: the surface of the PFT, the overflow weir, the sludge liquor drainage system and from subsequent handling of the sludge.
Secondary sludge storage Mechanical sludge thickening and dewatering	Minimize retention prior to thickening. Aeration may be used to maintain condition of sludge. Ensure that there is more than sufficient capacity, including standby, so that raw sludge does not back up in the system. Minimize turbulence of liquor discharge e.g. below belts, into sludge liquor system Enclose, vent covers to OCU. Minimize retention time of raw or secondary sludges prior to thickening, treatment and dewatering stages.	Cover tank, vent to OCU. Locally enclose and actively vent to OCU Review the requirement for a building	Biological sludges are odorous if they become anaerobic.
Sludge liquors	Discharge at level to reduce odor emission. Balance flow and composition. Return to secondary treatment, not primary or inlet, if imported sludges on site.	Chemical dosing e.g. using permanganate or iron salts, may be used to reduce hydrogen sulphide release	
Anaerobic sludge digestion	Ensure that there is more than sufficient capacity. tanks, feed, mixing and take-off points the gas handling system is fully operational. If gas is not required for heating or engines, it should be flared.	Chemical dosing of sludge with iron salts to reduce sulphide level in off-gas.	Capacity is required to prevent the risk of sludge backing up in the system causing upstream odor problems. Digester gases can contain significant levels of H_2S which is oxidized by flaring or burning.
Aerobic digestion Thermal treatment processes and drying	Ensure that there is more than sufficient capacity. Cover feed, mixing and take-off points Odor Control, possibly by thermal oxidation. Tall stack.	Cover tanks and ventilate to OCU.	Odors will be released during aeration of raw and secondary sludges. Volatilization of a range of organic compounds may occur due to the high temperature.

1.2 Ventilation and Odor Treatment

a) All buildings containing sewage or sludge processes will need some form of ventilation to avoid buildup of potentially hazardous (explosive or toxic) atmospheres. Where housing is close to the STW, this ventilation air shall be treated by an Odor Control system.
b) The Odor Control system shall be designed for a Sulphide Odor threshold limit not exceeding 0.00047 ppm at the discharge of the odor removal unit stack.
c) The design of the ventilation and Odor Control system shall take in to account the handling of potentially hazardous gases, and the zone requirements of the area in which it is installed.
d) Odor releasing units (such as screens or belt presses) within a building shall be locally enclosed, and a proportion of the required ventilation air drawn from the body of the building towards the odorous unit to ensure odors do not escape into the body of the building.
e) Siting of stacks and emergency vents shall be away from potential complainants.
f) The choice of odor treatment process and the number of treatment stages depends on:

1. Flow rate of air to be treated.
2. The strength and composition of the incoming air and whether intermittent or continuous.
3. The percentage removal required (the standard of odor treatment required to avoid an odor problem shall be derived from odor dispersion modelling).
4. Space availability and zoning requirements of the proposed location.

g) The design of Odor Control unit, ductwork, chemical storage and associated equipment shall take into account expected temperatures:

1. 25 - 35°C sewage.
2. 0 - 55°C ambient.
3. 90°C maximum radiating temperature (surfaces).
4. Up to 30°C air vented from the sewerage system to an OCU.

h) Preferred odor treatment technology is:

1. Wet chemical scrubbing, employing, as a minimum, single stage treatment, using alkali/oxidant such as sodium hypochlorite with sodium hydroxide.
2. Polishing treatment or treatment at small or remote sources (such as pumping stations) using activated carbon. In most cases,
3. carbon regenerated using alkali (caustic soda or potash) is preferred.
4. Post treatment of vented air or lightly odorous air by ducting to the activated sludge process shall be considered.
5. Post treatment of ventilation air, for example using carbon, shall be considered at sensitive sites and at pumping stations.

i) The same technology shall be used throughout a site, for ease of operation. At existing sites, existing technology shall be duplicated unless agreed otherwise by ADSSC.

j) Several sources should be combined to a single Odor Control unit, possibly providing more than one stage of treatment.

k) Odor Control equipment shall be designed to remove the range of odorous compounds expected. The factors influencing the treatment process, the number of units provided on a site and the number of stages of treatment shall be (as a minimum):

1. Odors from buildings housing sewage processes (e.g. screening) will include hydrogen sulphide (typically up to 10ppm in the associated ventilation system)
2. Lower concentrations (typically less than 1ppm) of other sulphurous and nitrogen compounds (such as ammonia).
3. Trace levels of solvent-type odors.
4. Odors from below vented covers could be ten times the values quoted above.
5. Odors below unvented covers could be one hundred times these values.

l) Odors from buildings housing sludge processes will include:

1. Odors from buildings housing sewage processes (e.g. screening) will include hydrogen sulphide (typically up to 10ppm in the associated ventilation system).
2. Hydrogen sulphide (typically 3 to 50 ppm in ventilation air).
3. Mercaptans (typically 3 to 50 ppm in ventilation air).
4. Dimethyl sulphide (typically 3 to 50 ppm in ventilation air) and similar organic sulphides.
5. Ammonia, if handling digested sludge/sludge liquors or if lime addition employed.

6. Polyelectrolyte breakdown products (amines).
7. Odors from below the covers of vented sludge storage tanks could contain ten times the above concentrations.
8. Concentrations below the covers of unvented tanks could be one hundred times these levels (toxic levels).

m) Odor Control units shall be designed and sized to maintain negative pressures within the space housing the odorous gases.

n) Odor Control equipment shall be designed to remove the range of odorous compounds expected. The factors influencing the treatment process, the number of units provided on a site and the number of stages of treatment shall be (as a minimum):

1. Odors from buildings housing sewage processes (e.g. screening) will include:
   - ❖ Hydrogen sulphide (typically up to 10 ppm in ventilation air).
   - ❖ Lower concentrations (typically less than 1ppm) of other sulphurous and nitrogen compounds (such as ammonia).
   - ❖ Trace levels of solvent type odors.
   - ❖ Odors from below vented covers could be ten times these values.
   - ❖ Odors below unvented covers could be one hundred times these values.
2. Odors from buildings housing sludge processes will include:
   - ❖ Hydrogen sulphide (typically 3 to 50 ppm in ventilation air).
   - ❖ Mercaptans (typically 3 to 50 ppm in ventilation air). Dimethyl sulphide (typically 3 to 50 ppm in ventilation air) and similar organic sulphides.
   - ❖ Ammonia if handling digested sludge/sludge liquors or if lime addition employed.
   - ❖ Polyelectrolyte breakdown products (amines).
   - ❖ Odors from below the covers of vented sludge storage tanks could contain ten times the above concentrations. Polyelectrolyte breakdown products (amines).
   - ❖ Concentrations below the covers of unvented tanks could be one hundred times these levels (toxic levels).

1.3 Materials

a) Ductwork, casings, sun covers and louvres shall be constructed of chemically reinstated glass reinforced plastic.

b) Glass Reinforced Plastic (GRP) shall meet the following specification:

1. Polyester Resin - ortho and isophthalic chemical resistant grades to BS3532.
2. Glass Reinforcement - water resistant E Type chopped strand mat or woven glass fabric to BSEN14181 and BS3749.
3. Surface Finish - Gelcoat - Flowcoat isophthalic resin to BS3532.
4. All drilled, cut or otherwise exposed edges are to be sealed with polyester resin.
5. Any non-GRP materials are to be fully encapsulated within the GRP laminate.
6. BS4994 and DIN DVS 2205.

c) Materials requiring corrosion protection shall be in accordance with Section 15004: Corrosion Protection.

1.4 Enclosures and Covers

a) In some instances, to contain and collect odors covers, or an enclosed building, are only way to ensure that odor release can be controlled. If processes are enclosed within a building, additional local covering is likely to be necessary to ensure that the working atmosphere is safe. Processes that are commonly provided with local covering are:

1. Inlet works (may also be within a building).
2. High-rate filters.
3. Sludge storage tanks.
4. Sludge liquor sumps.
5. Sludge import facilities.

b) Provision of covers will create a confined space where high concentrations of potentially hazardous gases may develop, requiring appropriate measures in terms of zoning (including for ventilation fans and/or odor treatment) and personnel access. Fan-assisted extraction/ventilation may be needed to:

1. Inlet works (may also be within a building).
2. Convey odors to an odor treatment system.
3. Prevent the accumulation of high levels of odors that could be displaced during operations.
4. Reduce the level of corrosion below covers.
5. Reduce condensation and consequent corrosion.
6. Prevent the accumulation of high levels of potentially hazardous chemicals.
7. Ensure that working conditions meet Health and Safety requirements.

c) Choice of materials for covers will need to take into account: strength, thickness, durability, weight, cost, aesthetics, supplier and operational requirements.
d) Covers shall be resistant to corrosion, both from external forces such as weathering and UV radiation, as well as internal chemical attack due to the hydrogen sulphide, sulphuric acid or organic acids below covers.
e) Fiber reinforced plastic (with appropriate choice of resin, UV absorbers and light stabilizers) and aluminum are commonly used. Vinyl ester resin is considered to have excellent corrosion resistant properties. Aluminum with the correct choice of alloy is also corrosion resistant, although susceptible to corrosion if splashed with sewage.
f) Covers shall withstand wind loadings and static loads.
g) Materials for covers and supports, and any equipment below the cover shall be resistant to corrosion. Where possible, motors, etc., shall be located outside the cover.
h) Suitable platform access and walkways shall be provided to any equipment. In general, facilities to allow access of personnel onto covers shall not be provided.
i) Inspection and access hatches will be required for repair and maintenance purposes. Alternatively, cover sections may be designed to be removable.
j) Where possible, design shall be such that equipment below covers can be easily and quickly removable.
k) Covers shall be sealed as far as possible. Inspection/access hatches shall be sufficiently durable so that they continue to be effectively sealed for the design life of a piece of plant.
l) Overflow and discharge pipes shall be designed and constructed to prevent a route for air under covers being discharged to the atmosphere.

2 CARBON DEODORISER UNITS

a) Carbon deodorizer units shall be based on the use of Activated Carbon.
b) They shall be of the carbon filter type. Housings shall be manufactured from a chemically-resistant grade of glass reinforced polyester and fittings shall be stainless steel grade 316L, unless otherwise stated. Seals and gaskets shall be PVC or neoprene.
c) The filters shall be single- or double-pass, as required for the areas to be controlled, to provide efficient use of carbon and to promote life expectancy. The media shall be provided in disposable cells to allow easy replacement and disposal. Should pre-filters be used, they shall be manufactured in resilient plastic random mesh which are washable and long lasting.
d) A full specification of the type and grade of activated carbon proposed together with the water regeneration process shall be included with the Tender.
e) Design Parameters are as follows:
    1. Concentration of H_2S gas in wet well: 250ppm (Sulphide gas concentration).
    2. Sulphide concentration in solution: 50 mg/l.
f) The type of activated carbon selected must be effective in dealing with odors arising from concentrations of hydrogen sulphide and other sewer gases.
g) The Tenderer shall state the expected life of the activated carbon and guarantee sufficient supplies for the first year of operation. The cost of the activated carbon shall be entered in the appropriate schedule.
h) The activated carbon shall be packed in disposable cells for ease of maintenance.
i) Fan motors shall be direct coupled and suitable for installation within a Zone 1 potentially explosive hazardous area and shall comply with Section 16000: Electric Motors.
j) Where the Odor Control system is fan-assisted all parts exposed to the fumes shall be non-metallic or stainless-steel construction, heavy gauge and resistant to attack, and the motor and drive shall be sealed from the exhaust gas path.
k) Each deodorizer unit shall be installed complete with adjustable dampers and isolation valves. Multiple inlets shall each have individual valves and dampers.
l) Suitable flap valves shall be provided to allow the circulation of fresh air into the well as necessary, so that the deodorizer can operate.
m) The deodorizer shall be supplied with a differential pressure gauge and a visible indicator to show the level of H_2S contamination in the activated carbon.

3 BIOLOGICAL ODOR CONTROL SYSTEM

3.1 Biofilter Units

a) Biofilters shall utilize peat media for the bio-oxidation of H_2S. Peat is a typical lignitic material which is capable of absorbing large quantities of water and has with good compaction resistance. Alternatives may be offered as options for consideration at the tender stage.
b) The filter shall be manufactured from GRP with rigid polyethelylene foam infill, boltable sectional panels, removable cover and base. Polyethelylene foam (25mm thickness) shall be fully-encapsulated and provide thermal insulation for site conditions.
c) Shading may be necessary to protect the biofilter from direct sunlight.
d) The GRP panels shall be suitable for outdoor locations; UV stabilized with a color-impregnated gel coat finish. Sectional panels shall be provided with substantial flanges utilizing stainless steel fittings. Panels shall be formed with 100mm deep internal webs to prevent short- circuiting of air and incorporate suitably reinforced external base flanges capable of withstanding wind loadings on the unit arising from wind speeds up to 50m/sec.
e) The bases shall be provided with adequately sized effluent drains.

f) A sprinkler system shall be sized to maintain the required filter bed media humidity. The sprinkler system manifold branches shall be fitted with isolation valves, suitably sized externally located strainers, union connections and spray heads. An overlapping sprinkler spray pattern shall be provided and on large installations, zoning may be provided, controlled via solenoid timer switches.
g) Pipework shall be PVC-U, ABS, or where necessary for superior mechanical strength, stainless steel.
h) Final effluent shall be utilized for the wetting of the media, where available. Alternatively, potable water with necessary pH chemical dosing control shall be provided.
i) The media support decking shall be manufactured from injection- molded polyethylene to provide a substantial deck designed to accommodate the media loading. A plenum chamber (500mm minimum depth) shall be provided to enable the installation of an air ductwork manifold system providing a uniform flow rate with minimum pressure drop through the support decking. The minimum support deck aperture size shall be 25mm x 25mm, rigidly interconnected and supported, with a minimum decking free area of 40%. Air shall be passed through the media in either "upward or downward" flow pattern.
j) The Biofilter panel sections shall be rigidly secured, where necessary, by a tie bar system to adequately resist the internal load of the peat media. Tie bars shall be installed in a square matrix configuration with necessary diagonal bracing connected via stanchion heads. Tie bars shall be stainless steel grade 316L and be bolted to enable tensioning after assembly to accommodate pressure and wind loadings.
k) A suitable bulking material shall be provided to allow for air percolation through the peat bed media and assist in reducing the resistance to the air flow. Heather is a preferred material which shall be capable of lasting the life of the bed and be resistant to rotting. The media shall be bio-degradable and non-hazardous, being suitable for safe site disposal.
l) Interconnecting ductwork shall be provided in accordance with the Section 15020: Pipework. Control dampers shall be fitted in ductwork branches, main extract branches and on the fan inlet side as an integral part of the ductwork system.
m) Condensate shall be drained from all low points within the system and adequately sized inspection hatches shall be provided wherever access is required for periodic maintenance of internals.
n) Exhaust air shall be discharged through a vertical chimney terminating with accelerating cone designed to provide dilution and dispersion.
o) The chimney shall be fitted with eddy shedders and shall be restrained by steel guy wires. The chimney design shall be approved by the ADSSC.
p) H_2S and methane monitoring shall be provided to control automated dampers and the provision of alarm situations at times of excessive saturation and potentially explosive mixtures. Monitors shall be provided in all buildings where access is required.

3.2 Bio-trickling Filter System

3.2.1 Process Description

The Odor Control system shall design to remove all the pollutant inclusive of hydrogen sulphide, organic reduced sulphur compounds (RSCs) and other odorous compounds from the foul air stream from the municipal wastewater odor sources using a bio-trickling filter operating in a counter-current manner. Co-current systems shall not be allowed.

The foul air shall enter the system from the bottom of each reactor and flow upward through each of the media layers installed in series. The media bed shall be intermittently or continually watered from top of rector using suitable reclaimed plant effluent or potable water as per the manufacturer recommendations. The water trickles through the media and is collected in a sump at the bottom of the reactor. The drain water from the system will pass from the sump in the bottom of the reactor vessel and be piped to a discharge point as designed. It shall be the manufacturer-responsibility to

select the right system (single / recirculation type) as appropriate to treat the odorous gas to comply the ADSSC emission standards

The hydrogen sulphide is oxidized by the bacteria resident on the lower media layer(s), as the foul air passes through the upper media layer (s), the resident bacteria will oxidize along with other organic odorous compounds. The airstream is then released to the atmosphere via the exhaust stack at the top of the reactor.

3.2.2 Products

The Odor Control equipment supplied under this section must be provided by a single manufacturer who will be solely responsible for the design, delivery and entire performance of the system. The equipment must be new and unused and meet the specifications and warranty requirements as per ADSSC terms & conditions.

3.2.2.1 General

The Odor Control equipment supplied under this section must be provided by a single manufacturer who will be solely responsible for the design, delivery and entire performance of the system. The equipment must be new

and unused and meet the specifications and warranty requirements as per ADSSC terms & conditions.

3.2.2.2 Quality Assurance

The bio-trickling filter manufacturer is responsible for the coordination with all the equipment suppliers to complete the system inclusive of FRP towers, air

blowers, nutrients system, pipelines, ducts, instrumentations, panels, etc.

The Contractor shall not be allowed for any substitutions. The biological Odor Control system manufacturer shall be experienced in the design, manufacturing, installation and operation of bio-trickling filters designed to remove hydrogen sulphide and all the organic RSCs from municipal wastewater odor sources. The system manufacturer shall have a minimum of five (5) years of experience of producing similar system, and shall show evidence of at least five (5) systems in satisfactory operation for that at least three (3) systems in the Gulf Regions. Any manufacturer whose main business is FRP manufacturing will not be accepted as a supplier for the Odor Control system specified herein.

3.2.2.3 Operating Conditions

Duty	Continuous Out Door
Location	90 degrees Centigrade (expose direct to sunlight) from the sewage at 25 - 35 degree Centigrade up to 100%
Surface temperature Inlet air temperature Inlet relative humidity Contaminants	Hydrogen sulphide, organic RSC's, ammonia, methyl mercaptan, Dimethyl sulphide and similar organic sulphides, amines and any other odor as identified during the odor investigation.

3.2.2.4 Design Requirements

The manufacture shall submit the proposal in way to provide all the details in a below mentioned order but all to comply with the overall requirement of this specification:

Number of vessels	_____	No
Model	_____	No
Air Flow rate	_____	m^3/S
Gas retention time	_____	Sec
Maximum pressure drops across vessel Contaminant	_____	W.C

concentration:

Average hydrogen sulfide concentration	ppmv
Peak hydrogen sulfide concentration	ppmv
Average odor concentration	OU/m^3
Peak odor concentration	OU/m^3
Average ammonia concentration	ppmv
Peak ammonia concentration	ppmv
Spray water flow	lit./min
Spray water pressure (dynamic)	psi

Performance requirements:

Average Hydrogen sulfide removal > 99.5 % at discharge or < 0.10 ppmv *

* _ Higher values to be taken

In all case the system shall be design to assure the avoidance of odor nuisance, the site shall remain under the strict vigilance for any odor complaint for the duration as agreed by the ADSSC and Engineer

3.2.2.5 System Components

A. Bio-trickling Filter Vessel:

The Bio-trickling filter vessel shall be free standing vertical "tower" type configuration operating in a counter-current manner. Each vessel shall consist of one (1) or more modules containing structured media and one (1) top piece shall be structured to confirm the quality of air release to the atmosphere to meet the contract requirements. Each vessel shall be constructed of Fiberglass Reinforced Plastic (FRP) and be designed with adequate strength to support the number of required modules. Each vessel shall contain internally as a minimum of 1.5 mm vinyl ester resin corrosion barrier. The structural layer shall consist of isophthalic resin with chop strand and continuous glass. The exterior top coat shall be isophthalic resin with UV resistant pigment (minimum service life of 15 years). The exterior color shall be white enamel.

Bio-trickling filter vessels shall not provide access to any area beneath the media or any location within the vessel where there is a chance for dripping acidic filtrate or hydrogen sulphide gas. The reactor vessels shall be provided with 316 stainless steel hold down lugs to account for all the anticipated loads to comply with local wind code requirements.

The vessel shall be designed to handle as minimum of pH of 1-2 of sulphuric acid to serve for all the intended working conditions. Vessel shall be designed to operate under a negative pressure or positive pressure based on the project requirements

B. Media

The structured media shall be of high porosity, chemically resistant plastic synthetic material made from polyvinyl chloride, polyethylene or polyurethane, etc. Organic media, carbon derived lava rock or lava rock media are not the preferred materials till it proved to be require for the specific system operations. In all case the media material shall be guarantee for the 15 years life and shall design to meet the ADSSC's required performances

The media characteristics (available surface area, density, and pressure drop) shall be structured and uniform throughout the media bed with pre-manufactured, Engineered flow channels.

The bio-trickling filter shall be designed structurally to withstand both the operating gas pressures (whether operating under a vacuum as preferred or under positive pressure) as well as any other stresses that might be expected during loading and unloading of the media (for example, people standing on top).

Where the design of the bio-trickling filter includes an activated carbon polishing unit (if allowed), the unit shall be adequately protected from aerosols and humidity. Monitoring of gas levels prior and

after the activated carbon unit shall be provided. It shall be designed to provide sufficient contact time and installed in such a manner as to provide simple, safe and effective replacement of the components

The media shall be guaranteed not to clog or require cleaning, scrubbing, backwashing, acid-washing or replacement for a period of fifteen (15) years.

Media shall resist compaction or swelling due to varying moisture levels and shall not degrade when subjected to low pH (i.e. pH <2) conditions.

The uniform structure of the media shall minimize the potential for short circuiting and encourage a uniform water and air flow pattern over the entire media cross-sectional area.

The manufacturer shall provide evidence that the airflow through the media is uniform from the bottom of the media is homogeneous at the average airflow rate. Sufficient media shall be provided to ensure that all the performance shall meet to the contract requirements as minimum.

Media shall be pre-installed in the FRP module (s) and tested in verification of all the designed parameters as mentioned in the contract shall need to be accepted by the ADSSC / Engineer; prior to the shipment to the job site,

C. Recirculation System

1. The recirculation system shall consist of a spray nozzle assembly above the bio-trickling filter media, and centrifugal recirculation pump. pipe shall be scheduling 80 PVC. Spray nozzles shall be PVC.
2. Motors are 3 Phase/ 50Hz/415V, TEFC, rated for Class 1, Division 2.
3. Pump to be constructed of corrosion resistant materials, as suitable for the intended service.
4. The recirculation system shall be designed to operate continuously for entire life of Odor Control system
5. Each spray nozzle shall be tested by the Manufacturer and a certificate of conformity supplied with the shop drawings to show that the nozzle has been tested and meets the specified standards for uniform distribution.
6. Spray nozzle array systems with multiple nozzles may be used as per the design requirements
7. As applicable, the spray system shall be supplied with a nutrient addition system to provide the macro and micronutrients required by the bacteria for optimal metabolism of the odorous compounds being treated.

D. Control System

1. Electrical Control Panel (ECP)

The ECP enclosure shall be NEMA 4X and constructed of FRP, and the panel shall come with a 316SS panel stand. The ECP shall house with all the necessary electronic components, PLC with Panel View Component, HMI, etc. for the control and monitoring of the complete system. Volt free / Dry contacts shall be provided for all the external notification of alarm status and any other notification as require under the contract, not to limited to for the followings:

- low spray water flow,
- high spray water flow,
- no nutrient flow (as applicable) and
- blower fails.

There should be an allowance to manually open the spray valve (located in the water control panel) for the purpose of routine maintenance checks (but the valve should be normally closed). The ECP shall require a single electrical connection of 415V/3Phase/50Hz. Transformers shall be provided as

necessary for power and control voltages. Panel shall contain the local control, monitoring and motor starters or VFD's for the Odor Control system components, including but not limited to;

a) NEMA 4X 304 stainless steel enclosure with mounting pedestal.
b) Hand/Off/Auto switches for recirculation pumps.
c) VFD with speed dial and Hand/Off/Auto switches for fans.
d) Status light for fans.
e) Status light for recirculation pumps.
f) Low flow alarm for recirculation system.
g) General alarm indicating light.
h) Alarm reset pushbutton.
i) Power On status light.
j) Door-mounted fused disconnect.
k) CSA/UL certified.
l) Panel shall be mounted a minimum of 914 mm from any potential leak point to comply with NFPA 820 requirements

2. Water Control Panel (WCP)

The Water Control Panel shall be constructed of FRP and be mounted on 316SS panel stand, back-to-back with the ECP (as applicable or as approved by the Engineer). The WCP shall contain a panel heater, valves, motorized ball valves, strainers, instruments and piping for the control of the sprinkler system and shall operate from control signals from the ECP. The WCP shall allow for a single connection to either a potable water source or suitable final effluent plant water source. The WCP shall house, if applicable, the nutrient addition system. The WCP shall also contain a flexible spray hose with a hand trigger to allow for convenient rinsing of the strainer, filling of the nutrient barrel, and general convenience. A dedicated ball valve shall be provided in front of the spray hose to allow for the operation of the water panel while simultaneously allowing for isolation in case of a leak in the hose.

3.2.3 Performance Testing

Performance testing shall not commence until the manufacturer and Engineer agree that they system has been satisfactorily started-up and sufficient time has been allowed for the generation of the required bacterial growth.

After the odor control system has been satisfactorily started-up and switched to normal operation, the Contractor shall, in the presence of the Engineer, demonstrate that the system will perform as specified in section 3.2.2.4 of this specification.

The Contractor shall provide the Engineer with a written test protocol and the performance test may not be conducted until the test protocol has been reviewed and approved by the Engineer.

The manufacturer shall present during the performance test and, at its own discretion, may conduct a parallel performance test as long as they do not interfere with the performance test being conducted by the Contractor.

The Contractor shall supply, install and operate all equipment, sensors and instrumentation required to complete the performance test.

A. H_2S Testing procedure

1. Measure airflow into each unit and, if necessary, adjust to the design airflow of +/- 10%. Airflow balancing can be conducted by manufacturer and witnessed by the Engineer. Airflow shall be measured at the beginning of the test period. The set position on the damper(s) and / or blower VFD(s) will be marked or noted.
2. Measure pressure drop across each bio-trickling filter at beginning of test period
3. Measure temperature and relative humidity of the inlet, outlet and ambient air.

4. Performance test period to begin at a noted time and last for four (4) hours. H_2S data from the common inlet location and from the outlet of each Odor Control system will be measured and logged once every 10 minutes to demonstrate performance during test period.

a) The inlet H_2S data will be logged with a pre-calibrated and approved gas data logger with appropriate range and accuracy for the inlet air stream (0-1000 ppmv or 0 - 200 ppmv range, 1 ppmv display resolution or 0.0 - 50 .0 ppmv range, 0.1 ppmv display resolution) as appropriate to match with the system requirement
b) The outlet H_2S data will be logged with a pre-calibrated and approved gas data logger with appropriate range and accuracy for the outlet air stream. (0.0 - 2.00 ppmv range, 0.01 ppmv display resolution or 0.0 - 50.0 ppmv range, 0.1 ppmv display resolution) as appropriate to match with the system requirement

B. H_2S Acceptance criteria:

The System's H_2S removal efficiency shall be determined by calculating the average inlet H_2S concentration and the average outlet H_2S concentration and using the following formula: H_2S removal efficiency (%) = (1 - average inlet H_2S concentration/average outlet H_2S concentration) x 100. The system shall have passed the H_2S performance test if the H_2S removal efficiency is > 99.5% for all the inlet air H_2S concentrations as mentioned at section 3.2.2.4 of this specification.

C. Odor Testing procedure

1. Measure airflow into each unit and, if necessary, adjust to the design airflow of +/- 10%. Airflow balancing can be conducted by manufacturer and witnessed by the Engineer. Airflow shall be measured at the beginning of the test period. The set position on the damper(s) and/or VFD(s) will be marked or noted.
2. Measure pressure drop across each biofilter at beginning of test period.
3. Measure temperature and relative humidity of the inlet, outlet and ambient air.
4. One (1) set of air samples, each consisting of one (1) inlet air sample and one (1) outlet air sample from each odor control system, will be collected in 10 L Tedlar bags with air sampling chamber. (In the event that there is more than one odor control system, a separate inlet air sample will be taken for each outlet air sample as near simultaneously as possible.) Each set of samples shall be collected in duplicate to minimize the risk of sample loss during shipping. One (1) set of bag samples per bio-trickling filter shall be analyzed for odors if the results found stable and satisfactory in comply to the standard. Bag samples will be shipped to an approved laboratory for analysis within 30 hours in accordance with ASTM 679 latest version (however as per ASTM 679-91- The airflow rate shall be 20 L / min).

D. Odor Acceptance criteria

In all case the system shall be design to assure the avoidance of any odor nuisance, the site shall remain under the strict vigilance for any odor complaint for the duration as agreed by the ADSSC and Engineer

E. Automatic Flow Control System testing procedure

In the presence of the Engineer, the manufacturer shall demonstrate the operation of the Automatic Flow Control System for the respective approval

1. Review the requirements list given in Section 3.2.2.5 (C & D) and demonstrate compliance with each point.
2. The following type procedure shall be followed for the testing of the water spray system or the manufacturer to propose their own system of testing for the ADSSC approval.

a) The cycle time shall be minimized to allow the procedure to be completed within 30 minutes or as directed by the Engineer

b) Open all manually controlled valves allow for maximum flow through the WCP. Set the target irrigation flow rate to 3 x the normal flow rate (to allow the valve to fully open) or to be selected as to suite the system's operational requirements. Demonstrate that the valve will reach to 100% open status within permissible time as per the design
c) In between the cycles, while the valve is CLOSED, set the target flow rate to the proper design irrigation flow rate. Demonstrate that the valve will automatically close in order to reach the design flow rate within permissible time of the spray operation as set for each cycle.
d) Repeat steps a. and b. above for a minimum of 3 additional set points both above and below the normal target irrigation flow rate or as approved by the ADSSC.
e) Set the target flow rate to the normal target irrigation flow rate. Partially close at least one valve upstream of the modulating ball valve and demonstrate that the irrigation valve will automatically adjust to a more open position in order to reach the design flow rate (as set) for the next spray cycle.

Return all Automatic Flow Control settings to their normal positions and fully open all upstream and downstream valves. Demonstrate that the system will return to normal flow control operation.

3.2.4 Media Warranty

The bio-trickling filter manufacturer shall warranty the structural media against all the defects in material and workmanship for fifteen (15) years from media delivery. In addition, the manufacturer shall also warranty the media against shrinking, swelling, plugging and further against any increase in pressure drop across the complete media beyond 5% form the initial reading for a period of fifteen (15) years. In the event that it is determined that a defect exists, at the manufacturer's shall replace the defective section in a manner the system operation shall not be suffered in any way and all works shall no cost to ADSSC.

4 CHEMICAL ABSORPTION UNITS

4.1 General

a) Chemical filters shall be suitable for treating sources of mal-odor to below the perception threshold levels associated with sewage gas.
b) The Odor Control plant shall be of a packed tower of two- or three-stage chemical type.
c) For smaller plants or lower concentrations, a two-stage scrubber system comprising of sodium hydroxide (caustic soda, NaOH) and sodium hypochlorite (NaOCl) shall be used.
d) For some installations or higher concentrations, a three-stage scrubber system, with the addition of a sulphuric acid (H_2SO4) stage, will be necessary.
e) All Air Handling Units (AHUs) shall be designed to provide negative pressure within the conditioned space, which shall be achieved by a balanced ventilation system.
f) The minimum design parameters are as follows:

1	Concentrations of H_2S in wet well:	500ppm.
2	Mercaptans:	Trace only.
3	Amines (mono/di/tri):	10ppm.
4	Ammonia:	50ppm.
5	Concentrations of H_2S in solution:	50mg/l.
6	Number of air changes per hour in sump	4 minimum.
7	(More if the Contractor deems it necessary)	
8	Removal of mercaptans:	No requirement
9	Pressure drop per scrubber stage:	No greater than 28mm Wg.

4.2 Component Parts

The complete unit shall comprise the following:

a) Duty/standby extract or supply fans.
b) Scrubber towers:
    1. Sulphuric acid (as required) dosing pumps, duty/standby.
    2. Sodium hydroxide (as required) dosing pumps, duty/standby.
    3. Sodium hypochlorite (as required) dosing pumps, duty/standby.
    4. Recirculation pumps dosing pumps, duty/standby.
    5. Water supply pumps dosing pumps, duty/standby.
c) Regenerable water softener.
d) Sulphuric acid storage tank of 1 week storage at maximum usage.
e) Sodium hydroxide storage tank of 1 week storage at maximum usage.
f) Sodium hypochlorite storage tank of 1 week storage at maximum usage.
g) Drench showers and hose supply.
h) Electrical equipment, including instrumentation and control.
i) Access platforms, ladders, etc.

4.3 General Mode of Operation

a) The units shall be self-contained and be provided with a spun stainless steel wire type pad and capable of operating at a minimum face velocity of 2 m/s. The removal efficiency shall be 99% for all aerosol droplets above 15 microns.
b) Gases shall be extracted and ducted to the inlet of the first stage scrubbing tower passing vertically through a packed bed section complete with a recirculation system set above the packing elements.
c) This liquid shall flow downward, counter-current to the gas flow.
d) In the packed bed section, the gas constituents shall be dissolved and diffused into the scrubbing liquid by means of the large liquid/fume interfacial surface contact area provided by the packing elements.
e) The treated gas air stream shall then flow through the knitted pad type mist eliminator. The entrained liquid droplets removed from the air stream agglomerate in the knitted fibers are returned to the recirculation system.
f) Liquid to the spray headers shall be recirculated from the base tank with evaporation losses and a continuous overflow, from the discharge side of the duty pump, replaced by water make up via a ball float valve. The bleed off rate will be determined by site operating conditions.
g) Liquid level in the recirculation tank shall be monitored by a level element, using conductivity rods, providing a low liquid level alarm signal and a low signal to stop the pumps, to avoid a condition of dry running. High liquid level alarm shall also be provided.

4.4 Stage 1 Operation (Sulphuric Acid)

a) The chemical condition of the recirculation liquid of this stage shall be monitored by a pH probe, enabling the bleed-off rate to be adjusted to maintain the liquor within limits and control the addition of 20% sulphuric acid.
b) Treated gases shall then pass from the side exit of the scrubber to the inlet of the adjacent second stage scrubbing tower.

4.5 Stage 2 Operation (Sodium Hydroxide and Sodium Hypochlorite)

a) Here a similar course of events to the first stage shall occur, but an additional Redox probe shall be provided in the sump to control the addition of sodium hypochlorite.
b) The pH probe in this secondary tower shall control the addition of 20% sodium hydroxide solution.

c) The final treated gases shall then be ducted to the inlet of the duty/standby extraction fans for discharge via the exhaust stack, or via suitable louvres if the extract fans are fitted on the scrubber inlet.

4.6 Scrubbing Tower Ancillaries

a) The scrubbing towers shall include conductive resin strips behind weld lines, nozzle fitting joints in vessel shell, etc. to enable a full spark test to be carried out. This will permit checks to be made on the integrity of the inner thermoplastic shell after installation and at any time during the lifetime of the vessel.
b) Each scrubbing tower shall have a corrosion-resistant thermoplastic liner, wrapped externally with glass reinforced UV-stabilized white pigmented polyester resin. It shall be designed in accordance with BS 4994 and consist of a vertical cylindrical tower to be manufactured in flanged sections with flat base.
c) The sump section of the units shall hold recirculating scrubbing liquor pumps and be complete with internal baffle, flanged connections and water level measurement.
d) A recirculation pump feed to include:
    1. Overflow.
    2. Make-up water inlet, incorporating float valve,
    3. Drain outlet.
    4. Chemical dosing points.
e) A gas bed section comprised of:
    1. Support plate and support ring.
    2. Packed bed of random packed cascade mini rings (if required).
    3. Flanged access cover, to permit removal/replacement of packed bed rings.
    4. pH probe
    5. Redox probe (if required).
f) A spray assembly system fitted with:
    1. Flanged connections for spray bar assemblies.
    2. Lower and upper inspection doors.
    3. Spray system with spiral type non-clogging nozzles.
g) A mist eliminator section comprised of:
    1. Demister ring support;
    2. Horizontally mounted aerofoil blade mist eliminator.
    3. Drain back to sump.
h) A conical transition section with discharge outlet to be mounted onto conical transition section. (This may comprise a separate stack, or outlet louvres.)
i) Gaskets shall be from flexible EPDM sheet.
j) All materials shall be chemical resistant with support plates and fasteners etc. in 316L stainless steel. i.e. high chloride-resistant stainless steels are required because of the high salinity levels.
k) Design calculations shall be submitted in respect of the discharge height required to prevent downwash of H_2S occurring due to the effects of adjacent structures.
l) An automatic condensate drain and trap shall be provided.

m) A self-contained pre-filter unit shall be provided with synthetic panel filters to 40% ASHRAE standard. The filter shall have continuous bonding between the periphery edges of the filter pack and the inside of the enclosing frame to eliminate any possible air bypass.
n) The enclosing frames shall be constructed of rigid, water-resistant waxed board. Units shall be securely loaded in side access frames which will assist access for maintenance.
o) The filter thickness shall be 50mm minimum with a free open area of 96%.
p) The chemical filter section shall contain media in vertical beds which shall be suitable for horizontal air flows. Overall bed depth shall be adjustable from 200mm minimum up to 750mm in 250m increments.
q) The air flow rate shall be designed in order to achieve a dwell time of two seconds over the media section.
r) The media shall be capable of providing adequate Odor Control for peak loadings of hydrogen sulphide up to 500 ppm whilst the average loading is anticipated to be 5 ppm.
s) An adequate means of access for inspection and replacement of the media shall be provided.
t) A media analysis service shall be provided in order to determine the life expectancy and replacement frequency date (twice annually) for a five-year period.

4.7 Air Fans and Associated Plenum(S)

a) Duty/standby air fans shall be installed and sized to maintain negative pressure within the odor space.
b) They shall be suitably rated for their duty and be selected to operate at or near their best efficiency point.
c) They shall be constructed of materials that are not susceptible to attack by the component gases to which they are exposed.
d) Fans and their drive systems shall be securely fixed to rigid supports.
e) Where the Odor Control system is fan-assisted all parts exposed to the fumes shall be non-metallic or stainless-steel construction, heavy gauge and resistant to attack.
f) The impeller shall be secured to the impeller shaft and shall be secured against circumferential movement. The impeller shall not be pinned to
the shaft nor shall shaft movement be relied on to ensure that the impellor is locked in position.
g) Pulley and V-Belt transmissions shall incorporate a minimum of two belt drives. V-belts shall be designed with a service factor of 1.6, based on the minimum absorbed power of the fan.
h) The motor and drive shall be sealed from the exhaust gas path.
i) Substantial outlet and inlet plenums with external stiffeners and flanges shall be provided for connection to the external ductwork.
j) The plenum housing shall be constructed from 14 swg 316L stainless steel to provide a fully weatherproof panel form. Unit framework shall be fully welded at each mitred corner and shall incorporate welded attachment mounts to enable intermediate stiffeners to be accommodated where necessary. Alternately, Frame Members shall be bonded/ mechanically fixed together to provide adequate strength to welding and to prevent air leakage. Insulation shall be provided as necessary.
k) Panels for access shall be designed to enable manual lift-off for general maintenance and access doors shall be provided with quarter turn quick release fasteners, which shall be of a lockable type.
l) Condensate shall be automatically drained from all low points.
m) Inspection panels shall be provided wherever access is required for periodic maintenance of mechanical plant.
n) Test holes for commissioning purposes shall be provided on each ductwork branch.
o) Ductwork shall be tested for gas tightness.
p) Supply and extract four-way type diffusers shall be installed complete with balancing dampers and be suitable for corrosive atmospheres. Suitable mounting supports shall also be provided.

q) Fan motors shall be direct-coupled units suitable for installation within the Zone 2 potentially explosive hazardous area.
r) Dual-speed motors shall be provided for all fans. They shall be controlled via gas sensors that switch to low-speed setting to minimize running costs. High speed operation shall be initiated on recording of high gas level concentrations and thermostats located within the conditioned space.
s) The fan units shall be supplied with anti-vibration mounts incorporating efficient impeller design to ensure minimal noise levels.
t) Regulation of the air flow shall proceed on satisfactory operation of the fan sets. Balancing of air flows within the ventilating duct system shall be carried out to the satisfaction of ADSSC. Adjustment of regulating dampers to achieve the specified air flow rates shall be completed prior to locking.

