
SECTION 11210

SCRAPER AND SUCTION BRIDGES

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 extraction system equipment, including but not limited to:

1. Scraper bridges,
2. Suction bridges,
3. Pipes,
4. 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 Concrete Section as will be shown on the civil construction drawings.

5. 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 Concrete Section.

6. 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. Section 03300 – Concrete ;
- B. Section 01030 – Basic Electrical requirements;
- C. Section 11318 – Grit classifier;
- D. Section 15420 – Air lift;
- E. Section 16000 – Handling equipment;
- F. Section 17100 – Instrumentation.

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

Identification number:	103-TB-101 and 103-TB-401
Type:	Travelling bridge Model RCA Alu by RMC or any other equivalent product
Number:	2
Location	Grit and grease removal tanks
Bridge characteristics: -Length net -Width net -Travelling speed -Number of wheels -Materials :	30.0 m 12.0 m 5 cm/s 4 Aluminium
Bottom scraper (grit) :	2 bottom scrapers per tank : 4 500 mm wide and 3 000 mm wide respectively Materials : Inox 304 L
Surface scraper (grease) :	2 surface scrapers per tank : 2 000 mm wide and 2750 mm wide respectively Materials : Inox 304 L
Motor:	0.37 kW – speed 4.7 tr/mn – 400V – 50 Hz – IP 55 – Class F
Accessories	2 Jib cranes installed on the side and on the middle of the travelling bridge for air turbine removal and/or installation after maintenance. Embarked electrical cabinet with folding electrical supply Air lift system for suction in two tanks

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1.3.2. OPERATING CONDITIONS

- A. The scraping bridge is gathering the solids on the bottom of the chamber towards a collection pit at one end. The solids are then recovered by a fixed pump or an air lift.
- B. In case of a suction bridge the solids are eliminated by a suction pump or air lift , set up on the movable bridge, and discharged into a lateral disposal along the chamber.
- C. The Contractor shall provide characteristics of the proposed equipment:
 - Rotating speed in rd/min or moving speed in m/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.

1.3.3. CONTROL AND MONITORING

The operation mode of scraper and suction bridges should have both:

- A. Manual control and PLC automatic control.
- B. Local control and distance control.

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

1. Manual / auto commutator
2. Lighted button "ON"
3. Lighted button "OFF"
4. 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 equipments will be connected to the general computer.

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

Malfunctions and alarms.

1.4. QUALITY ASSURANCE

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

1.6. GUARANTEE

1.6.1. PERFORMANCE

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

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. FABRICATION

2.1.1. SCRAPER BRIDGE

The scraper bridge should be equipped with:

- Either a U-shaped walkway, fitted with two guardrails, with access at each end (rectangular basin), and a ladder at the back of the bridge so that an operator can climb out should he fall into the basin,
- or a radial U-shaped walkway, fitted with two guardrails, with an electrical-contact retractable ladder for raising the bridge and a ladder at the back of the bridge so that an operator can climb out should he fall into the basin (round basin),
- A bearing system, with shaft(s) and geared motor(s),
- Either a bottom scraper for collecting solids,
- Or a surface scraper for collecting grease,
- Or a bottom and surface scraper,
- A solids/supernatant liquid extraction system
- An emergency stop, with safety stops,
- A festoon cable power supply system,
- A jam detector.

The long travel, raising and lowering movements of the grease scraper are interlocked with limit stops.

The on-board electrical cabinet is completely sealed and contains a heating resistor.

2.1.2. SUCTION BRIDGES

The suction bridge should be equipped with:

- either a radial U-shaped walkway, fitted with two guardrails, with an electrical-contact retractable ladder for raising the bridge and a submerged ladder at the back of the bridge so that an operator can climb out should he fall into the basin (round basin),
- Or a U-shaped walkway, fitted with two guardrails, with access at each end (rectangular basin), and a ladder at the back of the bridge so that an operator can climb out should he fall into the basin,
- A pivot consisting of a slewing ring and an electrical collector,
- A bearing system, with shaft(s) and geared motor(s),
- Jam detectors,
- A brake-formed sheet collecting gutter,

- Dip tubes with submerged bottom intakes,
- Hydrostatic drains, fitted with telescopic valves for collecting solids,
- A solids extraction system (vacuum pump, air lift, etc.)
- A surface scraper for floating; in the case of a radial system, the scraper consists of an adjustable fixed part and an articulated part.
- A system for cleaning the slotted sill.

The bridges are designed so that they can be disconnected quickly at the slewing ring without the need to raise the central pin.

2.1.3. MOTOR CHARACTERISTICS

2.1.3.1. MOTOR

The motor shall be:

- IP55 protected
- 380 Volts,
- 50-Hertz
- 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.

2.1.3.2. DRIVING HEAD

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

Shafts and gear-wheels shall be made of wrought steel.

2.1.3.3. WHEEL

Wheel shall be made of wrought aluminium.

2.1.3.4. VOLUTE

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

Blades will be made of stainless steel 316L.

2.2. DIMENSION TOLERANCES

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

2.3. PIPES

Inlet and outlet pipes shall be made of cast iron, stainless steel 304L or HPDE (Refer to Section 14100)

2.4. SPARE PARTS AND SPECIAL TOOLS

The Mandatory Spare parts are:

- For each alternative scraper bridge
 - 2 driving wheel
 - bushings
- For each longitudinal skimmer
 - 1 set of wheel
 - 1 set of bushing
- For each floor scraper
 - 1 set of spring
- For each suction scraper bridge
 - 1 motor reducer
 - 1 slip ring
 - 1 pump

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 2.2.

3.2.2. DRY TESTS

A. Testing of all operation characteristics during 24 hours and without water:

- a.** For each compressor taken individually,
- b.** For each compressors combination eventually necessary to get the overall installation flow.

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

B. Examination of paintwork.

3.2.3. COMMISSIONING TESTS

1. Examination of paintwork.
2. For each solid/floating materials removing system, checking of operation conditions for nominal flow and during 24 hours.
3. The supplier shall provide a extraction 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 sediment flushing and solid/floating material conveying. Each extraction system shall fit individually with requirements.
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.
5. Leakage shall not be observed out of the pipes.

SECTION 11301

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 fine screening equipment, including but not limited to:

1. Coarse screens,
2. Cleaning systems,
3. Level sensors,
4. Belt conveyor,
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 and shown on the approved Contractor shop 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. All platforms, ladders, or rungs that may be necessary for screens operations and handling will be provided by the Contractor.

The above listed equipment shall be considered as a package that shall be coordinated and integrated by the screen manufacturer.

PART 3 – TECHNICAL SPECIFICATIONS

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. Section 19 100 - Electrical Equipment;
- C. Section 17 100 – Instrumentation;
- D. Section 14 412 – Belt Conveyor;

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

Equipment numbers:	Screens: 101-BS-101; 101-BS-201 ;
Type:	Mechanically raked bar screen
Model	Straight, vertical
Number:	3 duty
Location	Outdoors
Nominal flow per device	11 500 m3/h
Mesh spacing	40 mm
Bar width	10 mm (opening 80%)
Channel dimensions	Channel depth: 3 450 mm (to top of wall) Channel width 1 500 mm
Screenings discharge level above channel floor	No particular requirements. Contractor shall coordinate with screenings belt conveyor layout
Materials	Stainless Steel 304 L except concrete embedded parts in Stainless Steel 316 L

PART 3 – TECHNICAL SPECIFICATIONS

	Frame in two parts (for transportation purposes)
Motor	0.55 kW – 8 tr/min – TRI – 400V – 50 Hz – IP55 - F
Accessories (per device)	Sensor of stop position for end of cycle; Head loss detection; Dismountable protection cover; Waste discharge hopper with hinges and hood; with inspection door and adapted to the screw hopper Waste guide table to incline level of waste discharge Deflectors for lateral waterproofing of the screen Motor/drum/strap hood with pneumatic jack
Accessories for the package	Local control box rated for outdoor installation for power supply, limit switch, overload protection device and automatic cleaning control program. Compacting Screw conveyor (See below)

Equipment number:	101-BS-301;
Type:	Manual bar screen
Model	Straight, vertical
Number:	1 Standby
Location	Outdoors
Nominal flow per device	11 500 m ³ /h
Mesh spacing	40 mm
Bar width	10 mm
Channel dimensions	Channel depth: 3 450 mm (to top of wall) Channel width 1 500 mm
Materials	Stainless Steel 304 L except concrete embedded parts in Stainless Steel 316 L
Accessories	Raking comb with handle for manual cleaning of the screen. Comb teeth adapted to this specific screen mesh spacing and bar size.

Belt Conveyor screw:

Equipment numbers:	101-BC-001
Type:	Belt Conveyor

PART 3 – TECHNICAL SPECIFICATIONS

Number:	1
Location	Outdoors
Nominal flow per device	12 m ³ /day screenings
Dimensions	9,8 m long, belt width 500 mm
Materials	Stainless steel 304 L
Motor	2.2 kW – 1400 rpm – TRI – 400V – 50 Hz – IP55 - F
Accessories	Support feet to support the belt conveyor on the channels top of wall and on the ground (2 m below top of wall of channels) Blockage sensor; Dismountable protection cover; SS 304L Waste distribution device in two dumpsters (manual rotation) Push button “forward” integrated in the screens local control box.
Requirements	Conform to Section 14 412 – Belt Conveyors

Level Detection:

Instrument numbers:	101-UF-001 ;
Type:	Ultrasonic level sensor
Number:	1
Location	Outdoors, raw wastewater
Requirements	See Section 17100

Note: level detection of sensor 102-UF-001 provided under Section 11 305 – Fine Screening will be used to compute the hydraulic headloss through the coarse screen.

1.3.2. OPERATING CONDITIONS

Coarse screens shall be discontinuously and automatically cleaned, thanks to both head loss detection and timer (with possible adjustments). Cleaning system shall be composed of a cleaning comb. The rake assembly shall include teeth, which penetrate the depth of the bar screen to ensure positive solids removal. The rake shall discharge its waste at least one time during the cleaning cycle through the topmost position.

Wastes are discharged in a conveying belt which evacuates them towards two skips. The end of the belt is equipped with a waste distribution device, manually rotated to direct wastes into one of the two skips.

1.3.3. CONTROL AND MONITORING

The racking mechanism and the conveying belt shall have a Manual mode and an Automatic Mode.

- Under Manual mode, each screen may be turned ON or OFF locally.
- Under Automatic Mode, the screens may be turned ON or OFF remotely.
- When at least one screen is ON, then the belt conveyor shall turn ON via an interlock.

When turned ON, the screen raking mechanism and the belt conveyor shall be operated according to the Manufacturer's program integrated in the local control box.

The local control box shall be equipped with:

1. Manual / Auto switch
2. Lighted button "ON"
3. Lighted button "OFF"
4. Defaults presentation.
5. Program for Cyclic working on clock or / and head losses detection,
6. Indicator of Malfunctions and Alarms, including but not limited to "high headloss alarm".

The following information shall be reported to the facility PLT for each piece of equipment:

- ON/OFF status
- Motor overload

The following information shall be reported to the facility PLT from the local control box:

- Auto /Manual Status
- Alarm status

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.

1.5. SUBMITTALS

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

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

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. FABRICATION

All main parts of the screens (bars, frame, fixings, fastenings, etc.) and their supports shall be made of stainless steel 304L.

All concrete embedded parts shall be made of stainless steel 316L.

The screens shall be provided with a frame allowing easy removal of the screen from the channels for maintenance purposes.

2.2. DIMENSION TOLERANCES

1. Tolerances of the screens equipment inner assembling before installation (hopper, cleaning comb, belt conveyor) 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 $\pm 0.5^\circ$.
4. The deviation of all screws installation angles (angle between the screw axis and the horizontal line) is not larger than $\pm 0.5^\circ$.

2.3. SPARE PARTS AND SPECIAL TOOLS

The Mandatory Spare Parts for the screens are the following:

- a) 1 set of all necessary lifting and operation cables
- b) 1 set 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 equipment 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 2.2 above.

3.2.2. DRY TESTS

1. Examination of paintwork.
2. The raking comb and the fine screens bars shall have no blocking or point of resistance, over the entire length of 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. 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 without observing any difficulties. The raking comb shall operate well without block or miss. The overload device shall react quickly and precisely.
2. The supplier should check that screen performances are in accordance with the 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.

SECTION 11305

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. Level sensors,
4. Compacting screw conveyor,
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 and shown on the approved Contractor shop 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. All platforms, ladders, or rungs that may be necessary for screens operations and handling will be provided by the Contractor.

The above listed equipment shall be considered as a package that shall be coordinated and integrated by the screen manufacturer.

PART 3 – TECHNICAL SPECIFICATIONS

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. Section 17100 – Instrumentation;
- C. Section 14 410 – Screw Conveyors;

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

Equipment numbers:	Screens: 102-BS-100; 102-BS-200 ; 102-BS-300
Type:	Mechanically raked bar screen
Model	Straight, vertical
Number:	3 duty
Location	Outdoors
Nominal flow per device	6 800 m ³ /h
Mesh spacing	10 mm
Bar width	10 mm (opening 50%)
Channel dimensions	Channel depth: 3 700 mm (to top of wall) Channel width 1 500 mm
Screenings discharge level above channel floor	No particular requirements Contractor shall coordinate with screenings screw conveyor layout
Materials	Stainless Steel 304 L except concrete embedded parts in Stainless Steel 316 L Frame in two parts (for transportation purposes)
Motor	0.55 kW – 8 tr/min – TRI – 400V – 50 Hz – IP55 - F

PART 3 – TECHNICAL SPECIFICATIONS

Accessories (per device)	<p>Sensor of stop position for end of cycle;</p> <p>Head loss detection;</p> <p>Dismountable protection cover;</p> <p>Waste discharge hopper with hinges and hood; with inspection door and adapted to the screw hopper</p> <p>Waste guide table to incline level of waste discharge</p> <p>Deflectors for lateral waterproofing of the screen</p> <p>Motor/drum/strap hood with pneumatic jack</p>
Accessories for the package	<p>Local control box rated for outdoor installation for power supply, limit switch, overload protection device and automatic cleaning control program.</p> <p>Compacting Screw conveyor (See below)</p>

Equipment number:	102-BS-400;
Type:	Manual bar screen
Model	Straight, vertical
Number:	1 Standby
Location	Outdoors
Nominal flow per device	6 800 m ³ /h
Mesh spacing	20 mm
Bar width	10 mm
Channel dimensions	<p>Channel depth: 3 700 mm (to top of wall)</p> <p>Channel width 1 500 mm</p>
Materials	Stainless Steel 304 L except concrete embedded parts in Stainless Steel 316 L
Accessories	Raking comb with handle for manual cleaning of the screen. Comb teeth adapted to this specific screen mesh spacing and bar size.

Compacting screw:

Equipment numbers:	102-SW-001
Type:	Screw compactor ; shaftless screw
Number:	1
Location	Outdoors

PART 3 – TECHNICAL SPECIFICATIONS

Nominal flow per device	36 m ³ /day non compacted screenings
Length	9 m long
Materials	Stainless steel 304 L
Motor	1.5 kW – 1400 rpm – TRI – 400V – 50 Hz – IP55 - F
Accessories	Support feet to support the screw conveyor on the channels top of wall and on the ground (2 m below top of wall of channels) Blockage sensor; Dismountable protection cover; Manual valve and sinusoid valve for compression chamber washing; Evacuation pipes for filtrates (ND 150 mm) to return to screening channel. SS 304L Waste distribution device in two dumpsters (manual rotation) Push button “forward” integrated in the screens local control box.
Requirements	Conform to Section 14 410- Screw Conveyors

Level Detection:

Instrument numbers:	102-UF-001; 102-UF-002
Type:	Ultrasonic level sensor
Number:	2
Location	Outdoors, raw wastewater
Requirements	See Section 17100

1.3.2. OPERATING CONDITIONS

Fine screens shall be discontinuously and automatically cleaned, thanks to both head loss detection and timer (with possible adjustments). Cleaning system shall be composed of a cleaning comb. The rake assembly shall include teeth, which penetrate the depth of the bar screen to ensure positive solids removal. The rake shall discharge its waste at least one time during the cleaning cycle through the topmost position.

Wastes are discharged in a conveying compacting screw which evacuates them towards two skips. The end of the compacting screw is equipped with a waste distribution device, manually rotated to direct wastes into one of the two skips.

1.3.3. CONTROL AND MONITORING

The racking mechanism and the compacting screw shall have a Manual mode and an Automatic Mode.

- Under Manual mode, each screen may be turned ON or OFF locally.
- Under Automatic Mode, the screens may be turned ON or OFF remotely.
- When at least one screen is ON, then the screw conveyor shall turn ON via an interlock.

When turned ON, the screen raking mechanism and the screw compactors shall be operated according to the Manufacturer's program integrated in the local control box.