4.8 Outlet Stack

a) The Exhaust air shall be discharged through a vertical chimney terminating with accelerating cone to provide dilution and dispersion.
b) The outlet stack shall be designed to withstand wind loadings in accordance with BS6399-2.
c) The stack shall be provided with an accessible sampling point.
d) The stack shall be provided with an accessible access ports/hatches to facilitate the cleaning of the internal surfaces.
e) Lightning protection requirements shall be assessed in accordance with the ADSSC Particular Specification.

4.9 Chemical Dosing Pumps

a) The Chemical Dosing pumps shall be of the double diaphragm type and have as a minimum standard:

1. Hypalon chemical diaphragm.
2. UPVC metering head.
3. Viton valve seats.
4. PTFE faced working diaphragm.
5. Caustic soda - stainless steel valve balls.
6. Sulphuric acid and sodium hypochlorite - glass valve balls.
7. Capability of altering dosing rate from 10-100%.
8. Integral pressure relief valve.
9. Pulsation dampers.

4.10 Water Softener

a) The water addition/softening systems shall each incorporate the following, as a minimum:

1. Break tank with air gap or approved double-acting check valve, complete with isolating valve.
2. Softener isolating valves.
3. Duplex style non-return valves.
4. Dual cylinder style water softeners, rated for continuous output with integral meter-initiated water power regeneration.
5. The softener shall use a fine bead resin bed in conjunction with a brine solution.

6. The softener shall be rated for 28 days use without the salt storage being replenished.
7. Flow regulating ball type valves.
8. Flow indicator sensors, variable with adjustable high and low sensor.

4.11 Chemical Storage Tanks

a) The storage tanks shall conform to BS 4994 and each incorporate the following features, as a minimum:

1. Visual cat-and-mouse style contents gauge.
2. Level transducer (low/high).
3. Tanker Fill Panel.
4. Bulk fill lines consisting of manual plug valves, and connections suitable for bulk tanker filling.
5. Lined plug outlet valve.
6. Diaphragm drain valve.
7. Overflow pipe, to direct chemical into bund in a safe manner which avoids splashing of operators or equipment.
8. Vent pipe.
9. Covered top.
10. Construction:
11. Sodium hydroxide - polypropylene/GRP.
12. Sodium hypochlorite - polyvinyl chloride/GRP.
13. Sulphuric acid - polypropylene/GRP.
14. Each tank shall be contained in a separate bunded area, which shall provide containment for 110% of the tank volume.

4.12 Instrumentation

a) pH transmitters shall be provided with 110V high and low alarm contacts, range 0-14 pH, fully programmable complete with electrodes and dip probes.
b) Redox transmitters shall be provided with 110V high and low alarm contacts, range 0-14 pH, fully programmable complete with electrodes and dip probe.
c) One conductivity type level measurement device of the 24V rod type shall be provided in each scrubbing tower.
d) One recirculation flowmeter with 110V magnetic low flow switch shall be provided.
e) One bleed flowmeter shall be provided.
f) One differential air pressure switch for extract fans shall be provided.
g) One pump pressure gauge and switch shall be provided for each pair of dosing pumps.
h) One hydrogen sulphide monitor shall be provided in the inlet to system.
i) One hydrogen sulphide monitor shall be provided in the outlet to the system.
j) A Radar / ultrasonic level sensor shall be provided for each of the storage tanks as approved by engineer.
k) All pipework shall either be of polypropylene or PVC material, flanged or solvent welded.
l) The following valves and accessories shall be provided as a minimum:

1. Hand-operated uPVC (ball) isolation valves on each side of the recirculation pumps.
2. Hand-operated uPVC (ball) isolation valves on each side of the dosing pumps.

3. Non-return valves at pump outlets.
4. Injection valves on recirculation line dosing.
5. Strainers on inlets to all pumps.
6. Isolation valves for all pump outlet pipework.
7. Pulsation dampers in the dosing pump outlet pipework.
8. Drain and flushing facilities at all low points in the pipework.
9. All pipework shall be contained so that in the event of a burst or leak the chemicals are directed into the secondary containment.

m) Hydrogen Sulphide and methane monitoring shall be provided to control automated dampers and the provision of alarm situations at times of excessive saturation and potentially explosive mixtures. Monitors shall be provided in all buildings where access is required.
n) Toxic gas detection unit shall be capable of detecting Hydrogen Sulphide levels in the range of 0-1000ppb (minimum range) prior to discharge.
o) The detection unit principal operation shall consist of a dry colorimetric cassette system providing quick responsive indication (10 sec) dependent on tape stain. Color changes shall be measured by an electro-optic detection system. Microcomputer control resulting in a digital signal matched to preset alarm program relayed to the telemetry unit via 4-20mA signal (Audio and Visual).

5 HOSES

a) In each area where chemicals are dosed or stored and there is the possibility of chemical spillage, hose reels shall be provided as a minimum standard.
b) They shall comply with BS 5274, BSEN 671-3 and BS 5306 part 1.
c) Each hose end shall be fitted with an adjustable jet spray shut-off of high impact nylon, and a separate isolating valve.
d) They shall comprise the swinging open type of reels.
e) The Contractor shall supply low pressure low velocity systems.

6 DRENCH SHOWERS

a) Drench showers shall be swinging chain operated type with a stainless-steel valve that locks on.
b) Each shower shall have a light to indicate its position.
c) Drench showers shall not be fed directly from the mains, unless a heater is incorporated to reduce any thermal shock to the user.
d) They shall be fed from surface-mounted water tanks.
e) An emergency eye/face wash fountain with a flexible hose shall also be incorporated into the drench shower.
f) Operation of the shower/emergency eye wash shall transmit an alarm to the main MCC/SCADA system/Regional control system.
g) Safety signs shall be attached securely by each shower.

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SECTION 15410

COARSE SCREENING EQUIPMENT

1 GENERAL

1.1 Work Included

1.1.1 Scope of Supply

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of the coarse screening equipment, including but not limited to:

1. Coarse screens,
2. Filth removing systems (raking grab, trolley, lift…)
3. Compacting screw
4. Skip.
5. Pre-embedded parts

The pre-embedded parts (steel plates, continuous sections...) to which will be attached the adjustment rods of the permanent embedded parts, shall be supplied, fitted and anchored in the primary concrete under Civil Works Section as will be shown on the civil construction drawings.

6. Embedded parts

Embedded parts are steel parts anchored either in the secondary concrete or primary concrete and which may be subject to operating loads.

The embedded parts (anchors, support parts, ...) shall be supplied and installed by the Contractor under the present section.

Concreting of the embedded parts shall be covered by Civil Works Section.

7. Covers above the slots shall be provided by the Contractor.

1.2 Related Work

1.2.1 Supplies And Works Included Under This Section Shall Comply With:

A) Section VII – A. General requirements
B) Section 01010 - Corrosion protection
C) Section 01020 - Basic mechanical requirements
D) Section 01030 - Basic electrical requirements

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A) Concrete works covered by the Civil Works Section
B) Electrical works covered by the Electrical Equipment Section
C) Section 17200 – Instrumentation

1.3 System Description, Characteristics and Operating Conditions

1.3.1 Operating Conditions

Coarse screens shall be discontinuously and automatically cleaned, thanks to both head losses detection and timer (with possible adjustments).

Both of the two hanging-raking machines will be able to remove filth from the three coarse screens. One will be working; the other will be in stand-by. The electric control cabinet should include the Program Logic Controller (PLC) which controls the two sets of machines.

Raking machine consists of a trolley and a raking grab unit. It is supported on hollow steel columns on which an over lift monorail system is set to guide the trolley. On one side, the monorail is divided in 2 monorails so when the stand-by trolley has to begin operations, it has to wait that the first one stops and goes back to its maintenance position.

In operation, the trolley and the grab move with the fingers open along the monorail until it is approaching the first raking position. As the raking grab goes down, it pushes accumulated debris towards the bottom of the screen into the screen invert. When the invert is reached, the grab stops and the fingers are closed. The grab is then raised with collected debris.

When the grab reaches its top, the trolley is traversed back to the selected dump position where the fingers are opened and the debris is deposited. The trolley and grab then return to the next raking position in order to finish cleaning the screens. The number of raking positions for a complete screens cleaning depends on the overall width and on the design of the screens and the grabs.

Garbage is deposited by the grab in a hopper that feeds a compacting and conveying screw. Filth is then conveyed into a skip.

If a large amount of debris or if another problem prevents the grab from reaching the screen invert, slack rope devices on the trolley will stop the lowering motion, fingers will be closed and the grab lifted. Then collected load is taken to the dump area and deposited; the trolley travels to the next raking position and continues its cycle.

An electrically driven pump directly set on a tank in the trolley supplies the hydraulic power to the grab. A timer is included in the PC circuit to prevent loss of oil in the event of a pipe fracture.

1.3.2 Control and Monitoring

The operation mode of the racking machines and compacting screw should have both:

1. Manual control and PLC automatic control.
2. Local control and distance control.

A local control box, including a manual emergency stop button, shall be set up close to the equipment. It will be IP 55 protected.

It will be composed at least of the following controls and instructions, for each equipment:

3. Manual / auto commutator
4. Lighted button “ON”
5. Lighted button “OFF”
6. Defaults presentation.

The Contractor shall provide a detailed document explaining the control and regulation system he wants to install, concerning both raking machines control and the way this equipment will be connected to the general computer.

Moreover, the following detectors shall be installed and connected to the PLC:

7. High and low levels detection soundings in channels
8. Cyclic working on clock or / and head losses detection,
9. Malfunctions and alarms.

A proximity sensor, located on the monorail, controls each raking position and is linked to the Program Logic Controller (PLC). When all positions of a screen have been raked, the trolley returns and stops at

a pre-determined park position. Particular care shall be taken for the reliability of grab position detection system.

1.4 Quality Assurance

1.4.1 Codes and Standards

EN 12255 – 3	Wastewater treatment plants – Preliminary treatment
EN 600034-9	Rotational Electric Machine (Noise Area Value)
DIN 3962	Gear Tolerance Grade Standard
EN 60204	Electric Installations of Equipment (General Requirement)
EN 60034	Rotational Electric Machine (Detecting & Operating States)
GB 4942.1-85	Electric Machine Case Protection
GB 50205	Steel Structure Engineering Construction & Test Acceptance Standard
GB 50231-98	Mechanical Equipment Installation Construction & Test Acceptance General Standard

1.4.2 Design Criteria

See performance specifications.

1.4.3 Shop Tests and Inspection

1. Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
2. Inspection and testing of standard products: the Contractor shall supply certificates of routine tests.
3. Workshop inspections and tests:
   a) The seals and the embedded parts shall be presented separately and unpainted for checking.
   b) The surface appearance of embedded parts shall be examined and their dimensions checked. Rolling, sliding and plate sealing surfaces shall be perfectly flat and smooth.

All dimensions shall be checked.

   c) Welds:

Refer to Section 01020.

1.5 Submittals

The supplier should submit the following documents (non-exhaustive list):

1. Detailed Ichnography and section diagram and specification for equipment, showing all functional dimensions and space necessary for maintenance, operation and installation…
2. Detailed performance specification of equipment and drawings of all parts
3. Hydraulic and process detailed calculation notes justifying that design criteria are respected.
4. Installation, maintenance and operation manuals with requirements of accuracy
5. Manufacture and quality assurance measures
6. Protective coating list of all parts
7. Commissioning tests list.
8. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.

9. Internal wiring diagrams and control principle drawing of control box
10. Weight and material of each component

1.6 Guarantee

1.6.1 Performances

Maximum head losses shall not exceed 200mm for all design flows.

The Contractor shall justify in his bid that the above required head losses are never reached and that water speed for maximum flow rate and for a 50% clog up rate must be less than 1m/s.

In addition, nominal flow rate must pass through each screen considering a 50% clog up rate and a water speed lower than 0.5m/s.

The Contractor shall design the grab capacity and shall provide a calculation note proving that the equipment he intends installing have an efficient capacity to remove, collect and evacuate debris for a Qmax flow and during 5 hours.

Compacting screw has to ensure maximum garbage water content of 55% and during 24h continuously.

1.6.2 Dimension Tolerances

1. The deviation of the plane position of the equipment shall be less than □ 10 mm. The elevation deviation shall not exceed □ 10 mm.
2. The deviation of screens installation angle (angle between the screen working face and the horizontal line) is not larger than □ 0.5°.
3. Bars verticality in flow perpendicular direction shall not exceed 1/1000.
4. The deviation of screw installation angle (angle between the screw axis and the horizontal line) is not larger than □ 0.5°.

2 PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1 Fabrication

2.1.1 Coarse Screens

Main parts of screens (frame, bars, lateral parts, fixings, fastenings, etc.) will be made of stainless steel 316L.

All platforms, ladders, or rungs that may be necessary for screens workings and handling will be provided under civil works contract. They will be made of aluminum (when out of water) or of stainless steel 316L (when immerged).

2.1.2 Hung Raking Grabs

Raking system is composed of an over lift monorail system, a trolley and a grab unit.

The following parts of the raking system will be furnished by the Contractor and made of specified materials:

- Trolley Frame: Stainless Steel 304
- Grab: Stainless Steel 316L
- Cable Drums: Stainless Steel 304
- Fixing & Fastenings: Stainless Steel 304
- Hoist Cable: Stainless Steel 304

- Cable Trolley: Stainless Steel 304
- Trolley Enclosure: Stainless Steel 304
- Chains & Sprockets: Stainless Steel 304
- Dome Nuts: Plastic PVC
- Cases for External Switches: Plastic PVC
- Cable Ducts: Plastic PVC
- Cable Connection Plate: Aluminum

The rake drive unit should be well lubricated for the safe operation of equipment.

The monorail track shall conform with specifications of section 02230 – Monorail hoist.

All fixing and fastening items will be provided by the Contractor.

2.1.3 Compacting Screw

Helical axial blade of the compacting screw will be made of special steel.

All the other parts (housing, driving axle, compaction zone …) will be made of stainless steel 316L.

The screw motor should adapt to 380V, 3-phase, 50HZ and the grade of protection is IP55.

A scouring system shall be provided in order to clean sequentially the compaction zone. All cleaning and drying water shall be rejected in hoppers or spouts; leakages won't be accepted out of the screw housing.

2.1.4 Skip

Skip will be made of painted carbon steel epoxy.

2.2 Spare Parts and Special Tools

1. The Contractor shall specify and supply the special tools required for equipment maintenance and for 2 years of operation.
2. The Contractor shall supply 2 spare sets of all necessary lifting cables.

3 EXECUTION

3.1 Inspection Before Erection

The Contractor shall check the setting and alignment of pre-embedded parts as well as the dimensions and setting of recesses in the civil works for embedded parts.

3.2 Field Quality Control

3.2.1 Inspections Before and After Concreting

1. 1. The following inspections shall be carried out before and after concreting:
   a) Distance between the lateral embedded parts,
   b) Flatness, verticality, horizontality of the embedded parts,
2. Erection tolerances:

Refer to Section 01020 and paragraph 1.6.2.

3.2.2 Dry Tests

1. Testing of the various operations required for grabs lifting and opening (friction surfaces shall be wetted),
2. Examination of paintwork.
3. Overlapping of the raking grab and the coarse screens bars shall have no blocking, from the top to the bottom of the screens. Each screen will be tested separately with both of the raking grabs.
4. Overall system must run for two hours without neither loading nor water: transmission should be calm, block phenomena should not be observed, and action of over loading equipment should be delicacy and fluent. The temperature of the screw axis shall not exceed 70°.

3.2.3 Commissioning Tests

1. Machine must run for 24 hours at nominal flow and with observing any difficulties.
2. The supplier should check that screen decontaminating machine performances are in accordance with required Guaranties, particularly concerning maximum head losses requirements.
3. Rags, waste plastics or other suitable material shall be tested in water flows to verify screens efficiency.
4. Contractor shall carry out a site load examination according to CJ/T3048-1995 standard. He shall check at least:
5. Screens and screw efficiency in the case of max design water level condition,
   a) effect of removing garbage,
   b) filth don't fall over harrow into the channel.
6. Leakage shall not be observed out of the compacting screw.
7. Examination of paintwork.

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SECTION 15415

FINE SCREENING EQUIPMENT

1 GENERAL

1.1 Work Included

1.1.1 Scope of Supply

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of the fine screening equipment, including but not limited to:

1. Fine screens,
2. Cleaning systems,
3. Compacting screws,
4. Conveying screw
5. Skip.
6. Pre-embedded parts

The pre-embedded parts (steel plates, continuous sections...) to which will be attached the adjustment rods of the permanent embedded parts, shall be supplied, fitted and anchored in the primary concrete under Civil Works Section as will be shown on the civil construction drawings.

7. Embedded parts

Embedded parts are steel parts anchored either in the secondary concrete or primary concrete and which may be subject to operating loads.

The embedded parts (anchors, support parts...) shall be supplied and installed by the Contractor under the present section.

Concreting of the embedded parts shall be covered by Civil Works Section.

8. Covers above the slots shall be provided by the Contractor.

1.2 Related Work

1.2.1 Supplies and Works Included Under This Section Shall Comply With:

A) Section 01000 - General requirements;
B) Section 01010 - Corrosion protection;
C) Section 01020 - Basic mechanical requirements;
D) Section 01030 - Basic electrical requirements;

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A) Concrete works covered by the Civil Works Section;
B) Electrical works covered by the Electrical Equipment Section;
C) Section 19800 – Water measuring system and instrumentation;

1.3 System Description, Characteristics and Operating Conditions

1.3.1 Operating Conditions

Fine screens shall be discontinuously and automatically cleaned, thanks to both head losses detection and timer (with possible adjustments). Cleaning system shall be composed of a rotary harrow and a cleaning comb. The rotating rake assembly shall include teeth, which penetrate the depth of the bar screen to ensure positive solids removal. The rake teeth root and the basket rings shall be designed in the same plane to ensure proper cleaning of the screen bars. The rake shall reverse its garbage at least one time during the cleaning cycle through the topmost position where it shall be cleaned by a cleaning comb installed at the top of the screen basket. Cleaning comb shall pivot and return to the stand-by position without the use of counterweights.

Filth is reversed in a central compacting screw, which shall be fixed to the same shaft as the rotary harrow and driven by a common drive. A cleaning system shall be provided for the compaction zone. After being dewatered, filth is reversed in a common conveying screw and driven to a skip.

1.3.2 Control and Monitoring

The operation mode of the racking machines and compacting screw should have both:

1. Manual control and PLC automatic control.
2. Local control and distance control.

A local control box, including a manual emergency stop button, shall be set up close to the equipment. It will be IP 55 protected.

It will be composed at least of the following controls and instructions, for each equipment:

3. Manual / auto commutator
4. Lighted button “ON”
5. Lighted button “OFF”
6. Defaults presentation.

The Contractor shall provide a detailed document explaining the control and regulation system he wants to install, concerning both raking machines control and the way this equipment will be connected to the general computer.

Moreover, the following detectors shall be installed and connected to the PLC:

7. High and low levels detection soundings in channels
8. Cyclic working on clock or / and head losses detection,
9. Malfunctions and alarms.

1.4 Quality Assurance

1.4.1 Codes and Standards

EN 12255 – 3	Wastewater treatment plants – Preliminary treatment
EN 600034-9	Rotational Electric Machine (Noise Area Value)
DIN 3962	Gear Tolerance Grade Standard
EN 60204	Electric Installations of Equipment (General Requirement)
EN 60034	Rotational Electric Machine (Detecting & Operating States)
GB 4942.1-85	Electric Machine Case Protection
GB 50205	Steel Structure Engineering Construction & Test Acceptance Standard
GB 50231-98	Mechanical Equipment Installation Construction & Test Acceptance General Standard

1.4.2 Design Criteria

See performance specifications.

1.4.3 Shop Tests and Inspection

1. Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
2. Inspection and testing of standard products: the Contractor shall supply certificates of routine tests.
3. Workshop inspections and tests:

   a) The seals and the embedded parts shall be presented separately and unpainted for checking.
   b) The surface appearance of embedded parts shall be examined and their dimensions checked. Rolling, sliding and plate sealing surfaces shall be perfectly flat and smooth.

All dimensions shall be checked.

   c) Welds:

Refer to Section 01020.

1.5 Submittals

The supplier should submit the following documents (non-exhaustive list):

1. Detailed Ichnography and section diagram and specification for equipment, showing all functional dimensions and space necessary for maintenance, operation and installation…
2. Detailed performance specification and drawings of all parts
3. Hydraulic and process detailed calculation notes justifying that design criteria are respected.
4. Installation, maintenance and operation manuals with requirements of accuracy
5. Manufacture and quality assurance measures
6. Protective coating list of all parts
7. Commissioning tests list.
8. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.
9. Internal wiring diagrams and control principle drawing of control box
10. Weight and material of each component

1.6 Guarantee

1.6.1 Performances

The Contractor shall justify in his bid that the above required head losses are never reached and that water speed for maximum flow rate and for a 50% clog up rate must be less than 1m/s.

In addition, nominal flow rate must pass through each screen considering a 50% clog up rate and a water speed lower than 0.5m/s.

The Contractor shall provide a calculation note proving that the equipment he intends installing have an efficient capacity to remove, collect, convey and evacuate debris for a Qmax flow (of far future) and during 5 hours.

The cylindrical fine screens shall be designed and built to withstand static and hydraulic forces exerted by water. All structural and functional parts shall be sized for the loads encountered during screening, conveying and pressing operations. All load capacities shall be justified by the Contractor.

Compacting screw has to ensure maximum garbage water content of 55% and during 24h continuously.

1.6.2 Dimension Tolerances

1. Tolerances of the screens' equipment inner assembling before installation (cylindrical screen, harrow, cleaning comb, compacting screw) shall be conform to the manufacturer instructions.
2. After installation, the deviation of the plane position of the equipment shall be less than < 10 mm. The elevation deviation shall not exceed ± 10 mm.
3. The deviation of screens installation angle (angle between the screen axis and the horizontal line) is not larger than ± 0.5°.
4. The deviation of all screws installation angles (angle between the screw axis and the horizontal line) is not larger than ± 0.5°.

2 PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1 Fabrication

2.1.1 Fine Basket Screens

Main parts of screens (bars, frame, axes, fixings, fastenings, etc.) and their supports will be made of stainless steel 316L.

All platforms, ladders, or rungs that may be necessary for screens operations and handling will be provided by the Civil works Contractor.

The screens shall be provided with a support stand allowing easy removal of the screen baskets from the channels for maintenance purposes. The supports and their stands shall be fabricated from stainless steel 316L and be able to withstand static and hydraulic forces exerted by the screen during operation.

2.1.2 Raking Equipment

All parts of the raking system (particularly rotary harrow and cleaning comb teeth) shall be made of stainless steel 316L.

All fixing and fastening items will be made of stainless steel 316L and provided by the Contractor.

2.1.3 Axial Compacting Screws and Conveying Screw

This specification concerns both:

1. The axial compacting screws of the cylindrical fine screens
2. The overall conveying screw.

Helical axial blades of all screws will be made of special steel.

All the other parts (housing, driving axle, compaction zone …) will be made of stainless steel 316L.

The screw motors should adapt to 380V, 3-phase, 50HZ and the grade of protection is IP55.

A scouring system shall be provided in order to clean sequentially the compaction zone. All cleaning and drying water shall be rejected in hoppers or spouts; leakages won't be accepted out of the screw housing.

2.1.4 Skip

Skip will be made of painted carbon steel epoxy.

2.2 Spare Parts and Special Tools

1. The Contractor shall specify and supply the special tools required for equipment maintenance and for 2 years of operation.
2. The Contractor shall supply the following spare parts:
   a) 2 sets of all necessary lifting and operation cables
   b) 2 sets of raking teeth

3 EXECUTION

3.1 Inspection Before Erection

1. The contractor shall check the setting and alignment of pre-embedded parts as well as the dimensions and setting of recesses in the civil works for embedded parts.
2. The fine screening equipment (cylindrical screen, harrow, cleaning comb, compacting screw) shall be assembled on site and checked before installation.

3.2 Field Quality Control

3.2.1 Inspections Before and After Concreting

1. The following inspections shall be carried out before and after concreting:
   a) Distance between the lateral embedded parts,
   b) Flatness of the embedded parts, verticality, horizontality,
2. Erection tolerances:

Refer to Section 01020 and paragraph 1.6.2.

3.2.2 Dry Tests

1. Examination of paintwork.
2. Overlapping of the raking harrow and the fine screens bars shall have no blocking, all around the screen.
3. Overall system must run for two hours without neither loading nor water: transmission should be calm, block phenomena should not be observed, and action of over loading equipment should be delicacy and fluent. The temperature of the screw axis shall not exceed 70°.

3.2.3 Commissioning Tests

1. Machine must run for 24 hours at nominal flow and with observing any difficulties. The rotary harrow shall operate well without block or miss. The overload device shall react quickly and precisely.
2. The supplier should check that screen decontaminating machine performances are in accordance with required Guaranties, particularly concerning maximum head losses requirements.
3. Rags, waste plastics or other suitable material shall be tested in water flows to verify screens efficiency.
4. Contractor shall carry out a site load examination according to CJ/T3048-1995 standard. He shall check at least:
   a) screens efficiency in the case of max design water level condition,
   b) effect of removing garbage,
5. Leakage shall not be observed out of the compacting screw.
6. Examination of paintwork.

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SECTION 15421

GRIT CHAMBERS MIXER

1 GENERAL

1.1 Work Included

1.1.1 Scope of Supply

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of the overall grit chamber mixers equipment, including but not limited to:

1. Pre-embedded parts

The pre-embedded parts (steel plates, continuous sections...) to which will be attached the adjustment rods of the permanent embedded parts, shall be supplied, fitted and anchored in the primary concrete under Civil Works Section as will be shown on the civil construction drawings.

2. Embedded parts

Embedded parts are steel parts anchored either in the secondary concrete or primary concrete and which may be subject to operating loads.

The embedded parts (anchors, support parts, etc.) shall be supplied and installed by the Contractor under the present section.

Concreting of the embedded parts shall be covered by Civil Works Section.

3. Covers above the slots shall be provided by the Contractor.

1.2 Related Work

1.2.1 Supplies and Works Included Under This Section Shall Comply With:

A) Section VII – A. General requirements;
B) Section 01010 - Corrosion protection;
C) Section 01020 - Basic mechanical requirements;
D) Section 01030 - Basic electrical requirements;

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A) Concrete works covered by the Civil Works Section;
B) Electrical works covered by the Electrical Equipment Section;
C) Section 15425 – Grit classifier;
D) Section 17200 – Instrumentation;

1.3 System Description, Characteristics and Operating Conditions

1.3.1 Operating Conditions

Adopting round horizontal cyclone mode in the grit chamber, the tangent incoming water turns 360° and goes out from upper part. During the process, with the action of the centrifugal force, a serial of actions will be accomplished: the grit will be segregated from organic matters at the progress of sedimentation, and then the grit falls and moves thought the chamber tunnel to the bottom.

Sedimentation shall be done in each grit chamber thanks to a vertical blade type mechanical mixer. The power transmission to the vertical axis is done by a reducer motor and a secondary reducing column gear.

Mixers have to operate for two main goals:

1. Increasing sedimentation efficiency in grit chambers.
2. Allowing a constant water level in grit tanks, regardless to flow rate.

The Contractor shall design grit chambers dimensions and parameters. He shall provide a calculation note to ensure the efficiency of his overall system. The efficiency of the paddles on grit sedimentation shall particularly be considered. Moreover, the shaft shall be designed considering requirements of the grit extraction system.

1.3.2 Control and Monitoring

The operation mode of the grit chambers mixers should have both:

1. Manual control and PLC automatic control.
2. Local control and distance control.

A local control box, including a manual emergency stop button, shall be set up close to the grit chambers area. It will be IP 55 protected. This control box shall also contain control facilities of the air compressors and of the grit classifiers.

The box will be composed at least of the following controls and instructions, for each equipment:

3. Manual / auto commutator
4. Lighted button “ON”
5. Lighted button “OFF”
6. Defaults presentation.

The Contractor shall provide a detailed document explaining the control and regulation system he wants to install, concerning both machines control and the way this equipment will be connected to the general computer. He shall particularly describe the automatic operation principle he wants to install for the mixers, namely:

7. The way water level in grit tanks will be maintained constant regardless to the influent flow rate.
8. Sedimentation control.

Moreover, the following detectors shall be installed and connected to the PLC:

9. High and low levels detection soundings in chambers.
10. Malfunctions and alarms.

1.4 Quality Assurance

1.4.1 Codes and Standards

A) GB50231-98 General Specification for Construction and Inspection of Mechanical Equipment Installation Engineering

B) SZ-06-99 Quality Inspection and Assessment Standard for Mechanical and Electrical Equipment Installation of Drainage Engineering

C) GB50235-93 Construction and Inspection Specification for Industrial Metal Pipe Installation Manufactory Technical Manual for Grit chamber facilities Installation

1.4.2 Shop Tests and Inspection

1. Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
2. Inspection and testing of standard products: the Contractor shall supply certificates of routine tests.
3. Workshop inspections and tests:
   a) The seals and the embedded parts shall be presented separately and unpainted for checking.
   b) The surface appearance of embedded parts shall be examined and their dimensions checked. Rolling, sliding and plate sealing surfaces shall be perfectly flat and smooth.
   All dimensions shall be checked.
   c) Welds:

Refer to Section 01020.

1.5 Submittals

The supplier should submit the following documents (non-exhaustive list):

1. Detailed Ichnography and section diagram and specification for equipment, showing all functional dimensions and space necessary for maintenance, operation and installation…
2. Detailed performance specification of equipment and drawings of all parts
3. Hydraulic and process detailed calculation notes justifying that design criteria are respected.
4. Installation, maintenance and operation manuals with requirements of accuracy
5. Manufacture and quality assurance measures
6. Protective coating list of all parts
7. Commissioning tests list.
8. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.
9. Internal wiring diagrams and control principle drawing of control box
10. Weight and material of each component

1.6 Guarantee

1.6.1 Performances

The type of blade-paddles shall be decided by the supplier, with a proper rotary velocity efficient to keep organic matter in suspension without affecting the desired grit removal efficiency.

Moreover, the driving shaft shall be sized to match discharge of the sand extraction system.

The organic matters attached with grits shall be segregated at a rate ≥95%.

The Contractor shall provide a calculation note proving that the equipment he intends installing have an efficient capacity to sediment grit as specified above, for a Qmax flow (of far future) and during 5 hours.

1.6.2 Dimension Tolerances

1. Tolerances of the mixers inner assembling before installation (blade paddles, hollow shaft, driving device) shall be conform to the manufacturer instructions.
2. After installation, the deviation of the plane position of the driving axis shall be less than ± 5 mm. The verticality of this shaft shall be less than 1/1000.
3. The elevation deviation of paddles shall not exceed ± 5 mm.

2 PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1 Fabrication

2.1.1 Paddles and Axis

Paddles are set on a stainless steel 316L-graded hollow shaft, in which removed sand/water mix shall flow up.

Paddles will be made of stainless steel 316L.

All fixing and fastening items will be made of stainless steel 316L and provided by the Contractor.

2.1.2 Motor and Gear Head

The gear reducer motor shall fit with:

- Working outdoors,
- Protection grade IP65.
- 380V,
- 3 phases,
- 50Hz,
- Rated power 10% higher than maximum actual power.

The secondary gear, made of 1.521 alloy steel, shall be located in a GG25 cast iron box.

The service life of the convolution bearing for supporting the impellers shall be 20 years as a minimum. The bearings of reducer shall be well lubricated with working duration no less than 100,000 hours. The gears designed should comply with ISO or equivalent standard, with servo ratio no less than 2.0.

All fixing and fastening items will be made of stainless steel 304L and provided by the Contractor.

2.2 Spare Parts and Special Tools

1. The Contractor shall specify and supply the special tools required for equipment maintenance and for 2 years of operation.
2. The Contractor shall supply 1 set of each of the following spare parts:
   a) hollow axis,
   b) paddles,
   c) gear head
   d) gear box

3 EXECUTION

3.1 Inspection Before Erection

1. The Contractor shall check the setting and alignment of pre-embedded parts as well as the dimensions and setting of recesses in the civil works for embedded parts.
2. The grit chambers mixers (blade paddles, hollow shaft, driving device) shall be assembled on site and checked before installation.

3.2 Field Quality Control

3.2.1 Inspections Before and After Concreting

1. The following inspections shall be carried out before and after concreting:
   a) Holes position
   b) Flatness, verticality, horizontality of the embedded parts,
2. Erection tolerances:

Refer to Section 01020 and paragraph 1.6.2.

3.2.2 Dry Tests

1. Examination of paintwork.
2. Machine must run for two hours without water and without any noticeable problem (noise, axial position…).

3.2.3 Commissioning Tests

1. Examination of paintwork.
2. Checking of operation parameters (rotation speed), for each agitator tested individually.
3. For each agitator, checking of operation conditions for nominal flow and during 24 hours. The water level shall remain nearly constant during these 24 hours testing operations (difference shall be less than 10cm).
4. The supplier shall provide grit sedimentation effectiveness testing report, taking samples from upper, middle, lower, left, middle and right part of sections of incoming and outgoing water ditches, in order to check the effectiveness of sedimentation. Each tank shall fit individually with requirements.
5. If the test results cannot satisfy technical requirements, the supplier has to make rectification, changing equipment or taking improvements until the requirements in tender documents are reached.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 15425

GRIT CLASSIFIERS

1 GENERAL

1.1 Work Included

1.1.1 Scope of Supply

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of the grit classifiers.

1. Pre-embedded parts

The pre-embedded parts (steel plates, continuous sections...) to which will be attached the adjustment rods of the permanent embedded parts, shall be supplied, fitted and anchored in the primary concrete under Civil Works Section as will be shown on the civil construction drawings.

2. Embedded parts

Embedded parts are steel parts anchored either in the secondary concrete or primary concrete and which may be subject to operating loads.

The embedded parts (anchors, support parts...) shall be supplied and installed by the Contractor under the present section.

Concreting of the embedded parts shall be covered by Civil Works Section.

3. Covers above the slots shall be provided by the Contractor.

1.2 Related Work

1.2.1 Supplies and Works Included Under This Section Shall Comply With:

A) Section VII - A. General requirements;
B) Section 01010 - Corrosion protection;
C) Section 01020 - Basic mechanical requirements;
D) Section 01030 - Basic electrical requirements;

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A) Concrete works covered by the Civil Works Section;
B) Electrical works covered by the Electrical Equipment Section;
C) Section 15421 – Grit chamber mixers;
D) Section 17200 – Instrumentation;

1.3 System Description, Characteristics and Operating Conditions

1.3.1 Main Characteristics

Each grit extraction system should be equipped with a complete set of accessories for safe, efficient and reliable operation.

1.3.2 Operating Conditions

After being extracted from the grit chamber well, a mixture composed of sand, air and water is conveyed through pipes to a grit classifier that has to separate grit and water.

The grit classifier used is composed of an inlet hopper, a segregating channel and a grit Archimedean screw. The unit is driven by a gear motor.

Maximum segregating flow and maximum conveying capacity shall be designed by the Contractor considering requirements of the grit extraction system. He shall provide a calculation note to ensure the efficiency of his overall system.

The Contractor's bid shall include in the Schedules of Particular:

- performance guarantees
- the simplified installation drawings of the proposed equipment
- the characteristics of the equipment
- the nature of the proposed materials
- the technical data sheets or manuals for the coatings used
- the coating procedure

1.3.3 Control and Monitoring

The operation mode of grit classifiers should have both:

1. Manual control and PLC automatic control.
2. Local control and distance control.

Grit classifiers local control facilities shall be located in the grit chambers control box with mixers and compressors commands.

The box will be composed at least of the following controls and instructions, for each equipment:

3. Manual / auto commutator
4. Lighted button “ON”
5. Lighted button “OFF”
6. Defaults presentation.

The Contractor shall provide a detailed document explaining the control and regulation system he wants to install, concerning both machines control and the way this equipment will be connected to the general computer. He shall particularly describe the automatic operation principle he wants to install for the grit classifiers control.

Moreover, the following detectors shall be installed and connected to the PLC:

- Malfunctions and alarms.

1.4 Quality Assurance

1.4.1 Design Criteria

See performance specifications.

1.4.2 Shop Tests and Inspection

1. Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
2. Inspection and testing of standard products: the Contractor shall supply certificates of routine tests.
3. Workshop inspections and tests:
   a) The seals and the embedded parts shall be presented separately and unpainted for checking.

b) The surface appearance of embedded parts shall be examined and their dimensions checked. Rolling, sliding and plate sealing surfaces shall be perfectly flat and smooth.

All dimensions shall be checked.

c) Welds:

Refer to Section 01020.

1.5 Submittals

The supplier should submit the following documents (non-exhaustive list):

1. Detailed Ichnography and section diagram and specification for equipment, showing all functional dimensions and space necessary for maintenance, operation and installation…
2. Detailed performance specification of equipment and drawings of all parts
3. Detailed calculation notes justifying that design criteria are respected.
4. Installation, maintenance and operation manuals with requirements of accuracy
5. Manufacture and quality assurance measures
6. Protective coating list of all parts
7. Commissioning tests list.
8. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.
9. Internal wiring diagrams and control principle drawing of control box
10. Weight and material of each component

1.6 Guarantee

1.6.1 Performances

After the grit classifier, at least 98% of the grit larger than 0.2 mm shall be removed from water. This figure is related to the grit chamber inlet flow.

Water content of the outlet sand shall be less than 60%.

The Contractor shall provide a calculation note proving that the equipment he intends installing have an efficient capacity to classify water and grit as specified above, for a Qmax flow (of future) and during 5 hours.

1.6.2 Dimension Tolerances

1. The deviation of the plane position shall be less than ± 20 mm. The elevation deviation shall not exceed ± 10 mm.
2. The deviation of screw installation angle (angle between the screw axis and the horizontal line) is not larger than ± 0.5°.

2 PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1 Fabrication

2.1.1 Inlet Hopper

The inlet hopper shall be made of thick stainless steel.

The slope of the hopper's sides shall be at least maintained at 600 from the horizontal level to prevent grit from building up.

An inner overflow weir shall be used to maintain a constant water volume and an appropriately sized drainpipe shall be installed to return the overflowing water to the grit chamber inlet channel.

2.1.2 Trough Channel

The segregating channel shall be made of thick stainless steel.

2.1.3 Archimedean Screw

The screw shall be made of thick stainless steel.

2.1.4 Gear Motor

The motor shall be:

- IP65 protection grade,
- Non-overloading,
- Constant speed motor with 380 Volts,
- 50-Hertz
- Class F insulation.

2.2 Spare Parts and Special Tools

The Contractor shall specify and supply the special tools required for equipment maintenance and for 2 years of operation.

3 EXECUTION

3.1 Inspection Before Erection

The Contractor shall check the setting and alignment of pre-embedded parts as well as the dimensions and setting of recesses in the civil works for embedded parts.

3.2 Field Quality Control

3.2.1 Inspections Before and After Concreting

1. The following inspections shall be carried out before and after concreting:
   a) Equipment position
   b) Flatness, verticality, horizontality of the embedded parts,
2. Erection tolerances:

Refer to Section 01020 and paragraph 1.6.2.

3.2.2 Dry Tests

1. Grit classifiers must run individually for two hours without neither loading nor water: transmission should be calm, block phenomena should not be observed, and temperature of the screw axis shall not exceed 70°.
2. Examination of paintwork.

3.2.3 Commissioning Tests

1. Machine must run for 24 hours at nominal flow and with observing any difficulties.

2. The supplier shall provide a grit segregation effectiveness testing report, taking samples from incoming and outgoing water ditches.
3. If the test results cannot satisfy technical requirements, the supplier has to make rectification, changing equipment or taking improvements until the requirements in tender documents are reached. All relative rectification expenses will be undertaken by the supplier.
4. Leakage shall not be observed out of the grit classifier.
5. Examination of paintwork.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 15550

VENTILATION

1 GENERAL

1.1 Work Included

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of the ventilation system to be installed in the structures and rooms.