The local control box shall be equipped with:

1. Manual / Auto switch
2. Lighted button "ON"
3. Lighted button "OFF"
4. Defaults presentation.
5. Program for Cyclic working on clock or / and head losses detection,
6. Indicator of Malfunctions and Alarms, including but not limited to "high headloss alarm".

The following information shall be reported to the facility PLT for each piece of equipment:

- ON/OFF status
- Motor overload

The following information shall be reported to the facility PLT from the local control box:

- Auto /Manual Status
- Alarm status

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.

1.5. SUBMITTALS

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

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

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. FABRICATION

All main parts of the screens (bars, frame, fixings, fastenings, etc.) and their supports shall be made of stainless steel 304L.

All concrete embedded parts shall be made of stainless steel 316L.

The screens shall be provided with a frame allowing easy removal of the screen from the channels for maintenance purposes.

2.2. DIMENSION TOLERANCES

1. Tolerances of the screens equipment inner assembling before installation (hopper, 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 $\pm 0.5^\circ$.
4. The deviation of all screws installation angles (angle between the screw axis and the horizontal line) is not larger than $\pm 0.5^\circ$.

2.3. SPARE PARTS AND SPECIAL TOOLS

The Mandatory Spare Parts are the following:

- a) 1 set of all necessary lifting and operation cables
- b) 1 set 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 equipment 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 2.2 above.

3.2.2. DRY TESTS

1. Examination of paintwork.
2. The raking comb and the fine screens bars shall have no blocking or point of resistance, over the entire length of 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. 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 without observing any difficulties. The raking comb shall operate well without block or miss. The overload device shall react quickly and precisely.
2. The supplier should check that screen performances are in accordance with the 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.

SECTION 11318 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 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 15420 – Air lift;
- D.** Section 17100 – Instrumentation;

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

Identification	103-GC-511, 103-GC-512, 103-GC-513
Type:	Grit classifier
Number:	2 + 1 in stand-by
Location:	Area 103 - Grit and grease removal tank
Nominal flow sandy water:	100 m3/h
Motor:	0.75 kW – 4.6 tr/min- TRI – 380V– 50 Hz – IP55 - F
Materials:	Shaftless spiral made of cold rolled flat bars in special steel, hardness 400 HB Tank, cover, u-flanges in stainless steel AISI 304L
Devices included:	
Inlet coupling ND200 / Outlet coupling ND250	
Cover plate	
Shaftless spiral for grit conveying	
Motor reducer (security)	

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.

The Contractor's bid shall include:

- performance guarantees
- the simplified installation drawings of the proposed equipment
- the characteristics of the equipment
- 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:

1. Manual / auto commutator
2. Lighted button “ON”
3. Lighted button “OFF”
4. 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 equipments 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. 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. Installation, maintenance and operation manuals with requirements of accuracy
2. Manufacture and quality assurance measures
3. Protective coating list of all parts
4. Commissioning tests list.
5. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.
6. Internal wiring diagrams and control principle drawing of control box
7. Weight and material of each component

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 60° 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:

- IP55 protection grade,
- Non-overloading,
- Constant speed motor with 380 Volts,
- 50-Hertz
- Class F insulation.

2.2. 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 $\pm 0.5^\circ$.

2.3. SPARE PARTS AND SPECIAL TOOLS

The Mandatory Spare Parts are:

-equipment maintenance

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

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 11 322

THICKENING SCRAPER AND PICKET FENCE

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 extraction system equipment, including but not limited to:

1. Scraper and picket fence with rotating mechanism,
2. 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 Concrete Section as will be shown on the civil construction drawings.

3. 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 Concrete Section.

4. 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;

PART 3 – TECHNICAL SPECIFICATIONS

1.2.2. WORKS UNDER THIS SECTION SHALL BE CO-ORDINATED WITH:

- A. Concrete works covered by the Civil Works Section;
- B. Section 11210 – Lamella plates;
- C. Section 17100 – Instrumentation.

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

Identification number:	105-PF-101 ; -102; -103; -104
Type:	Rotating Travelling bridge
Number:	4
Location	Primary sedimentation tanks
Picket fence for thickening:	<p>Maximum elevation of the pickets from the bottom of the tank: 884.00 masl</p> <p>Bottom slab elevation : 881.00 masl</p> <p>Intervals between pickets: 700 mm</p> <p>Materials : Galvanized Steel</p>
Bottom scraper:	<p>Height of the plate: 200 mm</p> <p>Suspended to the arm by 50/60 diameter tubes, adjustable in height</p> <p>Materials : Galvanized steel</p>
Motor:	<p>3 kW – speed 1.5 tr/mn – 400V – 50 Hz – IP 55 – Class F</p> <p>Installed outdoors.</p>

1.3.2. OPERATING CONDITIONS

- A. The picket fence is directing the solids towards the bottom of the tank.
- B. The bottom scraper plates are pushing the to the central collection pit. The solids are then recovered by suction and transported to the sludge holding and buffer tank.
- C. The Contractor shall provide characteristics of the proposed equipment:
 - Rotating speed in rd/min or moving speed in m/min
 - Nominal power of the driving motor

- Weight of the overall equipment and of each main part
- Main operation loads, particularly when they are in relation with Civil works fastenings.

1.3.3. CONTROL AND MONITORING

The operation mode of scraper and suction bridges should have both:

- A.** Manual control and PLC automatic control.
- B.** Local control and distance control.

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

1. Manual / auto commutator
2. Lighted button "ON"
3. Lighted button "OFF"
4. 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 equipments will be connected to the general computer.

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

Malfunctions and alarms.

1.4. QUALITY ASSURANCE

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

1.6. GUARANTEE

1.6.1. PERFORMANCE

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

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. FABRICATION

The Thickening Scraper and Picket Fence should be equipped with:

- A bearing system, with shaft(s) and geared motor(s),
- A central rotating shaft made of an ND500 tube on which two frames are welded on opposite sides. Two arms fabricated from folded steel plates shall be bolted to the frame. On these arms angle plates shall be welded at regular intervals to form the picket fence.
- A steel pivot guide equipped with an autolubricating ring filled with marine grade lubricant and installed at the bottom of the tank to ensure the proper rotation of the shaft
- Bottom scraper plates fabricated from folded steel plates equipped with rubber bibs for collecting solids towards the central pit, and suspended to the arm by adjustable height tubes.
- An emergency stop, with safety stops,
- A festoon cable power supply system,
- A jam detector.

2.1.1. MOTOR CHARACTERISTICS

2.1.1.1. MOTOR

The motor shall be:

- IP55 protected
- 380 Volts,
- 50-Hertz
- 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.

2.1.1.2. DRIVING HEAD

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

Shafts and gear-wheels shall be made of wrought steel.

2.2. DIMENSION TOLERANCES

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

2.3. SPARE PARTS AND SPECIAL TOOLS

The Mandatory Spare parts are:

- For each of the Thickening Scraper and Picket Fence
 - 1 scraper plate
 - bushings
- For each longitudinal skimmer
 - 1 set of wheel
 - 1 set of bushing
- For each floor scraper
 - 1 set of spring
- For each suction scraper bridge
 - 1 motor reducer
 - 1 slip ring
 - 1 pump

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 2.2.

3.2.2. COMMISSIONING TESTS

1. Examination of paintwork.
2. Verification of the rotation speed and vibration requirements.

SECTION 11332

SUBMERSIBLE HORIZONTAL SHAFT MIXERS

1. GENERAL

1.1. WORK INCLUDED

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of submersible horizontal shaft mixers equipment.

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 WORK

Supplies and works included under this section shall comply and be co-ordinated with all others parts and section of the contract.

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

<u>Identification</u>	
Type	Tri-blade
Number	2 (1 per sludge storage tank)
Location	Sludge storage tanks
<u>Operating conditions</u>	
Duty	Continuous or discontinuous
Drive	Constant speed
Fluid service	Primary sludge up to 35 g/l of suspended solids concentration
Fluid temperature	5-40°C

PART 3 – TECHNICAL SPECIFICATIONS

Fluid pH	6-9
Fluid specific gravity	1,05
Description	
Type	Immersed speed mixer
Number of blades	3
Impeller diameter	500 mm
Impeller rotation speed	270 rpm
Material	General requirements are indicated in part 2 : Products – Components and sub-assemblies. Particular requirements are as follows : Impeller : gray cast iron EN JL 1040
Motor:	4 kW– 400V – 50 Hz – IP 68 – Class F
Accessories (per installed mixer)	
Thermal sensor	
Guide bars, attachment for guide bars, elevating chain incl. suspension attachment : Stainless steel X2CrNi18-09 1.4307 (304L)	
10 m oil resistant electrical cable and bracket	
Cable fixing facilities and cable protection	
1 lifting device (rudder in galvanized steel and hoisting winch in stainless steel 304L)	

1.3.1. MAIN CHARACTERISTICS

- a. All mixers shall be driven by electric motors in accordance with the requirements of the electrical specifications.
- b. The direction of rotation of all the mixers shall be clockwise when viewed from the motor end of the mixer set assembly.
- c. All mixers of same type shall be identical in design and construction in all respects including performance, parts, mountings, connecting flange dimensions and materials.
- d. The mixer rotating assembly design shall be such that the first critical speed of the mixer with its motor and the transmission assembly, when running as one system, is at least 150 percent of the maximum operating speed of the mixer.

- e. Each component casting of the mixer 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.
- f. The mixers 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 due to grit.

1.3.2. OPERATING CONDITIONS

Submersible horizontal shaft agitators are used for maintain suspended solids in suspension and homogenize the sludge concentrations from different lamellar tanks prior to dewatering operations.

The agitators may be adjusted horizontally, and have self-cleaning paddles. The agitators are fixed to guide rails and can be handled using lifting device n fixed to the technical walkways.

Moreover the Contractor shall provide characteristics of the proposed equipment:

- Circulation speed of the fluids,
- Rotation speed,
- Absorbed power,
- Weight of the assembly and each equipment

1.4. QUALITY ASSURANCE

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.

The contractor shall submit the results of workshop test.

1.5. SUBMITTALS

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

1. Installation, maintenance and operation manuals with requirements of accuracy
2. Manufacture and quality assurance measures
3. Protective coating list of all parts
4. Commissioning tests list.
5. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.

6. Internal wiring diagrams and control principle drawing of control box
7. Weight and material of each component

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. GENERAL

The end stops shall be protected against any water infiltration occurring as a result of failure of the mechanical seals.

It must be easy to dismantle the various components.

The bearing shall be of the grease-lubricated sealed ball bearing type.

The seals shall be mechanical. The shaft shall be sealed using two tight mechanical seals fitted in tandem regardless of the direction of rotation.

The Contractor shall submit a detailed note describing the lubrication and greasing system that he proposes.

2.1.1. MOTOR AND GEAR HEAD

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.

2.2. FABRICATION

If applicable, particular requirements mentioned above in part 1 must be enforced.

2.2.1. BODY AND CASING

Gray cast iron EN JL 1040 or better

2.2.2. SHAFT

The pump shaft shall be of alloyed 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.

2.2.3. IMPELLER

Stainless steel X2CrNi18-09 1.4307 (304L)

2.2.4. NUTS, BOLTS AND OTHER SUPPORTS

All exposed nuts, bolts, double guide bars, attachment for guide bars, elevating chain incl. suspension attachment shall be in stainless steel X2CrNi18-09 1.4307 (304L).

2.3. DIMENSION TOLERANCES

- A.** Tolerances of the mixers inner assembling before installation (blade paddles, hollow shaft, driving device) shall be conform to the manufacturer instructions.
- B.** 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.
- C.** The elevation deviation of paddles shall not exceed ± 5 mm.

2.4. SPARE PARTS AND SPECIAL TOOLS

The Mandatory Spare Parts for each submersible horizontal mixer are:

- a.** 1 axis,
- b.** 1 paddles,
- c.** 1 gear head
- d.** 1 gear box

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.** Holes position
 - b.** Flatness, verticality, horizontality of the embedded parts,

- B.** Erection tolerances:

Refer to Section 01020.

3.2.2. DRY TESTS

- 1. Examination of paintwork.

3.2.3. COMMISSIONING TESTS

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

PART 3 – TECHNICAL SPECIFICATIONS

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 labour, 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.

1. Checking of operation parameters (rotation speed, flow speed, absorbed power), for each agitator tested individually.
2. 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).
3. The supplier shall provide mixing 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 mixing. Each tank shall fit individually with requirements.
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.

SECTION 11370

POLYMER PREPARATION

1. GENERAL

1.1. WORK INCLUDED

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of automatic polymer preparation unit, including but not limited to:

1. Polymer storage,
2. Automatic polymer preparation unit,
3. Polymer injection pumps,
4. Inline dilution,

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

The above listed equipment shall be considered as a package that shall be coordinated and integrated by the manufacturer.

The polymer equipment shall be designed for automatic operation.

1.2. RELATED WORK

Supplies and works included under this section shall comply and be co-ordinated with all others parts and section of the contract.

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

1.3.1.1. POLYMER STORAGE

Identification	201-BF-001
Type	Manual polymer big bag emptying station
Location	Sludge building – polymer room

Description	
Maximal capacity	1 000 kg
Components	Frame Lifting beam Telescopic support beam Vibrating support dish - 0,18 kW – 50 Hz – 380 V Access door Buffer hopper Gate valve
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies.

1.3.1.2. POLYMER PREPARATION

Identification	No global number, see element numbers hereafter
Type	Automatically preparation unit for dry polymer
Location	Sludge building – polymer room
Operating conditions	
Duty	Continuous – 16h/day – 7 days a week
Fluid service	Dry polymer
Description	
Preparation unit	Automatic preparation unit with three compartments (mix compartment, maturation compartment, storage compartment)
Preparation unit capacity	Between 2 and 6 m ³ /h (for one to three sludge dewatering equipments)
Total volume	9 m ³
Polymer concentration in solution	2 to 4 g/l
Automatic polymer feeding	Hopper stainless-steel with a cover, an inspection panel and one level sensor – Capacity 500 l

PART 3 – TECHNICAL SPECIFICATIONS

	Screw conveyor(201-SW-001) : 200 kg/h P = 0,55 kW
Automatic polymer dosing and injection	<p>Hopper stainless-steel with a cover and two level sensors – Capacity 50 l</p> <p>Dosing screw (201-DS-001)- capacity: 5 to 40 kg/h</p> <p>Wetting system for flushing-in and wetting of the powder, included : wetting cone – water line injection – 12 m³/h - 3 bars with surpression pump (201-SUR-001), solenoid valve (201-SV-001), pressure reducer, flow set valve, flow rate indicator with “no flow” pass detector.</p>
Mix compartment	<p>Capacity = 4 m³</p> <p>Cover with an inspection panel</p> <p>One vertical slow mixer (201-MX-001) – maximal speed = 100 rpm - P = 0,55 kW -</p> <p>Drainage device with valve</p> <p>Siphon-like partition</p>
Maturation compartment	<p>Capacity = 2,5 m³</p> <p>Cover with an inspection panel</p> <p>One vertical slow mixer (201-MX-002)– maximal speed = 100 rpm - P = 0,55 kW -</p> <p>Drainage device with valve</p> <p>Siphon-like partition</p>
Storage compartment	<p>Capacity = 2,5 m³</p> <p>Cover with an inspection panel</p> <p>Drainage device with valve</p> <p>Over flow device</p> <p>4 level sensors (201-FL-001/002/003/004)</p> <p>Polymer dosing pump connection</p>
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies.

1.3.1.3. POLYMER PROGRESSIVE CAVITY PUMPS

<u>Identification</u>	201-PC-101/201/301
Number	3
Location	Sludge building – Polymer room
Model	Progressive cavity pumps – horizontal installation
<u>Operating conditions</u>	
Duty	Continuous – 16 h/day – 7 days a week
Drive	Manual variable speed geared motor
Ambient environment	Indoor
Ambient temperature	5-40°C
Fluid service	Polymer solution (2 to 4 g/l)
Fluid temperature	15 – 30 °C
Fluid pH	6-9
Fluid specific gravity	1,05
<u>Description</u>	
Unit capacity	1 to 3 m ³ /h
Maximal pressure	2 bars
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies.
Motor	1,1 kW – 400 V – 50 Hz – IP 55 – F
Accessories (per installed pump)	
One suction and discharge pipe	
Upstream and downstream isolation valves (gate valves)	
Non-return valves (ball valve)	
Pressure gauges	
Magnetic flowmeters 201-MF-101/201/301	

Dry Running Protection Device

1.3.1.4. INLINE WATER SERVICE DILUTION

Inline water service dilution	3 water injection lines - 3 bars with solenoid valve (201-SV-101/201/301), pressure reducer, manual flow set valve, flow rate indicator with “no flow pass” detector.
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1.3.2. OPERATING CONDITIONS

1.3.2.1. GENERAL

The preparation unit is designed for an automatic functioning as soon as the dewatering units are operating.