1.2 Related Work

1.2.1 Supplies and Works Included Under This Section Shall Comply With:

A) Section VII – A. General requirements;
B) Section 01010 - Corrosion protection;
C) Section 01020 - Basic mechanical requirements;
D) Section 01030 - Basic electrical requirements;
E) Section 14100 – Pipes and fittings;
F) Section 14270 – Dosing pumps;

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A) Concrete works;
B) Section 15080 – Odor Control;

1.3 System Description, Characteristics and Operating Conditions

The installation is designed to feed the structures and rooms with air fresh and to collect inside the rooms the polluted air to be conducted outside for release to the atmosphere or for treatment in the deodorization system.

The installation shall be connected electrically and electronically to all other structures and shall operate in local/remote and manual/automatic modes. In normal operation, the entire installation is controlled automatically.

The equipment shall include:

- Air fresh inlet
- Electrical wire heating cell
- Fresh air ducts distribution
- Polluted air ducts collection
- Ventilators on lines
- Feeding ventilators to odors treatment (if applicable)

The assembly is designed to make operation easy. In particular, man operable valves on airducts will allow to adjust the flow.

Basically, the ventilation system will meet the following requirements:

- Supply of fresh air in the rooms with the specified air renewal
- Heat the fresh air (if applicable) in order to guarantee the inside specified temperature
- Exhaust the polluted air of the rooms with the specified air renewal

The air intake, the running of the electrical wires and the ventilators could be made either automatically or either manually.

1.4 Quality Assurance

1.4.1 Codes and Standards

XP X43-105 Air quality - Audit of air quality in non-industrial premises - Public means of transport and stations

1.4.2 Design Criteria

All equipment and constructional arrangements for which the Contractor is responsible under the terms of the Contract must be sufficient to achieve the treatment levels indicated in the Particular Specifications.

Unless otherwise specified, all the electrical equipment will be water proof registered IP55.

The following criteria shall be respected:

1. Air renewal ratio: pits and sumps: k = 20, Sludges, grease and sand treatment rooms: k =10, Screening rooms k = 10, all others rooms (except electrical rooms): k = 6
2. Fresh air feeding: 100% of the polluted air exhausted
3. Maximum air velocity speed in the pipes: 8 m/s (ventilator high speed)

1.4.3 Shop Tests and Inspection

1. Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
2. Inspection and testing of standard products: the Contractor shall supply certificates of routine tests.
3. Workshop inspections and tests:
   - ~ The seals and the embedded parts shall be presented separately and unpainted for checking.
   - ~ The surface appearance of embedded parts shall be examined and their dimensions checked. Rolling, sliding and plate sealing surfaces shall be perfectly flat and smooth.

     All dimensions shall be checked.
   - ~ Welds:

     Refer to Section 01020 – Basic mechanical requirements

1.5 Submittals

The supplier should submit the following documents (non-exhaustive list):

1. Detailed Ichnography and section diagram and specification for equipment, showing all functional dimensions and space necessary for maintenance, operation and installation…
2. Detailed performance specification of equipment and drawings of all parts
3. Process detailed calculation notes justifying that design criteria are respected.
4. Installation, maintenance and operation manuals with requirements of accuracy
5. Manufacture and quality assurance measures
6. Protective coating list of all parts
7. Commissioning tests list.

8. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.
9. Internal wiring diagrams and control principle drawing of control box
10. Weight and material of each component

1.6 Dimension Tolerances

The requirements of Section 01020 – Basic mechanical requirements – will apply.

2 PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

The characteristics shall be determined by the Contractor so that they comply with the Particular Specifications, and the present Section.

2.1 Fabrication

2.1.1 Pipes

All pipes will be aluminum spiral or Fiberglas made. The connections between pipes will be sleeve type.

All the low points on the pipe's profiles will be fitted with a man operable event. On each main duct, at a location specified by the Engineer, tee fittings with valves will be provided for sampling and "Pitot pipe flow measuring". Each manifold and vent will be fitted with a man operable register.

The standing and racks equipment will be in stainless steel or inert materials (HDPE, PP…)

2.1.2 Air Inlets

Each air inlet will be aluminum type (complying with the architectural requirements if any), fitted with anti-insect's grille and with rainproof protection.

According to the requirement of the inside temperature, wires electrical heating equipment will be fitted in connection with the air inlet; the power of this equipment will be assessed in relation with the minimum outside air temperature, the air temperature to provide inside and the volume of rooms; they will be fitted with the dust filters.

In any case, ventilators will be provided in order to provide a pressure equal to the requirement at the end of the fresh air delivering pipes plus 200 Pa.

2.1.3 Ventilators

The ventilators will be axial type for the lines and centrifuge type for the feeding of the odor treatment equipment.

If feeding an odor treatment, they will suck up the air from a general enclosure in which the collecting pipes will deliver the polluted air.

The ventilators will be provided in order to provide a pressure equal to the requirement at the end of the polluted pipes (or inlet of odor treatment equipment) plus 200 Pa.

The casing of the ventilators will be in galvanized iron covered by an epoxy painting (thickness 200 microns)

2.1.4 Watertight Manhole and Access

All the access and manholes to pits, sumps, and closed treatment basins (if applicable) will be fitted with watertight and easily dismountable items made of aluminum or inert materials. The vents intakes will be separately designed.

2.1.5 Instrumentation

H2S and NH3 sensors shall be installed at the inlet of polluted air.

The equipment shall comply with the requirements of the Particular Specifications and present section.

2.2 Spare Parts and Special Tools

The Contractor shall specify and supply the special tools required for equipment maintenance and for 2 years of operation.

3 EXECUTION

3.1 Inspection Before Erection

The Contractor shall check the setting and alignment of pre-embedded parts as well as the dimensions and setting of recesses in the civil works for embedded parts.

3.2 General

The ventilators and electrical wire heating equipment be installed through the hopper designed by the Contractor, and with the handling equipment provided through the Contract.

3.3 Field Quality Control

3.3.1 Inspections Before and After Concreting

1. The following inspections shall be carried out before and after concreting:
   a) Equipment position
   b) Flatness, verticality, horizontality of the embedded parts,
2. Erection tolerances:

Refer to Section 01020.

3.3.2 Dry Tests

All no-load tests are recorded and an acceptance report drawn up.

During these tests, vibrations, temperature increasing and noise shall particularly be checked.

3.3.3 Commissioning Tests

Treatment quality shall be checked in accordance with applicable regulations, and in particular standard NF X 43.105.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 15600

AIR COMPRESSORS

1 GENERAL

1.1 Scope

The present specification shall apply to units producing compressed air for various uses, especially pneumatic operation and air lift systems. They apply for the whole unit of compressor, air reservoir, filters and valves.

1.2 Related Works

1.2.1 Supplies and Works Included Under This Section Shall Comply With:

A) Section VII – A. General requirements;
B) Section 01010 - Corrosion protection;
C) Section 01020 - Basic mechanical requirements;
D) Section 01030 - Basic electrical requirements;

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A) Concrete works covered by the Civil Works Section;
B) Electrical works covered by the Electrical Equipment Section;
C) Section 15421 – Grit Chambers Mixer;
D) Section 15425 – Grit Classifiers;
E) Section 17200 – Instrumentation.

1.3 System Description, Characteristics and Operating Conditions

Compressors shall be electrically driven, piston, type. They shall deliver oil free air and shall be fitted with suction filter and silencer, automatic unloading device for starting at no load and safety relief valve.

One air cooled after-cooler shall be installed between the compressor and the air receiver.

The compressor, the motor and air reservoir should be mounted at a common bedplate.

The compressor should be automatically operated by a manostat measuring the air pressure in the air reservoir.

The compressor should be fitted with a security valve big enough to evacuate the entire airflow of the machine.

1.4 Quality Assurance

A) Standards

The ISO, ASTM standards shall apply.

B) Design criteria

Compressors shall be designed for the specified performances and shall operate without overheating, excessive vibration or strain.

Air flow capacities and pressures shall be chosen for the application in order to not overcharge the equipment.

C) Workshop test

1. Inspection and testing of raw materials used in the manufacture of the equipment: the Contractor shall supply certificates of mechanical tests and chemical analysis.
2. Inspection and testing of standard products: the Contractor shall supply certificates of routine tests.
3. Workshop inspections and tests:
   a) The seals and the embedded parts shall be presented separately and unpainted for checking.
   b) The surface appearance of embedded parts shall be examined and their dimensions checked. Rolling, sliding and plate sealing surfaces shall be perfectly flat and smooth.

All dimensions shall be checked.

   c) Welds:

Refer to Section 01020.

1.5 Submittals

The Contractor shall submit calculation notes, characteristics, shop drawings and part lists for approval.

2 PRODUCT

2.1 Fabrication

2.1.1 Compressor

The compressor casing and the piston shall be in ductile cast iron. The shaft shall be in stainless steel.

2.1.2 Air Reservoir

The air reservoir shall be in stainless steel. The reservoir shall be factory tested for a pressure of at least 1.5 times operating pressure. The volume of the reservoir shall be chosen in a manner to minimize the number of starts of the compressor to 15 per hour.

2.1.3 Piping

Pipework shall be done with stainless steel or UPVC pipes.

2.1.4 Nameplate

Each compressor shall bear a nameplate indicating capacity and pressure, serial No., type or model and other pertinent information.

2.2 Spare Parts and Tools

The following spare parts shall be furnished for each compressor:

a) One (1) check valve.
b) One (1) complete set of bearings.
c) One (1) complete set of V-belt.
d) Two (2) complete sets of all gaskets.
e) Three (3) complete sets of all packing required for the compressor.
f) One (1) lantern ring, complete set of piston rings.
g) Two (2) complete sets of all special bolts, screws and nuts.
h) One (1) complete set of special tools required for maintenance of the compressor.
i) One (1) pressure switch.
j) One (1) pressure gauge.

In addition to the above mentioned, the contractor shall propose and furnish the necessary spare parts for two years operation.

3 EXECUTION

3.1 Installation

The compressors can be fixed, used only for one specified purpose, or portable, multipurpose.

Fixed compressors shall be mounted on a concrete foundation. All handling and placing of the equipment including levelling and alignment shall be done by the Contractor. The compressor shall be fixed by expanding bolts or anchor bolts furnished by the Contractor.

3.2 Shop and Field Painting

The compressors and belplates shall have shop and field coating. Painting shall conform to the requirements as specified in section 01010 – Corrosion protection.

3.3 Field Tests

As soon as convenient after the equipment is installed, each unit shall be field tested to determine that the units have been properly installed, to verify factory test, and to demonstrate that the complete units will operate continuously without overheating and that the drives are not overloaded.

The portion of the test to demonstrate satisfactory continuous operation shall be for five (5) continuous hours. During the field test operation total pressure shall be as near the condition point total head as conditions at the site will permit.

Reading off of all essential data shall be taken and recorded at 30 minutes intervals. All instruments required for the readings shall be acceptable calibrated devices furnished by the Contractor at no additional cost to the Employer. Readings required include, but are not limited to, voltage, amperage, power factor, RPM, discharge pressure, flow, temperatures and vibration. Full details of test procedures will be as determined or approved by the Engineer based on conditions existing in the field at the time of the tests. The Contractor shall submit six (6) copies of all results arranged and neatly presented for the approval of the Engineer.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 16000

CONVEYING SYSTEMS

1 GENERAL

1.1 Work Included

The present specification shall apply to the conveying systems to be installed in the various plants and buildings, including but not limited to:

a) Single or double beam motorized bridge cranes.
b) Motorized wire hoists with monorail truck.
c) Hand operated chain hoists with monorail truck.
d) Revolving jib cranes with motorized wire hoist.

1.2 Related Works

1.2.1 Supplies and Works Included Under This Section Shall Comply With:

A) Section VII – A. General requirements;
B) Section 01010 - Corrosion protection
C) Section 01020 - Basic mechanical requirements;
D) Section 01030 - Basic electrical requirements;

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A) Civil Engineering works and Building works;
B) Section 08200 – Painting;
C) Electrical equipment;

1.3 Quality Assurance

1.3.1 Standards

1. Design standards

   AISC code and FEM rules or equivalent.

2. Materials

   ASTM, AFNOR standards or equivalent.

1.3.2 Design Criteria

According to the FEM rules:

- Mechanisms: Group 1 am
- Structures: Group 1

1.3.3 Workshop Test

A) Inspection and tests of raw materials: mechanical tests and chemical analysis certificates shall be delivered by the Manufacturer.
B) Inspection and tests of standard products and cables: routine tests.
C) Workshop inspections and tests:

1. Rails and embedded parts

The surface aspect of rails and embedded parts shall be examined and their dimensions checked. Rolling and sliding surfaces shall be perfectly flat and smooth;

2. All dimensions of systems members shall be checked;
3. The operation of the various motors and mechanisms shall be checked;
4. Welds:

Refer to Section 01020 - Basic mechanical requirements.

D) Shop test shall be carried out for motorized bridge and in particular:

- Load test of 125% rated load with operation of lifting up and down, travelling and cross travelling.

1.4 Submittals

Submit for approval complete shop drawings and descriptive literature showing details of fabrication and erection of all material and equipment furnished under this Section. The shop drawings shall include but not be limited to the following data where applicable:

1. Length of bridge crane span.
2. Overhang of bridge trucks relative to crane rail.
3. Bridge wheel tread diameter and wheel base.
4. Limits of hook travel in relation to walls of structure.
5. Speeds of bridge drive, trolley and hoist.
6. Horsepower, full load amperes and number of motors.
7. Hoist capacity and length of lift.
8. Number and type of hoist brakes.
9. Length of track.
10. Installation of runway beams and crane rails.
11. Electric power supply and wiring.
12. Others.

2 PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1 General Requirements

a) Hoist drums

All drums shall be grooved. The drums shall be supplied with cable clamps. The cable attachment points on the drums shall be easily accessible. The cable lengths shall be such that when the load is in its lowest position, at least three turns of cable remain on the drum.

b) Pulleys

Cable pulleys shall have machined grooves of a depth at least equal to one and a half times the cable diameter. The grooves must be designed to prevent any damage to the cables. The pulleys shall be made of steel (cast iron is not acceptable). The pulleys, lifting hooks and pulleys assemblies shall be designed with a safety factor greater than that used for the cables.

c) Lifting hooks

Lifting hooks shall be of forged or cast steel, or of welded plate. There must be no sharp angles nor curvatures of small radius, which could damage the cables. The hooks shall be supplied with hook safety catches to prevent any rope from becoming unhooked.

d) Chains and cables

The threads of cables strands shall be made of galvanized steel. The cables shall have a metallic central core and shall be grease impregnated inside and outside so as to resist corrosion and wear. The cables shall be rolled up to a diameter conforming with their characteristics for shipment and storage purpose.

If, during any particular maneuver, several lengths are used, the tension on each cable shall be equally distributed by means of pulleys of balancing beams. The only exception to this rule will be the case where such a procedure could cause the lifted item to jam. In such a case, the possible overload due to lack of balance shall be taken into account at the cable design stage. Eyes, end socket and other attachments for fastening the cables shall be galvanized and capable of withstanding 90% of the guaranteed breaking stress of the cables to which they are fixed.

The cable manufacturers shall supply test cables of sufficient length so that samples may be cut off for destructive tensile test. Cost of these tests shall be borne by the supplier. The minimum cable breaking load shall be equal to at least six times the maximum design load of the cable. The minimum breaking load shall be equal to at least four time the maximum design load of the chain.

e) Breaks

All breaking mechanisms, whether of the clamp or disc type shall exert a braking torque of at least 1.5 times the nominal driving torque. The brakes shall also be capable of operating 600 times/hour.

f) Operating speed and loads

The operating speeds shall be guaranteed under normal operating conditions and at all loads within a 5% tolerance band. The maximum operating loads specified by the Contractor shall be considered as guaranteed.

g) Nameplates

All equipment shall have a permanent nameplate clearly showing all pertinent information regarding the equipment, in the English language, following:

- Manufacturer's name and address.
- Name, type, serial number and other equipment identification data.
- Rating and other design data.
- Date of manufacture.
- Lifting capacity.

The lifting capacity shall be indicated on the frame of bridge crane and on the hoist casing.

2.2 Single Or Double Beam Motorized Bridge Crane

a) General

The crane shall be a motor operated, single or double girder, overhead travelling bridge crane with motorized trolley and hoist, controls and all appurtenances necessary to operate the crane. Design and manufacturing the crane with all structural steel members, welding, mechanical and electrical materials and assemblies of the bridge crane shall conform to FEM rules as specified.

Steel to be used for all structural steel members shall be E 24 grade or better. All members of the crane shall have a minimum safety factor of 5 based on the ultimate strength of materials. Maximum deflection of the bridge shall be 1/800 of the span with given rated load. The single beam motorized bridge crane shall be complete, including but not limited to the following components.

b) Components

1. Bridge

The bridge shall consist of steel girder carried by end trucks. The girder shall be designed to safety carry the full rated load and proportioned to resist all vertical, lateral and torsional forces within conservative limits. End trucks shall be built up from structural shapes and plates welded form a rigid section.

Trucks shall be precision bored to provide accurate alignments of wheel bearing assemblies. Wheel shall be finished to equal diameters in pairs and be double flanged hardened forged steel etc. Single travel speed of 10 meter per minute shall be provided. Each wheel shall be provided with anti-friction bearings and a sealed self-lubrication system.

2. Bridge Drive

Each end truck shall be provided with the bridge drive unit having a completely sealed reduction gear and brake motor. The bridge drive shall be designed to ensure a smooth start and sudden stop and all gearing shall be totally enclosed and in an oil bath. Rubber type end bumpers shall be provided at each end of the trucks.

3. Motorized Trolley and Wire Hoist

Motorized trolley and wire hoist unit shall be low head type or normal head type and shall be designed and manufactured in accordance with FEM rules or equivalent. The trolley shall have motorized drive, single speed, push button control, four flanged induction hardened forged steel wheel either sealed ball or tapered roller bearing, thrust brake and forged steel fittings.

The hoist shall have a lift, motorized drive, dual speed, upper and lower limit switches, push button control, two independent brake systems (one a solenoid operated motor brake and one a mechanical load brake, or approved equal), double reeving for plumb vertical movement of hook with wire cable and swivel safety latch hook.

4. Rails and Runway Beams

Crane rails shall be of the size recommended by the crane manufacturer. The rails shall be installed with staggered splices, appropriate pairs of anchor bolts with rail clips every 60 cm and a continuous strip of 5 mm neoprene between the rail and runway beam. Rails and runway beam shall have sliding splice to provide for expansion joints in concrete structure.

Heavy duty, high impact, rubber faced bumper stop shall be provided at each end of the runway rails. Runway beams shall be of a standard type I steel or H beam. Maximum deflection of runway beams shall be 1:1000 span with given maximum wheel load. The runway beams shall be installed on concrete brackets.

5. Electrical Conductors

The electrical conductor for runway and bridge shall be a PVC enclosed conductor system, 100 ampere vertical mount, safety enclosed conductor. The current collectors shall be made of reinforced fiber glass plastic and shall have spring loaded carbon brushes maintaining uniform contract pressure with copper conductor with 60 amperes in the runway and 30 amperes in the bridge. All accessories for the proper mounting of conductors and collectors shall also be provided.

6. Power Supply System for Motorized Trolley and Hoist

The power supply system for motorized trolley and hoist shall be a heavy duty festooned cross conductor system and shall be designed to store cabtyre cable in uniform scallops. Messenger wire or guide rail and cable hanger with accessories shall be stainless steel. All accessories for proper mounting of the festooned conductor system shall be provided.

7. Controls

The control shall be a push button pendant with a dust tight case, ballast resistor speed control and a pilot circuit to reduce the voltage at the push button to 24 volts. The pendant shall be suspended from the motorized trolley and hoist to the elevation required by the Engineer.

2.3 Motorized Wire Hoist

a) General

Motorized wire hoist, in all their parts, shall be of sufficient capacity to move the load, and shall be wired for electrical service.

Design and manufacturing the motorized wire hoist shall conform to FEM rules. All appurtenances necessary to operate the motorized wire hoist shall be provided. The motorized wire hoist shall be complete, including but not limited to the following components.

b) Components

8. Trolley

The trolley shall have motorized drive, single speed, push button control, four flanged induction hardened forged steel wheels with sealed ball or tapered roller bearings, thrust brake and forged steel fittings.

9. Motorized Wire Hoist

The hoist shall have a lift as required, motorized drive, single speed or dual speed, upper and lower limit switches, push button control, two independent brake systems (one a solenoid operated motor brake and one a mechanical load brake, or approved equal), double reeving for plumb vertical movement of hook with wire cable and swivel safety latch hook.

10. Truck

Monorail truck shall be a standard I beam with non-peening rolling surface and maximum deflection of 1:1000 span with given maximum wheel load. Heavy duty, high impact rubber faced bumper stops shall be provided at each end of truck.

11. Electric Conductor

Electric conductor system shall be enclosed conductor or festooned system.

a) Enclosed Conductor System

The electrical conductor shall be PVC enclosed conductor system, 100 ampere vertical mount, safety enclosed conductor. The current collectors shall be made of reinforced fibre glass plastic and shall have spring loaded carbon brushes maintaining uniform contact pressure with cooper conductors with 60 ampere capacity. All accessories for proper mounting of conductor and collectors shall also be provided.

b) Festooned Conductor System

The electrical conductor shall be heavy duty festooned conductor system and shall be designed to store cabtyre cable in uniform scallops. Messenger wire or guide rail and cable hanger with accessories shall be stainless steel. All accessories for proper mounting of the festooned conductor system shall be provided.

12. Controls

The controls shall be push button pendants with a dust tight case, ballast resistor speed control and a pilot circuit to reduce the voltage at the push button to 24 volts. The pendant shall be suspended from the hoist to the elevation required by the Engineer.

2.4 Hand Operated Chain Hoists

a) General

Hand operated chain hoist shall be plain or geared trolley with chain hoist. Design load and lifts shall be as required. Chain hoist shall be designed and manufactured in accordance with FEM Rules.

b) Construction and Materials

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 safety latch hook. The reduction gears shall be ample proportioned and provided 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 chain shall be electrically welded steel, heat treated, polished and accurate to pitch. The geared trolley shall be the gear drive type with 4 ball bearing pressed steel wheels, equipped with lifetime 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. Monorail truck shall conform to the requirements specified in previous Art. 2.3 Motorized Wire Hoist.

2.5 Jib Crane

a) General

Jib crane shall be 180˚ or 360˚ revolving type crane equipped with fixed motorized wire hoist.

b) Construction and materials

Jib crane shall preferably made up of fixed vertical support rigidly anchored in the concrete base and rotating arm.

The arm shall easily and smoothly rotate with minimum friction using lubricated sleeves or bearings. A locking device shall be provided to maintain the arm in any rotating position.

The controls shall be push-button pendant with a weather tight case and a pilot circuit to reduce the voltage at the push-button to 24 volts. The pendant shall be easily accessible in every rotating position.

2.6 Special Tools and Spare Parts

a) The Contractor shall specify and supply the special tools required for maintenance.
b) The Contractor shall supply the following spare sparts:

- ~ 1 coil of brake of each type,
- ~ 1 set of brake linings for each brake,
- ~ 1 motor of each type,
- ~ 1 drive roller for crane translation,
- ~ 1 drive roller for carriage drive,
- ~ 1 free roller for the translation,
- ~ 1 free roller for the carriage,
- ~ 2 sets of three suspension clips with insulators,
- ~ 1 set of flexible straight and ring connections of each type,
- ~ 1 set of signal and lighting lamps,
- ~ 2 relays of each type,
- ~ 1 set of contacts for each contractor,
- ~ 1 set of carbon brushes,

~ 100% of the first filling of oil and grease.

3 EXECUTION

3.1 Installation

The conveying systems shall be installed in strict conformity with the Manufacturer's instructions and as required by the Engineer.

Main switch for motorized equipment shall be wall mounted in accessible location.

3.2 Field Quality Control

The equipment shall be tested in accordance with BS 466 or equivalent international standard.

a) Rail-track

Rail-track position shall be checked before and after its definitive setting and clamping.

b) No-load test

During the testing maneuvers, the following items shall be checked:

- Correct operation and efficiency of brakes and limit switches.
- Vertical and horizontal travelling distances and approach measurement.
- Synchronization of pully operation when several hoists are used.
- Operating speeds.
- Operation and characteristics of manual and emergency control.
- Examination of paintwork.

c) Commissioning and acceptance tests

13. As far as possible, the load tests shall be carried out under the worst operating conditions in which the hoisting equipment shall be operated under its rated load. In the event of these conditions not being possible, the Contractor shall make provision for the additional loads necessary, in order to be able to simulate the required test conditions:

    - Under the rated load, the same items shall be checked as in the no-load test. In addition, the brakes shall be checked, so as to ensure that they stop the hoisting equipment operating at its rated speed, with a maximum slip of 10 mm and that the load is held in a stationary position without sliding. The bearings and other mechanical parts shall also be checked for temperature rise. The temperature of such mechanisms shall not exceed the value specified.
    - Under overload conditions, the overload safety system shall be checked.

After completion of the load tests, all suspect components shall be removed and cleaned in order to inspect the bearing surfaces for wear and lack of lubrication. Defective components shall be replaced at the Contractor's expense.

14. Testing of complete handling mechanism:

    - Static test:

With the handling mechanism in a fixed position, the hoisting equipment shall be tested under an overload 50% greater than its rated load. This load shall be maintained for one hour. The load shall then be relieved gradually. No defect or permanent deformation shall remain after complete removal of the load.

- Dynamic test:

After satisfactory completion of the static test, the testing load shall be decreased to a value 20% greater than that of the rated load of the hoisting equipment. Under these conditions, all the lifting and lowering operations shall be carried out successively for a period of fifteen minutes of effective operation, without vibration, deformation of detrimental temperature rise. Translational movements of the handling mechanism shall be tested under the same conditions as above.

During these maneuvers, the following shall be checked:

- correct behavior of the handling mechanism along its rolling track: the framework shall remain perpendicular to the track and shall under no circumstances give evidence of any defect or deformation,
- correct operation and efficiency of the brakes and limit switches,
- adjustment of the starting equipment, adherence of rollers on starting and braking.

After the dynamic tests, the hoist shall be located to its rated load and the following shall be checked:

- The deflection.
- The horizontal and vertical travel distances.
- Correct general operation of the safety mechanisms and accessories.
- Synchronization of pulley operation when several hoists are used.
- The operating speed.
- The lifting and lowering movements, which shall be made in a continuous smooth manner so that all maneuvers shall be possible with the desired accuracy.
- Brakes and stopping distance: the hoist brakes shall be capable of stopping the rated load operating at a normal speed with a maximum slip of 10 mm and maintaining this load in a stationary position without slipping.

The bearings and other mechanical parts shall also be checked for temperature rise.

After the dynamic test, suspect components shall be removed and cleaned in order to inspect the bearing surfaces for wear and lack of lubrication; defective components shall be replaced at the Contractor's expense.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 17100

SCADA SYSTEM REQUIREMENTS

1 GENERAL

The clauses in this section define the general requirements and standards of workmanship for the manufacture, supply, installation and commissioning of all SCADA equipment, and shall be applicable to these works unless stated to the contrary in the specification application clauses.

2 FUNCTIONAL DESIGN SPECIFICATION

The Contractor shall submit a Functional Design Specification (FDS) to be approved by The Engineer prior to manufacture and purchasing of equipment.

The FDS shall be submitted in English and the national language of the Purchaser on A4 size sheets numbered within each section and page within section, to include, but not limited to, the following for each Treatment Area and item of packaged plant:

a) Content List.
b) Reference to supporting standards, manuals and specifications.
c) Description of the design and design criteria.
d) Relevant details of associated mechanical, electrical and instrumentation equipment.
e) Control philosophy (functional description).
f) Complete set of supporting drawings.
g) Design documentation, including:
   - ~ A description of each major element of the control scheme.
   - ~ A flow-chart or pseudo-code description of each sequential element of the control scheme.
   - ~ Analysis of failure modes and shutdown procedures.
h) Calculations.
i) Quality control procedures and approvals.
j) Outline of test procedures.
k) Manufacturer's literature for each item of equipment supplied.

All drawing shall be on A4 or A3 sized paper as appropriate to ensure legibility include a title block detailing:

a) Purchaser's Name.
b) Contract Title.
c) Contractors Name.
d) Drawing Title.
e) Drawing Number.
f) Date.
g) Author.
h) Verification and approval by the Contractor prior submission.

3 SYSTEM OVERVIEW

A control center should be established in a location to be agreed with the Engineer to accommodate the Dispatcher equipment and operator workstations.

The system implemented should be able to operate within the control strategy described but shall be flexible enough to be easily changed should the control philosophy change.

The proposed system shall provide:

a) A centralized Dispatcher processing function, complete with standby facilities and local workstations.
b) Distributed intelligence using microprocessor based Programmable Logic Controllers (PLC's) for monitoring and data logging. Under normal operating conditions, the PLCs shall monitor and control plant to given schedules and record the installation's operational/performance data e.g. pump start/stop, inlet flow, storm tank level etc.
c) The PLCs shall have programmable alarm limits for discrete and rate of change settings. This shall apply to both real and derived values. There shall be a facility for high and low priority alarms, e.g. low, very low, high and very high.

In order to cater for communications failures, the PLC shall be capable of holding 8 days' worth of data as follows:

a) Analogue, totalized and derived signals - on significant change/15-minute intervals.
b) Digital signals on change of state.
c) The data gathered from the PLCs shall be incorporated into the Dispatcher database and shall also be made available to applications programs written by the client.
d) Where PLCs are programmed to perform local control of plant it shall be possible for the programs, schedules, set-points etc. to be downloaded from the Dispatcher. Subject to being assigned suitable privileges, system users shall have the facility to make short term alterations to PLC control schedules via the control center, e.g. to implement remedial action when an alarm occurs.

SCADA Control shall be affected at two levels, these being:

a) PLC local control via programs stored locally at the PLC, e.g. pump start, fallback control.
b) Supervisory control from the control center. An authorized user, at the control center shall be able to modify the control routines at any PLC by downloading new control (start/stop) schedules, new performance criteria e.g. increase/decrease flow/pressure or operating individual items of plant e.g. open/close valve, start/stop pump.
c) There shall be a requirement to download control programs and schedules to the PLCs from the dispatcher via the communications network.
d) The preferred method of communication with site-based PLC's is cable with GSM or telephone transmission system for remote sites. As future developments may require different forms of communication at specific sites, the equipment shall be capable of operating in all modes with minimal software changes.
e) The system shall operate using 'management by exception' techniques. The PLC shall monitor and control the site and record operational data. When an alarm condition is detected, the PLC will dial into the master station immediately to announce the alarm and forward any data collected. Where alarm conditions arise, individual alarm presentation with alarm lists, mimic and tabular diagrams, and help pages shall be available to assist the operator.

4 DISPATCHER SYSTEM HARDWARE

4.1 General

A centralized SCADA Dispatcher shall be provided for the SCADA system unless otherwise specified within the particular specification.

All equipment required to fulfil the requirements shall be industry standard proven computing equipment with a demonstrable long-term life cycle and support.

To permit other manufacturer's equipment, e.g. PLCs, to be added to the SCADA system, all equipment shall, wherever possible, interface using open-system communications protocols.

4.2 System Availability

4.2.1 General

The strategic importance of the SCADA system requires a high level of system availability, i.e. not less than 99.9% availability for each calendar year. The SCADA system shall therefore be provided with the following.

4.2.2 Hot Standby

The system shall be provided with a master and standby Dispatchers where the standby Dispatcher shall be continually updated and automatically assume responsibility within 30 seconds following failure of the master Dispatcher.

Synchronization of the databases following system recovery shall be automatic i.e. shall not require manual intervention.

4.2.3 Uninterruptible Power Supply (Ups)

The system shall be provided with a UPS capable of supporting all the main computer equipment (central processing units, discs, communications processors etc.), operating consoles and the alarm/event printer for a period of not less than 4 hours. The UPS shall be provided to cater for a 50% increase in load without the need for additional hardware.

Note: Essential services, e.g. UPS, generator and security etc. shall be monitored by the SCADA system.

4.2.4 Maintenance

The Dispatcher equipment shall be subject to a maintenance contract where a competent engineer shall attend site within 8 hours from the time the failure was reported, twenty-four hours a day, 365 days a year.

4.2.5 Communications Equipment

The Dispatcher equipment shall be provided with all necessary communications equipment to support:

a) All operator workstations.
b) All printing devices.
c) The communications network comprising:

- ~ Communications to all on-site PLCs.
- ~ All remote equipment.
- ~ Equipment as detailed in the particular specification.

4.2.6 Data Storage

Each master station shall be provided with the following storage media:

a) Random Access Memory – to store the "real–time"/instantaneous database.
b) Hard discs – to store the system configuration, mimics and local short–term (70 days) historical database etc.:

- ~ Digital points on change of state.
- ~ Analogue points at 15-minute intervals.
- ~ Derived points.

c) Optical disc - to store off-line (greater than 70 days old) historical database, system backups, data transfer etc.
d) USB keys - to transfer data to off-line PC equipment.

4.2.7 Operator Workstation

The operator workstations shall be the main Man-Machine Interface (MMI) and shall consist of 32 inch (minimum) Visual Display Units (VDUs) capable of displaying graphical and alphanumeric characters in at least sixty-four colors in all foreground/background combinations.

The VDU shall have an associated keyboard consisting of a standard typewriter QWERTY alphanumeric set, with additional numeric and special function keys, augmented by a mouse or tracker-ball.

4.2.8 Printing Devices

The system shall be provided with two types of printing device:

a) Alarm/Event Color Printer:
   ~ To provide a hard copy log of all alarms and significant events (with colors to differentiate alarms and level of alarms from events), e.g. operator sign-on or control override. A color ink-jet printer shall be provided.
b) Report Color Printer:
   ~ To provide high quality printed output for report summaries, program development, copies of mimic displays, historical trends etc. A high-speed color ink-jet printer with capacity of 10 ppm (color) shall be provided.

4.3 Remote Data Transfer

The SCADA system shall be capable of processing the data received from operational sites e.g. into daily minimum, maximum and means, and forwarding the raw and processed data to off-line packages e.g. Microsoft Excel.

5 SYSTEM FEATURES

5.1 General

The Purchaser requires a low-risk system supplied with proven software.

5.2 Software

The contractor will have to supply a software with developer version.

The sources files of the program will also have to be supplied.

The operating system will necessarily have to be under Windows last version system.

5.3 System Access

Users of the system shall be allocated individual passwords allowing each user an appropriate level of access commensurate with their requirements, responsibilities and areas of knowledge and interest.

Three general categories of access have been identified:

a) Data only.
b) Data and Control.
c) Data and System Management.

Data only shall be generally available to all system users. Data and control shall be limited to those personnel with the knowledge and responsibility to take control actions.

5.4 Color Graphics Displays

The following display types shall be available on all color graphics terminals:

a) Mimic diagrams.
b) Help pages.
c) Graphs.
d) Bar charts.
e) Alarm and event log listings.
f) System configuration and maintenance displays.

5.4.1 Mimics Diagrams

Mimic diagrams are required to present a pictorial representation of the plant and its present status. Features required are as follows:

a) Display of fixed (background) diagrammatic plant information and text.
b) Display of variable information i.e. symbols or text displaying plant status.
c) Easy picture creation, possibly using a CAD style package.

The Mimic diagrams will consist of a general Mimic of the plant and details Mimics specific to every phase of the process.

5.4.2 Display Of Variables

Variables can be considered as digital on/off parameters, analogue or totalizers.

Digitals may be either status (e.g., running/stopped) or alarm points, and shall be displayed by:

a) Text changing.
b) Symbol color changing.
c) Symbol shape changing.
d) Text or symbol flashing.

It must be possible to associate more than one digital point with a symbol, so that more than two colors/shapes can have operational meaning. For example, a pump may be shown in four colors indicating running/stopped/failed/non-operational.

In addition, it shall be possible to associate any number of symbols within different mimics with a particular digital point.

Analogues and totalizers shall be displayed by:

a) Numeric value.
b) Bar chart.
c) Graph.

It shall be possible to display all these three types of indication in mimic diagrams. Color changes shall be used to indicate further information about a point, e.g. if an alarm limit has been exceeded.

5.4.3 Display Attributes

Using the display facilities described above, the mimic diagrams shall indicate the following attributes for analogue, digital and totalizer points:

Attribute	Point Type
Status On/Off	Digital Status
Alarm/Normal	Digital Alarms
1st Stage Alarm (High, Low)	Analogues

2nd Stage Alarm (High-High, Low-Low)	Analogues
Communications Failure	All
Alarm Manually Suppressed (out of service)	All
Alarm Automatically Suppressed	All
Out of Range	Analogues

5.4.4 Pictures Creation

It is essential that picture creation is a straightforward procedure, a CAD type package would be suitable. It must be possible to create symbols which may then be used in any orientation, size and color and to create a symbol library, i.e. a part of a diagram which may then be used many times. It must be possible to display, on any single mimic diagram, information from anywhere within the system.

5.5 Help Pages

Help pages shall be available within the system, to assist the operators in dealing with received alarm conditions. These pages will be compiled by the plant managers and will provide advice as to which staff shall be notified of which alarms.

Help pages may be presented as individual pages accessed from a mimic, or as a window superimposed on a mimic.

5.6 Graphs

Graphical representation of historical data is required, with a selectable time base and the ability to put up to four graphs on display at once on the same axes, using different colors.

The system must be easy to use, with automatic default facilities so that only a minimum of instructions needs be given to the system to obtain each plot.

Features that will be required are:

a) Pre-configured and ad-hoc trend displays.
b) Ability to compare graphs over different time spans, e.g. today's flow compared against yesterday's flow.
c) Read-out of the actual value of a graph at a given time point.
d) Ability to roll a graph forward and backwards in time.
e) Ability to set the scale for each graph.
f) Trend graphs giving a plot of the selected variable up to the last scan, updating when a new value is received.
g) Ability to incorporate a trend graph as a feature on a mimic diagram.
h) Graphical output of both analogue and digital signals (real and derived). Digital signals will produce a square wave type plot indicating for instance when a pump started and stopped.
i) Auto ranging scale unless manually overridden.
j) Ability to display data from different sites within the same trend display.

5.7 Bar Charts

A bar chart type representation of analogue variables is required. This is required on mimic diagrams, and must be capable of horizontal or vertical orientation, with selectable scaling. Width of bars must be selectable so that the feature can also be used for such items as tank level pictorial representations.

5.8 Alarm And Event Log Listings

All alarms and changes of status (i.e. digital events) in the system shall be logged to disc. It shall be possible to recall this information to the screen via a select and sort program. This program shall sort and display information on at least the following bases:

a) Process Area.
b) Site type.
c) Site name.
d) Time period.
e) Signal identification numbers.
f) Signal state (on/off).
g) Alarm status i.e. cleared, accepted and unaccepted.
h) Alarms or status occurrences required.

Any sort parameters not entered shall default to "all".

5.9 System Set-Up and Maintenance Displays

Suitable displays of information shall be provided to display all set-up features of the system. These displays will be closely associated with the SCADA system set-up facilities.

5.10 Logging On/Off

Every user of the SCADA system shall be required to log on (i.e. activate) his terminal when he wishes to operate on it. The system will be aware of which terminals are logged on and the access rights of the user and will therefore be aware of where to send certain information.

5.11 Alarm Facilities

5.11.1 General

Digital points within the system shall be capable of operating as either status (e.g. running/stopped) or alarm points (e.g. normal/failed). A digital alarm point shall enter the Alarm State when it is either a logical '1' or logical '0' as designated in the system set-up for each point, the opposite state being the normal condition.

Analogue points shall be provided with two high alarm limits (high and high–high), and two low alarm limits (low and low–low). Should an analogue value either rise or fall from a value considered to be normal, a first stage high or low alarm limit will be encountered resulting in a new alarm condition. Should the value continue to rise (or fall) it will then encounter the second stage high–high or low–low alarm limit again resulting in a new alarm condition.