The operator is only required to load big-bags on the emptying station and to open the gate valve to load polymer powder in the automatic polymer feeding device. Polymer bags shall be lowered into the framework by an electrical stacker.

The preparation unit is divided into three separate chambers, so that a sufficient maturing time for the polymer solution can be ensured. The division of the reservoir largely prevents the matured and freshly prepared solution from mixing and ensures continuous discharge.

The contractor proposes all capacities to guaranty the reliability of dewatering operations.

All motors must be easily reached for maintenance operation.

Inspected panels must be enough sized to make cleaning operations easier.

Overflow and drainage devices must be connected to drain gutter.

A local control panel including all power supply (mixers, screws, solenoid valve, pumps) and automatism is also provided. Defaults must be sent to the SCADA.

1.3.2.2. AUTOMATIC POLYMER FEEDING

Dry polymer shall be fed by mechanical, positive displacement volumetric feeder. Motor shall be variable speed.

The discharge port of the volumetric feeder shall be completely enclosed in a chamber. The polymer/water initial wetting area shall be clearly visible. The acrylic barrel shall prevent inadvertent drifting of airborne polymer dust and protect feeder discharge from environment. The discharge port shall be fitted with a pneumatically operated valve to isolate dry polymer from the environment between cycles.

Dry polymer shall rely on gravity to transfer from feed device to wetting device. This shall eliminate the need for any type pneumatic conveying system.

1.3.2.3. DILUTION WATER

Dilution water flow for polymer batching shall be from well service water (6 bars) or in case of poor quality from drinking water supply, equipped with reduced pressure backflow preventer. Drinking water available service pressure is around 1,5 bars. The Contractor foresees the surpression pump to achieve needed service pressure for polymer preparation (at least 3 bars). Dilution water shall be maintained at a constant rate by means of a flow control valve. A differential pressure indicator/switch shall be supplied to display water differential pressure. Low differential pressure switch shall shut down system and energize alarm at Local Control Panel after adjustable time delay. Water flow (on/off) shall be controlled by a solenoid valve with spring to close for fail-safe operation. Dilution water feed shall include rotameter to provide visual indication of flow.

1.3.2.4. MIXERS

The Contractor shall provide characteristics of the proposed equipment:

- Circulation speed of the fluids,
- Absorbed power,
- Weight of the assembly and each equipment

1.3.2.5. PUMPS

1.3.2.5.1. Pump Duties

Each of the pumps shall be capable of operating continuously without damaging effects. 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.

1.3.2.5.2. 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.

1.3.2.5.3. Pump Rated Speed (NR)

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

1.3.2.5.4. 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.

1.3.2.5.5. **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.

1.3.2.6. **POST DILUTION ASSEMBLIES**

It shall provide additional dilution required by application. System shall include skid-mounted post-dilution units consisting of a static mixer in a clear PVC housing, rotameter-type flow indicator with rate-adjusting valve. The post-dilution water flow rate shall be adjustable. Provide rotameters to measure dilution water flow.

1.4. QUALITY ASSURANCE

1.4.1. 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.

1.5. SUBMITTALS

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

1. Installation, maintenance and operation manuals with requirements of accuracy
2. Manufacture and quality assurance measures
3. Protective coating list of all parts
4. Commissioning tests list.
5. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.
6. Internal wiring diagrams and control principle drawing of control box

7. Weight and material of each component

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. MIXERS

The mixer shall utilize stainless steel impellers. The mix tank impeller shall be driven by a washdown duty motor coupled with a right angle gear reducer. The gear reducer and motor shall be mounted on a stainless steel or fiberglass channel crossing the mixing/holding tank. The impeller shall be coupled to the gear reducer.

The impeller diameter shall be as large as possible to fit inside the tank diameter, guaranteeing the most uniform distribution of mixing energy.

The mixer shaft shall be stainless steel with clear PVC sleeve to direct polymer slurry from the wetting device into hollow-bladed impeller.

2.2. PUMPS

2.2.1. GENERAL

All pumping units shall be supplied as complete pumping systems, including the pump, its driving motor, the drive shaft and couplings, local control panels and all necessary appurtenances (including protection devices, switches, etc.).

Pumps and motors shall be flexible-coupled. That portion of the shaft extending through the mechanical seal (s) shall be equipped with a replaceable sleeve (sealed or positive locked to the shaft) such that the entire shaft need not be replaced when it is scored or worn in this area. Pump shafts shall be designed for a maximum deflection at the shaft seal of 0.05 mm (0.002 in). All couplings, connections, external sealing, etc. shall be weather protected, suitable for outdoor installation.

Pump shafts shall run in ball bearings. The bearings shall be grease-lubricated and shall be contained in dust-proof and moisture-proof housing. The bearings and frame design shall be such that the bearings can be re-lubricated by use of external greasing devices. The pump design shall ensure that the outboard bearing can carry a combined thrust and radial load. Bearings shall be adequately designed to carry all radial and thrust loads through the normal operating range of the pump. Bearings for pumps in continuous operation (or in continuous rotation of operation) shall have an L-10 life of at least 40,000 hours at the operating point.

Mechanical seals, not packing, shall be used for all pumping units. Seals shall be of the type not requiring water sealing or flushing water.

Oil level shall be maintained by a constant level oilier with visible oil supply.

All openings in the pump shall be large enough to permit passage of solids with maximum diameter of 60 mm.

Connections to concrete foundations for all pumps shall be sufficient to withstand a displacing force equal to that developed by an internal pressure equal to three times shut-off head at maximum operating speed.

Pumping units shall be designed to operate without damaging vibration over the entire specified range of flow and head conditions and (where appropriate) over the range of speeds specified.

Major pump components shall be of gray cast iron with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts, bolts and washers shall be of AISI type 304 stainless steel or better. All metal surfaces coming in contact with the pump- age, other than stainless steel or brass shall be protected by a factory-applied spray coating of alkyd primer with oxiranesther paint finish on the exterior of the pump. Sealing design of major pump components shall incorporate metal to metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton O-rings. Fittings will be of controlled compression of rubber O-rings in two planes and O-rings contact of four sides without the requirement of a specific torque limit.

Neither rectangular sectioned gaskets neither requiring specific torque nor scaling compound shall be considered as equal.

Pumping units shall have no dangerous critical or resonance frequencies. The Contractor shall be responsible for the analysis of critical speeds and the complete mass elastic system, and shall submit calculations in this regard to the Engineer or his representative for approval prior to erection.

Pumping units shall be suitable for connection to No.-Flow shut-off switches, such switches to be supplied with all check valves supplied.

Each unit shall be provided with an adequately designed cooling system. Provisions for external cooling and seal flushing shall be provided. The cooling system shall provide for continuous pump operation in liquid temperature of up to 40°C.

2.2.2. CABLE ENTRY SEAL

The Cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomere grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable the assembly shall provide ease of changing the cable. The cable entry junction chamber and motor shall be separated by a terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

2.2.3. MOTORS

The pump motor shall be a squirrel cage induction motor, shell type design, housed in an air-filled watertight chamber. The stator windings and stator leads shall be insulated with moisture resistant Class F insulation rated for 155°C. The stator shall be dipped three times in Class F varnish and shall be heat-shrink fitted into the stator housing. The motor shall be designed for continuous duty handling pumped media of 40°C and capable of up to 15 evenly spaced starts per hour. Thermal switches set to open at 125°C and closed at 70°C shall be embedded in the stator load coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomer o-ring seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. Wire nuts or crimping type connection devices are not acceptable. The motor and pump shall be designed and assembled by the same

PART 3 – TECHNICAL SPECIFICATIONS

manufacturer. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15 the motor shall have a voltage tolerance of plus or minus 10% the motor shall be designed for operation up to 40oC ambient temp. and with a temp. rise not to exceed 85oC. This chart shall also include data on starting and no-load characteristics. The motor and the cable are capable of continuous submergence underwater without loss of watertight integrity acc. To protection class IP68 (20m), the rated power shall be adequate so that the pump is not overloaded throughout the entire indicated pump performance curve.

Power cable includes two conductors 1.5 mm for the monitoring of thermal switches and optional protecting sensors.

2.2.4. BEARING

The pump shall be provided with grease lubricated thrust and radial bearings designed for all loads imposed by the specified service. Bearing life for all pump and motor bearings shall be 100,000 hours minimum

2.2.5. MECHANICAL SEAL

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two independent seal assemblies. The seals shall operate in an oil-reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump housing and the oil-chamber, shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper, secondary seal unit, located between the oil-chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotating for sealing. For special applications other seal face material shall be available. Other seal types shall not be considered acceptable or equal to the dual independent seal specified. Each pump shall be provided with an oil chamber for the shaft sealing system, the drain and inspection plug, for the oil, shall be accessible from the outside.

2.2.6. ROTOR AND STATOR

The pump shall be two-stage design employing a convoluted rotor operating in a similarly convoluted stator. The convolutions shall be configured to form a cavity between the rotor and stator which shall progress from the pump's inlet to discharge port with the operation of the rotor. The fit between the rotor and stator at the point of contact shall compress the stator material sufficiently to form a good seal and to prevent leakage from the discharge back to the inlet end of the pumping chamber.

2.3. FABRICATION

Polymer storage	Frame and telescopic support beam : galvanized steel Lifting beam : painted steel Buffer hopper and vibrating support dish : X2CrNi18-09 1.4307 (304L) or painted steel or galvanized steel All exposed nuts and bolts : Stainless steel
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PART 3 – TECHNICAL SPECIFICATIONS

	X2CrNi18-09 1.4307 (304L)
Polymer preparation	Tanks : polyester Pipe and valves : PVC pressure Mixers : stainless steel (304L) Hopper : stainless steel (304L)
Progressive cavity pumps	Body : gray cast iron EN JL 1040 Rotor : Stainless steel X20Cr13 1.4021 Stator : Buna-N synthetic rubber with a minimum shore durometer hardness of 60 bonded to a steel tube. Shaft : Stainless steel X20Cr13 1.4021

2.4. SPARE PARTS AND SPECIAL TOOLS

The Mandatory Spare Parts are

- for each mixer :
 - Set of pressure gauge assembly
 - 1 mechanical seals
 - 1 motor coupling

- for each size of pump furnished:
 - One stator,
 - One rotor,
 - One connecting rod,
 - One set connecting rod joint assembly,
 - One bearing assembly,
 - One set of V-belts,
 - Two sets of drive pins, washers, and screws,
 - Two sets of gaskets and o-rings,
 - One mechanical seal.

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 shaft mixers (blade paddles, 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

- A.** The following inspections shall be carried out :
 - a.** Holes position
 - b.** Flatness, verticality, horizontality of the embedded parts,
- B.** Erection tolerances:

Refer to Section 01020

3.2.2. DRY TESTS

- 1. Examination of paintwork.

3.2.2.2. 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 programme 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 labour, 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.

3.2.2.3. INSTALLATION INSPECTION

- a.** When the Contractor is satisfied that the unit sets have been properly installed he shall inform the Engineer who will carry out the installation inspection.

- b. The unit 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.

3.2.2.4. 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.

3.2.2.5. COMMISSIONING TESTS

- a. For each agitator, checking of operation conditions for nominal flow and during 24 hours. The supplier shall provide mixing 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 mixing. Each tank shall fit individually with requirements.
- b. For 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.
 - Performance proving tests shall be carried out on one pump set at a time by pumping clean water. 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.
 - 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.
- c. 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.

SECTION 11373
**COMBINED GRAVITY BELT SLUDGE THICKENING AND BELT
FILTER PRESS DEWATERING**

1. GENERAL

1.1. WORK INCLUDED

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

1. Gravity belt thickener (EMO type OMEGA 20 MD or equal)
2. Belt filter press (EMO OMEGA 1200 or equal),
3. Wash water pump,
4. Air compressor,
5. Screw conveyors,

The dewatering unit (items 1 to 5) shall be provided as a completely integrated system designed for continuous and automatic operation.

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

1.2. RELATED WORK

Supplies and works included under this section shall comply and be co-ordinated with all others parts and section of the contract.

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

<u>Operating conditions and performance requirements</u>	
Duty	Continuous – 16 h/day – 7 days a week

PART 3 – TECHNICAL SPECIFICATIONS

Ambient environment	Indoor
Ambient temperature	5-40°C
Fluid service	Primary sludge between 25 to 35 g/l of suspended solids concentration and polymer (powder)
Fluid temperature	5-40°C
Fluid pH	6-9
Fluid specific gravity	1,05
Sludge concentration after dewatering operation	Average : 24 % Minimum 22 %
Solids capture efficiency	> 94%

1.3.1.1. **GRAVITY BELT THICKENER**

<u>Identification</u>	202-BT-101/201/301
Number	3
Type	Gravity belt thickener
Location	Sludge building – dewatering room
<u>Description</u>	
Floculator	Tank capacity: 500 l 1 vertical mixer P = 1,1 kW – 50 Hz – TRI – 400 V – 50 Hz – IP 55 – F Variable frequency drive
Belt width	2,0 m
Maximum SS flow	1 000 kg SS/h
Flow rate	28 m ³ /h
Filtration length	2,70 m
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies.

PART 3 – TECHNICAL SPECIFICATIONS

Components for each unit	<p>Removal cover (X20Cr13 1.4021 or X2CrNi18-09 1.4307 (304L)) with sludge inlet flange and air extraction flange.</p> <p>Wash water line with solenoid valve, manual valve, manometer, pressure sensor and flowmeter.</p> <p>Hopper feeding the belt filter press with high level sensor.</p> <p>Sludge level sensors on belts</p>
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1.3.1.2. BELT FILTER PRESS

<u>Identification</u>	202-FP-101/201/301
Number	3
Type	Belt filter press
Location	Sludge building – dewatering room
<u>Description</u>	
Belt width	2,0 m
Maximum SS flow	1 000 kg SS/h
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies.
Accessories for each unit	<p>Removal cover (X20Cr13 1.4021 or X2CrNi18-09 1.4307 (304L)) with sludge inlet flange and air extraction flange.</p> <p>Wash water line with solenoid valve, manual valve, manometer, pressure sensor and flowmeter.</p> <p>Hopper feeding the screw conveyor with high level sensor.</p> <p>Mechanical device for belt tension</p> <p>Pneumatic device for belts self-aligning, jacks, compressed air injection with solenoid valve, security sensors.</p>

	Sludge level sensors
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1.3.1.3. **WASH WATER PUMP**

<u>Identification</u>	202-PC-101/201/301
Number	3
Type	Vertical multicellular pump
Location	Sludge building – dewatering room
<u>Description</u>	
Impeller type	Radial
Unit flow	18 m ³ /h
Inlet pressure	0.2 to 0.5 bars
Discharge pressure	5 to 7 bars
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies.
Motor	5,5 kW – 1500 rpm – TRI – 400 V – 50 Hz – IP 55 – F
Accessories (per installed pump)	Upstream and downstream isolation valves (gate valves) Inlet filter with automatically cleaning Flow rate indicator on suction pipe with “no flow” pass detector. Pressure gauges Dry running protection device

1.3.1.4. **AIR COMPRESSOR FOR SELF-ALIGNMENT**

<u>Identification</u>	202-CP-101/201/301
Number	3
Type	Piston compressors
Location	Sludge building – dewatering room

<u>Description</u>	
Aspiration	In the room
Unit flow	7 m ³ /h
Pressure	5 to 7 bars
Tank	100 l – safety valve – pressure sensor
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies.
Motor	1,5 kW –2850 rpm – TRI – 400 V – 50 Hz – IP 55 – F
Accessories (per installed compressor)	Condensate trap Inlet filter Inlet air dryer pressure relief valve and manometer

1.3.1.5. CONVEYING SCREW

<u>Identification</u>	202-SW-101/201/301
Number	3
Type	Shaftless screw conveyors
Location	Sludge building – dewatering and liming rooms
<u>Description</u>	
Capacity	5 wet t/hour
Trough diameter	328 mm
Trough length	Screws 1 and 2 : 8 m – Screw 3 : 13 m
Lead angle	15-20°
Maximum screw operating speed	30 rpm

Materials	General requirements are indicated in part 2: Products – Components and sub-assemblies.
Motor	Screws 1 and 2 : 3 kW – 1450 rpm – TRI – 400 V – 50 Hz – IP 55 – F Screw 3 : 4 kW – 1450 rpm – TRI – 400 V – 50 Hz – IP 55 – F
Accessories (per installed screw conveyor)	Removal cover on trough Torque switch Inlet hopper with drain outlet and gate valve Outlet hopper in sludge mixer

1.3.2. OPERATING CONDITIONS

The dewatering room must be organized to leave enough place for a fourth dewatering unit installed.

The dewatering unit shall be provided as a completely integrated system designed for continuous and automatic operation.