5.11.2 Alarm Priorities

Every alarm generated within the system shall be allocated an alarm priority to indicate the importance of the alarm. Whereas a digital point will have only one alarm priority, an analogue point will have three. This will allow the relative importance of the first and second stage high and high–high (low and low–low) alarms to be set. The alarm priority is used in conjunction with the 'area of interest' of the users logged onto the system to determine where and when a new alarm is enunciated. The priority of an alarm shall change if required depending on the time and date.

5.11.3 Alarm Annunciation

Alarms are to be enunciated on the operator workstation both visually and audibly, and have clear and unambiguous acceptance procedures. High priority alarms shall be presented for acceptance before low priority ones.

5.11.4 Alarms Filtering

The SCADA system shall have a "tool–kit" of facilities that may be applied to individual points in the system in order to prevent unnecessary annunciation of alarms. These shall typically include:

a) Analogues:

~ Dead Band.

- ~ Delay before initial alarm.
- ~ Minimum alarm repeat interval.
- ~ Logical suppression of new alarm if other conditions are presents.
- ~ Averaging values in PLC.

b) Digitals:

- ~ Delay before initial alarm.
- ~ Minimum alarm repeat interval.
- ~ Logical suppression of new alarm if other conditions are presents.

Users, subject to authorization (i.e. correct level of access), shall be able to manually suppress an alarm, e.g., if a transducer is faulty and is being particularly troublesome. The suppression of alarms shall be logged to the event list.

5.11.5 Derived Alarms

A combinational and sequential logic package is required within the SCADA system, allowing signals to be combined to form derived alarms. These may be combinations of analogue and digital information obtained from different sites (e.g., a pump may be running at a pumping station but no flow entering the associated inlet works resulting in a derived alarm indicating a potential burst).

5.12 Historic Information

5.12.1 PLCS

PLCs will sample and store values of analogue parameters at predetermined intervals to cater for loss of communications. These will normally be 15 minutes but shall be user configurable between 1 minute and 24-hour intervals.

5.12.2 Master Station

In addition to the raw operational data, a long-term archive of analogue max/min/mean values, pump hours run etc. will be maintained. Values stored will be as detailed within the Particular Specification.

5.13 Controls

5.13.1 Manual Control

It shall be possible to perform control operations (e.g. remote start/stop of pump) from any of the operator consoles. Access to controls will be limited by the access rights assigned to the individual passwords for various operatives (see System Access).

The issuing of control instructions shall take precedence over the scanning for alarms.

A well-organized select check and execute system is required.

5.13.2 Automatic Controls

Automatic control features shall be available within the SCADA system, and fall into two categories:

a) Profile type controls where a working pattern (e.g. of reservoir level) is downloaded to a PLC for use by a local control system. New profiles may be sent for each day or week etc., as required.
b) Combinational and sequential control:

There are circumstances where the only practicable way of closing a control loop is via the SCADA system, although this should be avoided whenever possible. The package used for alarm derivation will also fulfil the automatic control requirements. The following facilities shall be provided as a minimum:

- Logical AND/OR/NOT/EXOR/EQUALS.
- IF-THEN-ELSE Constructions.
- Arithmetic operations including >, $, >, #, =, +, -, H,), /.
- Logical constructions including time and data.
- Look-up tables, with interpolating facilities.
- Input to functions from any system point including digital, analogues, totalizers, controls from a keyboard, set-point input from a keyboard.
- Output from functions to be available as digital, analogue or totalizer points, or transmitted to any PLC as a control or set point.
- Access to point attributes in addition to present value, including:
  - Suppressed, telemetry failed, in alarm (and for analogues, which alarm level).

5.14 Terminal Time Out

When a terminal is used for control purposes, it shall have to be logged on specifically for that function. If it is not used for a user configurable period of time (e.g. 5 minutes) in this mode, it shall automatically revert to a display only mode. A warning should be provided one minute prior to the auto log off.

5.15 System Record

A record shall be kept on disc within the system of all operator actions, such as alarm acceptance or control actions performed on the system. The record shall include:

a) Time and date.
b) Action.
c) Operator.

This record shall be retrievable from the system using a similar select and sort routine to that specified for status and alarm logs.

5.16 Report Generation

The system shall be capable of generating both regular and individual reports. Reports must be easily configured and altered in order to maintain their relevance.

An example of a regular report which may be produced from the system is the following, designed to be made available to the works manager each morning:

a) Treatment works: previous day's output.
b) Alarms that have occurred during the night.

5.17 System Time

The system shall support:

a) Greenwich Mean Time (GMT/UCT).
b) Daylight Saving Time (DST).
c) Leap Years.

All data shall be logged at GMT/UCT + 3 hours, but automatically displayed in the appropriate local time adjusted for daylight saving.

5.18 System Data Configuration

The system shall be provided with privileged and secure on-line database building utilities i.e. it shall not be necessary to stop the scanning and alarm presentation facilities. Any configuration shall not be

installed into the active database until completed, verified and authorized by the user. A reliable verification procedure shall be required to prevent the creation on invalid files and the deletion of in-use files.

It shall be possible to define process point files, calculated/derived point files, remote PLC files, to include:

a) Meaningful point identification and description.
b) Allocation of points to groups/locations.
c) Range of analogue values in Engineering Units.
d) Alarm limits/categories.
e) Scan control/frequency.
f) Report control (whether change of state is to be logged to the alarm/event printer).
g) Save control (whether values are to be archived).
h) MIS control (whether values may be transferred to other systems).

5.19 System Response Times

The Dispatcher provided under this contract shall meet the following performance criteria:

Item	Description	Response (seconds)
1	From change of state of plant being detected by PLC	0.5
2	From change of state being detected by the Dispatcher to updating the SCADA database	0.5
3	From change of state in the SCADA database to updating the alarm list	0.5
4	From change of state in the SCADA database to updating the active mimic	0.5
5	All requests for mimic displays, alarm lists and help pages from the completion of the operator request.	3
6	All requests for trend display and event lists shall from the completion of the operator request.	3
7	Time to perform screen dump from completion of the operator request	3

6 PLC EQUIPEMENT

6.1 General

a) Programmable logic control devices (PLC's), where specified, shall be used to affect the monitoring and control of the plant or process.
b) They shall be capable of operating as either a standalone unit providing local operator interface information or form part of a supervised system complete with communications facilities.
c) The PLC shall be a modular unit capable of expansion. It shall support a minimum of 32 input/outputs but shall be capable of expansion up to 512 I/O.
d) The PLC shall operate from a nominal power source of either 110V or 230V AC 50 Hz. and incorporate its own integral 24V DC power supply for driving auxiliary modules.
e) The programmable controller shall have adequate memory and I/O ports to receive all control and sequencing signals and drive all indicator lamps, relays or solenoids as may be required to accurately control all the necessary functions of the control system.
f) The controller shall indicate the operating state of the outputs by means of light-emitting diodes (L.E.D.'s) and be equipped with sets of L.E.D.'s to indicate the controller status and to notify of any internal faults.
g) An integral means of turning all outputs off and ceasing the processor operation shall be fitted.
h) The PLC shall perform the majority of sequential functions and shall drive, either directly or by interposing relays, all the necessary outputs as detailed elsewhere.

i) Where the output load exceeds the rated capacity of an output port of the controller, suitably rated, D.I.N. rail mounted interposing relays shall be installed in the cabinet to amplify output controls signals. The maximum control voltage of the relays shall be 110 volts Ac.
j) D.I.N. rail mounted terminals shall be fitted in the bottom of the cabinet to allow the termination of all control and sequencing cabling. The terminals shall accept up to 4mm2 stranded conductor.
k) All output ports from the controller shall be correctly fused in order to protect the controller (by means of fused terminals). Fuse links shall be to BS 1362 or BS 4265 where fast action or semiconductor fuse links are required.

1. The PLC shall be capable of supporting the following component parts either inherently or via expansion when required and shall support all the required process I/O as detailed elsewhere:

- Power supply.
- Central Processor.
- Digital input.
- Digital output.
- Analogue input.
- Analogue output.
- Communications.
- High speed pulse counter.

6.2 Power Supply Requirements

a) The equipment shall be designed to operate from one of the following power supplies:

~ Mains power supplies shall be either (a) 230V AC or (b) 110V AC, 50 Hz. The mains operating voltage range shall be user selectable by a switch or selection link.

~ Mains power supplies as defined in sub-clause (a) above, but having an additional facility for operation directly from a 24V DC standby supply.

~ 24V DC supply with full protection against accidental reversal of the supply polarity.

b) The system circuitry shall be fully isolated from its power supply, using isolating barriers having resistances of not less than 2 megohms, measured at 500V DC to the requirements of BS 4743.
c) Depression of the mains supply voltage by 25% for a period of 5 seconds or interruption of the supply for 25 cycles shall not cause the system alarms to operate.
d) Mains borne transients of up to 1000V with energy levels of 1 joule shall not initiate system alarms or cause the system to operate outside the performance requirements of this specification after the occurrence of the transient.
e) Distortion of the AC mains supply waveform as defined in BS 6438 Clause 5.4.3 for a rated range of use III (B = 0.10) shall not cause system malfunction.
f) System cable terminations shall be made in a discrete termination section, housing terminal blocks sized, barriered and uniquely identified, to suit the voltage and current demands of the circuitry. Pinch screw type terminals are not acceptable.
g) Within the following ranges variation of the power supply to any system shall not cause it to operate outside the performance requirements of this specification as required under BS 6438.
h) -12% to +10% of the nominal 110V AC or 230V AC and a variation of the frequency within the range 45 Hz to 55 Hz.
i) -12% to +10% of the nominal 24V DC supply.

6.3 Digital Input Requirements

a) Two classes of input are acceptable:
   - ~ Nominal 24V DC input rating, opto-isolated, reverse polarity protected.
   - ~ Nominal 110V AC input rating, opto-isolated.

b) Mixing of 110V and 24V input ports in any given single installation shall not be acceptable.
c) Field contact inputs shall be debounced such that status changes will not be recognized unless the contact condition is maintained for at least 25 milliseconds.

6.4 Digital Output Requirements

a) Digital output shall be of the volt-free contact type.
b) Each output shall be electrically isolated from other outputs, the rest of the circuitry and earth. It shall have an insulation resistance to the rest of the circuitry and earth of greater than 2 megohms, when tested for 1 minute with 500V DC insulation tester.
c) System functionality shall be maintained when each output terminal is earthed in turn.

6.5 Analog Input Requirements

The preferred input signal is 4-20mA; continuous; linear supporting a fully floating max 250-ohm input impedance load. Analogue/Digital conversion shall have a minimum 8-bit resolution, linear to ±1%, accepting signals in the range 0-10mA and 0-20mA and voltages 1-5V, 0-1V and 0-100mV as required.

6.6 Analog Output Requirements

a) Analogue output shall be 4 to 20mA DC electrical signal with a linearly increasing output for increasing measurand value, complying with the requirements of BS 5863 Part 1, excluding Clause 3.6.
b) When the load resistance across the output terminals is varied from 0 to 1000 ohms the output signal current shall not change by greater than 0.1% of span, over the full output range.

6.7 Communication Ports

Communication ports will only be necessary on the PLC when its use is specified as part of an overall networked system. When required they shall provide the communication link between the PLC and other PLC's or PC based system.

6.8 Protocols

a) Provision of the communication required to satisfy this Specification shall include all necessary protocols for its successful operation.
b) A serial RS 232 port or network port shall be available to enable interfacing to local PC's for MMI purposes to allow local database and control sequence loading, interrogation or modification.

6.9 High Speed Pulse Counter

This input module shall accept voltage level input signals of either 5, 12, or 24 volt and have counting speeds up to 50 kHz. Encoded count signals of either 16 or 32 bits, bidirectional, shall be selectable and a minimum of 2, source or sink, independently configurable outputs shall be provided.

7 COMMUNICATIONS

7.1 General

The Contractor shall supply install and commission all necessary communications equipment and software to provide a complete integrated communications network for the SCADA system.

7.2 Employer Liaison

The Employer will be responsible for the processing the licenses required from the national licensing agencies.

The Contractor shall, however, provide all detail design calculations, equipment characteristics, equipment approval certificates and completed application forms for the Employer to enable the Employer to process all applications for communications circuits, frequencies etc. as an administrative task.

The Tenderer shall, within his bid, allow for all necessary tests to prove compatibility of the offered equipment with the national licensing agencies and communications standards.

7.3 Scan Times

The Contractor shall prepare a detailed assessment of the PLC scan times for his system and submit this to the Engineer for approval. The assessment shall assume the use of GSM or telephone transmission system to gather operational data from PLCs located at remote sites.

The longest scan time for PLCs with GSM or telephone communications shall not exceed two minutes under full system utilization.

7.4 Data Rates

The Contractor shall ensure that the data rates are not less than the following:

a) Public Switched Telephone Network (PSTN) Direct Exchange Lines (DEL) connection: 2400 Baud.

7.5 Transmission and Protocol

The Contractor shall wherever possible use an industry standard transmission protocol. The Contractor shall provide details of the proposed protocol to be used at the time of Tender.

7.6 Electronic Equipment

All communications equipment used in the communications system shall be of high reliability and shall comply with the most recent edition of appropriate National and International Standards Specifications and recommendations at the time of Tender.

7.7 Lightning Protection

7.7.1 Lightning Protection Devices

The Contractor shall provide lightening and surge protection devices at each PLC on each communications circuit, base station and at all other parts of the radio network to ensure isolation and automatic resetting of the system being subject to high surge currents. Devices shall be unfused.

Lightning protection shall conform to the appropriate sections of BS6651, code of practice for protection of structures against lightning.

Lightning protection shall be selected to provide the highest degree of protection possible for the circuit being protected i.e. the clamp voltage shall be the lowest possible commensurate with normal operation of the circuit.

The type and manufacturer of the Lightning Protection Unit (LPU) shall be subject to the approval of the Engineer.

LPUs shall be earthed to the nearest earth reference bar, as direct as possible without inductive loops by a single unjointed cable.

Individual LPUs shall bolt directly onto a lightning earth bus bar. Cables and cores containing the circuits to be protected shall not be loomed or grouped together until the circuits subject to induced lightning energy have passed through the protection units.

Where two or more LPUs are mounted on the same Din rail mounted earth bar, the cable shall be sized as follows:

a) Cables less than 6 meters: 10 sq. mm.
b) Cables greater than 6 meters: 16 sq. mm.

The whole assembly shall be mounted inside an insulated box, if not already mounted separately from other equipment, close to the chosen earth termination in order to achieve a short, straight connection.

LPUs that are mounted in an enclosure supplied with an a.c. electrical power supply that utilize Din rail mounted earth bars shall have either:

a) The earth bars insulated by means of proprietary stand-offs or.
b) The Din rail insulated in an approved manner from the electrical power earth or any earthed conducting surface.

The route for the earth conductor shall be as far away as possible from the vicinity of the signal cables.

The earth conductor shall be copper, no greater than 16 sq. mm in section, it's route shall be as short and direct as possible and, in any case, no longer than 10 meters.

Ideally the cable route should be straight, but any necessary bends shall have a long radius.

The earth termination and the method of connection shall be subject to the approval of the Engineer.

7.7.2 Earth Electrodes

The Contractor shall provide an earth electrode system in cases where the contract provides for the facility of lightning surge diversion equipment. The system shall be cabled to the main protective conductor system at the common point of connection of the distribution system that it serves.

Earth electrode systems shall be provided where specified in the particular Specification.

Where the provision of lightning protection is specified, the Contractor shall provide an earth electrode system in accordance with the relevant code of practice.

7.7.3 Earth Electrode Installation

Earth electrode installation shall connect earthing conductors to the general mass of the earth. The installation shall comprise one or more earth rods, mesh or combination thereof to obtain the required earth electrode resistance.

Earth rods shall be of proprietary manufacture, 16 mm outer diameter, made up of sections of 1.2 meters long with internal screw and socket joints and fitted with hardened steel tip and driving cap. They shall be driven into the ground to a minimum of 2.4 meters.

A minimum of two earth rods or other electrode shall be provided for each main earthing system and the conductor brought back to the main earth bus bar for each.

Connections to the electrodes are to be readily accessible for periodic inspection and shall be protected against mechanical damage and corrosion. The actual connection to the rod shall be by means of a purpose made nonferrous clamp and shall be made below ground level in a concrete inspection pit having a removable cover.

When the installation is complete, soil resistivity or other tests shall be performed and witnessed by the Engineer, to ensure that the required earth loop impedance figure of less than 5 ohms is attained.

7.8 Testing

The Contractor shall allow for the following tests with regard to communications equipment:

a) Factory testing of sub-assemblies.
b) Factory testing of complete units.
c) Factory simulated system tests to prove the performance of all elements of the integrated communications network.
d) Commissioning tests of all installed GSM or telephone equipment to record the characteristics for future maintenance of the network.

Test certificates shall be provided at each stage and for each complete unit and sub-system. The Contractor shall supply all test equipment and shall provide seven days notice prior to testing to the Engineer.

7.9 PSTN Communications

7.9.1 General

All equipment for connection to the PSTN lines shall be offered:

a) To comply in all respects to the National and Local regulations and approvals.
b) To comply with the most recent editions of appropriate CCITT Recommendations, National and International Standards Specifications and Recommendations.
c) Such that any line sending and receiving sensitivity controls shall be capable of alteration by removal of the unit by authorized maintenance personnel.
d) With evidence of prior use by major national telecommunications networks, together with type approval numbers and full details of CCITT Recommendations, National and International Standards Specifications and Recommendations met.

7.9.2 Modems

The Contractor shall supply and install all modems and interconnecting wiring to the SCADA system and telephone equipment as appropriate.

PLC equipment modems shall form part of the PLC unit and shall be compatible with the associated ‘line connection’ modules.

All modems shall be approved by the national and local service provider and shall comply with V21, V23, V26, and V29 (III-1) as appropriate.

7.9.3 On Site Communications Cables

On-site communications networks shall be by Belden type 9463 cable or similar approved.

7.10 GSM Modem

The modem GSM of the PLC is also an essential element because it assures the link with the control center and the distant users. It shall therefore be of a high reliability and have a guarantee of sustainability.

The modem GSM shall be integrated into the PLC. It cannot involve an office automation modem or an external modem of the business, the characteristics of which are not adapted to remote processing applications.

The modem GSM shall be used for GPRS communication.

8 TESTING

The Contractor shall provide for system testing as detailed. The tests shall conform to BS 5887 (code of practice for testing of computer-based systems) and BS 6238 (code of practice for performance monitoring of computer-based systems).

The Engineer shall approve all acceptance procedures for inclusion within the system specification.

8.1 Factory Acceptance Test

8.1.1 General

The Tenderer shall provide for full Factory Acceptance Test of the fully configured system, to include:

a) The complete system network.

Support for all PLCs with all points over an integrated network, simulated to include all types of communications units and interfaces.

b) Mimic display pages on the system as defined within the particular specification.
c) Test 1 - Simultaneous occurrence of:

~ The control center polling outstations in normal (i.e. daytime) operational mode receiving 50% of data from each PLC with 10% of points in alarm conditions.

~ Operator workstations performing:

* Simultaneous access.

* Access staggered by 2 seconds.

d) Test 2:

~ As test 1.

~ Performing daily system archive.

e) Test 3:

~ As test 1.

~ Performing archive data recovery.

* Full daily archive recovery.

* Four data points for one week (15-minute intervals).

f) Test 4:

~ As test 1.

~ Performing screen dump.

~ Printing daily report.

The simulation package shall use the SCADA system to demonstrate proper performance under full utilization conditions.

The Contractor shall record the following:

a) display response: this shall be no greater than as specified.
b) percentage CPU utilization.
c) scan time: this shall be no greater than 1 minute for full system scanning.
d) time to clear backlog: The Contractor shall also record any adverse conditions that become apparent.

The Contractor shall substantiate the validity of the simulation to the Engineer and shall confirm, at the time of Tender, by what means such simulation will be carried out.

a) The PLC to demonstrate:
   All control and failure recovery sequences, simulating all digital and analogue inputs and outputs on each system.
b) The communications system to demonstrate:
   Full simulation utilizing all interface nodes, with PLCs connected, in order to prove the performance over the network. Communications failures shall be simulated in order to prove the automatic re-routing of communications to SCADA system.

8.1.2 Factory Acceptance Test - Witnessing

The Factory Acceptance Test shall be conducted in the presence of witnesses, who shall be nominated, in writing, by the Employer and the Contractor respectively. The witnesses shall be empowered to act during the Factory Acceptance Test, on behalf of the parties they represent, to judge the success or failure of a particular test. Either party as necessary, in writing may appoint nominated Deputies.

The Contractor shall provide evidence that the tests (FAT/SAT) have been successfully performed prior to the witnessing by the Engineer.

8.1.3 Factory Acceptance Test - Procedures

The testing procedures shall be designed such that each separate testable entity (e.g. hardware configuration, picture building) consists of a well-defined series of tests.

Each test shall be documented to include:

a) The purpose of the test.
b) Any pre-requisites required allowing the test to be completed successfully.
c) Any hardware required allowing the test to be performed successfully.
d) A detailed schedule of activities to be performed within the test.

8.1.4 Factory Acceptance Test - Record

A log shall be maintained during the Factory Acceptance Test. This log shall record for each test performed:

a) The test results.
b) Any faults which occur.
c) Any remedial action taken.
d) Re-test results.
e) Decisions taken by the witnesses which may affect the test results.

The witnesses of both parties shall initial all entries within the log.

Copies of the log shall be provided to the Employer on completion of the Factory Acceptance Test.

8.1.5 Failure and Re-Test

The success or failure shall be determined as follows:

a) If the system performs as laid down in the Functional Design Specification the test shall be deemed successful.
b) The tests shall not be failed due to external conditions, e.g. power fail, provided the system fulfils the resilience criteria detailed within this tender document and any subsequent project specification.
c) The tests shall not be failed through incorrect operation provided the fault can be corrected by normal operating procedures and provided the test performed satisfactorily in all other aspects (e.g. printer ribbon failure).

Any test that is deemed unsuccessful may be retried following any remedial action that may be necessary.

If the system should fail any test and it is apparent that the fault may have affected the result of tests previously regarded as successful any or all of the tests affected may be re-tested.

To allow all participants to fully understand all aspects of the Factory Acceptance Test, the Factory Acceptance Test Specification as agreed between all parties shall be issued with the Contractor's Project Specification (CPS).

8.1.6 System Management

The Factory Acceptance Test shall include, but not be limited to, the following as defined within Contractor's Project Specification.

a) Hardware

The hardware configuration being tested shall be fully detailed and cross-referenced against the Tender Return Document.

b) System Start-up and Shut-down Procedures

These tests shall exercise the system start-up and shut-down commands including:

- ~ System start-up commands.
- ~ Operator log-in and log-out commands.
- ~ Password verification.
- ~ Any special function command keys.
- ~ Orderly system shut-down.

c) System Back-up and Recovery

These tests shall exercise the system back-up and recovery procedures, including:

- ~ System back-up to archive media.
- ~ System re-build from system archive media.
- ~ Synchronization of the Master Station and outstations.

8.1.7 Scada Data Base Configuration

These tests shall exercise the database commands including:

a) Password and level of access maintenance.
b) The creation and amendment of PLCs.
c) The maintenance of PLC communications parameters, e.g. telephone numbers, radio characteristics, change of media, scanning intervals, on/off telemetry scan.
d) Regions of interest.
e) Creation and amendment of SCADA points:

- ~ Name.
- ~ Type, e.g. status, analogue, derived.
- ~ Alarm limits.
- ~ Historic data recording and characteristics.
- ~ Re-transmission of value to associated points.
- ~ Scaling factors.
- ~ Calculation formulae maintenance.

~ Set output control parameters for digital, analogue and derived controls.

8.1.8 Picture Configuration

The tests shall exercise the picture configuration commands available to the privileged operators, including:

a) The creation of picture pages, to include foreground/dynamic and background/static picture elements.
b) The modification of picture pages, to include foreground/dynamic and background/static picture elements.
c) The deletion, copying and renaming of pictures.
d) Any function control key usage.
e) Examples of all picture types, e.g.:
   ~ Static information pages (e.g. indices).
   ~ Mimic pictures for information display and control monitoring.
   ~ Alarm list pages.
   ~ Statistical pictures (e.g. trends, histograms).
   ~ Help/text pages.
f) The display and printing of pictures.

8.1.9 Data Collection

These tests shall exercise the data collection commands available to the privileged operators, including:

a) The collection of digital, analogue and derived parameters.
b) The collection of all data from outstations at frequencies defined by the privileged operator.
c) The manual entry of data.
d) The inhibition of data collection from a PLC.
e) The inhibition of data collection from an individual point.
f) The editing of stored data (subject to correct level of access).

8.1.10 Supervisory Control

These tests shall exercise the supervisory control commands, including:

a) The creation and downline loading of control sequences.
b) Digital, e.g. open/close, and analogue, e.g. set point, controls of individual control points.
c) Revertive checks to ensure the correct control point is addressed.

8.1.11 Alarm/Event Handling

These tests shall exercise the alarm and event reporting procedures, including:

a) Digital and analogue alarms:
   ~ Reported on the alarm/event printer.
   ~ Logged to disc.
   ~ Reported to the appropriate operator consoles.
b) Events, e.g. issue remedial control command:
   ~ Are only issued from appropriate operator consoles.
   ~ Logged to the alarm/event printer.
   ~ Logged to disc.

~ Are subject to correct level of access and regions of interest.

c) Alarm acceptance/acknowledgement procedures.
d) Alarm list interrogation procedures.
e) Alarm list printing.
f) Alarm inhibits for an individual point.

8.1.12 Data Logging

These tests shall exercise the data logging and archiving procedures including:

a) Tests to ensure all data/alarms collected are logged to the on-line archive storage.
b) Tests to ensure data can be archived to and recalled from long term archive media.

8.1.13 PLC Programming

These tests shall exercise the PLC sequence programming procedures, including:

a) Sequence program editing, compilation and loading.
b) The ability to load new sequences on demand by a privileged operator.

8.1.14 Management Information System Development

These tests shall demonstrate the use of the enquiry package and the applications programs development tool kit, including:

a) The editing and compilation of programs.
b) The abstracting of data from the SCADA database.
c) The automatic scheduling of programs as a result of time-of-day queues and as a result of a SCADA event/alarm.

8.2 Site Acceptance Tests

The Contractor shall provide for full site acceptance tests for each item of plant to be provided under the Contract. This shall include the interface to the marshalling unit, the communication system, the earthing system and full functionality as demonstrated at the Factory Acceptance Test.

8.3 Systems Acceptance Test

The Contractor shall provide for full system test on completion to include tests as stated above.

All special test equipment relevant to the Contractor supplied equipment shall become the property of the Employer on completion.

9 TRAINING

The Contractor shall at time of tender state any minimum levels of training/experience required for participants, prior to attending the appropriate course.

The Contractor shall provide training for the Purchaser's staff as detailed. The Tenderer may offer training courses structured to meet his technical offering. These courses shall be subject to the approval of the Engineer and shall be detailed at the time of Tender.

In general training courses shall be provided at Purchaser’s offices as detailed within the particular specification. However, some courses may be held at the manufacturer’s works as agreed by the Purchaser.

The Contractor shall provide all course materials and equipment needed.

The training shall be organized such that the Purchaser shall be able to operate and maintain the SCADA scheme following completion of all training courses.

9.1 System Operators

The Contractor shall provide for the number of attendees as specified within the Particular Specification with 4 no. operators attending each course.

This purpose-designed course is to be held at the Works Control Centre. Training must be provided in advance of commissioning to enable the Purchaser's user staff to participate in the full process commissioning of the system and safely operate the plant and maintain the SCADA system.

System take-over shall not take place until satisfactory training has been provided.

This course shall be designed to familiarize the participants with the general running of the standard operating system and the SCADA package to include but not limited to:

a) Loading and starting up the Operating System.
b) System Operators interface.
c) Operator control of program/task execution.
d) Operator control of disc files.
e) File transfer tasks - archiving, retrieval.
f) Operator response to system failure, on-line/off-line diagnostics, transfer of control between the computers synchronization of the system database.
g) SCADA system interrogation facilities - alarm lists, log printouts select mimic and trend displays etc.
h) Alarm acknowledges accept/delete.
i) Control actions, e.g. start pump, close valve.
j) All functions associated with each access level of the SCADA system.

9.2 System Supervisor Personnel

The Contractor shall provide a five-day course for the number of attendees as specified within the Particular Specification.

To be held at the Works Control Centre prior to the systems hand-over and shall consist of all of the above tasks plus:

a) Basic systems design overview.
b) The use of computers to perform diagnostics and to tune other parts of the system.
c) Changing passwords and access control.
d) Sequence verification.
e) Preventative maintenance.

9.3 Systems Developers/Programmers/Engineers

The Contractor shall provide 1 no. five day course with the number of attendees as specified within the Particular Specification.

This course shall be designed to cover all configuration and advanced facilities of the SCADA package. To include, but not be limited to:

a) The system database structure.
b) System database building/configuration.
c) Mimic building.
d) Applications program interface to the system database.
e) Management information system interface.
f) Downtime loading of control programs/sequences to PLCs.
g) Advanced operating features.

9.4 Site Training

The Contractor shall liaise with the Engineer and the Purchaser on site as new areas of plant are to be changed over to the new system, to establish the following:

a) What training is required for operating and maintenance staff?
b) Who is to be trained?
c) Who will provide the training and when?

The Contractor shall supply O & M documentation prior to training. A section of the plant shall not be handed to the Purchaser for operation until training on the control systems has been completed. Should defects occur prior to Take-over of the whole scheme the Contractor shall be responsible for rectifying the fault prior to any other phased hand-over of the scheme.

This training course/workshop shall be designed as a "reference" course rather than a formal educational course, i.e. the Contractor's personnel shall be present to assist the Purchaser's personnel, as necessary, with any technical difficulties.

10 OPERATIONS & MAINTENANCE DOCUMENTATION

10.1 General

This contract shall include full documentation for all equipment and software provided under this contract. The documentation shall be written in a clear and concise manner which is fully formatted and indexed to provide documentation that is easy to understand and friendly to use. It shall be capable of incorporating upgrades and amendments to information in an efficient and effective manner. Generally, the documentation shall be compiled in A4 ring binders. Liaison will be required with the Engineer regarding the contents of the individual manuals.

All documentation shall also be provided on disk in the Employer standard format current at the letting of the contract. The Employer shall hold the copyright for these documents.

All drawings, unless within word-processing documents, shall also be provided in AutoCAD format on disk, or other media agreed with the Purchaser. All documentation shall conform to ISO 6592 Code of Practice for Documentation of Computer Based Systems. The Tenderer may offer manuals structured to meet his technical offering. These manuals shall be subject to the approval of the Engineer and shall be detailed at the time of Tender. The documentation shall be submitted to the Engineer for approval.

10.2 Full System Operating Procedures (6 No. Copies)

The Contractor shall provide full operating procedures detailing how to use the SCADA system, to include but not limited to:

a) Loading and starting up the Operating System.
b) System Operators interface, including:
   - ~ System mimic navigation.
   - ~ SCADA system interrogation facilities - alarm lists, event log printouts and trend display etc.
   - ~ Alarm acknowledges accept/delete.
   - ~ Control actions, e.g. start pump, close valve.
   - ~ All functions associated with each access level of the SCADA system.
c) Operator control of program/task execution.
d) Operator control of disc files.
e) File transfer tasks - archiving, retrieval.

f) Operator response to system failure, on-line/off-line diagnostics, transfer of control between the computers synchronization of the system database.

10.3 Full Software Documentation (6 No. Copies)

The complete software specification shall be provided and shall include the system design specification, flowcharts, logic diagrams, system software definitions, program index, system build definition, and system data for each system and module. The information shall not be disclosed to any third party without the author's consent.

10.4 Hardware Manuals (2 No. Copies)

The Contractor shall provide documentation for all equipment supplied within the Contract.

10.5 PLC Programming Documentation (1 No. Copy)

The Contractor shall provide a copy of all necessary PLC programming documentation as supplied by the PLC manufacturer.

11 QUALITY ASSURANCE

11.1 General

The SCADA Contractor shall be registered to ISO9001.

11.2 Quality Plan

The Contractor shall provide a quality plan within 4 weeks of award of the contract.

11.3 Software Development

All software development shall be carried out under an EU-recognized or equivalent quality system compatible with ISO 9001 that is defined in the quality plan.

11.4 Product Audit

The Engineer shall have the right to audit the product at any time during the contract period.

11.5 Quality Records

The Contractor shall maintain quality records in line with the quality plan throughout the period of the contract. These will provide an audit trail for the design and implementation of the technical solutions adopted for the project.

11.6 Access for the Engineer's Representative

The Purchaser shall have the right to audit the project at any time during the contract period.

11.7 Sub-Contractors

The Contractor shall be responsible for the quality of any sub-contracted work and the quality plan shall incorporate all the work undertaken by sub-Contractors.

The Tenderer shall nominate his sub-Contractors in his tender return. The Contractor shall be required to obtain the Engineers approval (which will not be unreasonably withheld) to change any nominated sub-Contractor.

11.8 Delivery and Installation

11.8.1 Scope

The Contractor shall be responsible for all costs involved with the delivery and installation of the equipment for the system.

11.8.2 Delivery

The Contractor shall provide all personnel and equipment necessary to unload the equipment and transport the equipment to its' final location.

11.8.3 Installation

The Contractor should be aware that there may be periods such as flood events or for operational reasons, that the Contractor will not be allowed to work on the system or some particular part of the system or PLC, for some specified period.

The Contractor shall make due allowances for this in his costing and programming of his installation and commissioning works.

11.9 System Recovery

The Contractor shall supply a full backup set of the supplied software, on suitable archival media (e.g., CD-ROM, magnetic tape, optical disk, etc.). The Contractor shall also himself keep a full backup of the supplied software for the life cycle of the supplied equipment.

11.10 Consumables

The Contractor shall supply all consumables for the SCADA equipment for the duration of the contract, including, but not limited to:

a) Printer paper.
b) Ink cartridges.
c) Storage media.
d) Cleaning materials.

11.11 Spares and Test Equipment

The Contractor shall provide a list of recommended spares and test equipment required to the SCADA system.

To minimize the spares holding, the Contractor's design should consider the benefits of standardization.

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SECTION VII – F: TECHNICAL SPECIFICATIONS: MECHANICAL AND ELECTRICAL WORKS

SECTION 17200

INSTRUMENTATION, MONITORING AND CONTROL

1 GENERAL

1.1 Work Included

This specification describes the arrangements relating to the main items of instrumentation envisaged at the plant, namely:

- flow measurements (pipe and Venturi flume),
- sampling,
- level measurements,
- gas detection,
- redox potential measurements,
- pH and rH measurements
- dissolved oxygen measurements,
- sludge blanket detection,
- pressure measurements.

1.2 Related Works

1.2.1 Supplies and Works Included Under This Section Shall Comply With:

A. Section 01010 Corrosion protection
B. Section 01020 Basic mechanical requirements
C. Section 01030 Basic electrical requirements

1.2.2 Works Under This Section Shall be Co-Ordinated With:

A. All the process equipment

1.2.3 Description

A. The installation is fitted with the necessary measurement and monitoring devices to ensure its smooth and safe operation, together with all devices for drawing up operating and production performance records.

They must also prevent any disorderly operation that may endanger staff, equipment, the environment or operation of the plant.

They must be reliable and have an availability rate that is compatible with the above-mentioned criteria, and allow all start-up and shut-down operations to be performed in complete safety.

All devices needed or required by regulations shall be provided at the appropriate locations.

B. Generally speaking, measuring techniques shall comply with European standards, and be approved in the case of those required by regulations. Those that are not covered by standards shall be of recognized design, suited to the use for which they are intended, and approved by the Owner or his representative.
C. Measuring points are suitably located at the best places for observing the phenomena or physical values in question.

Devices shall be installed in such a way that they do not influence the measurements (by causing turbulence, blockage, thermal bridges, hydrostatic loads).

All arrangements shall be made to prevent possible disturbance, especially eddy currents, electromagnetic currents and mechanical vibrations from affecting the performance of the instruments. They must never be fixed to grating or posts or solid structures subjected to significant vibrations. The instruments must be accessible and local indications easy to read at eye level from the nearest floor.

D. The installation also includes all sockets or devices required for carrying out tests, checking performance levels, establishing records, checking discharges and recirculation, etc. A sufficient number shall be provided for obtaining a complete picture of each function.

Generally speaking, equipment shall be designed to operate in a dusty, damp atmosphere.

Instruments shall be accurate to within 2%.

E. Instantaneous values and measurements are transmitted to the control room and recorded.

1.3 Regulations and Standards

Instruments shall comply with approved national or international standards.

2 GENERAL REQUIREMENTS

2.1 Applicability

The clauses in this section define the general requirements and standards of workmanship for the manufacture, supply, installation and commissioning of all instrumentation, monitoring and control equipment (excluding distribution switchgear and motor starter units), and shall be applicable to these works.

2.2 Contractor's Responsibility

The Contractor shall be responsible for:

- All aspects of design, application and subsequent operation of the equipment, monitoring facilities and control circuits in accordance with all the operational requirements of this specification.
- Liaison between subcontractors to ensure complete compatibility of all equipment at both component and system interface levels.
- Overall systems engineering to ensure that all equipment, components and systems together form a consistent, rational and fully integrated monitoring and control installation.
- Ensuring that each system is handed over complete in all detail and in perfect working order.
- The supply and installation of all components, such as signal amplifiers, isolators, interference suppressors, line protection devices etc. which may be necessary to achieve the correct and specified function or to provide a safe and reliable installation, whether or not such components are specifically called for in the specifications.

The approval by the Engineer of any drawing shall not relieve the Contractor from his complete design responsibility.

2.3 General Design Requirements

The Equipment shall be designed:

- Such that routine and occasional maintenance through its life shall be a practical minimum, compatible with the preservation of maximum reliability.

- To withstand the electrical, mechanical, thermal and atmospheric stresses to which it may be subjected under operational conditions, without deterioration or failure.
- And constructed to the highest available standards of manufacture, reliability, accuracy and repeatability.

Where more than one component or item of equipment is supplied to perform a particular function, all such items shall be identical and interchangeable.

The degree of environmental protection for all equipment and enclosures shall be in accordance with BS 5490 or IEC 529 as follows:

- IP54 for internal applications.
- lP55 for equipment in pumping stations and similar locations.
- IPW55 for external applications.
- IP67 for transducers and equipment mounted within valve or meter chambers or similar locations.

All instrumentation, monitoring and control equipment shall be designed and guaranteed suitable for operation under the environmental conditions.

Equipment in air-conditioned locations shall be rated for continuous operation in ambient temperatures up to 40°C. External equipment and internal equipment not in air-conditioned locations shall be rated for continuous operation over the ambient temperature range 0°C to 45°C. The above temperatures make no allowance for local temperature rises due to operation of the equipment itself or by adjacent equipment.

External equipment shall be protected from direct sunlight by a well-ventilated cabinet, canopy or other approved type of sunshade.

2.4 Drawing Approval

Where there is no detail in the Specification or associated drawings regarding the exact location or method of installation of measuring equipment, sensors or other site mounted equipment, the Contractor shall submit details of his proposed installation to the Engineer for approval and obtain this approval before starting any installation work.

The drawings, diagrams and schedules to be submitted for approval at an early stage in the contract shall include the following:

- System block diagrams.
- Fully detailed P & I diagrams.
- Control schematic diagrams showing clearly the operation of each system.
- Analogue loop diagrams showing all relevant detail including instrument reference and loop impedances.
- Power distribution diagrams for all instrumentation and control supplies.
- Certified drawings and technical data for all instruments.
- Drawings showing the location and relevant installation details for all panels and enclosures.
- Instrument installation and hook-up drawings.
- General arrangement drawings (internal and front panel) showing finish and relevant construction details for all panels and enclosures.
- Comprehensive instrument schedules covering all primary, secondary and panel instruments, giving all relevant data including reference (tag) No, input range and output ranges, input and output impedances, scale, supply voltage, manufacturer, type number and the like.

- Complete alarm schedules including legends, initiating contacts or equipment, and alarm grouping.
- Cable specifications, cable route drawings and comprehensive cable schedules.
- Interconnecting cable termination details.
- Earthing details.

2.5 Instrumentation And Control Supplies

2.5.1 Supplies - General

All instrumentation, monitoring and control circuits and equipment shall be supplied at a voltage not exceeding 55 volts to earth. These shall be from:

- A battery/charger unit, typically of 24-volt nominal output, but under no circumstances exceeding 48 volts nominal output.
- A double wound transformer having a fused primary, a 55-0-55 volt secondary with the center point earthed and each secondary line fused.
- A transformer/rectifier system, comprising a double wound transformer with a fused primary and a secondary having one end earthed, together with full wave rectifier unit incorporating voltage stabilization if necessary. The mean voltage of the rectified output shall not exceed the nominal output from the instrumentation battery/charger units.

Equipment such as battery/chargers, uninterrupted power supplies, inverters etc. shall be supplied as necessary to maintain the required electrical supplies to essential instrumentation, monitoring and control systems which are to be kept in operation during a main power failure. The essential equipment to be maintained during a power failure shall include workstations, mimic panels, control panels, alarm systems and flow measuring/indicating/recording/integrating equipment or as otherwise detailed in the application clauses.

2.5.2 Remote Control Supplies

On remote control/indication circuits (such as occur with valves, penstocks etc). d.c. voltages and relays shall be used in all cases where the cable capacitance could be of sufficient magnitude to maintain a.c. relays in an energized state. The Contractor shall be responsible for establishing where such d.c. operation of control/indication circuits is required and for providing a suitable supply at locations where an instrumentation battery/charger supply is not available.

2.6 Construction of Panels

2.6.1 General

All panels, cubicles, cabinets, consoles, and desks together with any other types of enclosure (excluding motor control centers and switchgear) which form part of the instrumentation, monitoring and control installation shall comply with the requirements of this Clause, and of Clauses 7 and 8 covering panel wiring, equipment and terminals.

Removable earthed metal gland plates shall be provided to accommodate all incoming/outgoing cables, and shall be fitted not less than 250 mm above the floor level.

All equipment, other than front of panel items, shall be mounted on racks or fixing bars and not directly onto the panels.

Each enclosure shall be vermin proof and dust proof with the necessary provisions made for natural or forced ventilation.

All panel construction and arrangement details shall be approved before manufacture, and panels shall be subject to inspection.

2.6.2 Panels for Internal Use

All instrumentation, monitoring and control panels, designed for use within buildings shall be constructed of prime quality, cold rolled and annealed mild steel or zinc coated sheet steel, of adequate thickness, welded and braced to form a rigid structure. The minimum sheet steel thickness shall be 1.6 mm, with panel fronts and desk tops being thicker (2.00 mm min) to provide the necessary strength to prevent bowing. Panel fronts shall be flat and free of bow and ripple. External corners and edges shall be rounded to give a smooth overall appearance. No design involving the use of externally visible assembly bolts or screws will be accepted. All floor standing enclosures shall be constructed with a 60 mm deep plinth arranged to provide a recessed kicking strip at the front.

Equipment mounting panels shall be not less than 2 mm thick and shall be strengthened and/or braced to avoid any distortion or vibration. Equipment mounting plates and brackets shall, if necessary, be hinged to provide quick and easy access to equipment securing screws, terminals and wiring.

Doors and access panels shall be adequately braced or strengthened to avoid any buckling or twisting. Doors shall be of folded and welded construction mounted on lift-off hinges, with one hinge engaging before the other. Where necessary, removable access covers secured by quick release fasteners shall be provided. All doors and access panels shall close onto neoprene or soft rubber sealing strips which shall be held in place mechanically and not by adhesive. All doors shall be lockable. Where “Walk-in” panels or structure are provided, they shall be fitted with lockable car type handles operable from inside even when locked.

Surface preparation and finish shall be in accordance with the specification, with all internal surfaces finished in white. The external finish color will be advised by the Engineer.

The design and construction shall be such as to provide an enclosure of superior quality which shall match all other panels in the same location in style, appearance and finish, and have environmental protection to lP54.

2.6.3 Panels for External Use

All instrumentation and control cubicles, kiosks etc. designed for use outside shall be manufactured of double skinned, resin bonded fiberglass, with a totally encapsulated infill of rigid weather and “Boils” proof plywood or equivalent between the two skins.

The roof section shall have a totally encapsulated infill of end grain balsa instead of plywood.

Box section steel shall be encapsulated into door edges and door frames. Hinges shall be of high tensile, non-corroding alloy with stainless steel pins and through fixing bolts. Large plane surfaces shall have adequate reinforcing to ensure rigidity.

The doors shall be complete with latching handles and locks. All door catches and locks shall latch onto steel reinforced surfaces.

The laminate material shall have flame retardant characteristics and shall retain stability, integrity and insulation for 30 mins when tested.

Color impregnated gel coats backed by colored resin shall be used to ensure maintenance tree and “color fast” finishes. The finish color, both internal and external shall be white.

Door mounted meters and transparent windows shall be of glass. Cubicles and kiosks shall be provided with canopies to protect the top surface and any meter or window glass from direct sun light. There shall be an air gap of 100 mm between the top surface of the cubicle and the canopy.

All internal equipment shall be mounted on support built into the fiberglass structure. Fixing bolts through the skin will not be accepted.

Each cubicle shall be constructed to provide environmental protection to IP55.

2.7 Panel Wiring and Equipment

2.7.1 Applicability

The requirements of this Clause shall apply to all instrumentation and control cubicles, desks, cabinets, mimic panels etc., but not motor control centers or switchgear.

2.7.2 Panel Wiring

Panel wiring shall be carried out using cable to the appropriate ISO or IEC Standards, installed in a neat, systematic manner, securely fixed and supported on insulated cleats or trunking, and arranged so as not to impede access to any internally mounted equipment.

Analogue signal cables and d.c. control cables at voltages not exceeding 48 volts (nominal) may be run together in the same cable bunch or trunking; but these cables shall be run separately from all other cables. In any cubicle, panel, or structure which is not fully enclosed (such as some mimic panel structures), all cabling which is or may be at a voltage in excess of 55 volts (nominal) to earth, shall be run in conduit.

For all cables, the sizing shall be fully adequate for the possible maximum loading, and de-rating shall be applied as appropriate for cable bunching and ambient temperature.

Identification ferrules shall be fitted to both ends of all wires, and shall be of the full circle type, threaded on to the cable such that all numerals are in line, and read outwards from the terminal.

Where stranded conductors are used, each end shall be fitted with a sleeved termination lug.

Terminations shall be restricted to one wire per terminal.

Cabling to door mounted equipment shall be bunched and cleated to form a loom with a loop of adequate length to allow easy door opening without causing strain to the components or cable.

Sharp edges of cubicles, trunking, components etc., which may be in contact with cables, shall be protected to avoid damage to cable insulation.

Requirements relating to terminals are covered in Chapter 2.8.

2.7.3 Panel Protection

All terminals and all live parts (on equipment) which are or may be at a voltage in excess of 55 volts (nominal) to earth, shall be enclosed by a protective cover, and carry a warning label stating the actual voltage.

For panels and enclosures covered under this section, the maximum potential between any two points within the panel or enclosure shall not exceed 250 volts.

Terminals and equipment which are supplied from other sources and which may remain live when the panel isolators are opened, shall be adequately protected and clearly labelled to this effect.

Adequate fuse protection for circuits and sub-circuits shall be provided and arranged such that any fuse failure causes the minimum disruption to controls and indications, and that any such fuse failure cannot create an unsafe operating condition. Fuses shall be of the HBC cartridge type with plastic molded carriers and bases.

2.7.4 Panel Earthing

A copper earthing bar shall be provided and bonded electrically to the main frame. It shall be provided with suitable brass screw terminals for the connection of the metal cladding, instrument frames, gland plates, cable tray, the armoring of all incoming cables and the site earthing system.

2.7.5 Panel/Lighting

Each enclosure shall be fitted with fluorescent lamp fittings to provide adequate and even illumination. Each lighting circuit shall be individually fused and switched.

2.7.6 Panel Heating

Each enclosure shall be fitted with one or more heaters to prevent condensation and assist ventilation. The heaters shall be so arranged and located that no deterioration can be caused to any equipment or wiring. The surface temperature of any part which may be accidentally contacted shall not exceed 65°C. The heating circuit shall be supplied via a fuse, an isolator and a Hand/Auto switch. In the "hand" position the heater shall run continuously and in the "auto" position the heater shall be controlled by a thermostat or humidistat. All switches and controls shall be mounted within the enclosure.

2.7.7 Panel Equipment

A fuse and isolating switch shall be provided for each incoming a.c. and d.c. supply.

Where instrumentation, monitoring or control equipment is to be operated on ac. supplies derived from within the cubicle, a 110-volt (55-0-55) control transformer (or transformers) shall be provided for this duty. Each micro-processor and/or programmable logic controller shall have its own control supply transformer.

Each cubicle shall be complete with a distribution unit providing an adequate number of fused outlets at 110 volts (55-0-55) for possible future requirements.

For internal panels only, a minimum of two, three-pin switched socket outlets shall be provided. These shall be mounted within the enclosure, shall operate at the panel supply voltage and shall carry a label clearly stating the voltage and rating.

All items of equipment mounted within the enclosure such as relays, electrical transducers, indicators, recorders, switches fuses, terminals etc. shall be arranged so as to provide easy access, be securely fixed and clearly labelled as to their function, designation, and where applicable, the voltage.

Where meters and recorders are mounted on vertical fronted panels, the mounted height shall be based on the height of the center line above finished floor level as follows:

- Indicating Meter: 1.35 m. min. to 1.90 m. max.
- Recorders: 1.45 m. min. to 1.85 m. max.

2.7.8 Labels

All labels for panels and other items as specified shall be provided in accordance with corresponded Clause.

Panels with doors which are not interlocked with an isolator (or isolators) giving complete protection shall carry a warning label having white letters on a red background as follows:

"DANGER LIVE TERMINALS" both in English and Lebanese language.

The relevant voltage shall be stated.

2.8 Terminals and Terminations

Terminals for the connection of all incoming/outgoing cables shall be provided and comprise anti-tracking moldings of melamine, phenolic or comparable material fitted on a purpose-built mounting rail. The conductors shall be secured by screw clamps or bars, but not pinch screws.

All terminals used on circuits not exceeding 55 volts (nominal) to earth, excluding power supplies and auxiliary drives, shall be of the disconnecting link type.

Every terminal shall carry a clear identity number. Terminals at different voltages shall be grouped separately, and each group shall be clearly labelled with its respective voltage and function.

Transparent protective covers complete with voltage warning label shall be provided on all terminals which are, or may be, at a voltage in excess of 55 volts (nominal) to earth.

Sufficient terminals shall be provided for terminating all cores of all cables (including spares) associated with the particular enclosure. The number of terminals shall be sufficient to cater for all anticipated requirements plus 20% spare terminals and 30% spare terminal rail.

Terminals for connecting to incoming/outgoing cables shall be mounted vertically wherever possible and arranged to provide easy access and to enable ferrule numbers to be read without difficulty. Direct termination onto such equipment as distribution boards, fuses or miniature circuit breakers is not acceptable.

2.9 24VDC Supply for Control

2.9.1 General

This Clause covers the requirements for 24 VDC supply, specified in the application clauses for the Operation of Control, Instrumentation, Alarm and Monitoring equipment, but not for switchgear tripping/closing batteries or other special function batteries.

220 VAC uninterruptible power supplies (UPS) must be provided for the supply of the equipment through control cabinets and panels. These UPS 220 VAC must be sized to enable the supply of the control components through a 220 VAC / 24 VDC convertor installed in the relevant control cabinets and panels to be installed in control rooms.

Where alternative a.c. supplies are available, provision shall be made for taking the supply to the UPS from either source (e.g. from either side of the bus-section switch) with facilities for changeover from one source to the other in the event of failure of the supply source.

The UPS unit shall form a composite unit and be housed in a single, sheet steel, floor standing cubicle having adequate ventilation and separate compartments for the batteries, chargers and inverter.

2.9.2 Batteries

The batteries shall be of the nickel cadmium type with a normal cell output of 1.4 volts, and shall be of adequate capacity to maintain full operation of the specific load equipment plus a further 10% for a period of 4 hours during mains failure, unless specified otherwise in the application clauses, and assuming a normal charge condition at the start of the mains failure.

The battery cases shall be made of translucent, high impact polystyrene so that the electrolyte level cans be seen through the battery casing.

All batteries shall be suitable for the intended service under the prevailing site conditions without excessive gassing or loss of electrolyte.

2.9.3 Battery Chargers

Duplicate chargers, one “duty” and one “standby” shall be provided and mounted on their own respective chassis in the upper cubicle compartment.

The controls for each charger shall be mounted on their own respective mounting plates, and these, together with all controls and indications projecting through the front of the upper compartment cabinet section shall be positioned at a height not exceeding 1 800 mm from floor level.

Each charger mounting plate shall contain:

- 1 “ON/OFF” Main switch.
- 1 Charger output Ammeter.
- 1 Charger output Voltmeter.
- 1 Lamp to indicate “Boost Charge” (Red).
- 1 Lamp to indicate “Float Charge” (Green).
- 1 Lamp to indicate “Charger Failed” (Red).

- 1 Lamp to indicate "High DL Voltage" (Red).
- 1 Lamp to indicate "Low DC Voltage" (Red).
- 1 Lamp "test button".

Each charger unit shall also be provided with:

- 1 “Float/Boost” elector switch, mounted internally.
- 1 set of a.c. supply fuses for each charger unit.
- A volt-free contact for charger failed alarm.
- A volt-free contact for low d.c. output voltage alarm.
- A volt-free contact for loss of d.c. output voltage alarm.

The above volt-free contacts shall open under fault conditions and be wired to a terminal block.

The battery charger unit shall also be provided with one set of full capacity rated output/d.c. terminals and fuses.

In the event of failure of the duty selected charger, the standby charger shall be connected automatically, and contacts for the remote alarm indication shall be provided. The alarm indications of the failed charger unit shall remain on until the duty charger has been repaired and returned to operation.

Reversion from “Standby” to “Duty” charger shall be a manual operation.

The chargers shall be of the solid state constant potential type, and shall be designed to regulate the charger output voltage to within +1 % for a mains input voltage variation.

The d.c. terminal voltage shall be further regulated such that under “Float” or “Boost” charge condition the d.c. voltage does not rise more than 10% of nominal.

The charger unit shall also be provided with both short circuit and reverse polarity protection.

All internal and external components shall be labelled in accordance with the Specification.

The cabinet shall be manufactured in accordance with Clauses 6.1 and 6.2 but with additional treatment to the interior surfaces to prevent any corrosion by battery chemicals and with environmental protection to lP52.

Internal wiring shall be in accordance with Clause 7.

Terminals and their positions shall be in accordance with Clause 8.

For each battery/charger unit, the Contractor shall supply a set of maintenance tools, spares and hydrometer; all of which shall be contained and secured within the charger cabinet.

The Contractor shall fix inside the cubicle a wiring diagram indicating and identifying all out-going terminals, components and fuses.

Special precautions shall be taken in the sizing of the battery and charger for tropical use, and all equipment shall be adequately rated for the prevailing site conditions.

2.9.4 Inverter

Inverters shall be solid state type and shall provide a single-phase output at 220 VAC.

Inverter mounting plate shall contain:

- 1 “ON/OFF” Main switch.
- 1 AC output Ammeter.
- 1 AC output Voltmeter.
- 1 AC output Frequency.

- 1 Lamp to indicate “Load on inverter” (Green).
- 1 Lamp to indicate “Load on reserve” (Yellow).
- 1 Lamp to indicate “Maintenance” (Red).
- 1 Lamp to indicate “Reserve fault” (Red).
- 1 Lamp to indicate “Inverter unsynchronized” (Red).
- 1 Lamp to indicate “Overload inverter built” (Red).
- 1 Lamp to indicate “Inverter fault” (Red).
- 1 Lamp to indicate “Inverter over voltage” (Red).
- 1 Lamp to indicate “Inverter bridge fault” (Red).
- 1 Lamp to indicate “Inverter over temperature” (Red).
- 1 Lamp to indicate “DC high voltage” (Red).
- 1 Lamp to indicate “Imminent shutdown” (Red).
- 1 Lamp to indicate “End of discharge” (Red).
- 1 Lamp to indicate “AC earth fault” (Red).
- 1 Lamp to indicate “General fault” (Red).
- 1 Lamp “test button”.
- 1 Lamp “reset button”.

Inverters shall have the following characteristics:

- Maintain an output frequency constant within ± 1% of nominal.
- An adjustable ac output voltage of ± 5% at nominal dc input voltage.
- A maximum deviation of ac output voltage of ± 2% over the entire ranges of load, dc voltage and power factor.
- Be capable of continuous operation under the ambient temperature specified.
- A limited overload capacity.
- An in-built current limiting circuit to provide short circuit protection.
- An ac output filter to limit the total harmonic voltage distortion across linear loads to 5%, over the entire range of load, voltage and power factor.
- A dc input filter to ensure that the r.m.s. value of ac voltage does not exceed 5% of the dc voltage.
- A totally enclosed floor mounting sheet steel enclosure with front access doors.
- The cabinet shall be manufactured in accordance with an environmental protection to IP52.

2.10 Alarm Systems

2.10.1 Alarm Systems - General

All alarm systems throughout the whole site shall be of the same type supplied in accordance with this Clause, and to the requirements of the specific application clauses.

Although it is intended that all alarms shall be initiated by contacts which open under fault conditions, each alarm channel shall be individually capable of accepting an input from contacts which open or close on occurrence of a fault.

The Contractor shall ensure that all necessary alarm initiating facilities are provided.

Each alarm system shall:

- Be supplied complete with an annunciator having two lamps to each light box.
- Include facilities for operating one local and two remote audible units. The local units shall be supplied and installed in the same panel as the annunciator. The remote units, if required, shall be supplied and installed in accordance with the specific application Clauses. All audible units shall be suitable as regards output and degree of environmental protection, for the particular application and location.
- Have fully equipped alarm channels for all the alarms ultimately required, together with 10% (one for every ten or part thereof) plus two, spare channels.
- Have alarm logic incorporating a short built-in delay (say 0.25 to 1.0 sec) to avoid initiation of an alarm from a fleeting contact.
- Be supplied from the relevant UPS and AC/DC power supply.

A rapid flashing indication is acceptable as an alternative to the dim lamp facility specified in the following sub-clauses.

2.10.2 Local Alarm Systems

Local Alarm Systems are defined as those systems which are installed at various locations round the site, as opposed to the Central Alarm System detailed in chapter 2.10.3.

Each local alarm system shall comply with the requirements of Clause 10.1 and shall:

- have manual reset facilities and be complete with “Reset”, “Alarm Accept” and “Lamp test” push buttons.
- have facilities for grouping alarm signals for display at the local annunciator and for grouping alarms for transmission to the Works Monitoring Centre. The alarms transmitted to the Works Monitoring Centre shall be maintained until “reset” at the local alarm system.
- have the following alarm sequence:

Condition	Visual	Audible
Normal	Off Off	Off
Alarm Flash	Flash Flash	On
Accept (alarm still on)	Steady Steady	Off
Return to Normal after Accept	Steady Steady (dim)	Off
Reset	Off Off	Off
Return to Normal before Accept	Flash Flash (dim)	On
Accept (after return to Normal)	Steady Steady (dim)	Off
Reset	Off Off	Off

2.10.3 Central Alarm System

The Central Alarm System is that system which is located in the works monitoring/control center, and is normally located in the administration building.

The central alarm system shall comply with the requirements of chapter 2.10.1 and shall:

- have automatic reset facilities and be complete with “Alarm Accept” and “Lamp Test” push buttons,
- have an additional output for each alarm channel to provide signals to a possible future event recorder or data logger,

- have the following alarm sequence:

Condition	Visual	Audible
Normal	Off Off	Off
Alarm	Flash Flash	On
Accept (alarm still on)	Steady Steady	Off
Return to Normal after Accept	Off Off	Off
Return to Normal before Accept	Flash Flash (dim)	On

2.10.4 Battery Maintained Alarm Systems

At locations where the alarm system is to be maintained during a period of power failure, the UPS shall be sized to maintain full operation for: a period of 4 hours, assuming the UPS battery to be in a normal charge condition prior to the failure.

2.10.5 Mains Powered Alarm Systems

At locations having a main powered alarm system, a power failure alarm shall be provided as detailed below. Where applicable, provision shall be made for taking the supply from a UPS unit with dual battery charger system and manual changeover from one battery charger to the other in the event of failure of supply. The alarm and annunciator system shall be operated from a 24-volt dc supply.

2.10.6 Power Failure Alarms

At all places where plant and/or switchgear are located, there shall be a power failure alarm incorporating a 5 second time delay. This alarm shall be initiated in the event of a total power failure, and at locations having dual feeders, both incomers shall be “dead” before the alarm is initiated.

For mains powered systems, this alarm shall be independent of the alarm system and shall be connected directly back to the Area Monitoring Centre alarm system. The alarm initiation shall be by a relay (or relays) which shall be energized under normal conditions, and de-energized under loss of supply so as to open the initiating contact (or contacts).

The alarm legends shall be of adequate size to ensure that they are easily readable from the normal operating or viewing location.

2.11 Pipe Flow Measurement

A. Preferably, flowmeters shall be of electromagnetic type.

In this case, the Contractor shall take all necessary steps to prevent deposits from occurring in pipes (pipes systematically pressurized, vertical assembly, etc.).

If a device is installed downstream of features that perturb flow (valves, bends, tees, etc.), the Contractor shall fit a stilling section equal to 3-5 times the nominal diameter.

If the Contractor intends to reduce the pipe diameter to install a flowmeter, the converging and diverging angles shall be less than 8°.

B. If ultrasonic flowmeters are used, the Contractor shall ensure that the necessary straight sections are provided (10D upstream and 5D downstream) and take all necessary steps to avoid scaling or rusting.
C. If rotameters are used, the Contractor shall install them in such a way that the measuring tube and float can easily be removed for cleaning operations and changing. They shall be of the side-connecting type and fitted with cut-off valves and a by-pass.
D. Vortex flowmeters shall have the same nominal diameter as the pipework and flanges. The flange and vortex must be perfectly aligned.

The flowmeter is fitted on a pipe with a minimum straight section of 4D upstream and 2D downstream. If the process has to be interrupted for maintenance operations, a bleed system must be fitted on the flowmeter.

Vortex flowmeters used to measure gas or steam flows rates shall be situated between 10D and 30D downstream of a regulating valve.

2.11.1 Magnetic Flow Meters

Magnetic flow meters shall be provided in accordance with the following:

- Meters shall be of the short form, having a modulated, direct current excitation and inherent total zero stability.
- The power consumption shall not exceed 16 watts per 100 mm of diameter.
- The output shall be 4-20 mA and the system accuracy shall be within ± 0.5% of rate. Test certificates shall be provided.
- The field coils shall be fully encapsulated.
- The equipment shall be guaranteed suitable for the ambient and process liquid temperatures.
- Each flow meter primary shall be supplied with a polyurethane or PFA liner and electrodes of the material best suited to the particular process fluid.
- Primary units shall be suitable for accidental submergence to a depth of 3 meters.
- The Contractor shall provide primary units having flanges in accordance with the relevant mechanical clauses relating to pipes, flanges, fittings, etc..
- The Contractor shall ensure that all primary units are rated well in excess of the maximum possible process fluid pressure, including possible surge pressures.
- Each primary unit shall be supplied and installed complete with a flange adaptor coupling or similar approved arrangement to permit removal for repair or inspection.
- The Flow meter equipment shall be supplied complete with amplifier (converter), drive unit (if applicable) and all cable for connecting between the components.
- The amplifier/converter shall be fully screened to prevent interference from adjacent equipment.
- The amplifier/converter shall incorporate voltage stabilization to ensure maintenance of system accuracy with a supply variation from 85 to 260 VAC.
- The Contractor shall provide a length of pipe having the same length and being flanged as the flow meter primary; to replace the meter should this have to be removed for repair.
- Each installation shall be provided with ultra-sonic electrode cleaning equipment. This equipment shall be installed complete with the necessary switches, push-buttons, timers etc.

Where a number of identical units are being provided, replacement flanged pipes shall be provided on the basis of one for every four (or part thereof) primary units.

2.11.2 Thermal Mass Flow Meters

Thermal Mass flow meters shall be provided in accordance with the following:

- Meters shall be of the probe type fitted on welded sleeve.
- The power consumption shall not exceed 5 Watts for any pipe diameter.
- The output shall be 4-20 mA and the system accuracy shall be within ± 2% of rate. Test certificates shall be provided.
- The probe shall be of draw-out type and shall be removable without interrupting the service.

- The equipment shall be guaranteed suitable for the ambient and process liquid temperatures.
- Each sleeve shall be supplied with a lining as specified for steel pipes and probe shall be of the material best suited to the particular process fluid.
- Primary units shall be suitable for accidental submergence to a depth of 3 meters.
- The Contractor shall provide carbon steel sleeves having flanges in accordance with the relevant mechanical clauses relating to pipes, flanges, fittings, etc.
- The Contractor shall ensure that all primary units are rated well in excess of the maximum possible process fluid pressure, including possible surge pressures.
- Each primary unit shall be supplied and installed complete with a flange adaptor coupling or similar approved arrangement to permit removal for repair or inspection.
- The Flow meter equipment shall be supplied complete with amplifier (converter), drive unit (if applicable) and all cable for connecting between the components.
- The amplifier/converter shall be fully screened to prevent interference from adjacent equipment.
- The amplifier/converter shall incorporate voltage stabilization to ensure maintenance of system accuracy with a supply variation from 20 to 30 VDC.
- The Contractor shall provide a length of pipe having the same length and being flanged as the flow meter primary; to replace the meter should this have to be removed for repair.

Where a number of identical units are being provided, replacement flanged pipes shall be provided on the basis of one for every four (or part thereof) primary units.

2.12 Venturi Flumes

2.12.1 General

Venturi flumes shall be designed to perform the following measurement conditions:

- The upstream head shall be measured at a distance of 3-4 times the maximum water height;
- The channel cross section shall be rectangular and constant (vertical walls)
- Slab and walls shall be totally smooth.

Venturi shall be made of polyester.

The sampler timber shall be made of stainless steel, with IP55 protection; the sampler container shall be made of inert materials.

2.12.2 Venturi Flume for Treated Effluents

Venturi flume for treated effluents shall be equipped with a flow measurement chain and with a sampler in accordance with the requirements of the present section.

2.12.3 Venturi Flume for Recirculation to the Inlet

Venturi flume for recirculation to the inlet shall be equipped with a continuous flow measurement chain.

2.13 Samplers

Samplers shall have the following characteristics:

- 24 flasks of 1 liter,
- vacuum pump taking,
- heater and refrigerating stocking container,

- taking filter localized to avoid flow disturbance and to take representative samples.

2.14 Level Measurements

2.14.1 General

A. A distinction is made between level probes, which involve ultrasonic or piezoresistive measurements, and alarms, which are level switches.
B. In the case of ultrasonic level probes, the sensor has a minimum protection index of IP 68 and is temperature-compensated. The transmitter has a protection index of IP 65 with a 4-20 mA output signal and maximum uncertainty of 1% of the measurement scale in service conditions.

   Piezoresistive measurement devices have a stainless-steel tube sensor with an amplifying box.

C. Alarms will detect very high or very low level, and then with switches will start or stop equipment or record alarm and information.
D. The control units shall incorporate facilities for adjusting independently both zero and span, and shall have an output of 4-20 mA proportional to level.
E. The sensor shall be installed on a structure provided for the purpose. All these measurements are carried out in stilling tubes.

2.14.2 Ultra-Sonic Level

2.14.2.1 Construction

Where such equipment is specified in the relevant application Clause, level measurement shall be accomplished the use of non-contact, echo-time measuring equipment operating at ultra-sonic frequency. The equipment shall transmit pulses which are reflected back to the sensor from the surface of the liquid whose level is being measured.

The equipment shall consist of a sensor or transponder incorporating both transmitter and receiver, together with a separate control unit.

The equipment shall be provided with automatic temperature compensation shall be suitable for operation in the designated application under the climatic conditions.

The sensor shall be suitable for mounting in the open, or within an enclosed tank, and shall be totally enclosed and hose proof with environmental protection to IP55 or lP67, as appropriate.

The control units shall incorporate facilities for adjusting independently both zero and span, and shall have an output of 4-20 mA proportional to level.

The overall accuracy of the level measurements shall be within ± 0.1% of the instrument span.

The connection between the sensor and control unit shall be via commercially available screened cable, and the equipment shall operate with up to 150 meters of such cable.

The Contractor shall ensure that each equipment, particularly with regard to the transmitted beam angle or cone and the blocking distance, is suitable for the application.

2.14.2.2 Installation

The sensor shall be installed on a structure provided for the purpose. The structure shall have a square hole approx. 300 x 300 mm at the sensor mounting position.

Under this Contract, a stainless-steel mounting plate of not less than 430 x 430 mm shall be provided. This plate shall be drilled to take the sensor and bolted securely to the civil structure. The Contractor shall ensure that, when bolted down, the mounting plate is exactly horizontal, so that the ultra-sonic beam will be perpendicular to the liquid surface.

The Contractor shall, where applicable, provide a canopy around and/or above the sensor and/or control unit to provide protection from direct sunlight.

2.14.3 Ultra-Sonic Open Channel Flow Measurement

Where ultra-sonic equipment is specified in the application clauses for measuring flow in open channels, the equipment shall be supplied and installed in accordance with chapter 2.14,2 but shall, in addition, include a linearizer either as a separate matching unit or incorporated within the control unit.

The Linearizer shall convert the level signal into a 4-20 mA signal proportional to flow in accordance with the type of flume or weir being used.

The overall accuracy of the level measuring and Linearizing equipment shall be within ± 0.2% of the instrument span.

2.14.4 Electrode Level Control Equipment

Electrode level control equipment shall consist of a control unit or units and a number of electrodes.

For all applications, sufficient electrodes and associated controls shall be provided to prevent "hunting" between the two states.

The Control Unit shall:

- Be of modular style and totally enclosed except for the front panel mounted terminals, controls and indications.
- Have all live parts at a voltage in excess of 55 volts to earth completely shrouded and complete with warning labels.
- Have an output relay with double pole changeover contacts of suitable material for the application.
- Have all internal equipment tropicalized, but without potting on the printed circuit boards.
- Have a light emitting diode mounted on the front panel to indicate when the relay is energized.
- Have a lockable sensitivity control potentiometer.
- Be designed for operating from a 230-volt a.c. supply.
- Be capable of operating at a distance of up to 100 m from the electrodes.
- Have a voltage on the electrodes not exceeding 25 volts.

The electrodes and holder shall comply with the following:

- The electrode holder shall be fully weatherproof, constructed from die-cast aluminum and provided with a mounting flange having a minimum of 4 No. fixing holes.
- The electrode holder shall be designed to allow a minimum of 75 mm adjustment of the electrode length.
- The electrode shall have glazed ceramic insulator cemented to the metal housing.
- The electrodes shall be of 18/8 stainless steel grade 316L to BS 970 Part 4 or equivalent, having a minimum O.D. of 25 mm and a wall thickness not less than 2.6 mm. The lower end of the electrode shall be sealed, and the upper end shall be locked to the ceramic insulator by a brass clamp.
- Cable entry shall be via a standard screwed gland entry.
- Each electrode shall be firmly secured to avoid any movement due to turbulence or flow velocity. The securing brackets shall be of the same material as the electrode and shall be installed above top water-level.
- Where electrodes pass through securing brackets, they shall be protected by heat shrunk sleeving extending from 300 mm above the bracket to 300 mm below the bracket.

All brackets and fixings as required for the complete installation shall be provided.

2.14.4.1 Float Switches

Float switches shall be the pendant type with the float suspended on a flexible cable, such that with the float free of the liquid, the float and cable hang vertically, but with a rising liquid level the float shall rise and tend to invert.

The float shall be of robust design and comprise a mercury switch having changeover contacts encapsulated in a hard plastic foam and connected to a 3 core cable. The whole assembly shall be covered and hermetically sealed in polypropylene or similar material.

With the tilting action which occurs on rising level, the contacts shall change over, but there shall be a dead band between opening one contact and closing the other, during which period the contacts shall be open. This dead band shall operate over an arc approximately 20° either side of the horizontal.

The contacts shall be rated for a minimum of 10 amps at 230 volts. The voltage on the contacts shall not exceed 55 volts nominal to earth.

In all applications, the installation shall be complete with approved means of preventing the float (and lead) from movement due to wind or liquid turbulence.

Where float switches are to be used in applications under which they may be submerged during normal operation (e.g. pump control and or low-level alarm); they shall be attached to a weighted chain to minimize movement due to turbulence and also provide a means of raising the units for maintenance and repair.

All brackets, fixings etc. as necessary for the complete installation shall be provided. The chain/float assembly shall be installed such that the point of suspension is not less than 400 mm from any side wall.

2.15 Temperature Measuring Equipment

2.15.1 Temperature Meters

Unless otherwise specified, platinum resistance elements shall be used for measuring spans of up to 200°C and chromel-alumel thermocouples for spans exceeding 200°C.

Each temperature sensor, unless otherwise specified, shall have a stainless steel thermowell, or pocket-and-extension assembly, non-corrodible metal sheath and waterproof terminal head.

Pockets for steam, oil and pressurized-water lines shall be welded; pockets for other duties shall be screwed.

The sensor assembly shall be designed to permit removal of the temperature element without twisting the leads.

2.15.2 Platinum Resistance Thermometers

Platinum resistance thermometers shall comply with BS 1041 Parts 2 and 3 and BS EN 60751.

Sensors shall have a resistance of 100 ohms at 0°C and shall conform to the European standard curve (DIN 43720), where Alpha = 0.00385. Each element shall be artificially aged during manufacture. Terminal heads and amplifiers shall be designed for four-wire connections between head and amplifier.

Platinum resistance elements shall be spring-loaded and fully encapsulated in ceramic material and the elements and high-temperature-resistant lead wires shall be hermetically sealed. The associated resistance-to-current converters shall have zero and span adjustments and input-output circuit isolation.

2.15.3 Thermocouples

Thermocouples shall be of the mineral-insulated type and unless otherwise specified shall be of the chromel-alumel (nickel-chromium v nickel-aluminum) type. Thermocouple junctions shall be welded. Ceramic-insulation material may be used for base-metal thermocouples but low-silicon insulation material shall be used for noble-metal thermocouples. Thermocouple systems shall have thermoelectric ice point reference chambers or receivers or amplifiers with automatic cold junction compensation.

Thermocouple receivers and amplifiers shall also have zero and span adjustment, common and series mode interference rejection circuits, radio-frequency filters, input-output circuit isolation and thermocouple break feature whereby the output is driven to zero or full-scale, as stipulated by the Engineer, when the receiver or amplifier input circuit is broken.

Thermocouple elements shall be electrically isolated from their sheaths but each terminal head shall have facilities for earthing the thermocouple and for terminating the screen of the extension or compensation cable. Amplifier chassis shall have facilities both for being earthed to the instrument case via a capacitor and for being electrically isolated from the instrument case.

2.15.4 Temperature Switches

Temperature switches shall have contacts with differing 'cut-in' and 'cut-out' values. Their nominal operating points shall be fully adjustable over the whole range of the instrument and the set-value shall be clearly indicated by a dial and pointer.

2.16 Gas Detection

Gas detection is done using an electrochemical cell, with the following scales:

- H2S: 0 to 50 ppm
- CH4: 0 to 1000 ppm

The O2 sensor must detect air that is suitable for breathing by staff.

All sensors are connected to a central detection unit with a protection index of IP 55.

2.17 Redox Potential Measurement

The system for measuring redox potential in the aeration tanks shall consist of at least the following:

- An immersion probe with temperature compensation and constant-potential system.
- An IP 65 transmitter, with two 4-20 mA output signals (oxygen and temperature).
- A probe support rod.

The Contractor shall specify in his offer:

- The working life of the probe.
- The drift and maximum uncertainty.

2.18 Dissolved Oxygen Measurement

The system for measuring dissolved oxygen in the aeration tanks shall consist of at least the following:

- An encased electrolyte probe with temperature compensation.
- An IP 65 transmitter, with 4-20 mA output signal.
- A probe support rod.

The Contractor shall specify in his offer:

- The working life of the probe.
- The drift and maximum uncertainty.

2.19 PH and RH Measurement

The system for measuring pH entering and leaving the treatment plant shall consist of at least the following:

- An immersion probe with temperature compensation and membrane electrode.

- An IP 65 transmitter, with 4-20 mA output signal.

2.20 Sludge Blanket Detection

The system for detecting sludge blankets in the clarifiers shall consist of at least the following:

- A 316 L stainless steel sensor, with IP 58 cable entry.
- A wall-mounted IP 65 transmitter, with 4-20 mA output signal.

2.21 Pressure Measurements

A. In the case of a pressure gauge, this will be of the Bourdon tube type, made of stainless steel.

The operating range will cover at least atmospheric pressure and the hydraulic test pressure required. Minimum diameter 100 mm. The gauge shall be fitted with a 1/2-inch NPT spigot connection.

The permissible uncertainty is 1% over the scale.

B. In the case of a pressure switch, the electrical contact is of the dry inverter type, with an adjustable threshold running from 0 to 100% of the measurement range concerned. If it is used in a safety chain, an initial reversing switch will be provided for safety, and a second for the image of the signal sent to the system.
C. Pressure transmitters comprise a scale adjustment system with a minimum ratio of 1 to 5 and zero adjustment.

The measuring device is made of stainless steel, with a 4-20 mA output signal. Temperature and pressure compensation are provided systematically in the case of low-pressure measurements.

2.21.1 Pressure Transducer Level Measuring Equipment

2.21.1.1 Construction

Pressure transducer level measuring equipment shall comprise a strain gauge or differential transformer type pressure transducer, a controller/transmitter and be complete with all necessary cable, conduits etc. as detailed below.

The pressure transducer shall be enclosed within an all welded, stainless-steel case not less than 19.0 mm dia. and shall:

- Have a single molded cable which is securely bonded to the transducer case and comprise electrical connections, venting tube, strain wire or cord and an outer covering of material suitable for the application.
- Be suitable for continuous immersion on all wastewater applications including raw sewage, primary sludge, secondary sludge and thickened sludge.
- Be constructed so that the sensor diaphragm is protected against damage by shock, debris etc., without restricting the transference of pressure changes from the surrounding medium.
- Incorporate automatic temperature compensation.
- Withstand a continuous overpressure of up to 400% without sustaining permanent deformation or calibration change.

The controller/transmitter shall:

- Be suitable for mounting within a control panel.
- Accept the signal from the transducer and provide a 4-20 mA output proportional to level (gauge pressure), for indication and control.
- Include independent zero and span adjustment.

The complete system shall:

- Operate with up to 100 m of cable between transducer and controller/transmitter.
- Provide an accuracy within ± 0.1% of the span with a linearity better than +0.1%.

2.21.1.2 Pressure Transducer Installation

For installations where the sump depth is in excess of 3 m or where the available headroom over the sump is limited, the pressure transducer shall be installed within a 100 mm dia. GRP tube to provide protection against mechanical damage to both the transducer and the cable. The GRP tubing shall have an adequate number of holes and/or slots to allow it to fill and drain as the level varies. The tubing shall be fixed to the sump wall at intervals not exceeding 2.5 m.

For installations where the sump depth does not exceed 3 m, the sensor shall be supplied and installed as a rigid assembly comprising a stainless-steel tube, a tube holder (both as used for control electrodes) and the transducer, with the cable passing through the tube. The transducer shall be a close fit located completely within the tube at the lower end. The assembly shall be fixed at not less than two places to the sump wall and installed with the bottom of the tube clear of the sump invert.

For all installations, the cable between the transducer and the controller/transmitter shall be a continuous length, and kept as short as is reasonably possible. This cable shall be run in conduit and installed well clear of all a.c. mains and power cables.

All fixings, brackets etc. as required for the complete installation shall be provided.

2.22 Applicability

2.22.1 Indicating Meters and Meter Relays

All indicating meters and meter relays for use in control and instrumentation panels, control desks, mimics, etc. shall comply with this chapter and the appropriate sub-chapter.