Sludge conditioning shall be improved by mixing in a flocculation tank before gravity belt thickener.

Sludge must be uniformly spread over belts by means of rulers.

The geared motors of gravity belt thickener and belt filter press are manual variable speed.

A scraper peels off sludge in the screw conveyor hopper.

Rubber rolls must be disposed to have a progressive pressing that improve dewatering operation and percent capture.

Contractor must describe the pneumatic device that keeps automatically belts in good alignment.

The unit must have at least these security devices:

- Sludge level sensors at the inlet of each element (gravity belt thickener, belt filter press, hopper of the screws conveyor),
- Sludge level sensors on belts,
- Wash water pressure sensor for each element (gravity belt thickener, belt filter press),
- Rolls and belts position sensors on the left and on the right,

Belts are washing continuously with well filtered water to keep their filtration capacities. One pump is provided for each of the three units.

As indicated on the structure plans, concentrates are collected in a concrete tank linked to the foul water sump.

The contractor includes one or several local control panels in the dewatering room with Operator Interface Terminal (OIT) connected to the SCADA. The OIT shall allow data entry, process monitoring, status monitoring and alarm monitoring of the dewatering unit.

1.3.3. DEWATERING PERFORMANCE REQUIREMENTS

The equipment provided for sludge dewatering shall achieve the following operational performance. The Contractor is responsible for installing the dewatering equipment package to achieve these performances.

The following performances shall be tested during the Commissioning Period:

- a. Cake solids: minimum 22%, average 24% solids with a sludge feed between 2.5 g/L and 3.5 g/L
- b. Percent capture: 94%
- c. Polymer usage: 6 kg dry polymer/ kg TSS in the sludge treated.

1.4. QUALITY ASSURANCE

1.4.1. 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.

1.5. SUBMITTALS

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

1. Installation, maintenance and operation manuals with requirements of accuracy
2. Manufacture and quality assurance measures

3. Protective coating list of all parts
4. Commissioning tests list.
5. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.
6. Internal wiring diagrams and control principle drawing of control box
7. Weight and material of each component

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. FABRICATION

Floculator tank	Tank : HDPE Vertical mixer : Stainless steel X2CrNi18-09 1.4307 (304L)
Gravity belt thickener and belt filter press	Frame, hopper, cover : Stainless steel X2CrNi18-09 1.4307 (304L) inox 304L Belts : polyester Rollers : Rubber All exposed nuts and bolts : Stainless steel X20Cr13 1.4021 or X2CrNi18-09 1.4307 (304L)
Wash water pump	Body, shaft and impeller : Stainless steel X2CrNi18-09 1.4307 (304L) All exposed nuts and bolts : Stainless steel X20Cr13 1.4021 or X2CrNi18-09 1.4307 (304L)
Air compressor	Body, shaft and piston : Stainless steel X2CrNi18-09 1.4307 (304L) or Tank : galvanized steel All exposed nuts and bolts : Stainless steel X20Cr13 1.4021 or X2CrNi18-09 1.4307 (304L)
Screw conveyors	Screw conveyor troughs : stainless steel 304 Screw Conveyor Flights: carbon steel Removal troughs cover : EPHD or stainless steel 304

	Inlet and outlet hoppers : stainless steel 304 Bearing end plates: stainless steel 304 Support Saddles: stainless steel 304 Gear box : cast iron EN JL 1040 and epoxy
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2.2. SPARE PARTS AND SPECIAL TOOLS

The Mandatory Spare Parts are

- for gravity belt thickener
 - 2 filtration belts
 - 6 pinch rollers
 - 90 nozzles
 - 3 scrapper
 - 3 rubber belts (sludge inlet)
 - 3 side belts (sludge orientation)

- for belt filter press
 - 3 lower belts
 - 3 upper belts
 - 3 lower scrappers
 - 3 upper scrappers
 - 120 nozzles
 - 6 set of jack seals
 - 30 EHDP belts support 1
 - 3 rubber belts (sludge inlet)

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 :
 - a.** Holes position
 - b.** Flatness, verticality, horizontality of the embedded parts,
- B.** Erection tolerances:

Refer to Section 01020

3.2.2. DRY TESTS

- a.** When the Contractor is satisfied that the unit sets have been properly installed he shall inform the Engineer who will carry out the installation inspection.
- b.** The unit 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.

3.2.3. COMMISSIONING TESTS

3.2.3.1. GENERAL

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

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 labour, 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.

3.2.3.2. 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.** The backdrive shall be modulated and other control inputs simulated for a minimum of 8 hours to provide an initial test of control responses. A controlled shutdown and emergency shutdown cycle shall be included.
- d.** All programmed sequence control, protection, alarms, and other specified control features in dewatering units shall be demonstrated. Control logic inputs and outputs shall be simulated for all equipment and devices composed or linked to dewatering units.

3.2.3.3. COMMISSIONING TESTS

Operational test will consist of beginning and tuning operation of the three dewatering units and subsequent successful operation for seven consecutive days; or longer if malfunctions occur.

The flow per dewatering unit may range between 50 and 100 percent of the liquid throughput specified in this Section.

Engineer and dewatering unit Supplier will be present for the operational test procedure.

If restart is required due to malfunctions during the seven consecutive days of operation, the Contractor shall be responsible for providing additional on-site startup service by the technical representative at no additional cost to the Owner.

The Contractor shall follow the operational test procedures as follows:

- Tune and adjust dewatering units to begin the operational test,
- Contractor shall bear the cost for supply of polymer for the operational test period.
- Subsequent to proper tuning, perform an initial thorough inspection of all system components, including electrical and instrumentation and controls. Verify that all required electrical testing has been completed.
- Repair or replace any faulty components found during initial inspection within 48 hours at no cost to the Owner.
- Subsequent to initial inspection, operate the dewatering unit for a minimum period of seven consecutive days, which shall coincide with closed-loop operational testing as specified. Operation shall be defined as a minimum of 10 continuous hours per day, excluding system startup and shutdown time.
- The initial startup procedure is deemed complete if no malfunctions occur during the seven consecutive days of operation.
- If malfunctions occur which preclude dewatering and shutdown of the dewatering unit during the seven consecutive days of operation, perform and complete corrective action within 48 hours. Restart the dewatering equipment for a minimum of seven consecutive days of additional operation.
- The startup procedure is deemed complete if no malfunctions occur during the seven consecutive days of subsequent operation.
- If malfunctions occur during the seven consecutive days of subsequent operation, terminate the operational test period and perform and complete corrective action within 48 hours prior to requesting an additional operational test.
- If an additional operational test is necessary, follow the procedures outlined above.
- The satisfactory completion of the operational test is at the sole discretion of the Project Representative.

3.2.3.4. GUARANTEED PERFORMANCE ACCEPTANCE TESTING (GPAT):

GPAT will consist of an initial dewatering unit optimization period followed by a period of performance verification in which an intensive sampling program will be conducted.

The Contractor shall develop a detailed procedure and schedule for GPAT (GPAT Testing Plan) and submit to the Engineer for approval, in accordance with Section 010000. The GPAT Testing Plan shall be approved by the Engineer prior to the start of GPAT.

Coordination of the detailed GPAT schedule with the testing of related processes and ancillary systems is the sole responsibility of the Contractor.

The Contractor shall conform with the GPAT testing requirements as follows:

- Provide all test equipment, including instruments, analyzers, chutes, sample drums, and bins required to conduct sampling and analysis during the GPAT period.
- At the Owner's discretion, the Contractor shall split all samples for duplicate analysis by the Owner.
- The Contractor shall bear all costs for sampling and analysis, including splitting samples for independent analysis by the Owner.
- The Owner will bear the cost of independent analysis on split samples.
- All analyses shall be performed by an independent laboratory.

The procedure for the GPAT is as follows:

- Operate dewatering equipments for a period of at least seven consecutive days at a minimum of 15 hours per day, excluding system start-up and shutdown. If the dewatering unit does not exhibit stable operation during this period, or if more data is required to fulfill the obligations of GPAT, the Engineer will direct the dewatering equipment manufacturer to extend the testing period at no cost to the Owner.
- Document system performance during this period and conduct sampling and analyses as specified in this section. Provide all raw data to the Project Representative, so that the Owner can independently monitor system performance.
- During the course of the GPAT test period, samples and/or measurements will be taken by the Contractor once per hour (starting one hour after the dewatering unit has reached stable operation each day), or more frequently over the course of each operating day. A minimum of 10 samples/measurements shall be taken each day. The Contractor may extend the GPAT test period, at no additional cost to the Owner.
- Evaluation of dewatering performance against the specified performance criteria will be based on an average of all samples taken, minus the highest and lowest value data points in each performance category: cake solids, percent capture, and polymer usage.
- During the course of the GPAT, the units must be operated at or above the minimum solids or liquid loading specified in this Section. Solids or liquid loading to the dewatering must be reported simultaneously with the collection of each sample.
- The Engineer reserves the right to assess the results. If in the Project Representative's sole discretion, the statistical deviation is considered in excess of acceptable levels, additional testing and analysis may be stipulated at no additional cost to the Owner. If sludge characteristics are not within the ranges specified in this Section, the Manufacturer shall make compensating calculations for the effects, if any, of the changed conditions. Supporting data from 3rd party technical journals or reference books shall be provided by the Manufacturer. These calculations will be considered by the Engineer in determining conformance with the specific conditions, but will not be the sole basis of the evaluation.
- The Contractor shall compile the results and descriptions into a bound report titled "Results of Guaranteed Performance Acceptance Testing".
- Within five working days of receiving the report, the Engineer will inform the Contractor as to whether the dewatering unit complies with the provisions of the Contract for dewatering performance.
- If the results of the GPAT indicate that the dewatering fails to meet the specified performance criteria, the Contractor will be allowed to retry the GPAT. In agreeing to retry the GPAT, the Contractor further agrees to the following:
 - All retesting shall be performed at no additional cost to the Owner.

- Any costs or delays to the Contractor due to the retry of the GPAT shall be the responsibility of the Contractor.
 - The Manufacturer shall revise the dewatering Optimization Report and resubmit to the Contractor and Project Representative prior to the restart of the GPAT.
- The Contractor will be allowed a total of three attempts at the GPAT. If after three attempts the dewatering unit does not meet the specified performance requirements, the Owner, at its sole discretion, may reject the equipment and require either replacement by the Contractor with dewatering equipment of the Owner's choosing or equivalent monetary compensation from the Contractor.

3.2.3.5. SAMPLING AND ANALYSIS:

The Contractor shall conduct sampling and analyses during GPAT in accordance with the following:

Sample	Analysis
Dewatering unit Feed	Total suspended solids (TSS) Volatile suspended solids (VSS) Total solids (TS)
Centrate	Total suspended solids (TSS) Total solids (TS)
Dewatered cake	Total solids (TS)
Limed sludge	Total solids (TS)

In addition, record centrifuge WAS feed instantaneous and cumulative flow rates, polymer usage, power usage, torque, and any other parameters necessary to demonstrate compliance with the performance requirements specified.

Incorporate final GPAT data in concise tabular form in the GPAT Report submitted at the conclusion of the test period.

SECTION 11379

LIMING EQUIPMENT PACKAGE

1. GENERAL

1.1. WORK INCLUDED

1.1.1. SCOPE OF WORK

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

1. Quick lime storage silo,
2. Arch-breakers (SODIMATE Type DDS 400 or equal),
3. Lime dosing screw (SODIMATE type DDMR 70 SCF - AB or equal),
4. Screw conveyors
5. Injector screws (SODIMATE Type DMR 80 SCF - AB or equal),
6. Lime/sludge mixer (SODIMATE Type MBV 240 or equal),

The liming equipment shall be provided as a completely integrated system designed for continuous and automatic operation.

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

1.2. RELATED WORKS

Supplies and works included under this section shall comply and be co-ordinated with all others parts and section of the contract.

1.3. DESCRIPTION

<u>Operating conditions</u>	
Duty	Continuous – 16 h/day – 7 days a week
Fluid service	Primary sludge between 22 to 26 % of suspended solids concentration and polymer (powder)
Fluid temperature	5-40°C
Fluid pH	6-9
Fluid specific gravity	1,05
Quick lime bulk density	800 kg/m ³
Quick lime bulk purity	> 90%
Sludge concentration after liming operation	>30 %
Sludge pH after liming operation	>12
Rate of lime	30 % - 40 %

1.3.1.1. QUICK LIME STORAGE SILO

<u>Identification</u>	203-LB-101/201/301
Number:	3
Location	Outdoor - Sludge building area
Model	Vertical cylindrical silo with long skirt
<u>Operating conditions</u>	
Duty	Continuous
Ambient environment	Outdoor
Ambient temperature	-25° to 42°C
<u>Description (for each silo)</u>	

PART 3 – TECHNICAL SPECIFICATIONS

Total volume	54 m ³
Useful volume	50 m ³
Diameter	2,90 m
Empty weight	4 000 kg
Total Height	13,20 m
Accessories	<p>Conical roof with cone angle of 15 degrees</p> <p>Conical bottom with cone angle of 60 degrees</p> <p>Outlet DN 200</p> <p>Ladder with crinoline, intermediate landing and security gates on the roof.</p> <p>Lifeline on the roof</p> <p>Dust filter on the top with cover (203-DF-101/201/301) – 0,08 kW – IP65 – 400V</p> <p>Safety valve</p> <p>Inspection panel Ø 600</p> <p>Loading pipe with fitting and cap</p> <p>High and low level sensors and revolving light and</p> <p>Lifting lugs</p> <p>On the skirt : one door 1,80 m x 0,8 m – exhaust air grill and ground connections</p>

1.3.1.2. **QUICK LIME ARCHBREAKER**

<u>Identification</u>	203-AB-101/201/301
Number:	3
Location	Sludge building area
Model	Arch-breaker spindle
<u>Operating conditions</u>	

PART 3 – TECHNICAL SPECIFICATIONS

Duty	Continuous
Ambient environment	Outdoor
Ambient temperature	-25° to 42°C
<u>Description (for each unit)</u>	
Capacity	100 to 500 kg/h
Body diameter	400 mm
Diameter	2,90 m
Components	Spindle with flexible blades fixed by hubs - Length = 1 m Rigid inferior arm Trapdoor Isolating valve DN 200 Adjustable link conduit
Gear motor	Speed 30 tr/mn Motor : 0,55 kW (400 V, 50 Hz, 1450 tr/mn, IP55)

1.3.1.3. LIME DOSING SCREW

<u>Identification</u>	203-DS-101/201/301
Number	3
Location	Sludge building area
Model	Spiral screw conveyor
<u>Operating conditions</u>	
Duty	Continuous – 16h/day – 7 days a week
Ambient environment	Outdoor
Ambient temperature	-25° to 42°C

PART 3 – TECHNICAL SPECIFICATIONS

Description	
Capacity	100 to 500 kg/h
Dosing spiral diameter	70 mm
Dosing spiral length	Screws 1 and 2 : 1 m – Screw 3 : 4 m
Materials	General requirements are indicated in part 2: Products – Components and sub-assemblies.
Gear motor	Speed : 90 rpm Motors screws 1, 2 and 3 : 1,1 kW – 1450 rpm – TRI – 400 V – 50 Hz – IP 55 – F – Frequency converter
Accessories (per installed screw conveyor)	Dosing tube Inlet hopper connected to archbreaker, Outlet hopper connected to lime screw conveyor One tamping sensor,

1.3.1.4. **LIME SCREW CONVEYOR**

Identification	203-SW-101/201/301
Number	3
Location	Sludge building - liming room
Model	Spiral screw conveyor
Operating conditions	
Duty	Continuous – 16h/day – 7 days a week
Ambient environment	Indoor
Ambient temperature	5° to 40°C
Description	
Capacity	100 to 500 kg/h

PART 3 – TECHNICAL SPECIFICATIONS

Conveying spiral diameter	80 mm
Conveying spiral length	Screw 1 to mixer 1 : 5 m Screw 2 to mixer 2 : 8,50 m Screw 3 to mixer 3 : 5 m
Materials	General requirements are indicated in part 2: Products – Components and sub-assemblies.
Gear motor	Speed : 110 rpm Motors Screw 1 : 1,1 kW Screw 2 : 2,2 kW Screws 3 and 4 : 1,1 et 5,5 kW 1450 rpm – TRI – 400 V – 50 Hz – IP 55 – F Frequency converter
Accessories (per installed screw)	Dosing tube Inlet hoppers connected to lime dosing screw, Outlet hoppers connected to lime injecting screw, Adjustable link conduit One tamping sensor,

1.3.1.5. **LIME INJECTING SCREW**

<u>Identification</u>	203-SW-102/202/302
Number	3
Location	Sludge building – Liming room
Model	Spiral screw conveyor
<u>Operating conditions</u>	
Duty	Continuous – 16h/day – 7 days a week
Ambient environment	Indoor
Ambient temperature	5° to 40°C

PART 3 – TECHNICAL SPECIFICATIONS

Description	
Capacity	100 to 500 kg/h
Dosing spiral diameter	80 mm
Dosing spiral length	Screws 1, 2 and 3 : 1 m
Materials	General requirements are indicated in part 2: Products – Components and sub-assemblies.
Gear motor	Speed : 115 rpm Motors (screws 1, 2 and 3) :0,75 kW – 1450 rpm – TRI – 400 V – 50 Hz – IP 55 – F
Accessories (per installed screw conveyor)	Tube Inlet hopper connected to lime screw conveyor, Outlet hopper connected to sludge/lime mixer One tamping sensor

1.3.1.6. **SLUDGE/LIME MIXERS**

Identification	
Number	3
Location	Sludge building – Liming room
Model	Paddles mixer
Operating conditions	
Duty	Continuous – 16h/day – 7 days a week
Ambient environment	Indoor
Ambient temperature	5° to 40°C
Description	
Capacity	Sludge : 4,5 m ³ /h – Lime : 0,6 m ³ /h

PART 3 – TECHNICAL SPECIFICATIONS

Components	<p>One inlet hopper with :</p> <ul style="list-style-type: none"> - on the top : one rectangular opening for sludge intake, one circular opening for lime intake and one screw tapping for level sensor - on one side : one bay panel <p>One trough with removal cover</p> <p>Two counter-rotating shafts, fitted with intersecting and adjustable paddles, Ø : 240 mm</p> <p>One outlet hopper</p> <p>Seal by adjustable stuffing box</p>
Gear Motor	<p>Speed : 26 rpm</p> <p>Motor : 2,2 kW – 400V – 50 Hz – IP55, F</p> <p>Frequency converter</p>
Materials	<p>General requirements are indicated in part 2: Products – Components and sub-assemblies.</p>
Accessories	<p>High level sensor (admittance detector)</p>

1.3.2. OPERATING CONDITIONS

The liming room must be organized to leave enough place for a fourth liming unit installed.