2.22.2 GENERAL REQUIREMENTS

All meters and meter relays:

- Shall comply with IEC 51 to accuracy Class 1 for instruments having a d.c. input and accuracy Class 1.5 for instruments having an a.c. input.
- Shall have a linear scale with clear graduations and markings.
- Shall have the units of the measured variable and any multiplying factor clearly marked on the scale plate.
- Shall have an external zero adjustment.
- Shall be flush mounting with matt or semi-matt black bezel.
- Shall match all other instruments on the same panel or on similar panels in the same room as regards style, finish and appearance.
- Intended for installation within a control room shall be fitted with anti-glare or low reflectivity glass.
- Intended for installation on an inclined surface shall be suitable for that application, and when so mounted, the accuracy shall be maintained over the full range.
- Having a 4-20 mA input shall have an off-set zero, so that an input of less than 4 mA will result in an indication below the scale zero.
- Shall be specified by the manufacturer as being designed for operations over the range 0°C to 50°C at up to 75° humidity and be suitable for storage over the range 10°C to +65°C.

2.22.3 Indicating Meters - Rectangular

- Shall have a rectangular format of not less than 48 x 96 mm.
- Shall be multifunctional one channel display with universal input, loop power supply, limit monitor and analogue output.

2.22.4 Level/Contents Indications

Meters indicating levels, tank contents and Indicators similar quantities shall have a vertical edgewise format and shall be solid state bar graph indicators. Instruments having a curved scale plate will not be acceptable for these applications. The top water level shall be marked on the scale.

Bar graph indicators shall have a dot matrix LED display and minimum dimensions of 144 x 36 mm.

2.22.5 Position Indication

Indicator lamps for valves and penstocks indication position shall comply with electrical specifications.

2.22.6 Meter Relays

Meter relays shall incorporate one or two adjustable set point contacts for alarm or control.

The set points shall be visible and adjustable from the front.

The alarms/controls shall have volt-free output contacts.

2.23 Integrators and Counters

2.23.1 General

The integrator and counter may be combined into the flow measurement instrument, or the integrator may be mounted remotely from the numerical display unit.

The counter shall be flush mounting with a matt or semi-matt black bezel, and shall match all other instruments on the same panel as regards style, finish and appearance.

If a counter reset facility is provided, this shall be arranged such that accidental operation is impossible, and should preferably not be located on the front panel.

A low signal cut-off facility shall be provided on all integrators, and this shall be adjustable over the range 0.5% to 5% of the flow.

Integrated flows shall be in cubic meters per second and this, together with the measurement designation and any multiplying factor shall be clearly marked on the face of the counter, or on a matching label immediately below the counter.

Unless otherwise stated in the specific application Clause, the multiplying factors shall be as follows:

Multiplying factor	Instrument	Range
x 1	0	5 000 m^3/day
x 10	5 001	50 000 m^3/day
x 10^2	50 001	500 000 m^3/day
Alternatively,		
x 1	0	60 l/s
x 10	61	600 l/s
x 10^2	601	6 000 l/s

The Contractor shall submit for approval to the Engineer details of integration rates and multiplying factors for all integrators to be supplied under the Contract.

2.23.2 Predetermining Counters

Where a sampler is to be operated as a function of flow and/or where indicated in the application Clauses, the relevant integrator shall incorporate a predetermining counter having a minimum of 3 digits. The predetermining counter shall be on the front of the instrument with thumb-wheel setting facilities and shall operate such that a relay with change-over contacts is energized when the preset quantity is reached. The relay shall remain energized for approximately 10 seconds, following which the counter shall automatically reset and start counting again.

The accuracy shall be ± 0.2% of span or better.

2.24 Penstocks Position Indicators

Penstocks position indicators shall be automatic two position indicators on local control panels, which show the state of the remote penstock. During changes of state or loss of supply, the indication shall remain at that last position until either a fully open or fully closed position is reached at which time it shall move to the appropriate vertical or horizontal position.

2.25 Status Indicator Lamps

2.25.1 General

Where an instrumentation and control DC voltage supply is available, status indicator lamps shall be supplied from this source.

In applications where a DC voltage supply is not available, status indicator lamps shall operate on available a.c. supplies. For these applications, the indicator shall be a low voltage lamp supplied via a transformer incorporated within the light unit. The lamps shall have a voltage rating higher than the transformer secondary.

2.25.2 D.C. Operated Lamps

On all mimics and elsewhere as practicable, indicators shall be by light boxes or illuminated LED incorporating two lamps. Multi-color, single aspect indications on mimics may be single lamp units if twin lamp versions are not available.

All lamp status indications on control panels, mimics, instrumentation and control sections of MCC's shall be switched by relays located within the panel or enclosure incorporating the display, and powered by the local DC voltage supply. This is to ensure that all lamps in the display are of the same brightness.

Where resistor shall be connected in series with each lamp or pair of lamps, the circuit shall be arranged so that the relay contact shorts out the resistor to illuminate the lamp. The resistor value shall be such that, when in series with the lamp (or lamps), the filament shall start to glow when maximum DC voltage is applied.

The lamp relays shall be reed relays mounted with the lamp resistors on printed circuit boards. This requirement is to reduce space and DC power requirements. The relay contacts shall be adequately rated: for the duty of switching filament lamps.

All indicator lamps on instrumentation and control panels, mimics, etc., shall be incorporated within a lamp test facility.

2.26 Illuminated Pushbuttons and Open/Close Indicators

The illuminated pushbuttons shall have bezel dimension of not less than 24 x 36 mm, and shall be mounted in pairs to provide remote hand control of louvers, valves, penstocks and similar devices.

Each pair shall consist of one "open" (or "lower") pushbutton with red translucent screen, and one "close" (or "raise") pushbutton with green translucent screen. The screens shall be engraved and filled to show the action (open or close) and the device reference number.

Operation of the pushbutton shall initiate the appropriate action.

With the valve, penstock or louver fully closed, the green (close) lamp only shall be illuminated; and with the device fully open, the red (open) lamp only shall be illuminated. While the device is changing from one state to another, both lamps shall be illuminated.

The pushbutton contacts shall have a minimum rating of 5 amps at 240 volts 50 Hz.

The switch and associated circuits shall be arranged so as to provide the required operating characteristics for each device. All pushbutton circuits shall operate in the same manner. Circuit arrangements requiring the pushbuttons to be held down while the device is changing from one state to another, will not be accepted.

The open/close indicators shall be of the same type and appearance as the illuminated pushbuttons, with the same lamp colors and indicating sequence, but the screens shall be engraved “opened” and “closed”.

All indicator lamps shall be included within a lamp test facility.

2.27 Trip Amplifiers

Trip amplifiers shall operate on various analogue signals and shall:

- Operate from a 230 VAC or 24 VDC.
- Have an input impedance in the order of 20 ohms.

Trip amplifiers or analogue alarm relays shall have single or dual set points as required and shall:

- Have switched outputs with changeover contacts of suitable material and rating for the application.
- Have set points which is infinitely variable over the whole input range by means of a lockable knob calibrated 0-100%.
- Have a dead band of not less than 2.5% of input span.
- Have a trip repeatability of ±0.25% of span.

2.28 Control and Interposing Relays

All relays shall operate on a supply not exceeding 55 volts (nominal) to earth unless otherwise specified in the application clauses, and shall:

- Operate reliably over the range +10% to -15% of the nominal supply voltage.
- Be of the plug-in type complete with plastic cover and retaining clip.
- Have vacuum impregnated coils and be suitably treated for operation under the specified environmental conditions.
- Have contact material suitable for each application.
- Have relay bases of the front connected, screw clamp type.

Mixed voltage shall not be connected to the contacts of any relay.

All relays and the associated wiring shall be protected by suitably rated fuses.

Relays having different contact arrangements or coil voltages shall not be interchangeable.

A permanent means of identification shall be fixed to each relay base and this identification shall be in accordance with the circuit diagram reference.

Where voltages from a remote source (i.e. voltages which cannot be isolated from within the cubicle) are connected to a relay or associated terminals, fuses etc., the Contractor shall ensure that all such live parts are fully shrouded and that appropriate warning notices are fitted.

The Contractor shall be responsible for ensuring that a.c. relays cannot be held in due to capacitance effects on long switching lines. Where such a possibility exists, a d.c. supply shall be provided.

2.29 Plant Control and Indication

The requirements detailed below are written with specific reference to control/Indication circuits associated with power actuated valves and penstocks, but shall apply equally to all other plant control/indications where similar conditions occur.

Although two or more auxiliary or limit switches may initially be set up to give simultaneous operation, it is impossible to ensure that such simultaneous operation will be maintained over an extended period. To avoid the possibility of a system malfunction due to the above, the use of duplicate auxiliary or limit switches to provide the same effective status signal will not be accepted.

Where a valve or penstock status signal is to be used in more than one circuit (e.g. control and indication), one set of auxiliary or limit switch contacts only together with a slave relay if necessary, shall be used to initiate the operation of all such circuits.

2.30 Operation Of Control Penstocks and Valves

2.30.1 General

In each case where flow or level is to be controlled by a modulating penstock or valve, the installation shall be complete with local manual operation, remote/local selection, local open/close PB's, a controller and a suitably sized actuator with a position indicator. All installations shall be in accordance with this Clause unless otherwise specified in the particular application clause.

Each system shall comply with the operational requirements for the control of the process, but shall include such timers or other means as may be necessary, to ensure that the number of actuator starts and the total actuator running time are within the limitations recommended by the manufacturer.

2.30.2 Hand Controls

For each system there shall be a remote/local selector switch, and raise/lower pushbuttons (non-maintained action). In the case of valves, the pushbuttons shall be labelled "open/close".

2.30.3 Position Indication

Unless otherwise stated in the application clause, the valve or penstock position and status shall be connected to the control and monitoring system via a dedicated Profibus network.

3 INSPECTION AND TESTING

3.1 Works Testing

- Conformity checks.
- Visual inspection.

3.2 On Site

- Appearance.
- Water tests on measurement accuracy.

Checks on flowmeters shall comply with the regulations in force and in particular the provisions of section 81 of the French General Technical Specifications - Works, article 62, and with standard NF ISO 9104 (Method for evaluating the performance of electromagnetic flowmeters used for liquids).

4 CORROSION PROTECTION

See the specifications concerning corrosion protection.

SECTION VII – EMPLOYER'S REQUIREMENTS

PART G: PARTICULAR REQUIREMENTS FOR NEW SEA OUTFALL WORKS

SECTION VII – G: PARTICULAR REQUIREMENTS FOR NEW SEA OUTFALL WORKS

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G.1 SCOPE AND FUNCTIONAL REQUIREMENTS

G.1.1 Works Description

The works include two sea outfalls:

- Jnah Sea Outfall
- Ramlet El Bayda Sea Outfall

The works shall cover all onshore and offshore components required to safely discharge wastewater into the marine environment, due to emergency needs resulting mainly from overflow conditions. Noting that stormwater, could also be mixed with the wastewater to be discharged in the sea outfall. The required works include mainly:

- Jnah Sea Outfall:
  - Onshore Works:

    Extend the existing GRP overflow pipe (900mm Dia.) of pumping station (PS2) located at Jnah to reach the shore line. The onshore extension necessitates to install a new sewer line consisting of:

    ~ HDPE pipes, 800 mm Dia., for a total length of 175m (between MH-02 and MH-03) (Mostly inside existing box culvert and encased in the remaining onshore part).

    Note: the GRP pipes DN 900, shown on drawings as proposed (between MH-A and MH-02), have been recently inspected and found already installed and connected to the existing box culvert.

    ~ Construction of new manhole (MH-02), located directly upstream the connection with the box culvert.

    ~ Wastewater diversion works for construction purposes.

    ~ Construction of a pressurized sewer manhole at the sea shore to connect the overflow pipe to the sea outfall (MH-03).

  - Offshore Works:

    ~ Installation of HDPE sea outfall pipe (1400mm Diameter, L=920m, figures to be confirmed and validated by the Contractor's design) including diffusers and providing all stabilization requirements.

- Ramlet El Bayda Sea Outfall:
  - Onshore Works

    ~ Installation of GRP overflow pipe 800mm. diameter, in Ramlet El Bayda area, starting from the proposed collection manhole (M1) till reaching the shore line (point M7), for about 385m. long.

    ~ Construction of new manholes (from M1 to M6).

    ~ Wastewater diversion works for construction purposes.

    ~ Construction of a pressurized sewer manhole at the sea shore to connect the overflow pipe to the sea outfall (between points: M7 and A).

    ~ Installation of HDPE sea outfall pipe (600mm Diameter, L=1,024m, figures to be confirmed and validated by the Contractor's design, but the diameter should not be less than 600mm), including diffusers and providing all stabilization requirements.

G.1.2 Scope

The Contractor shall perform all marine, bathymetric, geotechnical, hydraulic and environmental investigations necessary for the final design of both sea outfalls.

Reference design documents for the Jnah Outfall and preliminary conceptual documents for Ramlet El-Bayda Sea Outfall are provided for information only and shall not relieve the Contractor of full design responsibility for each of the two sea outfalls.

The Contractor shall design, investigate, construct, commission, operate and maintain two sea outfalls:

- Jnah Sea Outfall
- Ramlet El Bayda Sea Outfall

The works include all onshore and offshore components required to safely discharge wastewater/stormwater into the marine environment.

G.1.3 Functional Objectives

Each Sea Outfall shall:

- Convey the specified design discharge flow;
- Achieve the minimum required dilution ratio;
- Prevent shoreline contamination;
- Remain structurally stable under marine loading;
- Operate reliably during the Operation Period;
- Achieve a minimum structural design life of 50 years.

G.1.4 Design Responsibility

The Contractor shall be fully responsible for:

- All marine investigations (Including; Geotechnical investigations, hydrographic survey, water quality, …)
- All onshore investigations (Including: Topographic survey, upstream pipelines and manholes assessment, survey of nearby structures…)
- Hydraulic design;
- Structural design;
- Diffuser design;
- Stability verification;
- Burial/protection design;
- Environmental compliance.

The Jnah reference design is provided for information only.

The Ramlet El Bayda Sea Outfall shall be fully designed by the Contractor, noting that a draft preliminary concept is provided for information only.

G.2 PERFORMANCE REQUIREMENTS

G.2.1 General

The Contractor shall design, construct and operate the Sea Outfalls to achieve the performance criteria specified herein and in Form 9 – Schedule of Guaranteed Performances.

Failure to achieve the required performance shall trigger the remedies specified in the Contract.

G.2.2 Hydraulic Capacity

- Jnah Sea Outfall: Qmax = 1.5 m^3/s
- Ramlet El Bayda Sea Outfall: Qmax = 0.50 m^3/s

Each sea outfall shall be able to convey its Qmax continuously and safely without surcharge, instability, or loss of performance.

G.2.3 Minimum Discharge Depth

The diffusers shall be located such that the minimum water depth (above the crown of the main pipe) at discharge is not less than 15 m under the defined design water level.

G.2.4 Minimum Initial Dilution

Each diffuser shall achieve initial dilution ≥ 1:50 at design discharge conditions. Compliance shall be demonstrated by validated modelling and, where required, post-commissioning verification.

G.2.5 Hydraulic Integrity

The sea outfall pipeline system shall, as a minimum:

- withstand depression (vacuum) of 0.5 bar;
- be designed with minimum pressure rating PN 6 (or higher as required by design);
- satisfy velocity criteria of ≥ 0.7 m/s (minimum), ≤ 2.0 m/s (preferred average), ≤ 2.5 m/s (peak).

G.2.6 Marine Stability

The sea outfall systems shall remain stable and functional under 50-year storm conditions, adopting as bid-stage basis Hs = 7.1 m and Tp = 13 s, subject to verification/update by Contractor investigations during final design.

G.2.7 Design Life

Minimum design life shall be: 50 years.

G.3 DESIGN CRITERIA

G.3.1 General

The Contractor shall design both Sea Outfalls in accordance with the minimum design criteria specified in this Section.

The design philosophy adopted for the Jnah Sea Outfall shall form the minimum basis of design for both outfalls unless more stringent site-specific conditions are identified by the Contractor's investigations.

All assumptions and calculations shall be documented in the Design Report.

G.3.2 Design Flows

The Sea Outfalls shall be designed for the following minimum discharge capacities:

- Jnah Sea Outfall: Not less than 1.5 m^3/s.
- Ramlet El Bayda Sea Outfall: Not less than 0.50 m^3/s.

The hydraulic design shall ensure safe discharge at peak flow conditions without exceeding allowable upstream pressure limits.

G.3.3 Hydraulic Criteria

The hydraulic design shall be performed using recognized and validated software including hydraulic and marine dispersion modeling and shall comply with the following minimum requirements:

- Flow Regime: Gravity flow.
- Maximum internal velocity shall not exceed 2.5 m/s, for peak flow (Unless justified), while it shall not exceed 2.0 m/s for average flow.
- The system shall prevent sediment deposition (Minimum Self-Cleansing Velocity: 0.7m/s).
- Total headloss shall be calculated including all fittings and diffuser losses.
- Uniform distribution of flow through diffuser ports shall be achieved.
- Maximum backpressure at upstream pumping station shall remain within allowable limits, as follows:

a) Jnah Sea Outfall

The Jnah Sea Outfall shall be designed to ensure that, under normal operating conditions (gravity discharge), the total head required by the Sea Outfall system at the shoreline pressurized connection manhole (MH03) does not exceed 2.04m water head (approximately 0.20 bar). This value represents the maximum total head available at the shoreline connection, as established in the reference design report. Based on this report, the corresponding net available head at the lift station overflow is 3.83m, including an estimated headloss of 1.79m within the onshore section.

Should the Contractor's hydraulic calculations indicate higher headlosses in the onshore section, the Sea Outfall shall nevertheless be designed on the basis of maintaining an available head of 2.04m at the shoreline pressurized connection manhole (MH03). In such case, the Contractor shall consider that pumping into the overflow pipe originating from the existing pumping station will provide sufficient additional head to overcome all linear and singular headlosses within the onshore section while maintaining the required 2.04m head at the pressurized connection manhole (MH03). The possible needed pumping system to be located in the pumping station PS2, in addition to all the necessary works on the existing downstream manholes (to handle the additional head), are not included in the current project scope of work.

The Contractor shall verify these values during detailed design and confirm compatibility with final hydraulic calculations.

b) Ramlet El Bayda Sea Outfall

The Ramlet El Bayda Sea Outfall shall be designed such that, under normal operating conditions (gravity discharge), the total head required by the Sea Outfall system at the shoreline pressurized connection manhole shall be ensured, taking into consideration the total headloss occurred in the onshore section.

The Contractor shall define these values during detailed design and confirm compatibility with final hydraulic calculations.

G.3.4 Marine Environmental Loads

The structural design shall consider as a minimum:

- Wave action;
- Current forces;
- Buoyancy effects;
- Scour and sediment transport;
- Seismic loading.
- Design Wave (Stability): 50-year return period (H1/50).
  - Significant Wave Height (Hs): 7.1 m.
  - Peak Period (Tp): 13 s.
  - Direction: N255° (Prevailing storm direction).
- Currents:
  - Design ambient current speed: 0.05 m/s to 0.25 m/s.
  - Wind-induced shore currents: 0.8 m/s (surf zone).
- Sea Water Density: 1026 kg/m ^{3}.
- Tide Levels (Chart Datum):
  - Mean Sea Level (MSL): +0.20m.
  - Extreme Level (100-year): +0.75m.
- Wind Speed: Design wind speed for modeling 9 m/s.

Where investigations indicate more severe conditions, design shall be updated accordingly.

G.3.5 Stability Criteria

The offshore pipeline and diffuser shall be designed to ensure:

- Stability against sliding;
- Stability against flotation;
- Stability against overturning;
- Resistance to progressive displacement.

Safety factors shall comply with internationally accepted marine design practice.

- On-Bottom Stability: The pipeline must be stable against flotation, drag, and lift forces generated by the 50-year return wave (Hs=7.1m).

- Weighting: Concrete collars/weights must be used. An EPDM rubber gasket must be installed between the pipe and concrete weights to prevent damage.
- Maximum allowable total settlement for pipelines and diffusers is 50 mm

G.3.6 Burial and Protection

The Contractor shall determine burial depth or stabilization measures based on:

- Geotechnical conditions;
- Hydrodynamic loading;
- Scour potential;
- Long-term stability requirements.

Protection measures may include trenching, rock armoring, ballast, or equivalent systems.

- Surf Zone: Buried in trench with backfill up to 13m. water depth with a minimum cover of 1.0m below seabed crown up to 9m water depth
- Offshore/Diffuser: Protected by concrete mattresses, rock armor (15-100 kg grading), or concrete domes over risers to prevent snagging by fishing trawlers.

G.3.7 Diffuser Configuration:

- Riser spacing: 8 m to 12 m intervals.
- Port height: Nominal height exceeding 0.8 m above seabed.
- Port orientation: Horizontal discharge, perpendicular to pipeline axis.

G.3.8 Geotechnical and Marine Investigations

The Contractor shall perform all investigations necessary to define:

- Bathymetry;
- Seabed soil conditions;
- Bearing capacity and settlement;
- Metocean parameters;
- Scour risk.

For the Ramlet El Bayda Sea Outfall, such investigations are mandatory prior to finalizing detailed design.

Reference data provided in the Tender Documents shall be used for information only.

G.3.9 Seismic Design

The sea outfalls shall be designed in accordance with applicable Lebanese seismic regulations.

Seismic effects shall be considered in stability verification and joint integrity.

G.3.10 Durability and Design Life

All components shall be designed to achieve a minimum structural design life of 50 years.

Materials and corrosion protection systems shall be selected accordingly, ensuring appropriate corrosion resistance, pressure resistance, internal abrasion, external abrasion, etc.

G.4 ONSHORE AND OFFSHORE INVESTIGATIONS REQUIREMENTS

G.4.1 General

Onshore investigations: The Contractor shall carry out all onshore investigations including CCTV survey for existing upstream wastewater pipelines and topographic survey for the proposed works locations.

Offshore investigations: The Contractor shall carry out all needed marine, bathymetric, geotechnical, geological and metocean investigations necessary to develop and verify the detailed design of both Sea Outfalls.

Investigations shall be sufficient to:

- Confirm seabed profile and alignment feasibility;
- Establish soil characteristics;
- Determine burial depth and stabilization requirements;
- Verify hydraulic modeling assumptions;
- Confirm environmental conditions.

Existing data provided in the Tender Documents are for reference only and shall not relieve the Contractor of responsibility for adequate investigations.

G.4.2 Bathymetric Survey

The Contractor shall perform updated bathymetric surveys covering:

- Proposed alignment corridor;
- Diffuser zone;
- Shore crossing area;
- Adjacent seabed areas subject to scour.

Survey shall:

- Use multibeam echo sounder or equivalent;
- Be referenced to approved coordinate system;
- Identify seabed obstructions and irregularities;
- Produce contour maps and digital terrain models.

G.4.3 Geophysical Survey

The Contractor shall carry out:

- Side-scan sonar survey;
- Sub-bottom profiling.

These surveys shall define:

- Seabed features;
- Debris or obstructions;
- Sediment thickness and layering.

G.4.4 Geotechnical Investigation

The Contractor shall perform marine geotechnical investigations sufficient to determine:

- Soil classification;
- Shear strength parameters;
- Bearing capacity;
- Settlement characteristics;
- Liquefaction potential (if applicable);
- Scour susceptibility.

Investigations shall include offshore boreholes, sampling and laboratory testing as required.

For the Ramlet El Bayda Sea Outfall, such investigations are mandatory prior to finalizing design.

G.4.5 Metocean Data

The Contractor shall establish site-specific metocean parameters including:

- Wave height and period;
- Current velocities and directions;
- Tidal variation;
- Wind data;
- Seasonal variations;
- Storm return periods.

Where long-term measured data are unavailable, validated marine databases may be used subject to approval.

G.4.6 Environmental Baseline Data

The Contractor shall collect or verify marine environmental data necessary for hydraulic dispersion modeling, including:

- Water temperature profiles;
- Salinity stratification;
- Background water quality;
- Seasonal variations.

G.4.7 Deliverables

The Contractor shall submit:

- CCTV report for existing wastewater pipelines inspection
- Topographic survey
- Bathymetric survey report;
- Geophysical survey report;
- Geotechnical investigation report;
- Metocean report;
- Environmental baseline report;

- Alignment recommendation report;
- Design parameter summary.

All reports shall include raw data and interpreted results.

G.4.8 Alignment Finalization

The final alignment of both Sea Outfalls shall be determined by the Contractor based on investigation results and submitted for approval.

Alignments shown in Tender Documents are indicative only.

G.4.9 Responsibility

The Contractor shall bear full responsibility for:

- Adequacy of investigations;
- Interpretation of data;
- Suitability of final alignment;
- Design based on obtained information.

No additional payment shall be made due to seabed conditions identified through investigations.

G.5 MATERIALS AND CONSTRUCTION REQUIREMENTS

G.5.1 General

The Contractor shall supply all materials, equipment and components necessary for the complete execution of the Sea Outfall Works.

All materials shall be:

- New and unused;
- Suitable for continuous marine exposure;
- Compatible with design pressure and environmental conditions;
- Selected to achieve a minimum structural design life of 50 years.

G.5.2 Pipeline Materials

Offshore and onshore pipelines may consist of HDPE, GRP, GRE or other suitable marine-grade materials, subject to approval.

The selected pipe material shall:

- Be rated for maximum operating and surge pressure;
- Be resistant to marine corrosion and abrasion;
- Be suitable for burial and seabed conditions;
- Be compatible with selected installation method.
- 50-year durability

The Contractor shall specify:

- Pipe class and pressure rating;
- Wall thickness or SDR;
- Jointing method;
- Applicable manufacturing standards.

G.5.3 Diffuser System

The diffuser system shall:

- Be fabricated from marine-resistant materials;
- Resist marine growth and abrasion;
- Maintain hydraulic performance over time;
- Be structurally stable under marine loading;
- Be accessible for inspection and maintenance.
- 50-year durability

The Contractor shall determine:

- Number of ports;
- Port diameter;
- Port spacing;

- Port orientation;
- Diffuser length.

G.5.4 Corrosion Protection

All metallic components exposed to marine environment shall be protected by:

- Approved protective coating systems; and/or
- Cathodic protection systems.

Corrosion protection shall be designed for the full design life of the Sea Outfalls.

Monitoring and maintenance of corrosion protection systems shall be included in the Operation Period obligations.

G.5.5 Concrete and Structural Works

Concrete used for:

- Chambers;
- Anchor blocks;
- Thrust blocks;
- Encasement
- Shore crossing protection;
- Protection and stabilization structures;

shall be designed for marine exposure conditions in accordance with applicable standards.

Reinforcement shall be adequately protected against corrosion.

G.5.6 Installation and Workmanship

The Contractor shall execute all works in accordance with:

- Approved method statements;
- Recognized marine construction practices;
- Manufacturer recommendations;
- Technical Specifications annexed to this Section.

The Contractor shall remain responsible for:

- Stability during installation;
- Temporary works;
- Safety of marine operations.

G.5.7 Quality Control

The Contractor shall implement quality control procedures covering:

- Material manufacturing;
- Coating application;
- Jointing procedures;
- Installation tolerances;

- Testing and inspection.

Inspection and Test Plans shall be submitted for approval.

G.5.8 Protection During Construction

During construction, the Contractor shall:

- Protect installed pipeline sections;
- Prevent excessive seabed disturbance;
- Avoid environmental contamination;
- Protect existing utilities and infrastructure.

G.5.9 As-Built Verification

Upon completion of construction, the Contractor shall submit:

- As-built drawings;
- Post-installation bathymetric survey;
- Verification of burial depth;
- Verification of diffuser positioning.

SECTION VII – G: PARTICULAR REQUIREMENTS FOR NEW SEA OUTFALL WORKS

G.6 TESTING AND COMMISSIONING REQUIREMENTS

G.6.1 General

The Contractor shall carry out all testing and commissioning activities necessary to demonstrate that both Sea Outfalls:

- Comply with the Employer's Requirements;
- Achieve the guaranteed performances specified in Form 9;
- Are hydraulically compatible with the upstream pumping stations;
- Meet structural, environmental and operational requirements.

Commissioning shall not be deemed complete until all required tests have been successfully performed and approved.

G.6.2 Pre-Commissioning Submissions

Prior to commencement of testing, the Contractor shall submit for approval:

- Detailed Testing and Commissioning Plan;
- Hydrostatic testing procedures;
- Instrument calibration procedures;
- Diffuser inspection methodology;
- Marine safety procedures during testing;
- Environmental verification plan.

No testing shall commence without approval of the Testing and Commissioning Plan.

G.6.3 Pre-Commissioning Mechanical and Structural Verification

Before hydraulic testing, the Contractor shall verify:

- Installation of pipeline sections in accordance with approved drawings;
- Alignment and elevation tolerances;
- Burial depth (where applicable);
- Installation of ballast, rock protection or stabilization systems;
- Installation and integrity of diffuser system;
- Installation of valves and instrumentation;
- Installation and activation of corrosion protection systems.

Verification shall include post-installation bathymetric survey and visual inspection (diver or ROV).

G.6.4 Hydrostatic and Pressure Testing

Where applicable, the Contractor shall perform hydrostatic testing of pipeline sections in accordance with approved procedures.

Testing shall verify:

- Structural integrity;
- Joint tightness;
- Absence of leakage;

- Compliance with design pressure rating.

Test pressure shall be defined based on final design pressure and surge analysis.

All test results shall be documented.

G.6.5 Hydraulic Commissioning

During commissioning at design discharge conditions, the Contractor shall verify:

- Achieved discharge flow (Qmax);
- Pressure at upstream pumping station discharge flange;
- Total headloss across the Sea Outfall system;
- Compliance with maximum allowable backpressure limits defined in G3.3;
- Absence of abnormal vibration or structural movement.

For Jnah Sea Outfall, total required head at the shoreline interface shall not exceed the specified allowable head.

For Ramlet El Bayda Sea Outfall, total dynamic head shall remain within the rated duty head of the associated pumping station.

G.6.6 Transient and Surge Verification

The Contractor shall verify that start-up, shutdown and emergency operating conditions do not generate unacceptable surge pressures.

G.6.7 Diffuser Performance Verification

The Contractor shall demonstrate that the diffuser system:

- Achieves minimum initial dilution ratio of 1:50 at design discharge;
- Provides uniform discharge distribution among ports;
- Operates without blockage or malfunction.

Verification shall be based on:

- Approved hydraulic and dispersion modelling;
- Field verification or monitoring where required.

G.6.8 Environmental Compliance Verification

During commissioning, the Contractor shall verify that:

- No visible surface pollution occurs;
- No shoreline contamination is observed under design conditions;
- Discharge complies with applicable environmental standards.

Environmental verification shall be documented.

G.6.9 Instrumentation and Monitoring Systems

All monitoring instruments associated with the Sea Outfalls shall be:

- Installed;
- Calibrated;
- Integrated with SCADA (where applicable);

- Functionally tested.

Instrumentation shall include, where applicable:

- Flow measurement;
- Pressure monitoring;
- Corrosion monitoring systems.

G.6.10 As-Built Documentation

Upon completion of commissioning, the Contractor shall submit:

- Final as-built drawings;
- Post-installation bathymetric survey;
- Hydraulic performance verification report;
- Structural verification report;
- Corrosion protection commissioning records;
- Final testing and commissioning report.

G.6.11 Completion of Commissioning

Commissioning of each Sea Outfall shall be considered complete only when:

- All tests have been successfully performed;
- All performance guarantees have been demonstrated;
- All documentation has been submitted and approved.

Approval of commissioning does not relieve the Contractor from obligations during the Operation Period.

G.7 OPERATION AND MAINTENANCE REQUIREMENTS

G.7.1 General

The Contractor shall operate and maintain both Sea Outfalls throughout the Operation Period in accordance with approved Operation and Maintenance Manuals.

The objective shall be to ensure:

- Continuous reliable discharge;
- Compliance with environmental standards;
- Preservation of structural integrity;
- Achievement of guaranteed performances.

G.7.2 Routine Inspection

The Contractor shall perform periodic inspections including:

- Visual inspection of onshore components;
- Underwater inspection (diver or ROV) of offshore pipeline and diffuser;
- Inspection following major storm events;
- Monitoring of burial condition and seabed stability.

Inspection frequency shall be defined in the O&M Manual.

G.7.3 Preventive Maintenance

Preventive maintenance shall include:

- Cleaning of diffuser ports where required;
- Inspection and maintenance of corrosion protection systems;
- Valve inspection and servicing.

G.7.4 Corrective Maintenance

In case of defect or malfunction, the Contractor shall:

- Diagnose the issue;
- Implement corrective repair;
- Restore full operational performance;
- Report corrective actions taken.

All corrective works shall be executed at no additional cost to the Employer.

G.7.5 Monitoring and Reporting

The Contractor shall:

- Maintain monitoring records;
- Submit periodic reports;
- Immediately report any non-compliance or abnormal condition.

G.8 PERFORMANCE GUARANTEES

G.8.1 General

The Contractor shall guarantee that both Sea Outfalls achieve the performance criteria specified in Form 9 – Schedule of Guaranteed Performances.

Failure to achieve guaranteed performance shall trigger remedies defined in the Contract.

G.8.2 Minimum Performance Parameters

The below refined minimum performance parameters shall be adopted.

1. Capacity
   - Jnah Sea Outfall – Design discharge (Qmax): 1.5 m^3/s (basis from Lot 4 design/spec)
   - Ramlet El Bayda Sea Outfall – Design discharge (Qmax): 1.0 m^3/s

Requirement statement (for both): Each sea outfall shall safely convey Qmax continuously without instability, failure, or loss of performance.

2. Minimum discharge depth at diffuser
   - Minimum discharge depth at diffuser (both sea outfalls): ≥ 15 m below water level

Requirement statement:

The diffuser shall be located such that the minimum water depth at the diffuser is not less than 15 m under the defined design water level (Offshore pipeline length may change accordingly).

3. Minimum initial dilution
   - Minimum initial dilution (both outfalls): ≥ 1:50

Requirement statement:

The diffuser shall achieve initial dilution ≥ 1:50 at design discharge conditions using validated mixing/dispersion modelling.

4. Hydraulic limits (set as guaranteed operational constraints)
   a) Depression (vacuum resistance)
      - Minimum allowable depression resistance (both outfalls): 0.5 bar
   b) Design pressure rating
      - Minimum pressure class for outfall pipeline: PN 6 (minimum)
      - Plus: bidder to confirm surge and operating pressures in design report.
   c) Velocity limits
      - Minimum self-cleansing velocity: ≥ 0.7 m/s
      - Preferred average velocity: ≤ 2.0 m/s
      - Peak velocity allowable: ≤ 2.5 m/s (only at peak flow)
5. Structural / marine performance
   - Design storm return period: 50-year event
   - Design offshore significant wave height (basis value): Hs = 7.1 m (bid-stage basis)
   - Peak period (basis value): Tp = 13 s (bid-stage basis)

SECTION VII – G: PARTICULAR REQUIREMENTS FOR NEW SEA OUTFALL WORKS

Requirement statement: The outfall system (pipeline + diffuser + protections) shall remain stable and functional under the 50-year storm marine loading.

6. Durability / service life guarantees

- Pipeline & diffuser structural design life: 50 years
- Valves / mechanical components minimum design life: 25 years (Lot 4 spec basis)
- Corrosion protection system design life: bidder shall state, but not less than the above design life intent for protected components (and must be maintainable during DBO period).

7. Operational availability (DBO-specific)

You need something measurable but not overly complex:

- Availability of each outfall during Operation Period: Bidder to propose ≥ 98 %

8. Remedies

Where guaranteed performances are not achieved, the Contractor shall:

- Implement corrective measures;
- Modify, repair or upgrade components;
- Achieve compliance at his own cost.

SECTION VII – EMPLOYER'S REQUIREMENTS

PART H: TECHNICAL SPECIFICATIONS FOR NEW SEA OUTFALL WORKS

SECTION VII – H: TECHNICAL SPECIFICATIONS FOR NEW SEA OUTFALL WORKS

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SECTION VII – H: TECHNICAL SPECIFICATIONS FOR NEW SEA OUTFALL WORKS

Preliminary Note

This part has been extracted entirely from the tender documents prepared by Khatib & Alami for CDR for: *"Beirut City Services Upgrading project, Phase III - Lot IV"*, Specifications.

The extracted information relates to the implementation of the new Jnah Sea Outfall. The Contractor shall note that these specifications shall also be appropriately applied to the new Ramlet El-Bayda Sea Outfall.

The mode of measurement of items mentioned in this part are not to be applied; measurement will be applied as mentioned in the "Price Schedules" included in Part 1 of these tender documents.

H.1 PARTICULAR CONTRACT REQUIREMENT

H.1.1 Outfall Stability

According to local constraints, the Contractor may consider to respect different stability design depending on pipe location. The Contractor must guarantee for each pipe part parameters contributing to pipe stability.

Outfall weight

The Contractor guarantees the actual pipe weight with attached weights.

Backfill

The Contractor guarantees the contribution of backfill material to the outfall stability. Field or model tests may be required to be run by the Contractor at his own cost to support contribution values he indicates.

Anchoring

Anchors are not allowed in the area where sea bed level may vary during storms. Resistance of anchors indicated by the Contractor will be controlled on site before their use.

Respect of hydro sedimentary constraints

The Contractor guaranties a minimum burial of the top of the pipe and weights of 1.0 m in water depths shallower then 9 m.

Overpressure

The Contractor will install a pipe (pipe and all related devices, joints, valves, …) of ISO PN nominal pressure greater than 1.5 times the functioning pressure (including transitional phenomena) for a 1.5m^3/s discharge.

Depression

For compatibility with the waste water treatment surge devices, the Contractor guaranties his pipe at least accepts a 0.5 bar depression.

Limit Wave Height

The Contractor subscribes to limit wave height values beyond which outfall works are suspended. These values may be different according to the works phase (dredging, pipe laying, backfilling, …).

Design Life of structures and equipment

Minimum 50-year life duration is requested for the outfall and its fittings.

The Contractor indicates the guaranties he subscribes in terms of life duration for:

- Corrosion resistance,

- Pressure resistance,
- Internal abrasion,
- External abrasion,
- Weighing elements (concrete weights, individual weights, additional weighing materials, …).
- Hydrodynamic stability, checked by using 50-year return period H1/50 wave height. The wave height H1/50 is equal to 7.1m and is to be taken as an indicative value for the bidding stage. The exact wave height value shall be obtained from Beirut Harbour Authority at the final design stage.

H.1.1.1 Design By the Contractor

The Contractor shall be responsible for all aspects of the detailed design of the Sea Outfall works. Detailed topographic surveys and data collection shall be carried out before the design.

The Contractor shall take due account of the requirements and criteria stated in the Tender Documents. Consideration shall be given to the need for air release and the prevention of choking due to variations in flow rate and sea level.

The civil and structural design shall be carried out in accordance with the requirements of the Tender Documents.

The design of the outfall shall be based on a peak water flow of 1.5 m^3/s.

Flow shall be by gravity.

The pipeline will be laid in trench in the sea bed in depths up to 13 m.

It is generally considered that velocity should be at least 0.7 m/s, but not higher than 2 m/s for average flow. A velocity till 2.5 m/s can be considered as acceptable only for peak flow.

The outfall structures and pipeline shall have a design life of 50 years in accordance with industry standards.

Mechanical equipment (valves) shall have a minimum design life of 25 years. The design of all structures and pipelines shall take full account of the harsh environmental conditions, including wind, waves, currents, and salt sprays.

Pipelines, diffusers and protection structures within the sea shall be limited to a total settlement of 50 mm.

The marine section of the pipeline shall be buried within a dredged trench with a minimum cover depth of 1.0 m below the crown of the pipe up to a water depth of 9m.

The diffuser shall be as per drawing No. BY163000-N-182.

Pipeline, riser, crosshead and discharge nozzle sizes shall be selected in the design to achieve good flow balance between individual ports.

All diffuser ports shall be at a nominal height exceeding 0.8 m above the seabed.

Each riser/crosshead assembly shall be provided with a covering structure to provide protection against snagging by dragging lines, cables, fishing equipment etc. The protection structure shall be fabricated in the basic shape of a dome or truncated pyramid, in either precast concrete or stainless steel and shall be founded at a depth of at least 1m below the seabed/scour protection, with no structural connection to the diffuser pipework. The protection structure shall extend above and around the crosshead and shall incorporate appropriate openings so as to avoid any restriction of the discharge flow.

The diffusers shall be provided with scour protection stone of nominal size 15–100 kg.

Each riser pipe shall incorporate a dismantling flange.

The diffuser shall be terminated by a flanged 45 degrees bent closed with a bolted blank flange to PN10.

At the maximum flow rate, the discharge flow volume from each individual diffuser port shall be within 10 % of the mean value for all ports.

The outfall pipe and diffuser shall be stable against wave action currents and buoyancy.

The marine trench backfill and diffuser anti-scour protection shall be designed to avoid liquefaction of the bed and backfill during the early months following installation, to secure the outfall pipe for the 50-year design life and to restrict settlement of the diffuser in compliance with the specified limits.

The Contractor's engineer shall prepare a detailed design of the outfall including at least the following:

- Detailed calculations of the outfall for the temporary and permanent stages. The calculations shall be in English and submitted to the Engineer for review and approval in four hard copies.
- Detailed computerized construction drawings, submitted for the Engineer's review and approval in four hard copies and a soft one.
- All relevant and required modifications to the calculations and/or drawings arising from adjustments and/or changes during construction.
- Complete "As Built" drawings at the completion of the works. These drawings shall be submitted in six soft copies.
- Drawings to be submitted in the latest version of AutoCAD or similar software.

The Contractor is responsible to prepare all required calculations and documents in order to obtain the required permit for works.

The design prepared by the Contractor shall be submitted to the Engineer for review and approval upon completion of the following stages:

- Preliminary design
- Final design
- Detailed design

The Contractor shall complete all design work in 56 days from the date of issuing by the Engineer of the Order of Commencement.

H.1.2 Datum

The levels of the works are related to the National Elevation of Lebanon. For the purpose of this contract this datum is also referred to as Mean Sea Level. A suitable benchmark will be established and agreed with the Engineer. This benchmark shall form the sole point of reference for the execution of the works to avoid errors the same level datum shall be used for both the wastewater treatment plant and the sea outfall.

H.1.3 Standard Specification

For convenience, and in order to establish the necessary standards of quality, reference has been made to specifications issued by national or other widely recognized bodies. Such specifications shall be referred to as "Standard Specifications" and shall be the latest editions of such standard specifications issued prior to the issue of the Tender Documents, together with such additions and amendments as may have been issued prior to the same date.

Subject to the written approval of the Engineer, any other internationally accepted standard which requires an equal quality of work may be used.

In referring to Standard Specifications, the following abbreviations are used:

ANSI	American National Standards Institute

API	American Petroleum Institute
ASTM	American Society of Testing and Materials
AWWA	American Water Works Association
BS	British Standards
ISO	International Organization for Standardization
WIS	Water Industry Standard (UK)
EN	European Standards

If the Contractor proposes to use a Standard Specification other than that specified, three copies of the proposed Standard Specification with translations in the English language, if the Specification is in another language, shall be submitted to the Engineer not less than 28 days before approval of the Standard Specification is required.

Copies, in English language, of all Standards used in connection with the Works shall be supplied to the Engineer.

Proper storage of materials, fuel, plant and equipment. The stores shall be of such size and construction that they shall provide adequate storage and protection of stocks of materials, fuel, spares, etc, in quantities ensuring uninterrupted progress of the work, and the workshops shall be suitably equipped to provide for carrying out major repairs, overhaul or modification by the Contractor of all plant and equipment in or on the works.

The location of all offices and stores shall be agreed beforehand with the Engineer and shall be such as to avoid obstruction or nuisance to the public.

The Contractor shall also provide sufficient closets or latrines to the satisfaction of the Engineer and relevant authority. They shall be properly screened and maintained in a clean and sanitary state at all times.

The Contractor shall be responsible for making all arrangements for the proper disposal of waste.

H.1.4 Available Survey Information

A marine survey for the outfall route was carried out by the Lebanese Army.

H.1.5 Environmental Aspects

The Contractor shall take all reasonable steps to minimize the adverse effects of both the temporary and permanent works on the environment. Before any work commences (and in case within 28 days of the commencement date) the Contractor shall submit an environmental protection plan in accordance with the EIA Study and the Mitigation and Protection Measures for the construction of the Jnah Sea Outfall describing how potential adverse impacts will be mitigated.

The Contractor shall comply with the requirements of CDR Safety, Health and Environmental Regulations.

H.2 MATERIALS AND WORKMANSHIP

H.2.1 Materials – General

All pipes, fittings and appurtenances used in the works shall be to the relevant standards and shall be clearly marked with the standard mark, where appropriate, manufacturer's name or mark, date of manufacture, nominal size and class of pipe.

Wherever in the Specification tests on materials and tests on completed items are called for or implied, they shall be carried out according to, and the materials shall comply with the requirements of the standard Specification. Other equivalent national standard specifications may be substituted for the above at the sole discretion of the Engineer if requested by the Contractor.

H.2.2 Pipework

H.2.2.1 Pipes

It shall be the Contractor's responsibility to determine the optimum pipe length for construction in considering manufacture, shipping, and haulage eventually by floating by strings at sea, delivery to site, condition of roads, traffic management and minimization of welded joints.

The ends of the pipes shall be suitably protected during transport, handling and storage.

Test certificates for all pipes will be required.

The Contractor shall exercise due care and attention to prevent damage to the pipe.

Temporary transit packing shall not be removed until the pipe is being strung in the assembly area. Pipes shall not be moved by rolling.

Pipes in temporary storage shall be laid on wedged timber bearers, such that the pipe is at least 75mm above the ground and a solar reflective coating shall be applied to protect the coating.

The time period between delivery of the pipe and installation shall not exceed six months.

H.2.2.2 Fittings

Flange joints shall be supplied complete with all necessary bolts, nuts, and gaskets and shall be protected, where buried, with denso-paste, denso-tape and polyethylene sheeting, or similar approved wrapping, which shall be installed in accordance with the manufacturers written instructions and to the approval of the Engineer.

H.2.2.3 High Density Polyethylene Pipes

High density polyethylene pipes are used for marine section and those for below ground use in nominal sizes greater than 63 shall comply with the relevant provisions of WIs No. 4-32-03. Pipes may be High Density polyethylene (HDPE) of minimum pressure rating PN 6. Normal outside diameters and normal pressures shall be in accordance with the requirements of ISO 161-1:1996, Part 1, Metric series. A bending radius of 60 times the Diameter (Rmin = 60.D) can be considered to be minimum radius for the pipe during sinking.

Pipes shall be joined by butt fusion welding, unless otherwise specified by the Engineer. Polyethylene butt fusion joints and fittings shall comply with relevant provisions of BS EN 12201-5:2011.

Polyethylene piping shall be laid in accordance with the pipe manufacturer's recommendations and to the approval of the engineer. The contractor shall comply with the manufacturer's recommendations to minimize the effects of expansion because of differences in temperature during installation. Anchoring requirements shall be determined by the contractor's calculation to be approved by the Engineer.

H.2.2.4 Measurement

Total price shall include supplying, installation, testing and commissioning (Linear meter)

H.2.3 Sacrificial Anode Protection

All flange studs, concrete weights, supplemental weight hardware, and other pipeline steel elements shall be protected against corrosion by Contractor supplied and installed sacrificial anodes sufficient to protect for a 50-year life from installation.

Calculation and details for all the above shall be submitted to the Engineer for approval along with the complete material specification from the manufacturer.

Alternative protection systems would be considered. Where the Contractor proposes alternative systems, the tender must be accompanied by details and specifications.

H.2.4 Materials for Bedding and Backfill

Imported backfill material, including material for the bedding of the pipeline, protection of the pipe against rock armor and rock armor shall be quarried hard stone, predominantly free of intrusions and unweathered. Rock and stone shall be clean, sound, durable, free from earth or other soft or decomposed or injurious materials and shall show no cracks or fissures caused by the initial processes of decomposition, and shall not break down in the seawater existing at the Site.

If suitable, the dredged material can be used as a substitute of imported Type 2 material. This will have to be approved by the Engineer after the examination of representative samples of the dredged material for each fill load.

Armor shall be hard dense rock obtained from a quarry with a proven record of supplying stone for marine works and shall comply with the following requirements:

a) Shape of pieces
   Pieces of rock shall have an aspect ratio, i.e. the ratio between the greatest dimension and the least dimension of the piece), not greater than three.
b) Specific gravity:
   Rock material shall have an apparent specific gravity of not less than 2.6 where apparent specific gravity is defined as the ratio of the bulk density of the rock material as its natural moisture content to the density of pure water.
   Bulk density shall be measured in accordance with the test for determination of relative density in BS EN 1097-3:1998.
c) Water absorption
   When tested as set out in BS 812-109:1990, rock for armor shall not absorb more than 2.5 per cent by weight.
d) Aggregate impact value
   When tested as set out in BS EN 1097-2:2010, rock for armor shall have an aggregate impact value not greater than 20 per cent using the standard test fraction.
e) Bedding, pipe surround, rock armor materials.

H.2.4.1 Measurements

Total price shall include supplying & installation (Linear meter)

H.2.5 Concrete

H.2.5.1 Cement

Cement shall be Ordinary Portland Cement or an equivalent approved brand complying with the requirements of BS EN 197-1:2011 and Sulphate Resisting Portland Cement complying with the requirements of PD CEN/TR 15697:2008 or ASTM Type V cement.

Alternatively, cement may be a normal or special combination of cement complying with the relevant provisions of BS EN 197-1:2000 and ggbs or pfa in accordance with the table below, to be included as part of the concrete mix by simultaneously combining them with the other concrete materials at the concrete mixer.

Cementitious component other than cement	Use of concrete	British Standard to be complied with	Percentage by mass of total cementitious content	
			normal	special
pfa	Any	BS 3892-3:1997	15-35	25-40
ggbs	Concrete designed to retain an aqueous liquid	BS 6699	0-50	70-90
ggbs	Other	BS 6699	0-65	70-90

The cement shall be delivered to Site in the Manufacturer's original sealed and branded bags and stored in a proper manner off the ground to prevent deterioration. The Contractor shall submit a weekly report to the Engineer showing the amount of cement brought to Site, the amount of cement used, and the balance left on Site, the oldest batch being used first.

The Engineer may ask the Contractor to test any cement brought to the Site as he sees fit. Should any cement fail to pass the required tests, it shall not be used in the works and shall be removed from Site all at the Contractor's expense.

The Contractor shall propose the proportions of ggbs on pfa to meet normal or sulphate resisting conditions to the Engineer for approval.

For all cement used in structural concrete the Contractor shall provide when requested by the Engineer certificates of the relevant proportions of any ggbs or pfa.

H.2.5.2 Ground Granulated Blast Furnace Slag

Ground granulated blast furnace slag (ggbs) for use with Portland cement shall comply with BS 6699.

H.2.5.3 Pulverized-Fuel Ash

Pulverized-fuel ash (pfa) for use as a component material in cementitious grout or non-structural concrete shall comply with BS 3892-3:1997.

Pfa for use as a cementitious component in structural concrete and annulus grouts shall comply with BS EN 450-1:2005+A1:2007. Pfa for annulus grouts shall be pre-blended and bagged before delivery to the Site.

The maximum sulphate content of pfa expressed as SO3 shall be 2.5 per cent by weight of pfa but if the weight of pfa in the mix exceeds the weight of cement in the mix, the maximum content of SO3 shall be 1.5 per cent.

The maximum SO3 content of the mix shall not exceed the limit given elsewhere in the Specification.

The fineness as expressed by the specific surface shall be within the range of Zones B or C in BS 3892-3:1997, and not more than one test in ten shall show a result falling outside this range.

Pulverized fuel ash shall only be used in conjunction with cement complying with BS EN 197-1:2000 and the total sulphate content of the mix from all sources, expressed as SO3 shall not exceed that stated elsewhere in the Specification.

H.2.5.4 Water

All water used for washing the aggregates, mixing the concrete or curing purposes shall be clean drinking water free from all foreign matter such as organic impurities, acids or salt in such quantities as to cause efflorescence on the face of the concrete. It shall be free of all matter that would adversely

affect the setting time or strength of the concrete, or that may instigate electrochemical corrosion of the reinforcement. The water shall pass the tests in BS EN 1008:2002.

At the commencement of the Works the Contractor shall if requested by the Engineer, send a sample of the water proposed for concrete and mortar to an accredited laboratory capable of carrying out the required analysis of the water.

The results of the analysis shall be submitted to the Engineer. The sample of water sent for analysis shall be taken in the presence of the Engineer.

H.2.5.5 Aggregates for Concrete

Materials used as aggregates shall be obtained from a source known to produce aggregate satisfactory for concrete and shall be chemically inert, strong, hard, durable of limited porosity, and free from adhering coatings, clay lumps and organic impurities that may impair the strength or durability of the concrete.

The sulphate (expressed as SO3) and chloride (NaCl) content of fine and coarse aggregate when determined by standard chemical analysis shall not exceed 2.0 per cent and 0.8 per cent respectively.

The aggregate shall be tested by the Contractor at his expense as outlined in BS. 812. Test certificates shall be submitted to the Engineer for his approval prior to any concreting being carried out. The Engineer may require the Contractor to wash the aggregates he proposes to use should this be necessary. If at any time a significant physical or chemical change in the nature of the aggregates occurs, or a new source is used, the Engineer may direct that some or all of the tests be repeated.

Coarse Aggregate

Coarse aggregate shall be crushed or uncrushed gravel or crushed stone. It shall be structurally and chemically stable and shall be free from impurities, organic matter, or dust. When subjected to the abrasion test according to the Los Angeles method (Ratlers Test) the loss shall not exceed 10% per 100 revolutions of the drum nor exceed 35% per 500 revolutions of the drum.

Nominal sizes of aggregates shall be in accordance with Table 1 below.

Table 1: Coarse Aggregate Gradation

zA	Percent by Weight Passing of Nominal Size			
	1/2”	3/4”	1/2”	3/8”
2”	100			
1 1/2”	85-100	100		
3/4”	0-20	85-100	100	
1/2”			85-100	100
3/8”	0-5	0-20	0-45	85-100
No.4		0-5	0-10	0-20
No.8				0-5

Fine Aggregate

The fine aggregate shall be clean sharp, coarse natural sand or sand obtained by crushing suitable gravel or stone stable in composition free of organic matter and chemical impurities, and shall not contain more than 2% of silt by weight. The grading of fine aggregate shall be in accordance with Table 2 below.

Table 2: Fine Aggregate Gradation

Size of Sieve	Percent by weight passing
3/8”	100
No.4	95-100
No.8	80-100

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No.16	50-85
No.30	25-60
No.50	10-30
No.100	2-10
No.200	0-2

Delivery and Storage of Aggregates:

Aggregates shall be delivered to Site in clean and suitable vehicles. Different types or sizes of aggregate shall not be delivered in one vehicle

Each type of size of aggregate shall be stored in a separate bin or compartment having a base such that contamination of the aggregate is prevented. Dividing walls between bins shall be substantial and continuous so that no mixing of types or sizes occurs.

The storage of aggregates shall be arranged in way so that as far as possible rapid drying out in hot weather is prevented in order to avoid sudden fluctuations in water content. Storage of fine aggregates shall be arranged so that they can drain sufficiently before use in order to prevent fluctuations is water content of the concrete.

H.2.5.6 Admixtures for Concrete or Grout

Accelerating, retarding and water-reducing admixtures for concrete or grout shall comply with the relevant provisions in BS EN 480. Air-entraining admixtures shall comply with the relevant provisions of BS EN 480. Super plasticizing admixtures shall comply with the relevant provisions of BS EN 480.

Calcium chloride shall not be used in concrete which is to be reinforced, contain embedded metal, or has been designed to retain an aqueous liquid. Where used with sulphate-resisting cement, or in concrete which is to be reinforced or contain embedded metal, the chloride ion content of admixtures shall not exceed 2% by mass of the admixture or 0.03% by mass of the cement. Admixtures containing chlorides shall not be used in reinforced concrete designed to retain an aqueous liquid.

General

a) The use of admixtures in concrete may be required under the Contract to promote special properties to the concrete or may be proposed by the Contractor to assist compliance with the Specifications. In all cases the Contractor shall submit to the Engineer full details of the admixture he proposes to use and the manner in which he proposes to add it to the mix. The information provided shall include:

   1. The typical dosage and the detrimental effects of an excess or deficiency in the dosage.
   2. The chemical names of the main active ingredients in the admixture.
   3. Whether or not the admixture contains chlorides, and if so, the chloride ion content expressed as a percentage by weight of admixture.
   4. Whether the admixture leads to the entrainment of air when used at the manufacturer's recommended dosage, and if so, the extent to which it does so.
   5. Long- and short-term effects of the admixture on concrete including the effects on different types of cement and aggregates.
   6. Storage life.
   7. Safety precautions required in handling.
   8. Compatibility with other additives.
   9. Compliance with Standards.

b) The chloride ion content of any admixture shall not exceed 2 per cent by weight of the admixture nor 0.03 per cent by weight of the cement in the mix.
c) Admixtures shall not be mixed together without the consent of the Engineer.

Super Plasticizing Admixtures

a) Super plasticizing Admixtures shall comply with BS EN 480.

b) If the Specification or the Drawings specify or the use of super plasticizing admixtures is subsequently authorized by the Engineer, the Flow Table test carried out in accordance with BS EN 12350-5:2009 shall be used to control and record workability.
c) Test cubes shall be made in accordance with BS EN 12390-3:2009 except that the concrete shall be placed in the cubes and compacted to the same degree as the concrete placed in the Works.
d) In addition to the normal trial mix cubes required an additional set of cubes shall be made with 1.5 times the intended super plasticizing admixture addition to assess the effect of over dosage on the concrete.
e) If the super plasticizing additive is not specified but the Contractor requests permission to use it, the Engineer shall not approve its use unless full particulars including chemical constituents of the admixture are submitted and the additional trial mixes mentioned above have been carried out and all are considered satisfactory.
f) The Engineer reserves the right to refuse the use of upper plasticizing admixture for concrete required for particular structures.

Air Entraining Agents

a) In addition to the general requirements, air entraining agents shall be capable of producing air content in concrete mixes within the limits stated in the Specification or on the drawings without any tendency to produce excessive air content in the event of prolonged mixing times.
b) The effect of a proposed air entraining agent shall be tested by the Contractor in trial mixes produced in the plant which he proposes to use for the Permanent Works.
c) Air entraining agents shall comply with BS EN 480.

Workability Agents

a) Subject to the agreement of the Engineer, admixtures may be used by the Contractor to assist in meeting the requirements of the Specification or to aid the placing of concrete.
b) Workability agents shall comply with BS EN 480 and shall not have any adverse effect on the properties of the concrete. If a reduction in strength of the concrete is caused, the Contractor shall counteract this by a reduction in water cement ratio or by an increase in cement content.

H.2.6 Steel Reinforcement

The steel reinforcement for concrete shall comply with the requirements of BS 4449:2005+A2:2009 with Type 2 bond classification.

All hard drawn steel wire mesh fabric shall conform to BS 4483:2005. The main wires shall be held rigidly at the correct spacing by cross-wires electrically welded to them.

H.2.7 Precast Concrete Units

H.2.7.1 General

Precast concrete units shall be provided by an approved specialist supplier or may be manufactured by the Contractor if the Contractor's samples and workmanship are approved.

H.2.7.2 Precast Concrete Blocks

Precast Concrete Blocks shall conform to BS 2028, 1364 Type `A' Dense Aggregate Blocks. Blocks shall be solid or hollow, of the sizes required and shall be made in approved molds of metal construction of sufficient strength to ensure the manufacture of blocks of even size and shape.

Concrete blocks for general walling shall be of an approved size. Cutting where necessary shall be such that clean sharp arises are produced without fracture or cracking of the portion to be used. Voids in cut blocks shall be filled solid with concrete.

Where concrete blocks are described as 'hollow', cavities are not to exceed 1/3 of the bearing surface and the material is in no case to be less than 50mm thick.

The face of concrete blocks to be plastered shall have a reasonably dense fair finish from molds.

The face of concrete blocks for finishing fair face shall have a smooth and dense finish from the molds.

H.2.7.3 Non-Structural Precast Concrete

Non-Structural Precast Concrete units shall be made to the form, surface finish and dimensions of the required size. Any units damaged during manufacture, hoisting or fixing will be rejected.

The Contractor must allow for any molds, for any light reinforcement which may be necessary to prevent breakage or damage in handling, for casting in specified lengths, for hoisting and, unless otherwise described, for bedding and jointing where necessary in 1:3 (cement: sand) mortar.

H.2.7.4 Structural Precast Concrete

Structural Precast Concrete materials and workmanship shall be in accordance with BS EN 1992-1-1:2004.

The precast units shall be cast under cover and shall so remain for at least 7 days during which period they shall be kept damp or otherwise efficiently cured. No units shall be erected until 21 days after casting except with the written approval of the Engineer.

No unit shall be erected until it has been approved by the Engineer as being free from defects and all surfaces are to the required standard.

All precast units shall be marked with an individual identification. Lifting hooks are to be attached only to those positions specified by the Engineer.

H.2.7.5 Measurements

Total price shall include supplying and installation (per Number).

H.2.8 Cement Mortar

Mortar, except for block work, shall consist of cement and fine aggregate (as specified hereinbefore) mixed in the proportions of one part of cement to four parts of fine aggregate with the addition of clean fresh water of such a quantity so as to form a final mixture of plastic consistency. The mortar shall be mixed in such small quantities as may from time to time be required and any mortar which has begun to set or has been mixed for a period longer than one half hour shall not be used in the Works.

H.2.9 Cement Grout

Grout shall consist of cement and clean fresh water mixed in the proportion of two parts by weight of cement to one part by weight of water. Any grout which has been mixed for a period longer than one hour shall not be used in the Works.

Code of Practice that may be substituted therefore shall be held to be the latest edition published two months prior to the last date for submission of tender. All relevant particulars and conditions in British Standards or British Standard Codes of Practice relating to standard of material, quality and workmanship, shall be complied with and, except as otherwise noted, all tests specified shall be conformed to. In cases where no particular specification is given for any article or material to be used under the Contract, the relative British Standard or British Standard Code of Practice, where one exists, shall apply.

Other equivalent national standard specifications may be submitted for the above at the sole discretion of the Engineer if requested by the Contractor.

H.2.10 Supply of Materials and Equipment

H.2.10.1 General

The Contractor shall supply all materials required for the construction of the various structures.

All materials shall comply with relevant Lebanese Standards and in the absence of these, European standards (CEN), American standards or other standards mentioned in the technical specifications may be used.

All materials shall be supplied with the required certificates of compliance.

The Contractor shall include in his offer the name and relevant information as detailed above. The supplier included in the Contractor's offer shall be binding and the Contractor shall not be allowed to change his supplier, unless specifically approved in writing by the Engineer.

It is the Contractor's responsibility to check the clearances and load limits of roads, bridges, existing facilities, etc. the Employer takes no responsibility for any stated ratings.

The Contractor shall be liable in all respects for the temporary importation and final exportation of all the Contractor's equipment and materials. The Contractor shall be responsible for all activities with regard to the importation and delivery including the actions of the customs agent.

The Contractor shall supply and deliver all materials and services needed to perform the Work.

Transportation, Off-Loading, Stockpiling, Hauling, Storage & Stringing

The Contractor shall submit procedures for the transportation, off-loading, stockpiling, hauling, storage, and stringing of pipeline materials. The Contractor shall be responsible for the loading; off-loading, stockpiling, hauling and stringing of all materials, inclusive of materials supplied by the Engineer and shall take all precautionary measures required in the process. All material shall be loaded, off- loaded, stockpiled whenever required, hauled to and strung at the fabrication site. The Contractor shall provide all care necessary to eliminate any possibility of damage.

Material Receipt and Acceptance

Upon receipt of materials, whether received from Vendors, the Engineer or their agents, the Contractor shall inspect said materials and provide a Materials Receipt Report.

A copy of this report shall be provided to the Engineer. The Materials Receipt Report shall record each item received, it's condition (acceptable or not acceptable), the type of damage and note any differences in the quantities expected or shown on the shipping documents versus what was actually received.

Subsequent claims by the Contractor relative to the Engineer supplied materials will not be considered if the above-referenced report has not been submitted in advance to the Engineer.

All individual pipe joints (lengths), fittings, etc. shall be provided with unique identification marks. Pipe joint length measurements shall be recorded by the Contractor and noted in the Material Receipt Report and the Contractor's "Pipe Tracking Log.".

Off-Loading

Nylon soft slings or padded hooks shall be used when handling HDPE pipe. Slings shall be designed in such a manner as to eliminate any damage to the pipe.

Pipe shall not be rolled or dropped from the truck bed to the ground. No materials shall be dropped on or permitted to fall on the pipe.

Stockpiling & Hauling

The Contractor shall receive and load all pipes at delivery points selected by the Engineer. The pipe shall be stockpiled at storage sites to be agreed upon by the Engineer.

All sharp or leading edges of vehicles and equipment used in the hauling and handling of pipe shall be padded. Suitable bedding shall be inserted between all individual pipe sections to avoid any damage.

Traffic Control

It is the Contractor's responsibility to provide traffic control measures necessary to minimize hauling delays while ensuring the safety of vehicles, pedestrians and construction workers.

Storage

The Contractor may elect to furnish his own lay-down area at a site separate from that provided by the Engineer. Whatever the solution, pipe storage sites shall be properly sized, selected and prepared with a level surface with ample drainage to ensure minimal water accumulation. The Contractor's on-site geotechnical expert shall take care to ensure that a minimum bearing capacity is available for the materials and necessary transport equipment.

Materials such as pipe, cement, paints, etc. which are liable to deterioration or damage due to humidity, exposure, extremes of temperature or other adverse weather conditions shall be suitably stored and protected. Any loss of material caused by inadequate storage or protection shall be replaced at the Contractor's expense.

Storage sites shall be emptied in accordance with the advancement of construction. Any left over after construction shall be transported where directed by the Engineer.

When a storage site is emptied of materials, the Contractor shall clean the site including any access road and reinstate all affected areas to their original condition. Thereafter, the site shall be handed back over to the landowner in question.

Other Materials

The Contractor shall be responsible for the off-loading, safe storage, loading and hauling of all such materials to the construction site and/or any site where they may be required.

All supplies which may deteriorate due to weather or climate influences shall be stockpiled in a secure manner. All facilities required for the purpose shall be furnished and maintained by the Contractor at no cost to the Engineer.

Materials with machined or fragile surfaces (such as flanges, gaskets, studs, fittings, equipment, valves, etc.) shall be coated, handled and stored in such a manner as to ensure that contact of the machined surfaces with the ground or other materials which may damage them will be prevented.

H.3 CONSTRUCTION PROCEDURE PACKAGES

H.3.1 General

The Contractor shall provide Construction Procedure Packages not limited to the following activities.

H.3.2 Installation Procedures

The Contractor shall be responsible for preparation of detailed installation engineering calculations, manuals and procedures covering all aspects of the Work. Work shall not proceed until the Engineer has approved installation engineering and procedures.

As a minimum, the installation and procedures documents shall include the following:

1. Connection of pipeline to the pressurized manhole at the shoreline
2. Pre and post installation survey operations
3. Marine operations for floating equipment and vessels
4. Detailed procedures for fusion of HDPE pipe joints including:
   - Qualification of fusion procedures
   - Destructive testing
   - Recording and preservation of fusion parameters
   - Quality control of fusion joints
   - Qualification and Certification of fusion operators
   - Pipe joint and materials traceability
   - NDT of fused joints
5. Storage, handling, and transport of pipe materials
6. Make up of pipe strings
7. Offshore or onshore temporary storage of pipe strings before installation
8. Detailed pipeline assembly and installation procedures
9. Detailed procedures for fabrication and attachment of concrete weight collars
10. Pipeline installation stress calculations demonstrating that installation stresses will not exceed allowable levels
11. Procedures and equipment to be used to continuously monitor and record pipeline stresses during installation.
12. Procedures and equipment to be used to monitor and control pipeline tensions during installation
13. Procedures and equipment to be used to install supplemental weights, mats and or anchors
14. Weather forecasting for designated installation period
15. Contingency procedure for occurrence of adverse weather during the installation activities
16. Pipeline gauging procedures (buried sections)
17. Procedures for intermediate pressure testing
18. Survey equipment, calibrations, and methods
19. Survey and pipeline positioning control during installation
20. Detailed diving and subsea construction procedures

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21. Diving safety, contingency, and, emergency procedures.
22. Project safety procedures
23. Contingency procedures for location and repair of pipeline leaks
24. Contingency procedures for repair of pipeline damage during installation
25. Procedures for rectification of post installation pipeline spans that exceed the allowable limits
26. Design and fabrication of concrete weights
27. Design and fabrication of pipeline end structures
28. Diving and subsea construction
29. Protection of the sea and surrounding areas from pollution caused by dredging or other construction activities
30. Centerline Survey Procedure
31. Dredging Procedure
32. Flange Installation
33. Leak Testing Procedure.
34. Stud Tensioning Procedures
35. Wet and Dry Buckle Repair
36. Procedures for positioning the pipeline to the route requirements
37. Procedure for free span rectification
38. Procedure for shore approach installation
39. Tie-in Procedures
40. Others as required by Project specifications
41. Documentation Procedure
42. Communication procedure with the consultants
43. Implementation Procedures for the Environmental Protection Measures as outlined in the EIA Study

The above procedures shall be submitted for review and approval by the Engineer a minimum of 30 days prior to the start of each specific activity.

H.4 WELDING

H.4.1 General

If any welding is required on the HDPE pipes, before beginning work on fusion of the pipe, the Contractor shall qualify an appropriate fusion procedure(s).

Removal of the external welding beads to less than 4 mm is a requirement and shall be included in all production.

No production welding shall take place until the Contractor has submitted the records required. All procedure tests and welder qualification tests shall be carried out in the presence of the Engineer or of an independent "Bureau de Controle" approved by the Engineer at the cost of the contractor should welding take place in the factory.

Prior to the commencement of welding, the Contractor shall submit the proposed welding procedure specification.

Butt fusion welding shall be performed according to ISO 12176 and to the manufacturer's recommendations. Welding equipment shall be as recommended by the manufacturer. The contractors' staff operating welding equipment shall have qualifications as recommended by the manufacturer and be in their possession any personal certificates for welding as recommended by the manufacturer.

H.4.2 Welder Qualification

Upon approval of the fusion or welding procedure by the Engineer, all fusion technicians will be required to present up-to-date international certificates or will be required to qualify under the procedure. All fusion technician qualifications will be witnessed. The Contractor shall give the Engineer at least one-month prior notice of all procedure and welder qualification tests. All tests and subsequent laboratory examinations shall be as close to the site as possible.

The Contractor will be required to pre-qualify and test all welding procedures per their applicable codes. Costs for all qualification of production welding procedures, contingency procedures, repair procedures, etc, as required to perform the Scope of Work shall be included in the tender price.

Procedure and welder qualification documents will be made part of the Contractor's project quality control plan.

H.4.3 Inspection

All weld preparations shall be examined by the Resident Engineer prior to welding commencement. Welding shall not commence without the Resident Engineer's approval. All welding shall be subject to examination by the Resident Engineer.

All costs associated with inspection and testing of production welding and leak testing shall be borne by the contractor and included in the tender price.

H.5 MARINE SECTION - GENERAL

H.5.1 Route and Position of the Offshore Section

The position of the seaward section of the outfall shall be as shown on drawing BY163000-N-168. The invert levels are shown on drawings BY163000-N-172 & BY163000-N-173 and the outfall shall be laid to gradients continuously falling towards the seaward end of the diffuser.

H.5.2 Hydrographic Surveys

The Contractor shall provide for the undertaking of accurate hydrographic surveys prior to and during dredging and pipe pulling operations; and following pipe installation and backfill operations; to the satisfaction of the Engineer. All soundings data shall be reduced to MSL and processed to produce survey charts at a scale of 1:2500, unless otherwise specified, by the Contractor. All survey charts and sounding records shall be submitted to the Engineer.

Details of the extent and specific requirements of each hydrographic survey are to be agreed between the Contractor and the Engineer before undertaking the survey operations. The initial hydrographical survey may be done using a multi-beam sounder to have more detailed information.

Prior to any dredging operations the Contractor shall carry out an initial bathymetric survey of the immediate area surrounding the route of the long sea outfall. This shall consist of three longitudinal sounding lines along the outfall line and 20 m to each side over the entire length of the outfall + 250 m. Cross-section sounding lines shall be surveyed at 25 m intervals. The longitudinal sounding survey along the centerline of the outfall shall be as close as possible to the proposed route but in no case more than ± 5 m from the precise line, shall be repeated twice and the averaged seabed profile shall be the main reference for all follow-up surveys. During dredging operations similar bathymetric surveys are required on a regular basis to monitor the progress, profile and extent of the seabed trench.

The route of the diffuser shall be surveyed in greater detail to include three longitudinal lines on either side of the proposed centerline at 10 m intervals and three centerline surveys. Further cross-section sounding lines shall be surveyed at 3 m maximum intervals to enable 40 m wide area seabed contour plans to be drawn at a scale of 1: 1000 and with 0.25 m contour intervals. This diffuser survey shall be used to determine the final heights of the riser pipes.

Prior to launching the pipeline, the Contractor shall carry out a bathymetric survey of the pipeline trench. The pattern of the primary survey lines shall be at right angles to the pipeline trench with the secondary lines in the longitudinal direction. The intervals of the primary lines shall be 10 meters and the secondary lines shall include 3 centerline surveys and 3 lines on either side if the centerline at 10 m intervals unless otherwise directed by the Engineer. Side-scan sonar may be required by the Engineer to supplement this information. The survey charts and cross-sections showing all results of the survey shall be submitted to the Engineer for approval.

After the launching and positioning of the pipeline and prior to backfilling the pipe trench or constructing the rock armoring the Contractor shall repeat the survey detailed above.

The surveys shall be repeated during backfilling and construction of the rock armoring as directed by the Engineer in order to establish the extent of the fill placed. The surveys shall cover the whole of the trench area and consist of cross- sections at intervals not exceeding 10 m and longitudinal sections at intervals not exceeding 10 m over the disturbed area. Surveys showing sections of the trench not completely filled to the minimum profile shall be indicated as "Check Surveys" in the Price Schedule. Surveys showing sections of the pipe trench covered to at least the minimum fill profile shall be indicated as "Final Fill Survey" in the Price Schedule.

The final survey shall be conducted as above after the Engineer's approval of the backfill. A similar survey shall be executed at the end of the Maintenance Period.

For the reduction of all soundings to MSL the Contractor shall install an automatic tide gauge as close as possible to the site, accurately surveyed to MSL and it should be checked daily for correct operation

for the duration of the marine works and the specified surveys. A summary of the tide measurements and the raw data shall be delivered weekly to the Engineer. The system shall be capable of transmitting the tide level to receivers on the dredger, pull-barge and survey vessel. It shall also be suitably damped and fitted with a 7-day chart. Computerized control tied in with the position fixing equipment and the radio tide gauge is required.

H.5.3 Survey Vessels

The Contractor shall provide for the required duration of the marine works, survey vessels for echo-sounding of the trench areas, submarine pipeline and the final covered trench. The draft should not exceed 1 meter; the steering mechanism and vessel motor power shall be such that the vessel can be navigated in a straight line as required for the seabed profiling.

The vessel (s) shall be provided with sufficient dry area under a coach roof to accommodate the electronic instrumentation, Contractor's staff and Engineer's Representative and to protect all from weather conditions. There shall be sufficient open deck space to accommodate other Contractor's equipment and staff and a maximum of four representatives of the Engineer/Employer. Life jackets shall be provided for all personnel on board the vessel (s), and shall be the inherently buoyant type to BS 3595.

The Contractor shall observe and shall provide such lights as are prescribed by the International Association of Lighthouse Authorities (IALA) and the International Regulations for the Prevention of Collisions at Sea, and fix any other temporary navigational buoys, beacons or warnings as may be required by the Lebanese Authorities. The Contractor shall make his own arrangements and obtain any necessary permission to use such safe moorings as he considers necessary.

All navigational and survey data shall be logged and simultaneously interfaced on board the survey vessel (s) and should include date and time, event number, vessel heading, lay back and computed Easting and Northing. Real time plotting of survey tracks and events must be performed on board on an attached track plotting system in order to monitor adherence to the pre-selected survey routes.

The Contractor shall include details of his proposed data logging system in the Data Schedule accompanying the Tender, together with any filter parameters and data acquisition settings he intends to use.

The survey vessel shall have adequate steering and motor power, and shall be fitted with suitable equipment to enable navigation on a predetermined survey line at a regulated speed.

Soundings shall be obtained using a simultaneous twin frequency echo sounder with digital output and analogue paper trace set to read depths below the waterline.

The echo sounder used shall be of the precision hydrographic type with the following minimum capabilities:

- Depth Accuracy ± 0.15 m
- Sounding Rate 5 soundings per second
- Measuring Units Meters
- Frequency approximately 200 kHz
- Sound Velocity Setting Adjustable
- Transducer Draught Setting Adjustable
- Paper Speed Adjustable over a wide range
- Event Mark Manual and External input
- Beam Width Narrow

The shallowest valid depth obtained during every one second interval "on line" shall be logged for subsequent processing. Tidal reductions shall be logged simultaneously and applied to observe soundings. The trace shall be marked with either event marks or time intervals. Heave compensation is preferred, however if the echo sounder is not fitted with this equipment, the Contractor shall state how he intends to remove the effects of heave from his soundings. The Contractor shall nominate the echo sounding equipment (and heave compensator) he intends to use, and include manufacturer's specifications in the Data Schedule accompanying the Tender.

Soundings shall be reduced to MSL and plotted after each day's works to check for inconsistency and to identify areas where extra lines are required.

The bathymetric profiles shall continue inshore as close as possible to the high-water line. Part of this work may therefore be carried out by land survey levelling, if practicable.

H.5.4 Wind Recording

The Contractor shall supply and install for the duration of the marine operations a suitable automatic wind speed and direction recorder as close as possible to the marine outfall at an unobstructed site not sheltered from winds. Required accuracy ±1.5%. The recorder shall be fitted with a 7-day chart. It shall be checked daily by the Contractor, and maintained for the duration of the Contract. Wind speed and direction measurements shall also be made on board survey and other marine vessels using a hand-held anemometer at least four times per day during marine works.

Interpreted wind information is to be supplied weekly to the Engineer. The wind data shall include average hourly wind speeds and directions, maximum hourly 1 minute wind gust velocities and time of maximum hourly wind gusts.

H.5.5 Marine Plant

The Contractor shall conduct his operations both ashore and afloat in accordance with the existing statutory rules and regulations or such as may be issued from time to time. The Contractor shall list the construction plant he proposes to use in the Data Schedule.

The Contractor shall afford the Engineer and his staff reasonable access to any of his floating plant at any time during the progress of the Contract. Life jackets shall be available for use by the Engineer and his staff.

When vessels are being used as Diving Platform adequate arrangements shall be provided to ensure that divers may safely enter and leave the water. In the event of an emergency the vessels shall be capable of immediately returning to the base.

Life jackets shall be provided for both the Contractor’s and the Engineer’s personnel and shall be of the inherently buoyant type to BS EN ISO 12402-8:2006+A1:2011 and BS EN ISO 12402-3:2006+A1:2010.

All vessels used upon the Contract shall be fully equipped in accordance with the latest safety, fire-fighting and emergency equipment requirements as laid down by the Department of Transport, Marine Division for vessels operating on survey and diving work, or as may be applicable.

H.5.6 Diving

All diving operations shall be carried out in accordance with the Diving Operation at Work Regulations 1981, the Diving Operations at Works (Amendment) Regulations 1992 and any other amendments that may be issued.

Prior to underwater operations the Contractor shall submit to the Engineer a copy of the diving rules that he intends to use in relation to the general conduct of the diving operations, including any specific instructions relating to any hazards peculiar to the Works.