The liming unit shall be provided as a completely integrated system designed for continuous and automatic operation.

Lime screws and mixers shall be closed and connected to reduce dust emission.

Units shall not need preventive cleaning.

1.4. QUALITY ASSURANCE

1.4.1. 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.

1.5. SUBMITTALS

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

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

2. PRODUCTS – COMPONENTS AND SUB-ASSEMBLIES

2.1. FABRICATION

Quick lime storage silo	Silo : Stratified polyester Lifeline : aluminium or stratified polyester Outlet flanges : stainless steel X2CrNi18-09 1.4307 (304L) Access equipments, exhaust air grill, dust filter cover : Aluminium Ground connections and lifting lugs: galvanized steel. Loading pipe and accessories : stainless steel X2CrNi18-09 1.4307 (304L)
Lime archbreaker	Arch breaking spindle: stainless steel 304 Body: painted carbon steel Flexible blades: stainless steel 304 Gear box : cast iron EN JL 1040 and epoxy
Lime screw conveyors Lime dosing screw Lime injector screw	Screw conveyor tube : stainless steel 304 Screw Conveyor Flights: carbon steel Inlet and outlet hoppers : stainless steel 304

	Bearing end plates: stainless steel 304 Support Saddles: stainless steel 304 Gear box : cast iron EN JL 1040 and epoxy
Sludge lime mixers	Inlet and outlet hopper stainless steel 304 One trough with removal cover stainless steel 304 Two counter-rotating shafts : carbon steel Gear box : cast iron EN JL 1040 and epoxy
Bolts, nuts and washers:	stainless steel X2CrNi18-09 1.4307 (304L)

2.2. SPARE PARTS

- Quick lime storage silo
 - One dust filter
- Lime archbreaker
 - 3 Flexible blades
 - One set of end bearings and packing
 - One gear motor
 - One set of seals
- Lime screws (for each type of screw)
 - One gear motor
 - One set of seals
- Sludge/Lime mixers
 - 3 counter-rotating shafts
 - 1 set of end bearings and packing
 - 3 set of seals
 - One gear motor

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 :
 - a.** Holes position
 - b.** Flatness, verticality, horizontality of the embedded parts,

- B.** Erection tolerances:

Refer to Section 01020

3.2.2. DRY TESTS

- a.** When the Contractor is satisfied that the unit sets have been properly installed he shall inform the Engineer who will carry out the installation inspection.
- b.** The unit 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.

3.2.3. COMMISSIONING TESTS

3.2.3.1. GENERAL

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

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 labour, 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.

3.2.3.2. 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. The backdrive shall be modulated and other control inputs simulated for a minimum of 8 hours to provide an initial test of control responses. A controlled shutdown and emergency shutdown cycle shall be included.
- d. All programmed sequence control, protection, alarms, and other specified control features in dewatering units shall be demonstrated. Control logic inputs and outputs shall be simulated for all equipment and devices composed or linked to dewatering units.

3.2.3.3. COMMISSIONING TESTS

Operational test will consist of beginning and tuning operation of the three liming units and subsequent successful operation for seven consecutive days; or longer if malfunctions occur.

The flow per liming unit may range between 50 and 100 percent of the liquid throughput specified in this Section.

Project Representative and liming unit Supplier will be present for the operational test procedure.

If restart is required due to malfunctions during the seven consecutive days of operation, the Contractor shall be responsible for providing additional on-site startup service by the technical representative at no additional cost to the Owner.

The Contractor shall follow the operational test procedures as follows:

- Tune and adjust liming units to begin the operational test,
- Contractor shall bear the cost for supply of lime for the operational test period.
- Subsequent to proper tuning, perform an initial thorough inspection of all system components, including electrical and instrumentation and controls. Verify that all required electrical testing has been completed.
- Repair or replace any faulty components found during initial inspection within 48 hours at no cost to the Owner.
- Subsequent to initial inspection, operate the dewatering unit for a minimum period of seven consecutive days, which shall coincide with closed-loop operational testing as specified. Operation shall be defined as a minimum of 10 continuous hours per day, excluding system startup and shutdown time.
- The initial startup procedure is deemed complete if no malfunctions occur during the seven consecutive days of operation.
- If malfunctions occur which preclude dewatering and shutdown of the dewatering unit during the seven consecutive days of operation, perform and complete corrective action within 48 hours. Restart the liming equipment for a minimum of seven consecutive days of additional operation.
- The startup procedure is deemed complete if no malfunctions occur during the seven consecutive days of subsequent operation.
- If malfunctions occur during the seven consecutive days of subsequent operation, terminate the operational test period and perform and complete corrective action within 48 hours prior to requesting an additional operational test.
- If an additional operational test is necessary, follow the procedures outlined above.
- The satisfactory completion of the operational test is at the sole discretion of the Project Representative.
- Owner will bear the cost and be responsible for disposal of the dewatered cake during operational testing.

SECTION 13 210 LAMELLAS PLATES

1. GENERAL

1.1. WORK INCLUDED

This section of the specifications covers the Lamellas of the primary sedimentation tanks.

The supply shall include the following main items:

1. Lamellas,
2. Lamellas assembly system,
3. Anchoring and Support system.
4. 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
- B.** Work under this section shall be co-ordinated with:
1. Civil Engineering works and Building works;

1.3. DESCRIPTION

1.3.1. LAMELLAS

The lamellas shall be installed in four lamellar tanks. Each lamellar tank shall be divided in 2 parts on each side of the collection channel. A total of 8 zones shall be equipped with lamellas presenting the following characteristics:

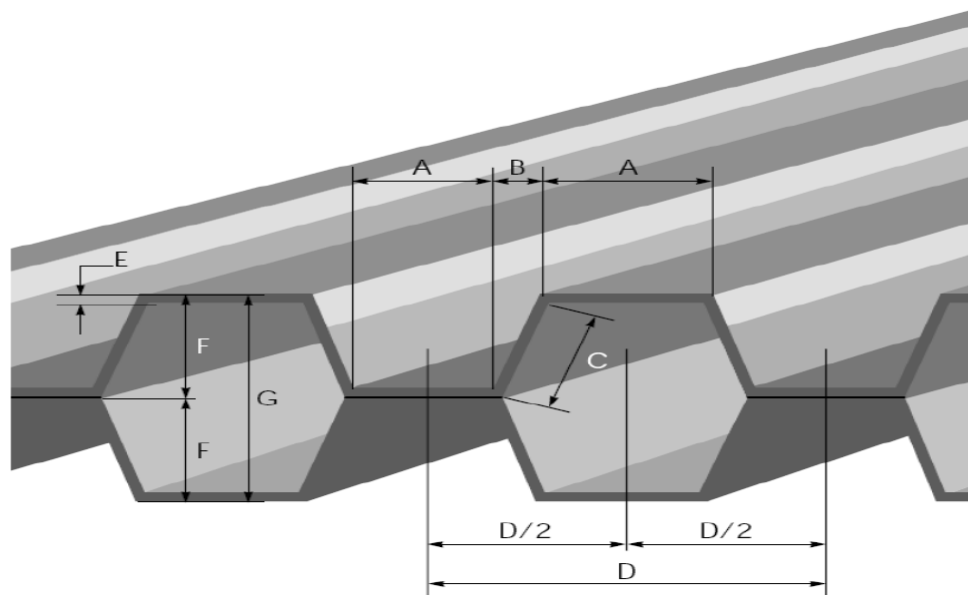
Type:	Lamellas 90 x 40 V
Location:	Primary sedimentation
Number of zones:	8

PART 3 – TECHNICAL SPECIFICATIONS

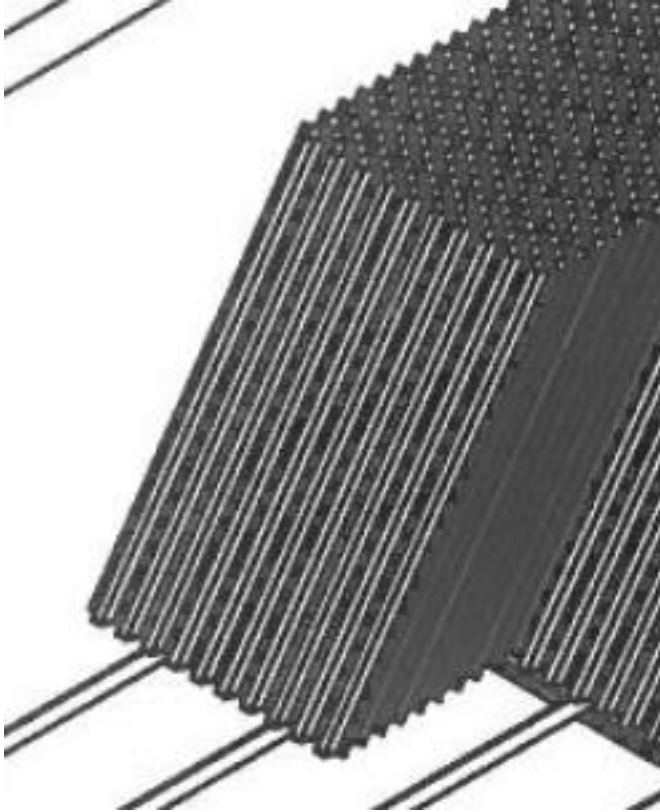
Dimension of each zone	15.85 m x 7.85 m
Height:	1 900 mm
Width	1 000 mm standard width On one side, plates shall be cut according to the overall basin dimension. Plates may be cut on site.
Angle	60 degrees
Plate Material:	Super high impact Polystyrene type : Thermoplastics ISO 2897-PS-I,G,093-03-07-18 or ISO 2897-PS-I,G,093-03-10-18
The plates shall be assembled with 304 SS staples on site.	

Specific dimensions of lamella plates stated below shall be met:

Length of overlap (A)	mm	30
Length of tube side (B)	mm	15
Length of tube side (C)	mm	42,72
Length of one wave (D)	mm	90
Plate thickness (E) varies within the thermoformed plate between:	mm	0.7 minimum 1.2 maximum
Depth of one wave (F)	mm	40



Each lamella shall be cut such that when installed at a 60 degree angle the bottom and top part of the lamella plate shall be completely horizontal. The height of the assembled lamellas (1m90 long each) shall be 1m46, as they shall be welded together at a 60 degree angle.



1.3.2. SUPPORT SYSTEM

The support system shall support the entire weight of the plates plus 50%, in order to account for organic material collected on the plates when the tank is emptied for maintenance.

The support system shall be made of SS 304, and the anchoring system shall meet the corrosion protection requirements of Section 01010.

1.4. QUALITY ASSURANCE

1.4.1. DESIGN CRITERIA

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

1.4.2. 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 lamellar plates shall be presented, for checking
- a) Welds:

Refer to Section 01020.

1.5. SUBMITTALS

Refer to Section 01 000 -General requirements

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. MANUFACTURE

The tolerance on the dimension of each plate delivered on site shall be +/- 0.1%.

The one site assembly of the bee's nest pattern shall be performed by the contractor immediately before installation on the support system in the tank. Blocks of 6 to 8 plates stapled together shall be prepared outside of the tank, then installed on the support system, at which point the blocks shall be stapled together.

The dimensions of the bee's nest pattern assembly specified in Section 1, shall be met with a tolerance of +/- 0.1%.

2.2. TRANSPORT AND STORAGE

Plates shall be transported and stored at temperatures between -10 °C and + 60 °C.

2.3. SPECIAL TOOLS AND SPARE PARTS

The Contractor shall supply the following tools and spare parts:

- 1. 100 plates, unwelded
- 2. Air powered stapler

3. EXECUTION

3.1. INSPECTION BEFORE ERECTION

- A. The Contractor shall check the dimensions of the delivered plates prior to welding.
- B. The Engineer shall check the plates prior to their assembly: Any plate showing signs of bulking due to heat above 60°C during transport and storage shall be rejected by the Engineer.

3.2. FIELD QUALITY CONTROL

- A. The Contractor shall check the setting and alignment of support system prior to fixing the welded plates

- B.** The Contractor shall check the dimensions and the regularity of the pattern of the welded plates prior to their fixing on the support system.

oOo

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 01000 - 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 09910 – 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 convey 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: 1990 - Elastomeric seals for joints in pipework and pipelines
- BS 3505: 1986 – Specifications for unplasticized polyvinyl chloride pressure pipes for cold potable water.
- BS EN 1452 - 2000 - Joints and fittings for use with unplasticised PVC pressure pipes (including hydraulic pressure tests).
- BS 4514: 1983 uPVC soil and ventilating pipes, fittings and accessories
- BS 4660: 1989 Unplasticised PVC underground drain pipe, fittings for drainage and sewer pipes. Nominal size 110 and 160.
- BS 5255: 1987 Thermoplastics waste pipes and fittings
- BS 8301: 1985 Code of Practice for building drainage
- NF EN 681-2: Rubber 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

- BS EN 545 (or NF EN 545 – 2010): Ductile iron pipes, fittings, accessories and their joints for water pipelines — Requirements and test methods.

- EN14901: Ductile iron pipes fittings and accessories – epoxy coating (heavy duty) – requirements and test methods.
- NF EN 598: Pipes, connections and fittings.
- NF A 48-870: Standard joints.
- NF EN 681: Joint rings.

1.3.1.3. STAINLESS STEEL PIPES

- ISO 5252: Steel tubes.
- ISO 1127: Stainless steel tubes - Dimensions, tolerances and conventional masses per unit length.

1.3.2. DESIGN CRITERIA

All piping shall be designed for a minimum working pressure of 10 bar except 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 co-ordinated 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

Utility Network pipe materials shall be in accordance with the information given in the table hereafter.

TYPE OF FLUID	PIPES IN BUILDING	BURRIED PIPES
Waste water	-	Ductile Iron or Concrete
Decanted water	-	Ductile Iron or concrete
Decanted service water, Ø40	PVC	PVC
Foul Drain water	PVC	Ductile Iron,HDPE or PVC
Grease	PVC	Ductile Iron or PVC
Sand	Ductile Iron or SS	Ductile Iron
Chemicals	HDPE	HDPE
Liquid sludge	Stainless Steel	Ductile Iron
Foul air	Aluminium or PVC	-
Compressed air	PVC	-
Well service water	HDPE or PVC	HDPE or PVC
Drinking water	HDPE or PVC	HDPE or PVC

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.

B. Assembly

Pipes shall consist of 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.

Air shall be used for cooling.

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

All supports, fixing accessories and screws shall also be made of stainless steel.

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:

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

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" values 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 HDPE pipes must comply with the international standards in force.

B. Assembly

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

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

Welds shall be made:

- **either by polyfusion:** an electrically heated mirror shall be used to reach a plasticising temperature at the ends of $200^{\circ}\text{C} \pm 10^{\circ}\text{C}$. The weld shall be made by pressing the ends together under a pressure of 1.5 to 2 kg/cm² to obtain a single 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.

Polyethylene connectors will also be joined by polyfusion, 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.

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

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.

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

The general characteristics of ductile iron pipes, connections and fittings must comply with the international standards in force.

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

B. Connection of pipes

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

C. Lining

Socket jointed pipes shall be lined with centrifuged high alumina cement mortar and sockets with red epoxy paint.

D. Coating

Coatings shall be as follows:

- A layer of electrolytic zinc and epoxy paint on all pipes
- Red-brown epoxy powder for flange connections and connecting parts.

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 pressurised 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 sealed joints.

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

Pipe elements include:

- PVC tubes
- Ductile iron fittings

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 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 standardisation 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 standardisation 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 General Requirements

3. EXECUTION

3.1. HANDLING OF PIPES

Pipes of all types must be handled with care. 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.

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.

Pipes may be cut by any process suited to the material in question, so as not to disturb its physical state and obtain a clean cut.

The Contractor shall do his utmost to ensure that the new spigot ends resulting from such operations are smooth 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 ends shall be carefully cleaned.

Whenever work is interrupted, pipes being laid shall be blocked with a plug to prevent foreign bodies or animals from entering.

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

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

3.4. TESTING PIPES

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 required for carrying out the tests, as stipulated, and all necessary equipment.

B. Test methods

Tests shall be carried out in accordance with section 70 of the French General Technical Specifications.

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.

oOo

SECTION 14150

VALVES, GATES & APPURTENANCES

1. GENERAL

1.1. WORK INCLUDED

The present specification shall apply to the valves, gates and appurtenances as designed by the Contractor.

1.2. RELATED WORKS

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 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 09910 – Painting;
- C.** Section 14100 – Pipes and fittings;
- D.** Electrical equipment specifications;

1.3. QUALITY ASSURANCE

1.3.1. STANDARD

International standards when available shall apply for valve construction and materials:

- AWWA standards
- ASTM standards
- API standards
- ISO standards
- DIN standards

Others standards (NF, BS, JIS, etc.) may be accepted.

1.3.2. DESIGN CRITERIA

1. All valves of the same type shall be from one manufacturer.
2. The Contractor shall make evidence of the hydraulic performance of the valves proposed and particularly the following:
 - Air valves.
 - Flow control valves.
 - Altitude valves (level control valves).
 - Overspeed valves.
 - Check valves.

1.3.3. SHOP TESTS

1. 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.

2. 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.

1.4. SUBMITTALS

The Contractor shall submit detailed shop drawings and working drawings with relevant calculation notes.

a. Calculation notes

The Contractor shall provide documentary evidence of the performances of the valves for the service as required.

b. Shop drawings

Shop drawings shall include but not limited to the following:

1. Lists and schedules of valves.
2. Dimensions, and materials.
3. Instructions for installation.

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:

- 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 section 14100 – Pipes and fittings.

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 AFNOR, ASTM, BS, DIN or other internationally accepted standards.

Valves shall be equipped with hand lever, 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. Painting

All valves, gates and appurtenances, unless otherwise specified shall be shop primed on the exterior in accordance with the applicable specification of section 09910 - Painting.

All valves, gates and appurtenances, shall have an inside lining certified by the recognized authorities for linings in waste water service.

2.2. GATE VALVES

All gates valves will have screw and yoke rising stem.

2.2.1. GATE VALVES

Gate valves shall be designed and manufactured in accordance with AWWA C500 or other internationally accepted standards. Working pressure shall be 10 bar.

The valve body and bonnet shall be of DIN 1693 grade GGG-40 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.

2.2.2. RESILIENT-SEATED GATE VALVES

Resilient-Seated (RS) gate valves shall be designed and manufactured in accordance with AWWA C509 or other internationally accepted standards. Working pressure shall be 10 bar.

RS type gate valves shall be DIN 1693 grade GGG-40 ductile cast iron-body resilient-seated gate valves with non-rising stems (NRS) and outside screw-and-yoke rising stems. 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.

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 non-metallic applied 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. Total dry film thickness on the interior and exterior surface shall be more than 400 microns and not less than 300 microns respectively.

2.2.3. BRONZE GATE VALVES

Bronze gate valves shall be designed and manufactured in accordance with standard approved by the Engineer. Working pressure shall be 10 bar. 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.

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. Working pressure shall be 10 bar.

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.

2.3. BUTTERFLY VALVES

2.3.1. FLANGED BUTTERFLY VALVES

Valves shall be cast iron or ductile iron disc elastomer-seated, tight closure butterfly valves and shall be designed and manufactured in accordance with AWWA C504. Valves shall be designed for a maximum nonshock shut off pressure of 10 bar. Flanges shall conform to ISO PN 10 and flange to flange dimensions shall conform to ISO 5752 series 14. Valves body shall be ductile iron and shall conform to DIN 1693 grade GGG-40.

Valve shafts shall be made of AISI 316 stainless steel or Monel. 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 the following seat surfaces which shall conform to 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, 600 mm and smaller shall be clamped, mechanically secured, bonded, or vulcanized to the valve body.

Rubber seats for valves, 700 mm to 1,800 mm shall be mechanically clamped or secured to the valve body or disc.

All clamps and retaining rings for elastomer seats shall be of corrosion-resistant material with a maximum zinc content of 16 per cent and a maximum aluminium 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 grade GGG-40.

- Stainless steel: AISI 316 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.

2.3.2. WAFER BUTTERFLY VALVES

Wafer butterfly valves for water shall meet the applicable requirements specified in 2.3.a) above for flanged Butterfly valves except as otherwise specified herein.

Valves shall be designed to fit between two pipe flanges and for the maximum nonshock shut-off pressure of 10 bar.

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 watertightness specifications of paragraph 2.3.a).

2.4. CHECK VALVES

2.4.1. SWING CHECK VALVES

Swing check valves shall be DIN 1693 grade GGG-40 ductile cast iron body and disc, and bronze seating type. The valves shall be designed and manufactured in accordance with AWWA C508. Working pressure shall be 10 bar. Flanges shall conform to ISO PN 10 and flange to flange distance shall conform to ISO 5752 series 14.

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 by-pass pipe and by-pass valves.

2.4.2. 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 and for a working pressure of 10 bar.

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.

2.4.3. 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. Working pressure shall be 10 bar. 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 seatings 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 c) above.

2.4.4. 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. Working pressure shall be 10 bar. Valves shall be equipped with flanged ends. The body shall be cast iron conform to ASTM A48-64-35B. 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 grade GGG-40 ductile cast iron body, non-lubricated, resilient faced eccentric plug type valves. Valves shall be designed for a working pressure of 10 bars.

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 everlay 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. GLOBE VALVES

2.6.1. 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. Working pressure shall be 10 bar. 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.

2.6.2. 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.

2.7. 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.

2.8. BALL VALVES

2.8.1. BALL VALVES FOR WATER LINES

Stainless steel ball valves shall be non-lubricated and shall have stainless steel ball and body with Teflon seats. Valves shall be designed for a working pressure of 10 bar and shall have screwed ends. Valves shall be wrench operated.

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

2.8.2. STAINLESS STEEL BALL VALVES FOR CHEMICAL SERVICE

Stainless steel ball valves shall be non-lubricated and shall have stainless steel ball and body with Teflon seats. Valves shall be designed for handling chemicals and for working pressure of 10 bar. Valves shall have flanged ends.

Valve ports shall be at least the area of a circle of diameter equivalent to the nominal size of the valve. Valves, 100 mm and smaller in diameter shall be wrench operated. Valves, 125 mm and larger shall be hand wheel operated through a worm gear. Port position shall be plainly visible to the operator by means of an indicator.

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

2.9. OVERSPEED VALVE

The overspeed 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 overspeed detection system with adjustment facilities,
- shut-off mechanism ensuring irreversible closing of the valve upon overspeed 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.

2.10. PRESSURE REDUCING VALVES

Pressure reducing valves for plant water service shall be DIN 1693 grade GGG-40 ductile cast iron body, self-contained, direct-acting, spring-loaded type. Valves shall operate at a primary pressure range of 0 to 10 bar and at an adjustable secondary pressure range of 1.5 to 6 bar. Valves shall have flanged ends and the working pressure shall be 10 bar.

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.

2.11. AIR VALVES

2.11.1. SINGLE ORIFICE TYPE AIR VALVES

Single orifice type air valves shall be DIN 1693 grade GGG-40 ductile cast iron body and single float actuated air valves with flanged ends. Valves shall be designed and manufactured in accordance with standard approved by the Engineer. Working pressure shall be 10 bar.

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 casting stop valve and cast iron flange.

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

2.11.2. DOUBLE ORIFICE AIR VALVES

Double orifice air valves shall be DIN 1693 grade GGG-40 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 standard approved by the Engineer. Working pressure of all air valves shall be 10 bar.

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.

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

2.12. PRESSURE RELIEF VALVES

2.12.1. 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.

2.12.2. CONSTRUCTION

The pressure relief valves shall consist of:

- a fixed bevelled 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.

Watertightness shall be obtained by very carefull machining of the rigid corrosion-resistant metal contact surfaces.

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

Watertightness 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 disadjustment.

The valve shall be equipped with a connecting flange according to ISO PN 10.

2.12.3. 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 oxyde primer and additional finishing coats.

2.12.4. 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.

2.12.5. 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.

2.13. VALVES ACTUATORS

2.13.1. 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.

2.13.2. MANUAL ACTUATORS

1. Manual Actuators for Gate Valves (500 mm and smaller)

Manual actuators for gate valves, 500 mm and smaller 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.

2. Manual Actuators for Gate Valves (600 to 1,000 mm)

Manual actuators for gate valves, 600 to 1,000 mm 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.

3. 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 handweel 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
300	25
400 to 600	30
800 to 1500	50

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

4. 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.

2.13.3. ELECTRIC ACTUATORS

1. 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 volt, 3-phase, 60 hertz, service for open-close service.

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

– 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.

– 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.

2. 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 lever 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.

2.14. SPECIAL TOOLS AND SPARE PARTS

Refer to General Requirements

3. EXECUTION

No item.

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SECTION 14160 PENSTOCK

1. GENERAL

WORK INCLUDED

SCOPE OF THE WORK

This section of the specifications covers the supply and installation of penstocks and actuators as shown on the tender drawings for the Ameria stage II Pumping station.

The supply shall include the following main items:

- 1) Complete set of embedded parts,
- 2) Gate leaf,
- 3) Gate frame,
- 4) Manual or electrical gate operator,
- 5) Stem guide, and top wall mounting brackets where required,
- 6) Corrosion protection work,
- 7) Anchoring and support parts to be held or embedded in the primary concrete.

RELATED WORKS

SUPPLIES AND WORKS INCLUDED UNDER THIS SECTION SHALL COMPLY WITH THE REQUIREMENTS OF THE FOLLOWING

- 1) Section 01020 – Basic Mechanical Requirements.
- 2) Section 01010 – Corrosion protection.

COORDINATION

Work under this section shall be coordinated with work covered by the following sections:

- 1) Section 15400 – Main pumps & motors.
- 2) Part 8 – General requirement.

PART 3 – TECHNICAL SPECIFICATIONS

- 3) Part 9 – Civil Engineering works and Building works.
- 4) Part 11 – Electrical Equipment.

SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

MAIN CHARACTERISTICS

SCREENING AREA

Identification number	101-SG-101/201
Type:	Sluice Gate
Number:	2
Location:	Coarse Screens
Height:	3300 mm plate ; 3950 mm frame
Width	1 500 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal)
Operation:	Motorized

Identification number	101-SG-301
Type:	Sluice Gate
Number:	1
Location:	Coarse Screens
Height:	3300 mm plate ; 3950 mm frame
Width	1 500 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal)
Operation:	Manual crankset

Identification number	102-SG-101/201/301
Type:	Sluice Gate
Number:	3
Location:	Fine Screens
Height:	3400 mm plate ; 4200 mm frame
Width	1 500 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal)
Operation:	Motorized

Identification number	102-SG-401
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PART 3 – TECHNICAL SPECIFICATIONS

Type:	Sluice Gate
Number:	1
Location:	Fine Screen stand by
Height:	3400 mm plate ; 4200 mm frame
Width	1 500 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal)
Operation:	Manual Crankset

Identification number	102-GC-001/002
Type:	Sluice Gate
Number:	2
Location:	Exit pipe to Grit and Grease Removal (ND 1400)
Height:	1 500 mm
Width	1 500 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal)
Operation:	Motorized

GRIT AND GRIT REMOVAL AREA

Identification number	103-SG-003
Type:	Sluice Gate
Number:	1
Location:	Grit and grease removal tanks
Height:	400 mm
Width	400 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal)
Operation:	Manual

Sedimentation Tanks Bypass

Identification number	105-SG-001,-002
Type:	Sluice Gate
Number:	2
Location:	Sedimentation tanks
Height:	1000 mm
Width	1000 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal)
Operation:	Motorized and level of opening controlled by the flow in the downstream flowmeter.

OPERATING CONDITIONS

The gate shall be designed for operation with seating and/or unseating head water conditions as indicated in the above table.

Where required, penstocks will be operated by means of electrically driven actuators with integral reversing starters. The motor drive will be automatically disengaged when under manual operation.

The gates shall be designed to ensure tight closure whilst maintaining freedom of the leaf movement during operation and minimizing sliding wear of the sealing faces.

Particular care will have to be taken for operation with the gate located at the emergency culvert outlet. It must be opened as soon as general power switch off occurs in TPS1 or TPS2. As this gate must be opened when a general switch down occurs, it can't be activated electrically. Therefore it must be in relation with the detection of a particular level in TPS2 intermediate shaft, namely 13.40. This process will be powered by solar batteries and stand-by diesel generator unit with automatic starter.

DESIGN CRITERIA

CODES AND STANDARDS

- 1) DIN 19704 Principles for computation of steel hydraulic plant.
- 2) DIN 19705 Recommendation for the design, construction and erection of hydraulic steel structure equipment.
- 3) DIN 4114 Steel construction – Stability analysis – Buckling – Lateral buckling – Local buckling.
- 4) DIN 1045 Reinforced concrete structures: design and construction.
- 5) NF A 46.503 Medium and heavy plates. Tolerances on dimensions and excess weight.

DESIGN CRITERIA

Refer to the table here above main characteristics.

The nut in the gate will be of rising spindle penstocks, and the handwheel of non-rising penstocks. The penstocks shall be designed to withstand without damage an MCE (maximum credible earthquake).

A neoprene seal shall be provided on 4 sides , except where installed in open channels, then neoprene seal shall be provided on 3 sides.

The operating gear of all penstocks will be capable of opening or closing the gate against an unbalanced head equal to the maximum working pressure.

Handwheels will be rotated clockwise to close the penstocks, and clearly marked with the words 'Open' and 'Close', with arrows in the appropriate direction.

Penstocks will be fitted with position indicators which will indicate whether the penstock is fully open or closed.

Handwheel and reduction gearbox will be designed for easy hand operation.

The gear boxes will be oil or grease filled.

Where required, penstocks shall be fitted with flush inverters to give a smooth flow passage at the bottom of the penstocks.

When the distance between the sill and the base floor is important, the extension rod will be fitted with a guide bearing every 2 m.

Each actuator will be fully weather proof and fitted with anticondensation heater, upper and lower limit switches and torque switches.

All local controls will be protected by a lockable cover.

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 inspection and tests:
 - a) At the end of manufacture, penstocks shall be presented, unpainted, for checking. The seals shall be presented separately.
 - b) Gate and embedded parts:

THE SURFACE ASPECT OF EMBEDDED PARTS SHALL BE EXAMINED AND THEIR DIMENSIONS CHECKED. SLIDING AND FRICTION SEALING SURFACES SHALL BE PERFECTLY FLAT AND SMOOTH.

ALL DIMENSIONS OF GATE MEMBERS SHALL BE CHECKED.

The Engineer reserves the right to participate in these tests.
 - c) Welds: Refer to Section 15010 – Basic auxiliary mechanical equipment requirements.

GUARANTEE

VIBRATION

The operation of the gate shall be guaranteed free of vibration.

SEALING

The equipment shall satisfy the guarantees specified hereunder, without any special means having to be used for sealing.

The leakages shall not exceed 0.02 l/s per linear meter of seal.

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

MANUFACTURE

EMBEDDED PARTS

The embedded part will be of welded construction.

PENSTOCKS

The penstocks shall be of welded construction. The frame shall be in steel grade E 24-2, the gate leaf in stainless steel.

Non-ferrous metal sealing faces shall be formed from accurately machined or bronze strips bedded and fixed to machined recesses by non-corrodible countersunk screws. The faces of the strips will be then brought together in the operating position and hand scraped to a watertight finish.

Rubber sealing faces will be formed from synthetic rubber suitably shaped to interlock grooves in the frame of door and will be securely bonded thereto.