The Contractor shall also issue to the Engineer a general Method Statement of his proposed diving operations and a copy of his Safety Policy.

Copies of the Diving Operations Log Book shall be issued to the Engineer on a daily basis.

During the course of the Works, members of the Engineer's staff who are qualified to dive in accordance with the Regulations will carry out routine underwater inspections. The Contractor shall be responsible for the diving operations and diving supervision of the Engineer's staff and shall provide all the necessary support to enable diving operations to be undertaken safely and in accordance with the Regulations. When the Contractor is using surface supplied equipment, he shall allow the use of this equipment by suitably qualified members of the Engineer's staff and will provide backup personnel and equipment to enable them to carry out underwater inspection of the Works. Where no surface supplied equipment is available, the Contractor shall provide sufficient SCUBA equipment, a suitable boat to act as transport and diving platform, and back up personnel. The Contractor shall maintain and make the following diving equipment available to the Engineer's staff.

- 2 No. 5 mm thick neoprene wetsuits together with all ancillaries including hoods, bootees, masks, fins, aqualung harnesses with stab jackets, depth gauges, weights, diving knives, etc.
- 2 No. complete sets of aqualung or SCUBA equipment
- Access to Contractor's suitable portable compressor for recharging the air bottles, together with four spare air bottles.

The Contractor shall provide and maintain guide lines between each part of the underwater Works which require to be inspected and shall insure that any section may be readily located from the surface at all times.

Within a period of one month prior to the end of the Maintenance Period the Contractor shall mobilize a diving team including personnel, suitable vessel and diving equipment to enable the Engineer's staff to carry out a full underwater inspection of the whole Works.

The Contractor shall list the items of diving equipment that he proposes to use (including work boats and decompression chamber) in the Data Schedule.

The minimum diving team shall comprise three suitably qualified divers and a Diving Supervisor.

Before diving operations commence, the Contractor shall notify the Engineer the name of the Contractor's Approved Doctor.

H.5.7 Underwater Visual Recordings

From the start of, and until completion of all underwater Works, the Contractor shall maintain ready for use by the Engineer's Representative a closed-circuit television system with operators as necessary. The system should be of a type that will produce good color resolution in visibility of 1 meter or more at working depths.

The system should include:

- Diver held camera
- Surface unit (mains operated)
- 150 m cable on drum
- Camera light and interconnecting cables
- Surface monitor
- Video tape recorder
- The facility for sound dubbing

The Contractor shall provide and maintain a 35 mm still underwater camera of a well- known trademark (eg. Nikonos) with an underwater flash unit ready for use as required by the Engineer or for the use of the Engineer's staff. The Contractor shall provide suitable film and powerpacks. Development of the films will be arranged by the Contractor and original material (negatives and one set of prints) will be delivered to the Engineer's Office after development.

H.5.8 Sea Conditions

The Contractor shall make due allowance for variations of the near shore oceanographic conditions, tidal regime and wind conditions. The Contractor shall not be entitled to any payment, compensation or allowance by reason of extra expense or loss which may be due to, or arise from any variations, inaccuracies or omissions in the Marine Survey Report with reference to the predicted tidal levels, current speeds and wind conditions.

H.5.9 Geotechnical Investigations

The Contractor shall undertake geotechnical investigations of the sea bed along the outfall route to confirm the nature of the sea bed material. This investigation shall be carried out before any dredging plant is mobilized. At least three boreholes shall be drilled at distances of approximately 400, 800 and 1100m from the shoreline. The boreholes shall penetrate a minimum of 7m below the sea bed and cores shall be recovered to provide samples for laboratory testing. In addition, three sea bed cone penetration Tests shall be carried out to a depth of 15m to provide in-situ strength data.

The Contractor shall detail the equipment he proposes to use in the Data Schedule. The Contractor may propose an alternative geotechnical investigation provided that it produces a similar level of information and allows detailed engineering analysis for pipeline stability, dredgibility, etc...

H.5.10 Unexploded Ordnance Survey

The Contractor shall arrange for a survey of the outfall route and surrounding area for unexploded ordnance. The survey shall be carried out by a company specializing in such surveys and approved by marine insurers. The Contractor shall give details of the company he proposes to employ and the survey strategy in the Data Schedules. It is expected that the survey area should be at least 1600m by 200m wide or such larger area necessary to cover the area of marine activities involved in the laying of the outfall pipe and to area where operation vessels and barges may drop their anchors. The survey should be by side scan sonar, magnetometer and Dropdown CCTV.

H.5.11 Marine Operations and Co-Operation with Harbour Authority

The Contractor shall comply with all requirements of and maintain liaison with the Harbour Directors of the Ports of Beirut and Ouzai.

As the construction site is relatively near to the Ports of Beirut and Ouzai, the Contractor shall liaise with the Harbours Directors prior to construction for co-ordination of marine traffic during critical construction stages. Full details of the Contractor's methods of working including details of floating plant shall be made available to the Harbour Master prior to commencement of any work. The Contractor shall liaise with the Harbour Master at all times and shall program his operations such as not to interfere with traffic entering or leaving the Ports of Beirut and Ouzai outside the construction site.

H.5.12 Notice to Mariners

The Contractor shall ensure that all statutory requirements are observed in connection with "Notice to Mariners".

H.5.13 Harbour Dues and Pilotage Fees

The Contractor shall pay all dock charges, wharfage, anchorage charges, charges on ships, charges on goods, conservancy charges and other charges in respect of all materials and plant required for use in or in connection with the Works and all operations associated with the works.

The Contractor shall pay any pilotage fees in respect of the movement of his floating plant.

H.5.14 Fishing Interests

The Contractor shall take into account and respect the interest of the local fishing community. Close liaison with Ouzai Harbour Director will be necessary to ensure that the Contractor's activities have the minimum effect on the fishing practices in the area. Where construction activities will affect the passage of fishing craft or fishing practices the Contractor will in consultation with the Engineer arrange for notifying the interested and affected parties at least 14 days prior to such construction activities. No discussions shall be held with Ouzai Fisheries Office or representatives of the fishing interests without prior notice to and approval of the Engineer.

H.5.15 Lighting, Marking, Buoying and Watching

During the execution of the survey, the Contractor shall provide all navigation lights and markers required by the Engineer, the Lebanese Marine Authority, or statutory authority in accordance with International Lighthouse Authorities regulations, for the proper indication of submerged work and moorings for his vessels. He shall also provide for all watching and maintenance required in connection with the foregoing and provide and maintain at his own cost any guards and fencing required by the Engineer or statutory authority for the protection of the survey, and for the safety and convenience of the public or others. The Contractor shall maintain all such lights, markers, buoys, guards and fencing in sound condition until the survey is completed and all the Contractor's craft and equipment has been removed from the site.

Should the Contractor in any way obscure or affect lights, signals, buoys or navigational aids the Contractor shall at his own expense pay all costs whatsoever for the reciting and reinstating or providing alternatives for the aforesaid to the satisfaction of the maritime authorities.

H.5.16 Notice of Operations

No operation shall be carried out by the Contractor or a sub-contractor without full and complete notice having been given to the Engineer by the Contractor sufficiently in advance of the time of the operation to enable the Engineer to make such arrangements as he may deem necessary for its inspection and checking.

H.5.17 Moorings for Floating Craft

The Contractor shall make all arrangements for and shall provide temporary moorings for his floating craft and plant. The location and details of these temporary moorings shall comply with the requirements of the maritime authorities. These moorings shall be maintained and eventually removed by the Contractor

H.5.18 Warning Signs and Danger Signals

The Contractor shall provide and maintain at his own expense all necessary Warning Signs and Danger Signals such as light buoys and other signs necessary to alert vessels and boats of construction works. The nature, position and number of these features shall comply with requirements of the maritime authorities.

H.5.19 Liability For Damage to Shipping

The Contractor shall be held responsible for any damage or injury to shipping craft of whatever description which may occur during the execution of the Contract through any act of omission or default of the Contractor or any person in his employ or for whom he is responsible.

H.5.20 Responsibility Regarding Existing Structures and Wrecks

The Contractor shall establish the location of any disused mooring blocks, structures, cables or wrecks on the seabed before starting work, and shall take precautions as necessary such as marking with buoys etc. to safeguard his own operations.

H.5.21 Removal of Sunken Plant

The Contractor shall raise and remove any plant (floating or otherwise) belonging to him or any Sub-Contractor or to any person employed by him which may be sunk or stranded or gone adrift in the course of the Works or otherwise deal with same as the Engineer may direct. Until the same shall be raised or removed the Contractor shall set all such buoys and marker lights and comply with all the requirements for the safety of navigation as required by the Engineer or by any authority having jurisdiction so to require.

In the event of the Contractor not carrying out the obligation imposed on him by this Clause or in the event of the statutory or other authorities having jurisdiction to buoy or light such sunken plant or craft and raise and remove the same (without prejudice in the first mentioned event to the right of the Employer to hold the Contractor liable) the Contractor shall refund to the Employer all costs incurred in connection herewith.

The fact that the plant or craft sunk, stranded or gone adrift is insured or has been declared an actual or constructive loss shall not absolve the Contractor from his obligation under this Clause.

The Contractor shall give both to the Engineer and the statutory authorities having jurisdiction immediate notice of the occurrence of any sinking, stranding or going adrift as is referred to in \this Clause.

The Contractor shall take all measures deemed necessary by the Engineer or the relevant authorities to prevent pollution by oil leakage from such sunken plant.

H.5.22 Communications

The Contractor shall provide radio communication between his site office and all offshore stations and vessels.

The Contractor shall provide two portable UHF or VHF radio sets, complete with spare batteries and battery chargers, for exclusive use of the Engineer. These radios will be capable of providing two-way communications between the farthest offshore construction activity and the site office. Alternatively, the Contractor shall provide two portable cellular phones for the Engineer's sole use.

The Contractor shall provide an oral communication system for use between the working divers and the surface vessel as well as facilities for recording communications between diver/diver/surface.

The Contractor shall be responsible for obtaining all necessary licenses and official permissions from the responsible authorities for the operation of communication equipment and for adopting frequencies which shall not interfere with other local transmissions or other equipment of any type.

H.5.23 Engineers Access to Contractors Survey Equipment and Crew

The Contractor shall make available the survey vessel, survey equipment and survey staff and crew for the Engineer when compulsory surveys are not conducted in order to:

1. execute surveys not specified in the Specifications or to check/confirm findings from surveys if and when required.
2. to use the survey vessel as a diving platform for underwater inspections by the Engineer's staff. The Contractor's provision of equipment and assistance to diving inspections will be as described in the Specifications.

The Engineer and the Engineer's Representative shall be allowed to have access to any survey as described in the Specifications and shall have the right for request of a repeat of the survey or part of it or additional investigations to accomplish the specific survey.

The Contractor shall allow in his rates for the use of the survey vessel by the Engineer as described above.

H.5.24 Noise Suppression

The Contractor shall ensure that the level of noise resulting from the construction of the Works does not constitute a nuisance and that noise emissions conform with and that all plants are adequately silenced to conform to requirements of BS 5228-1:2009 and to the mitigation and protection measures for the construction of Jnah Sea Outfall (to be set).

These restrictions shall apply particularly to all hours outside normal working hours. When after-hours work is inevitable, such as the launching of the pipeline the Contractor shall liaise prior to such an operation with the Engineer to decide upon the precautionary methods and liaison procedures with the interested and affected parties as well as the relevant authorities.

H.5.25 Environmental Protection and Reinstatement

The Contractor shall co-operate with the Engineer to comply and to adhere to environmental practices with reference to international as well as national policies as far as it is practical.

The shoreline shall be restored to conditions prior to the Construction and Final approval shall be given by the Engineer.

H.6 MARINE SECTION - TRENCHING AND BACKFILLING

H.6.1 General

This Section covers the dredging, trenching and transportation of material and its deposition as backfill or disposal to spoil grounds.

H.6.2 Dredging Officers

Competent Dredge masters and Hopper and Tug Masters shall be employed on all shifts to ensure proper supervision during the execution of the Works.

H.6.3 Dredging Plant

Dredging plant to be used on the Works shall comply with the requirements of Lloyds Register of Shipping Classification 100 A1 for dredgers. Proof that such classification is currently valid in respect of the dredging plant to be used shall be submitted to the Engineer within the period specified in the Contract for submission of the Contractor's Program.

H.6.4 Ownership of Dredged Materials

Materials of any kind obtained from the dredging carried out in the execution of the Works shall remain the property of the Employer.

All fossils, antiquities and other objects of interest or value which may be found in carrying out the Works shall be taken out and preserved by placing in suitable containers and immediately immersed fully in water collected at the site of discovery. Such containers shall then be handed to the Engineer.

Discoveries which cannot be so treated shall be reported immediately to the Engineer and shall not be disturbed further pending receipt of the Engineer's instructions.

H.6.5 Dredging of Pipeline Trench

The Contractor shall give the Engineer at least 14 days written notice of his intention to commence dredging works on any part of the works. Immediately thereafter a "Pre- dredging Survey" shall be carried out by the Contractor.

The dredging works shall not be commenced until the Engineer has given his consent, which consent shall not be unreasonably withheld.

The extent of the dredging shall be the minimum practicable in the opinion of the Engineer for the Construction of the Works. The dredging shall be regularly monitored by the Contractor in accordance with the Specification.

Any extra dredging beyond the limits specified or ordered can be filled with dredged material if approved by the Engineer or otherwise it shall be filled with imported materials at the Contractor's expense. The Contractor shall inform the Engineer of any requirement to backfill and shall submit his proposed method of working for approval.

The Contractor shall prepare a plan of dredging operations for the Works, detailing the location and program of dredging and the dumping and handling of the excavated materials and/or other materials. The program shall include an appropriate allowance for downtime due to weather and sea conditions. The Contractor shall submit for the Engineer's consent his proposed plan of operation at least 28 days before his intended date to commence dredging works.

All equipment to be employed by the Contractor shall be set out in the Data Schedule.

H.6.6 Trench Depth and Width

The trench depth will vary along the pipeline due to the sea bottom topography and the relief of the seafloor. The pipe trench must always be wide enough to permit placement of the pipe and its attached weights and flanges and adequate backfill materials to provide proper pipe support. Refer to Drawing No. 1345-2041.

The minimum trench depth below seabed and the minimum bottom width of the trench along the route of the pipeline shall be specified by the Contractor and approved by the Engineer.

H.6.7 Control And Accuracy - Line, Level and Gradient

Control of the trenching operation shall be affected by the use of the specified position fixing system, echo sounding equipment operated in conjunction with a laser. The use of alternative methods shall be subject to the Engineer's approval. Computerized control of the position fixing and echo sounding equipment with the radio tide gauge is required.

Tolerances on trench levels shall be such that the finished levels of the trench to be dredged shall not exceed plus 150 mm or minus 150 mm from the levels indicated, with a continuous fall towards the diffuser end.

H.6.8 Final Inspection of Trench

Prior to the placement of the sea outfall the Contractor shall undertake a survey of dredged trench in accordance with the Specification and submit the results of the survey to the Engineer for approval before proceeding with the pipe installation.

The trench dredged on the seabed prior to placement the pipeline shall be subjected to a final inspection by the Engineer who shall be given every assistance by the Contractor in the execution of this inspection.

H.6.9 Trenching Methods

The plant and methods to be used shall be suitable to achieve the allowable tolerances in accordance to the technical specifications.

The use of a cutter-suction dredger is allowable. For water depths less than 5 m the use of an underwater excavator seems practical. Final finishing of the entire trench level may also be completed using an underwater excavator.

Alternative methods will be considered. The Contractor shall propose his preferred choice of machinery with full details outlined in the Data Schedule, including backup facilities.

H.6.10 Dumping of Excavated Material

The Contractor shall be responsible for the temporary storage of dredged material which will be re-used as bedding and backfill material for the outfall pipeline. The stored material shall not interfere with shipping, fishing activities or port activities. The area and boundaries of the stored material shall be approved by the Engineer. The coastal waters shall be protected from suspended material from the stored material by approved containment or banding.

The Contractor shall submit his proposals for dumping and storage for the re-use of the dredged material to the Engineer for approval. No dumping or storage of excavated material shall take place before approval of the locations. The necessary permission and licenses shall be arranged by the Contractor with the relevant authorities.

Surplus dredged material and material not suitable for re-use for the Works or for any other purpose shall be disposed of at sea to spoil grounds beyond the 100-fathom depth contour, to the approval of the Engineer and the relevant authorities.

H.6.11 Material for Pipeline Protection

The types of material to be used for bedding, protection of the pipeline against rock armor and rock armour should be as specified in the Specification. The minimum thicknesses and Types of material shall be defined by the Contractor.

The bedding of the pipeline will be of the dredged material if suitable and approved by the Engineer. The trench shall be backfilled with dredged material if suitable and approved by the Engineer or otherwise suitable material as specified in the technical specifications. Material from any part of the foreshore cannot be used. The use of jetting techniques will not be allowable. Details of the proposed backfill materials and placing methods shall be submitted with the tender.

H.6.12 Backfilling and Rock Armoring

A survey shall be carried out by the Contractor in accordance with the Specification in order to check the finished levels and profile of the pipeline prior to backfilling and armoring. A final inspection will be carried out by the Engineer who shall be given every assistance by the Contractor in this respect.

Following the inspection and immediately on receiving the written approval of the Engineer the pipeline shall be backfilled and armored as required by an approved means and without delay.

Backfill material and rock armor shall be approved by the Engineer, and shall be made available in good time in anticipation of the Engineer's instruction to backfill.

The Contractor shall obtain and transport to site all the required backfill materials ready for depositing by suitable crafts of which details shall be entered in the Data Schedule. The Contractor shall be responsible for ensuring the safety from his deposition procedures, of the outfall pipeline, the diffuser and its assemblies. Deposition programs, methods and procedures shall be drawn up from time to time by the Contractor to be agreed upon by the Engineer. Each load shall be deposited in accordance with such agreed program, methods and procedures and to the satisfaction of the Engineer.

Placing of backfill and rock armor shall be carefully controlled to avoid disturbing or damaging the pipeline or diffuser riser units. No point dumps shall be permitted but deposition shall take place in such a way that each load is evenly spread in a controlled manner. The material shall be spread as smoothly as possible along the route of the pipeline until the required depth of fill is reached.

The Contractor shall regularly monitor the effects of the deposition of materials regarding profiling and controlling of the discharge.

Rock armor shall be placed by a method that ensures that rock does not segregate during placement and does not allow the stone to fall further than 1 meter to the required location. Armor rock within 3-meter radius of the diffuser units shall be placed in such an approved manner to avoid damage. The Contractor shall provide the Engineer with a detail procedure with regard of the placement of rock armor at the diffuser units in order to ensure that damage not occur to any part of the diffuser.

Should damage occur to any part of the diffuser the Contractor shall report the damage immediately to the Engineer and the Contractor shall provide details and a program of the procedures to follow for repair to the Engineer for his approval. No claim will be considered for any reimbursement for additional costs of any kind occasioned by the Contractor's damage to the diffuser.

If requested by the Engineer the Contractor shall deposit additional material at locations as directed by the Engineer.

H.6.13 Measurements

Excavation, Backfilling & Rock Protection will be measured per linear meter.

H.7 MARINE SECTION – CONSTRUCTION

H.7.1 Design and Method of Construction

The Contractor will design the pipe so that the pipe stability is compatible with soil conditions. In the near shore area, a deep layer of unconsolidated mud may exist on the pipe route and may generate settlement.

The pipeline shall be buried in the trench after initial smoothing of the trench bottom. The pipes and fittings shall be designed to safely sustain and absorb flow induced vibrations.

The pipe shall be installed by the float and sink method where concrete weights are installed at a distance of 3 meters center as shown on Drawing 1345-2042. The concrete weights have to be fixed properly to the pipeline to prevent sliding during installation. To increase the coefficient of friction and to avoid scratches in the surface of the pipe an EPDM rubber gasket shall be installed between the pipe and the concrete weights. The pipeline shall be equipped with blind flanges in each end and at the outmost end the blind flange shall also be equipped with pipes and valves for air evacuation and air filling. Before sinking starts the route shall be marked properly with buoys floating at the sea surface and the pipeline shall be positioned in the correct route by boats, barges and small boats. The sinking shall start by opening the air valve at the outmost end carefully. Once the sinking reaches the outmost end of the pipe the correct pulling force and sinking speed shall be applied to prevent dynamic acceleration forces when the last volume of air leaves the pipe. The length of the pulling wire shall be in accordance to the maximum depth to secure a safe landing of the pipe end at the bottom. The landing takes place when the pulling force is gradually reduced to zero.

The design and installation steps of the float and sink method of PE piping shall comprise the following steps:

- Selection of the design, weight and frequency of spacing of the ballast weights that will be used to sink and then hold the pipe in its intended location.
- Selection of an appropriate site for staging, joining and launching the pipe
- Preparing the land-to-water transition zone and, when required, the underwater bedding
- Assembly of the individual lengths of pipe into a continuous string of pipe
- Mounting of the ballast weights (This step may be done in conjunction with the next step)
- Launching the joined pipe into the water
- Submersion of the pipeline into the specified location
- Completion of the land-to-water transition

The float and sink method shall be done in accordance with the general guidance of the marine installation of the second edition handbook of PE pipe published by the Plastics Pipe Institute (PPI) for the conduct of each of the steps described above.

The contractor shall provide facilities for the land to water transition to enable pig launching and maintenance of the pipes.

The Contractor shall submit the method of constructions with full details which must be included with the tender. Drawings, proposed specialist Sub-Contractors (if any), plant and other details necessary must be provided to enable the Engineer to fully evaluate the proposal. The construction methods are subject to the Engineer's and Employer’s final approval.

H.7.2 Landside Construction Site

The Contractor will be responsible for making arrangements to obtain an adequate landside construction site through agreements with landowners. Alternatively, or additionally temporary reclamation of an

area of sea shore can be undertaken to expand the available area and to provide for a landside construction site to accommodate strings. The sides of any reclaimed area shall be contained within a bund wall, constructed of sandbags imported granular material or sheet piles which will be designed to prevent loss of fill material into the sea. The Contractor will be wholly responsible for the design of any such bunds.

The Contractor shall provide with his tender a plan of the site layout, including any proposed reclamation area, winch details, access roads and facilities for approval by the Engineer before any works commence on the site.

H.7.3 Placement Operation

Great care is to be taken during the placement operation to ensure that the stresses induced in the pipeline do not exceed the safe working stresses in the pipeline.

The Contractor shall make his own assessment regarding the risks of adverse weather conditions delaying the placement operation and damaging the pipeline or temporary works.

The Contractor shall also make arrangements for having standby plant available to complete the placement operation in the event of a mechanical breakdown. These arrangements and provisions shall be agreed with the Engineer, prior to commencing marine works.

The Contractor's proposals must include methods for preventing rotation of the pipe during installation and these measures shall be for the approval of the Engineer.

H.7.4 Allowable Stresses

The Contractor shall submit full calculations showing the stresses introduced by his proposed plant method.

H.7.5 Diffuser Construction

The sinking method of the diffuser is carried out in a different way than the pipeline. The diffuser shall be produced or assembled in one piece and towed to the site the same way as the pipeline sections. The contractor shall drill the holes in the diffuser on site. Concrete weights and buoyancy elements shall be fixed on the pipe before submerging. The capacity of the buoyancy elements must be greater than the weight of the pipe including the fixed weights. The submersion is done by lowering the diffuser as a beam from barges. The diffuser shall not be lifted out of the water. A proper calculation of the static system shall be carried during submerging. The calculation shall include the number of fix points and hook points needed to get a safe installation and shall determine the number of boats/barges with cranes needed if the diffuser shall be submerged in one piece. The diffuser can be divided into pieces and submerged separately. In this case they will be joined together on sea bottom or some distance above by flange connections. In the calculations of necessary support from buoyancy bodies the safety factor against buckling shall not be less than 3, taking into account the sinking process will be influenced by the waves and current. The buoyancy bodies must stand the water pressure at the required water depth and shall not be allowed to slide along the pipeline during the sinking. The cranes will lower the diffuser to the sea bottom.

The Contractor shall put forward proposals for the construction and placement of the diffuser.

The diffuser will be designed to provide a minimum average initial dilution of 50.

The dismountable plate located at the diffuser end shall be made of stainless steel 316L as a minimum requirement along with the steel flanges, bolts and backing rings.

Because of uncertainty on actual flow, part of the diffuser ports will remain closed and duckbill type valves will be supplied for all ports. Only part of them will be installed according to initially expected flow.

The Contractor's proposals must provide for maintaining the diffuser section upright during placement.

The method proposed will be subject to the Engineer's approval. Full details must be submitted with the tender.

The final location of the diffuser will be designed by the Contractor and needs to be approved by the Engineer.

No claim will be considered for any reimbursement for additional costs of any kind occasioned by the Contractor's failure to position the diffuser outlets within the specified location approved on or for extra work contingent upon necessary re-design of the risers.

Drawing BY163000N-182 shows a schematic sea outfall diffuser.

H.7.6 Diffuser Protection

To protect the diffuser pipes against accidental ship collision, a number of navigation warning buoys system (to be finalized according to guidelines/requirements/ specifications to be provided by the Lebanese Ministry of Transport) will have to be installed in the neighborhood of the diffuser.

The diffuser heads and riser units shall be properly supported and protected.

The diffusers shall be provided with scour protection stone of nominal size 15-100 kg.

Riser protection units such as precast reinforced concrete protection units or others may be needed to protect the diffuser against dropping and dragging ship anchors. Details of these blocks shall be prepared by the Contractor to his preferred construction method. The final arrangement will be subject to the Engineer's approval. Drawing BY163000N-183 shows a possible outline design and configuration of diffuser protection blocks.

APPENDICES

APPENDIX A - MITIGATION AND PROTECTION MEASURES

SECTION VII – H: TECHNICAL SPECIFICATIONS FOR NEW SEA OUTFALL WORKS

1. Introduction

This document presents the Environmental Mitigation and Protection Plan set for the Sea Outfall.

In principle, mitigation measures are intended to reduce the effect of potentially significant impacts on the environment thus, they are highly dependent on the significance of the predicted impact, the nature of the impact (permanent versus temporary), or the phase of the project (construction versus operation), by reducing or eliminating, to the extent possible, many of the identified environmental impacts.

2. Potential Environmental Impacts incurred during the construction of Sea Outfall

This section outlines the potential environmental impacts expected to be induced by the construction activities of Sea Outfall.

Surface and Groundwater Quality

- Oil and lubricants may leak from the marine machineries during sand and seabed dredging, backfilling, and installation of the Sea Outfall pipeline.

Onshore pipe installation that extends from the existing sewer network to shoreline will involve limited concrete works and are a possible source of negative impact on sea water quality resulting from onshore runoff

Soil Quality and Land Degradation

- Dredging activities may cause damage to the seabed along the dredging alignment and with less magnitude at the surrounding,
- In case of improper disposal techniques, the dredged materials may also harm the disposal site through covering soil with new blanket of materials.

Air Quality and Odors

- Several gaseous pollutants are expected to be emitted from the exhausts of machineries used in onshore and offshore construction works and mainly consist of Carbon dioxide (C02), Nitrogen dioxide (N02), Sulfur dioxide (S02), Particulate Matter (PM), and Hydrocarbon compounds (HC).

Health and Safety

- Marine work environment usually comprises a harsh setting, particularly during foul weather conditions which may lead to injuries from a number of cases related to fatigue, equipment usage or failure, and accidental vessel collisions.
- Dredging works and diving for visual inspection are also considered major causes of safety and health hazards.

Noise

- No significant noise emissions are expected from the installation of the Sea Outfall onshore section.
- The marine works are expected to release some noise from heavy machinery to install the Outfall at the seabed.

Ships and barges may create noise pollution that disturbs Waste Generation

- Wastes are expected to be generated from excavated materials, dredged sand and rock fragments, chemical wastes including used oils and lubricants from marine vessels, general refuse, domestic waste, and machinery replacement parts.

Visual Intrusion

- In general, offshore construction works may produce minimum visual intrusion because the marine vessels will be conducting most of the works underwater.

Biological Environment

- Sand dredging and backfilling may minimally impact the marine biological environment especially along the alignment of the Sea Outfall and with fewer effects on the surrounding areas.

Socio-economics

- Limited positive socio-economic impacts include providing temporary local job opportunities in construction and associated activities for the local laborers.
- Production and yield of surrounding agricultural farms may get minimally impacted from possible dust emissions, truck and equipment traffic, and temporary blockage of irrigation channels.

Traffic

- In general, no significant impact on the onshore traffic flow as the Sea Outfall is located away from any traffic flow.
- No significant impact on the marine traffic since the pipe alignment is away from major ports at sea.

Archaeology, tourism, and cultural heritage

Neither the visual inspection nor the bathymetric survey proved the presence of any archeological sites.

3. Environmental Mitigation and Protection Plan for the Construction of Sea Outfall

The below table (Table 1) outlines the Mitigation and Protection Measures for the construction of the Sea Outfall (marine and land sections) component, which shall be adopted and implemented by the Contractor throughout the construction phase of the Sea Outfall.

Table 1-a: Mitigation and Protection Plan Recommended for the Construction of Sea Outfall

Environmental Element	Environmental Mitigation and Protection Plan for the Construction of the Sea Outfall
Water Quality (Seawater)	Regarding the potential environmental impacts that may be incurred by the construction of the Sea Outfall onshore (land) and offshore (marine) sections on seawater quality, the Contractor shall consider adopting and implementing the following measures by integrating them within the construction works: ***Offshore (marine) section*** • Avoid dredging activities on steep seabed to avoid the stability and erosion risks of the sand shore. • Adopt and implement standard working practices to reduce the presence of foam, oil, grease or litter in the water within and adjacent to the reclamation site, as well as along the route to and from marine borrow areas (if marine borrowing was adopted). • Carefully load barges to avoid splashing of material. • Fit barges used for the transport of dredged materials with tight bottom seals. • Fill barges to a level which ensures that material does not spill over during loading and transport to the disposal site. ***Onshore (land) section*** • Direct surface runoff into storm drains via adequately designed sand/silt removal facilities such as sand traps, silt traps, and sediment basins. • Regularly maintain silt-removal facilities to ensure that these facilities are functioning properly at all times. • Discharge rainwater pumped out from trenches or foundation excavations into storm drains via silt-removal facilities and not directly to the marine environment. • Cover open stockpiles of construction materials with tarpaulin or similar fabric during rainstorm events to prevent the washing away of construction materials.

SECTION VII – H: TECHNICAL SPECIFICATIONS FOR NEW SEA OUTFALL WORKS

Environmental Element	Environmental Mitigation and Protection Plan for the Construction of the Sea Outfall
	• Compact earthworks as soon as the final surfaces are formed to prevent erosion especially during the wet season. • Immediately contain and clean up oil leakage or spillage. • Collect and store spent oil and lubricants for recycling or proper disposal. • Provide all fuel tanks and chemical storage areas with locks. • Contain sewage from kitchens, toilets, and other domestic facilities in sanitary cesspools before being transported by trucks to the nearest wastewater treatment plant or authorized disposal sites. Provide immediate clean-up actions following any spillages of oil, fuel, or Chemicals
Soil quality and Groundwater	For mitigating the potential impacts of constructing the Sea Outfall on the soil and groundwater quality, the Contractor shall consider adopting and implementing the following measures: ***Onshore (land)section*** • Properly store chemicals onsite. • Install natural or synthetic liners beneath chemical storage tanks. • Provide proper surface drainage. • Minimize onsite water and chemical usage • Limit the exposure of the soil to accidental releases of pollutants. • Use of non-toxic and readily biodegradable materials. • Fill the extra dredging space (beyond the limits specified or ordered) with dredged or imported materials.
Air Quality	The Contractor shall consider adopting and implementing the following mitigation measures to control and ensure the lowest impacts on air quality: ***Offshore and onshore sections*** • Maintain good housekeeping practices throughout the construction phase to limit dust/particulate dispersion • Ensure proper maintenance for vehicle, machineries, and barges. • Install air filtration systems on the sources of power generators and engines. Specific to the onshore (land) section • Provide windbreaks to and source enclosures to limit PM emissions as a result of wind erosion. • Adopt watering techniques for adequate temporary dust control.
Odor	During the construction phase of the Sea Outfall component, along with the other components of the Project, no odor emissions are expected. No protection or mitigation measures are suggested for the impact of odor during the construction of the Sea Outfall.
Health and Safety	Health and safety are considered primarily in terms of potential exposure to Particulate Matter (PM) and noise, and accident occurrence to workers and pedestrians. As a result, the Contractor shall adopt and carry out the following mitigation measures for the construction of the Sea Outfall component, which are also applicable to all other components of the Project: ***Offshore and onshore sections*** • Provide training to a dedicated staff about the fundamentals of Occupational Health and Safety (OHS) procedures. • Provide appropriate Personal Protective Equipment (PPE). • Provide adequate loading and off-loading spaces. • Develop an emergency response plan. • Supply an onsite medical facility or first aid. • Provide appropriate lighting during night-time works. • Follow the guidelines set by the Council of Development and Reconstruction (CDR) as well as other recognized international applicable practices for health and safety. Specific to the onshore (land) section • Restrict access to the construction site by proper fencing. • Establish buffering areas around the site. • Provide guards on entrances and exits to the site. • Install warning signs at the entrance of the site to prohibit public access.

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<table>
<tr><th>Environmental Element</th><th>Environmental Mitigation and Protection Plan for the Construction of the Sea Outfall</th></tr>
<tr><td></td><td>• Implement speed limits for trucks entering and exiting the site and from the highway.</td></tr>
<tr><td>Noise</td><td>No significant noise emissions are expected to be released during the construction phase of the onshore section of the Sea Outfall but the usual noise associated with excavation works, welding, and compaction, However, the marine works are expected to release some noise from heavy machinery to install the Outfall at the seabed of which it is relatively distant from residential agglomerations, therefore, the Contractor shall consider adopting and implementing the following measures to control and attenuate the levels of noise generated:

<u>On Shore (marine) section</u>
Operate onsite well-maintained mechanical equipment only. Shut down equipment which may be intermittent in use between work periods or throttle them down to a minimum. Properly maintain dredging equipment during period of dredging works.
<u>Onshore (land) section</u> Erect noise barriers along active work sites, if needed. Operate well-maintained mechanical equipment only.
Shut down equipment that may be intermittent in use between work periods or throttle them down to a minimum.
Utilize silencers or mufflers on construction equipment.
Properly maintain construction equipment during construction works.
Schedule noisy activities during daytime periods.
Provide noise enclosures or semi-enclosures.
Additional reference should be made by the Contractor to the standards of noise levels set by the United States Environmental Protection Agency (USEPA) for the relevant onshore construction activities:

Table l a: Typical noise levels for various construction phases
<table>
<tr><th>Phase</th><th>Sound Pressure Level dB (A)</th></tr>
<tr><td>Ground clearing</td><td>84</td></tr>
<tr><td>Excavation</td><td>79</td></tr>
<tr><td>Foundations</td><td>78</td></tr>
<tr><td>Erection</td><td>75</td></tr>
<tr><td>Finishing</td><td>75</td></tr>
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Source: USEPA, 1972 cited in Canter, 1996
The Contractor shall abide by the national Lebanese noise level guidelines (set by the Ministry of Environment Decision No. 52/1 - 1996 (Appendix 10)) as outlined in Table 1b below. Noise levels shall be measured at the project site boundary within the specified surrounding area, as defined in Table 1b - Area Classification.</td></tr>
</table>

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Table 1-b: Lebanese noise guidelines (one of the classified Zones)

Area Classification	Maximum accepted Noise Level (dB(A))		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Residential Area with few construction sites, commercial activities, or on highway	50-60	45-55	40-50

Environmental Element	Environmental Mitigation and Protection Plan for the Construction of the Sea Outfall
Waste Generation	• The Sea Outfall construction will generate wastes that include excavated materials, dredged sand and rock fragments, chemical wastes including used oils and lubricants from marine vessels, general refuse, domestic waste, machinery replacement parts, and several other types. The Contractor shall consider adopting and implementing the below mitigation measures addressing the generated construction waste: ***Offshore (marine) section*** • Reuse the dredged materials for the purpose of construction as bedding and backfill materials for the Sea Outfall pipeline if considered suitable in terms of their physical and gradation properties. • Dispose of unsuitable dredged material surplus at sea to spoil grounds beyond the 100-fathom depth contour. • Draft an agreement with the Municipality of Beirut or the local solid waste collector for the collection and transfer of domestic waste generated offshore to identify collection sites. • Segregate and properly store and dispose of empty chemical containers. ***Onshore (land) section*** • Segregate and properly store and dispose of empty chemical containers. • Provide storage in a separate area that has an impermeable floor, adequate ventilation, and a roof to prevent rainfall from entering. • Clearly label all chemical wastes in English and Arabic that should be stored in corrosion-resistant containers and arranged so that incompatible materials are adequately separated. • Draft an agreement with the Municipality of Beirut or the local solid waste collector to identify collection sites and schedule the removal of wastes. This will minimize odor, pest infestation, and litter buildup. • Strictly prohibit the onsite burning of wastes. • Prevent disposal of food, il, sewerage, or chemical wastes directly into the marine environment.
Landscape and Visual Intrusion	The Sea Outfall offshore construction works are expected to produce few impacts on the visual scenery since the pipe will be installed under an agricultural road that is used mainly by farmers with very minimum traffic flow. Similarly, the marine construction works are expected to produce minimum visual intrusion since the marine vessels will be conducting most of the works under water. The Contractor shall consider adopting and implementing the following measures for mitigating the visual intrusion induced by the construction of the onshore section of the Sea Outfall: ***Onshore (land) section*** • Enclose the site with non-transparent fencing to minimize visual impacts of construction works. • Preserve existing vegetation when feasible. • Guarantee that all related materials are brought from licensed quarry sites according to the regulations set by the Ministry of Environment (MoE)
Biological Environment (Marine Biodiversity)	The Contractor shall consider adopting and implementing the following measures regarding mitigating the potential impacts on the biological environment of the Project: ***Offshore (marine) section*** • Prevent disposal of food, oil, sewerage, or chemical wastes directly into the marine

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Environmental Element	Environmental Mitigation and Protection Plan for the Construction of the Sea Outfall
	environment. • Avoid the use of suction hoppers for dredging to prevent any incidental entrainment offish, shellfish, and reptiles in ecologically-sensitive areas.
Socio-economic	The construction of the Sea Outfall poses limited and temporary socio-economic benefits. No negative socio-economic impacts were identified for the construction phase of the Sea Outfall. No protection or mitigation measures are suggested for socio-economic impacts during the construction of the Sea Outfall.
Element Traffic	No significant impacts are expected to generate from the Sea Outfall construction as it is located away from any traffic flow. However, during construction phase, possible minimal negative impacts may be created on the onshore traffic flow. As for the marine section, the pipe alignment is away from major ports; consequently, no major impacts on marine traffic are expected. The Contractor shall consider adopting and implementing the following measures during the construction works of the Sea Outfall: ***Offshore and onshore sections*** • Develop and communicate preliminary routing schemes where needed. Specific to the onshore (land) section • Limit the movement of heavy machinery to off-Peak hours.
Resource Use	Regarding the mitigation measures pertaining to resource use, particularly for water and energy, which are considered initiative steps towards a more environmentally sustainable construction of the Project. The Contractor shall consider adopting and implementing the following measures during the construction works of the Sea Outfall: Water-saving measures • Reduce water usage through the adoption of dry-cleaning practices prior to water cleaning of working areas and vehicles. Energy-saving measures • Use of energy-efficient construction equipment that should be properly operated, maintained, and turned off whenever not in use.
Archaeology, Tourism, and Cultural Heritage	For Jnah Sea Outfall, neither the visual inspection nor the bathymetric survey proved the presence of any archeological sites. Moreover, no nearby touristic or archeological spots that may get affected by the construction works are located near the Sea Outfall structures. However, the Contractor shall apply care in all sea outfalls construction locations to avoid damages to any archeological remains that may exist, or any nearby touristic spot.

APPENDIX B - MARINE SURVEY REPORT REQUIREMENTS

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