The nut in the door of non-rising spindle penstocks and in the handwheel of rising spindle penstocks will be gunmetal.

SPECIAL TOOLS AND SPARE PARTS

The Contractor shall specify and supply the special tools required for gate maintenance.

The Contractor shall supply the following spare parts: One complete set of seals with 20 % of the stainless steel bolts for the gate leaf.

3. EXECUTION

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.

The Contractor shall check the dimensions and setting of the sluice.

FIELD QUALITY CONTROL

INSPECTIONS BEFORE AND AFTER CONCRETING

Inspections

- a) Position of the sill,

- b) Distance between the lateral embedded parts,
- c) Perpendicularity of the lateral embedded parts with the sill,
- d) Flatness of the embedded parts, vertically, horizontally.

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 embedded parts,
- 3) Checking the position of lateral guide systems with respect to embedded parts,
- 4) Checking the position and operation of the wedging system,
- 5) Examination of paintwork.

FINAL TESTS

With the water levels available at the time of the tests:

- 1) Inspection of seals,
- 2) Testing of the various operations required for closure and opening of the sluice,
- 3) Examination of paintwork.

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SECTION 14 161 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
- B.** Work under this section shall be co-ordinated with:
1. Civil Engineering works and Building works;

1.3. DESCRIPTION

Identification number:	101-SL-001
Type:	Stop logs
Number:	1
Location:	Screening
Height:	3150 mm frame

PART 3 – TECHNICAL SPECIFICATIONS

	2900 mm plate
Width	1 500 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal) OR Aluminium
Peripheral equipment:	Lifting tools
Stop logs shall tighten to frames; stop logs equipped with jointing material in EDPM rubber	

Identification number:	101-SL-002
Type:	Stop logs
Number:	1
Location:	Screening
Height:	2700 mm frame 1900 mm plate
Width	1 500 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal) OR Aluminium
Peripheral equipment:	Lifting tools
Stop logs shall tighten to frames; stop logs equipped with jointing material in EDPM rubber	

Identification number:	101-SL-003
Type:	Stop logs
Number:	1
Location:	Screening
Height:	3450 mm frame 3000 mm plate
Width	1600 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal) OR Aluminium
Peripheral equipment:	Lifting tools
Stop logs shall tighten to frames; stop logs equipped with jointing material in EDPM rubber	

Identification number:	101-SL-004/101/201/301
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PART 3 – TECHNICAL SPECIFICATIONS

Type:	Stop logs
Number:	4 frames
Location:	Screening
Height:	3950mm frame
Width	1 500 mm
Cast in Place frame Materials:	304 SS
Peripheral equipment:	Lifting tools
Stop logs shall tighten to frames; stop logs equipped with jointing material in EDPM rubber	

Identification number:	102-SL-101/201/301/401
Type:	Stop logs
Number:	4 frames, 3 plates interchangeable between area 101 and 102
Location:	Screening
Height:	4200 frame 3400 mm plate
Width	1 500 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal) OR Aluminium
Peripheral equipment:	Lifting tools
Stop logs shall tighten to frames; stop logs equipped with jointing material in EDPM rubber	

Identification number	103-SL-101, 103-SL-201, 103-SL-301 and 103-SL-401
Type:	Stop logs
Number:	4
Location:	Grit and grease removal tanks
Height:	1 900 mm frame 1 600 mm plate
Width	900 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal) OR Aluminium
Peripheral equipment:	Lifting tools
Stop logs shall tighten to frames; stop logs equipped with watertight joint material in EDPM rubber	

PART 3 – TECHNICAL SPECIFICATIONS

Identification number	105-SL-101/102, -201/202, -301/302, -401/402
Type:	Stop logs
Number:	8 frames, 2 plates
Location:	Grit and grease removal tanks
Height:	1 900 mm frame 1 500 mm plate
Width	1000 mm
Cast in Place frame Materials:	304 SS
Plate Materials:	Anticorrosion Coated Steel (coating type ACQPA, Im 2A NI575, or equal) OR Aluminium
Peripheral equipment:	Lifting tools
Stop logs shall tighten to frames; stop logs equipped with watertight joint material in EDPM rubber	

1.4. QUALITY ASSURANCE

1.4.1. DESIGN CRITERIA

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

1.4.2. 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.
 - a) Welds:
Refer to Section 01020.

1.5. SUBMITTALS

Refer to Section 01 000 -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 metre of seal shall not exceed the following values:
 - a) local leaks: 0.025 litres per second,
 - b) average leaks: 0.010 litres 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 centre 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

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 14201 CENTRIFUGAL 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 the centrifugal 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 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. Section 19100 - Electrical Equipment;
- C. Section 17100 – Instrumentation;

1.3. DESCRIPTION

Identification	103-PP-501/502/503
Number:	2 + 1 non-installed stand-by
Location	Grit and grease removal tanks – Grit extraction

PART 3 – TECHNICAL SPECIFICATIONS

	pumps
Type	Monobloc – horizontal installation Dry installation
<u>Operating conditions</u>	
Duty	Discontinuous – Max 6 starts per hour
Drive	Constant speed
Ambient environment	Indoor
Ambient temperature	5 to 40 °C
Ambient relative humidity	
Fluid service	
Concentration of grits	3 g/l
Fluid temperature	
Fluid pH	6-9
Fluid specific gravity	
<u>Description</u>	
Impeller type	Vortex
Unit flow	100 m ³ /h
Total head	3 m
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies. Particular requirements are as follows : Impeller : Abrasive resistant cast iron EN JL 1040 Shaft : Stainless steel X20Cr13 1.4021
Motor	2.4 kW – 1000 rpm – TRI – 400 V – 50 Hz – IP 55 – F
Accessories (per installed pump)	

Foundations steel rail
One suction and discharge pipe
Branch connection on suction pipes for injection of industrial water (pipe declogging)
Branch connection on suction pipes for injection of pressurized air (decompaction of accumulated grits)
Upstream and downstream isolation valves (gate valves)
Non-return valves (ball valve)
Pressure gauges

<u>Identification</u>	103-PS-001 and -002
Number:	1 + 1 stand-by (installed)
Location:	Grit Tank - Foul water sump
Type	Submersible centrifugal pumps – Vertical installation
<u>Operating conditions</u>	
Duty	Max 6 starts per hour
Drive	Constant speed
Fluid service	Foul water with up to 1 % solids content consisting of grit, organic and inorganic materials and greases.
Fluid temperature	5-40°C
Fluid pH	6-9
Fluid specific gravity	1
<u>Description</u>	
Unit capacity	250 m ³ /h

PART 3 – TECHNICAL SPECIFICATIONS

Total head	8 m max
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies. Particular requirements are as follows : Body and Impeller : gray cast iron EN JL 1040
Motor	12 kW – 400 V – 50 Hz – IP 68 – F
Accessories (per installed pump)	
Discharge connection	
Discharge pipe	
Isolation valve (gate valve, manual) and check valve (ball valve)	
Double guide bars, attachment for guide bars, elevating chain incl. suspension attachment	
10 m oil resistant electrical cable and bracket	
Cable fixing facilities and cable protection	
1 lifting device	

<u>Identification</u>	105-PP-801
Number:	1
Location:	Sedimentation Tank Gallery
Type	Monobloc – horizontal installation , Dry installation
<u>Operating conditions</u>	
Duty	Max 6 starts per hour
Drive	Constant speed
Fluid service	Decanted water
Fluid temperature	5-25°C
Fluid pH	6-9

PART 3 – TECHNICAL SPECIFICATIONS

Fluid specific gravity	1
Description	
Unit capacity	4 m ³ /h
Total head	6 Bar
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies. Particular requirements are as follows : Body and Impeller : gray cast iron EN JL 1040
Motor	1.5 kW – 400 V – 50 Hz – IP 68 – F
Accessories (per installed pump):	
Foundation	
One suction and discharge pipe, including necessary elbows and 2 ball valves and 1 check valve according to P&IDs	
Pressure gauges installed between the pump and the check valve	
2 particle filters (500 micron) – 1 duty one standby – with manual backwash.	
Lifting ring	
25 m of cable	

Identification	105-PP-811
Number:	1
Location:	Sedimentation Tank Gallery
Type	Monobloc – horizontal installation , Dry installation
Operating conditions	
Duty	Max 6 starts per hour
Drive	Constant speed

PART 3 – TECHNICAL SPECIFICATIONS

Fluid service	Decanted water
Fluid temperature	5-25°C
Fluid pH	6-9
Fluid specific gravity	1
<u>Description</u>	
Unit capacity	45 m ³ /h
Total head	3 Bar
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies. Particular requirements are as follows : Body and Impeller : gray cast iron EN JL 1040
Motor	7.5 kW – 400 V – 50 Hz – IP 68 – F
Accessories (per installed pump):	
One suction and discharge pipe, including necessary elbows and 2 ball valves and 1 check valve according to P&IDs	
Pressure gauges installed between the pump and the check valve	
2 particle filters (500 micron) – 1 duty one standby – with manual backwash.	
Lifting ring	
25 m of cable	

<u>Identification</u>	205-SP-001, 205-SP-002
Number:	1+ 1 stand-by (installed)
Location:	Sludge building - Foul water sump
Type	Submersible centrifugal pumps – Vertical installation

PART 3 – TECHNICAL SPECIFICATIONS

<u>Operating conditions</u>	
Duty	Max 6 starts per hour
Drive	Constant speed
Fluid service	Foul water with up to 1 % solids content consisting of grit, organic and inorganic materials and greases.
Fluid temperature	5-40°C
Fluid pH	6-9
Fluid specific gravity	1
<u>Description</u>	
Unit capacity	200 m ³ /h
Total head	9 m
Materials	General requirements are indicated in part 2 : Products – Components and sub-assemblies. Particular requirements are as follows : Body and Impeller : gray cast iron EN JL 1040
Motor	10 kW – 1500 rpm – 400 V – 50 Hz – IP 68 – F
Accessories (per installed pump)	
Discharge connection (cast iron)	
Discharge pipe	
Isolation valve (gate valve, manual) and check valve (ball valve)	
Double guide bars, attachment for guide bars, elevating chain incl. suspension attachment	
10 m oil resistant electrical cable and bracket -	
Cable fixing facilities and cable protection	
1 lifting device (rudder in galvanized steel and hoisting winch in stainless steel X2CrNi18-09 1.4307 (304L))	

1.3.1. 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 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.
- e. 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.
- f. 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.
- g. 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.
- h. 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 due to grit.

1.3.2. OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

1.3.2.1. PUMP DUTIES

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.

1.3.2.2. 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.

1.3.2.3. PUMP RATED SPEED (NR)

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

1.3.2.4. 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.

1.3.2.5. 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 designed by the Contractor.

1.3.2.6. 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. 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 01000 – 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 01000 - General requirements, the Contractor shall provide the following curves for each pumping unit:

- Efficiency (%)
- Power (kW)
- Required NPSH

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,

2. PRODUCTS – COMPONENTS AND SUB-ASSEMBLIES

2.1. GENERAL

All pumping units shall be supplied as complete pumping systems, including the pump, its driving motor, the drive shaft and couplings, local control panels and all necessary appurtenances (including protection devices, switches, etc.).

Pumps and motors shall be flexible-coupled. That portion of the shaft extending through the mechanical seal (s) shall be equipped with a replaceable sleeve (sealed or positive locked to the shaft) such that the entire shaft need not be replaced when it is scored or worn in this area. Pump shafts shall be designed for a maximum deflection at the shaft seal of 0.05 mm (0.002 in). All couplings, connections, external sealing, etc. shall be weather protected, suitable for outdoor installation.

The submersible pumps shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. There shall be no need for the personnel to enter the wet-well. Sealing of the pumping unit to the discharge shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with O-ring, gasket or diaphragm which has to be replaced will not be acceptable. No portion of the pump shall need any support directly on the sump floor.

Pump shafts shall run in ball bearings. The bearings shall be grease-lubricated and shall be contained in dust-proof and moisture-proof housing. The bearings and frame design shall be such that the bearings can be re-lubricated by use of external greasing devices. The pump design shall ensure that the outboard bearing can carry a combined thrust and radial load. Bearings shall be adequately designed to carry all radial and thrust loads through the normal operating range of the pump. Bearings for pumps in continuous operation (or in continuous rotation of operation) shall have an L-10 life of at least 40,000 hours at the operating point.

Mechanical seals, not packing, shall be used for all pumping units. Seals shall be of the type not requiring water sealing or flushing water.

Oil level shall be maintained by a constant level oiler with visible oil supply.

All openings in the pump shall be large enough to permit passage of solids with maximum diameter of 60 mm. Impellers must be of the enclosed type. All submersible pumps shall be of the centrifugal type easily removable for inspection or service and requiring no bolts nuts or any other fastenings.

Connections to concrete foundations for all pumps shall be sufficient to withstand a displacing force equal to that developed by an internal pressure equal to three times shut-off head at maximum operating speed.

Pumping units shall be designed such that, on any point along the full speed operating curve of the pump, no components are over loaded. Pumping units shall be designed to operate without cavitations or damaging vibration over the entire specified range of flow and head conditions and (where appropriate) over the range of speeds specified.

Major pump components shall be of gray cast iron with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts, bolts and washers shall be of AISI type 304 stainless steel or better. All metal surfaces coming in contact with the pump- age, other than stainless steel or brass shall be protected by a factory-applied spray coating of alkyd primer with oxiranesther paint finish on the exterior of the pump. Sealing design of major pump components shall incorporate metal to metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton O-rings. Fittings will be of controlled compression of rubber O-rings in two planes and O-rings contact of four sides without the requirement of a specific torque limit.

Neither rectangular sectioned gaskets neither requiring specific torque nor scaling compound shall be considered as equal.

Pumping units shall have no dangerous critical or resonance frequencies. The Contractor shall be responsible for the analysis of critical speeds and the complete mass elastic system, and shall submit calculations in this regard to the Engineer or his representative for approval prior to erection.

Pumping units shall be suitable for connection to No.-Flow shut-off switches, such switches to be supplied with all check valves supplied.

Each unit shall be provided with an adequately designed cooling system. Provisions for external cooling and seal flushing shall be provided. The cooling system shall provide for continuous pump operation in liquid temperature of up to 40°C.

2.1.1. CABLE ENTRY SEAL

The Cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomere grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable the assembly shall provide ease of changing the cable. The cable entry junction chamber and motor shall be separated by a terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

2.1.2. MOTORS

The pump motor shall be a squirrel cage induction motor, shell type design, housed in an air-filled watertight chamber. The stator windings and stator leads shall be insulated with moisture resistant Class F insulation rated for 155°C. The stator shall be dipped three times in Class F varnish and shall be heat-shrink fitted into the stator housing. The motor shall be designed for continuous duty handling pumped media of 40°C and capable of up to 15 evenly spaced starts per hour. Thermal switches set to open at 125°C and closed at 70°C shall be embedded in the stator load coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomer o-ring seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. Wire nuts or crimping type connection devices are not acceptable. The motor and pump shall be designed and assembled by the same manufacturer. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15 the motor shall have a voltage tolerance of plus or minus 10% the motor shall be designed for operation up to 40°C ambient temp. and with a temp. rise not to exceed 85°C. This chart shall also include data on starting and no-load characteristics. The motor and the cable are capable of continuous submergence underwater without loss of watertight integrity acc. To protection class IP68 (20m), the rated power shall be adequate so that the pump is not overloaded throughout the entire indicated pump performance curve.

Power cable includes two conductors 1.5 mm for the monitoring of thermal switches and optional protecting sensors.

2.1.3. BEARING

The pump motor shaft shall rotate on two permanently grease lubricated bearings. The upper bearing shall be a single row roller bearing. The lower bearing shall be a two row angular contact ball bearing to compensate for axial and radial forces.

2.1.4. MECHANICAL SEAL

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two independent seal assemblies. The seals shall operate in an oil-reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located

between the pump housing and the oil-chamber, shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper, secondary seal unit, located between the oil-chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotating for sealing. For special applications other seal face material shall be available. Other seal types shall not be considered acceptable or equal to the dual independent seal specified. Each pump shall be provided with an oil chamber for the shaft sealing system, the drain and inspection plug, for the oil, shall be accessible from the outside.

2.1.5. IMPELLER

The impeller shall be dynamically balanced, double shrouded non-clogging design having a long through let without acute turns. The impeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in normal wastewater. Whenever possible, a full vanes, not vortex, impeller shall be used for maximum hydraulic efficiency, thus, reducing operating costs. The impeller shall be, retained with an lien head bolt and shall be capable of passing min 60 mm diameter solid. All impellers shall be coated with alkyd resin primer. Mass moment of inertia shall be provided by the pump manufacturer upon request.

2.1.6. WEAR RINGS

A wear ring system shall be used to provide efficient sealing between the volute and the suction inlet of the impeller. The wear ring shall be stationary and made of brass or rubber-clad steel frame, which is driven, fitted to the volute inlet. These pumps shall also have a stainless steel impeller wear ring heat – shrink fitted to the suction inlet of the impeller to mate the stationary wear ring.

2.1.7. VOLUTE

Pump volute shall be single-piece non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size as specified. The volute shall have a mating flange machine, and provided with a blind-flange, correct positioned for a flushing valve.

2.2. FABRICATION

If applicable, particular requirements mentioned above in part 1 must be enforced.

2.2.1. CASING

The casing shall be gray cast iron EN JL 1040 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.

2.2.2. 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.
- gray cast iron EN JL 1040
- Stainless steel, AISI 304 or equivalent

2.2.3. SHAFT

The pump shaft shall be of alloyed 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.

2.2.4. SHAFT COUPLING

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

2.2.5. VOLUTE AND BODY

Volute and body shall be gray cast iron EN JL 1040.

2.2.6. NUTS, BOLTS AND OTHER SUPPORTS

All exposed nuts, bolts, double guide bars, attachment for guide bars, elevating chain incl. suspension attachment shall be in stainless steel X2CrNi18-09 1.4307 (304L).

2.3. SPARE PARTS AND TOOLS

The Mandatory Spare Parts are for each submersible pump:

- 1 set of o-ring
- 1 security ring
- 1 stuffing
- 1 wrench

- 1 packing ring

The Mandatory Spare Parts for each electropumps are:

- 1 rotor
- 1 statoric ring
- 1 packing

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:

- Holes position
- Flatness, verticality, horizontality of the embedded parts,

B. Erection tolerances:

Refer to Section 01020

3.2.2. DRY TESTS

- Examination of paintwork.

3.2.3. COMMISSIONING TESTS

3.2.3.1. 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 programme 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 labour, 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.

3.2.3.2. 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.

3.2.3.3. 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.

3.2.3.4. 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 14202
PROGRESSIVE CAVITY 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 the progressive cavity 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

Supplies and works included under this section shall comply and co-ordinated with all others parts and section of the contract.

1.3. DESCRIPTION

<u>Identification</u>	
Number	3
Location	Primary settling tank – sludge feed to dewatering
Model	Progressive cavity pumps – horizontal installation
<u>Operating conditions</u>	
Duty	Continuous – 16 h/day – 7 days a week
Drive	Manual variable speed geared motor

PART 3 – TECHNICAL SPECIFICATIONS

Ambient environment	Indoor
Ambient temperature	5-40°C
Ambient relative humidity	
Fluid service	Primary sludge up to 35 g/l of suspended solids concentration
Fluid temperature	5-40°C
Fluid pH	6-9
Fluid specific gravity	1,05
<u>Description</u>	
Unit capacity	20 - 40 m ³ /h
Maximal pressure	3 bars
Materials	<p>Body : gray cast iron EN JL 1040</p> <p>Rotor : Stainless steel X20Cr13 1.4021</p> <p>Stator : Buna-N synthetic rubber with a minimum shore durometer hardness of 60 bonded to a steel tube.</p> <p>Shaft : Stainless steel X20Cr13 1.4021</p>
Motor	11 kW – 400 V – 50 Hz – IP 55 – F
Accessories (per installed pump)	
One suction and discharge pipe	
Branch connection on suction and discharge pipes for injection of industrial water (pipe declogging)	
Branch connection on suction and discharge pipes for injection of pressurized air (decompaction of accumulated sludge)	
Upstream and downstream isolation valves (gate valves)	
Non-return valves (ball valve)	
Pressure gauges	

Dry Running Protection Device

1.3.1. 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 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.
- e. Each component casting of the 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.
- f. 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 due to grit.

1.3.2. OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

1.3.2.1. PUMP DUTIES

Each of the pumps shall be capable of operating continuously without damaging effects. 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.

1.3.2.2. 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.

1.3.2.3. PUMP RATED SPEED (NR)

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

1.3.2.4. PUMP SHAFT POWER

The pump shaft power characteristics shall be stable within the duty range and shall be non-overloading at the pump operating speed.

1.3.2.5. 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. 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 01000 – 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 01000 -General requirements**, the Contractor shall provide the following curves for each pumping unit:

- Efficiency (%)
- Horsepower (kW)

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,

2. PRODUCTS – COMPONENTS AND SUB-ASSEMBLIES

2.1.1. GENERAL

All pumping units shall be supplied as complete pumping systems, including the pump, its driving motor, the drive shaft and couplings, local control panels and all necessary appurtenances (including protection devices, switches, etc.).

Pumps and motors shall be flexible-coupled. That portion of the shaft extending through the mechanical seal (s) shall be equipped with a replaceable sleeve (sealed or positive locked to the shaft) such that the entire shaft need not be replaced when it is scored or worn in this area. Pump shafts shall be designed for a maximum deflection at the shaft seal of 0.05 mm (0.002 in). All couplings, connections, external sealing, etc. shall be weather protected, suitable for outdoor installation.

Pump shafts shall run in ball bearings. The bearings shall be grease-lubricated and shall be contained in dust-proof and moisture-proof housing. The bearings and frame design shall be such that the bearings can be re-lubricated by use of external greasing devices. The pump design shall ensure that the outboard bearing can carry a combined thrust and radial load. Bearings shall be adequately designed to carry all radial and thrust loads through the normal operating range of the pump. Bearings for pumps in continuous operation (or in continuous rotation of operation) shall have an L-10 life of at least 40,000 hours at the operating point.

Mechanical seals, not packing, shall be used for all pumping units. Seals shall be of the type not requiring water sealing or flushing water.

Oil level shall be maintained by a constant level oiler with visible oil supply.

All openings in the pump shall be large enough to permit passage of solids with maximum diameter of 60 mm.

Connections to concrete foundations for all pumps shall be sufficient to withstand a displacing force equal to that developed by an internal pressure equal to three times shut-off head at maximum operating speed.

Pumping units shall be designed to operate without damaging vibration over the entire specified range of flow and head conditions and (where appropriate) over the range of speeds specified.

Major pump components shall be of gray cast iron with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts, bolts and washers shall be of AISI type 304 stainless steel or better. All metal surfaces coming in contact with the pump- age, other than stainless steel or brass shall be protected by a factory-applied spray coating of alkyd primer with oxiranesther paint finish on the exterior of the pump. Sealing design of major pump components shall incorporate metal to metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton O-rings. Fittings will be of controlled compression of rubber O-rings in two planes and O-rings contact of four sides without the requirement of a specific torque limit.

Neither rectangular sectioned gaskets neither requiring specific torque nor scaling compound shall be considered as equal.

Pumping units shall have no dangerous critical or resonance frequencies. The Contractor shall be responsible for the analysis of critical speeds and the complete mass elastic system, and

shall submit calculations in this regard to the Engineer or his representative for approval prior to erection.

Pumping units shall be suitable for connection to No.-Flow shut-off switches, such switches to be supplied with all check valves supplied.

Each unit shall be provided with an adequately designed cooling system. Provisions for external cooling and seal flushing shall be provided. The cooling system shall provide for continuous pump operation in liquid temperature of up to 40°C.

2.1.2. CABLE ENTRY SEAL

The Cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomere grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable the assembly shall provide ease of changing the cable. The cable entry junction chamber and motor shall be separated by a terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

2.1.3. MOTORS

The pump motor shall be a squirrel cage induction motor, shell type design, housed in an air-filled watertight chamber. The stator windings and stator leads shall be insulated with moisture resistant Class F insulation rated for 155°C. The stator shall be dipped three times in Class F varnish and shall be heat-shrink fitted into the stator housing. The motor shall be designed for continuous duty handling pumped media of 40°C and capable of up to 15 evenly spaced starts per hour. Thermal switches set to open at 125°C and closed at 70°C shall be embedded in the stator load coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomer o-ring seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. Wire nuts or crimping type connection devices are not acceptable. The motor and pump shall be designed and assembled by the same manufacturer. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15 the motor shall have a voltage tolerance of plus or minus 10% the motor shall be designed for operation up to 40°C ambient temp. and with a temp. rise not to exceed 85oC. This chart shall also include data on starting and no-load characteristics. The motor and the cable are capable of continuous submergence underwater without loss of watertight integrity acc. To protection class IP68 (20m), the rated power shall be adequate so that the pump is not overloaded throughout the entire indicated pump performance curve.

Power cable includes two conductors 1.5 mm for the monitoring of thermal switches and optional protecting sensors.

2.1.4. BEARING

The pump shall be provided with grease lubricated thrust and radial bearings designed for all loads imposed by the specified service. Bearing life for all pump and motor bearings shall be 100,000 hours minimum

2.1.5. MECHANICAL SEAL

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two independent seal assemblies. The seals shall operate in an oil-reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump housing and the oil-chamber, shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper, secondary seal unit, located between the oil-chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotating for sealing. For special applications other seal face material shall be available. Other seal types shall not be considered acceptable or equal to the dual independent seal specified. Each pump shall be provided with an oil chamber for the shaft sealing system, the drain and inspection plug, for the oil, shall be accessible from the outside.

2.1.6. ROTOR AND STATOR

The pump shall be two-stage design employing a convoluted rotor operating in a similarly convoluted stator. The convolutions shall be configured to form a cavity between the rotor and stator which shall progress from the pump's inlet to discharge port with the operation of the rotor. The fit between the rotor and stator at the point of contact shall compress the stator material sufficiently to form a good seal and to prevent leakage from the discharge back to the inlet end of the pumping chamber.

2.2. FABRICATION

If applicable, particular requirements mentioned above in part 1 must be enforced.

2.2.1. PUMP BODY

The pump body shall be gray cast iron EN JL 1040 or equivalent.

2.2.2. ROTOR

The rotor shall be made of Stainless steel, AISI 304 or equivalent.

2.2.3. STATOR

The rotor shall be made of Buna-N synthetic rubber with a minimum shore durometer hardness of 60 bonded to a steel tube.

2.2.4. SHAFT

The pump shaft shall be of alloyed 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 made of Stainless steel, AISI 304 or equivalent.

2.2.5. NUTS, BOLTS AND OTHER SUPPORTS

All exposed nuts, bolts, shall be in stainless steel X2CrNi18-09 1.4307 (304L).

2.3. SPARE PARTS AND TOOLS

The Mandatory Spare Parts are for each size of pump furnished:

- One stator,
- One rotor,
- One connecting rod,
- One set connecting rod joint assembly,
- One bearing assembly,
- One set of V-belts
- Two sets of drive pins, washers, and screws,
- Two sets of gaskets and o-rings,
- One mechanical seal.

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. Holes position
- b. Flatness, verticality, horizontality of the embedded parts,

B. Erection tolerances:

Refer to Section 01020

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

3.2.3.1. 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 programme 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 labour, 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.

3.2.3.2. 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.

3.2.3.3. 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.

3.2.3.4. 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 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 14410

SCREW CONVEYORS

1. GENERAL

1.1. WORK INCLUDED

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of screw conveyors.

The equipment shall be complete with all base plates, foundation bolts and all other items of equipment necessary to make the installation 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 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.** Section 19 100 - Electrical Equipment;
- C.** Section 17 100 – Instrumentation;
- D.** Section 11 305 – Fine Screening;
- E.** Section 11 373 – Belt filters;
- F.** Section 11 379 – Liming;

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

1.3.1.1. FINE SCREENING COMPACTING SCREW

Refer to Section 11 305 – Fine Screening.

1.3.1.2. SKIPS FEEDING SCREW CONVEYOR

<u>Identification</u>	203-SW-001/002
Number:	2
Location	Skips area
Model	Shaftless screw conveyor
<u>Operating conditions</u>	
Duty	Continuous 16 h/day – 7 days a week
Ambient environment	outdoor
Ambient temperature	-25 to 40°C
Fluid service	Limed sludge between 30 to 35 % of suspended solids concentration and lime
Fluid temperature	10-50°C
Fluid pH	7-14
Fluid specific gravity	1,1
<u>Description</u>	
Capacity	20 wet t/hour
Trough diameter	550 mm
Trough length	12 m
Lead angle	0°
Maximum screw operating speed	20 rpm

PART 3 – TECHNICAL SPECIFICATIONS

Materials	General requirements are indicated in part 2: Products – Components and sub-assemblies.
Motor	10 kW – 1450 rpm – TRI – 400 V – 50 Hz – IP 68 – F
Accessories (per installed screw conveyor)	Removal cover on trough Torque limiter Inlet hopper SS 304L Waste distribution device in two dumpsters (manual rotation)

1.3.2. OPERATING CONDITIONS

Screws are sized in case four dewatering and liming units would simultaneously operate.

Screw conveyors shall be provided as a completely integrated system designed for continuous and automatic operation.

Skip that should be fed is chosen by the operator, there is no level sensor above skips.

Units shall not need preventive cleaning

1.4. QUALITY ASSURANCE

1.4.1. 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.

1.5. SUBMITTALS

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

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

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. FABRICATION

Screw conveyors	Screw conveyor troughs : stainless steel 304 Screw Conveyor Flights: carbon steel Removal troughs cover : EPHD or stainless steel 304 Inlet and outlet hoppers : stainless steel 304 Bearing end plates: stainless steel 304 Support Saddles: stainless steel 304 Gear box : cast iron EN JL 1040 and epoxy
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2.2. SCREW CONVEYORS

The flight, shaft, and complete drive components shall be structurally designed for a conveyor capacity of 100 percent trough loading at maximum motor horsepower. The torque capacity of the drive unit shall be sufficient to start the conveyor with the trough 100 percent loaded.

Flushing connection shall consist of a 304 stainless steel pipe nipple welded to trough at invert.

Trough cover shall be hinged to the trough at the top of the trough U-flange. The cover shall be removal and be attached to the screw conveyor trough, with cover support brackets along one edge. Each cover shall also have a handle made of stainless steel, The handle rod shall be fully welded to cover. Each cover section shall have two toggle clamps.

Trough covers at discharge end of the conveyors shall be furnished with relief hatches with position switch to provide alarm indication in event of cover opening.

Each screw conveyor shall be driven by an electric motor connected to the shaft with a V-belt in the piggy back arrangement. The drive system shall be designed by the manufacturer for starting the conveyor fully loaded with the trough 100 percent filled. Shear pin or couplings shall ensure that jamming of any component does not cause mechanical damage to the equipment.

Tail end bearings shall be grease lubricated, double pillow block and shall be mounted outside the conveyor trough. End bearings shall be completely serviceable from outside the conveyor. Grease zerk fitting for non-drive end bearings shall be extended with stainless steel tubing to surface of adjacent grating platform to allow remote lubrication. A packing gland seal with 3 rings of packing shall be provided around the shaft where the shaft passes through the trough ends. The bearing and seals shall be capable of supporting the applicable thrust loads by means of snap rings and shall prevent angular misalignment of the shafts. Bearings shall have an L-10 life of 100,000 hours.

Controls and Accessories:

- To detect zero speed of the screw, each conveyor drive shall be provided with a zero speed switch.
- Relief hatches shall be furnished with position switches that detect cover opening.
- Conveyors shall be provided with a cable operated safety stop switch on both sides of the trough. Two single pole, double throw switches shall be provided for each cable operated safety stop switch.

Conveyors and gate valves shall be operated by Local Control Stations.

2.3. SPARE PARTS AND SPECIAL TOOLS

The Mandatory Spare Parts are for each screw :

- One set V-belts or timing belts.
- One set of end bearings and packing

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 :
 - a.** Holes position
 - b.** Flatness, verticality, horizontality of the embedded parts,
- B.** Erection tolerances:

Refer to Section 01020

3.2.2. DRY TESTS

- a.** When the Contractor is satisfied that the unit sets have been properly installed he shall inform the Engineer who will carry out the installation inspection.
- b.** The unit 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.

3.2.3. COMMISSIONING TESTS

3.2.3.1. 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.** The backdrive shall be modulated and other control inputs simulated for a minimum of 8 hours to provide an initial test of control responses. A controlled shutdown and emergency shutdown cycle shall be included.
- d.** All programmed sequence control, protection, alarms, and other specified control features in dewatering units shall be demonstrated. Control logic inputs and outputs shall be simulated for all equipment and devices composed or linked to dewatering units.

3.2.3.2. COMMISSIONING TESTS

Operational test will consist of control the smooth running during dewatering and liming units commissioning tests.

SECTION 14 412

BELT CONVEYORS

1. GENERAL

1.1. WORK INCLUDED

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of screw conveyors.

The equipment shall be complete with all base plates, foundation bolts and all other items of equipment necessary to make the installation 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 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.** Section 19 100 - Electrical Equipment;
- C.** Section 17 100 – Instrumentation;
- D.** Section 11 301 – Coarse Screening;

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

Screenings belt conveyor: refer to specification 11 301 (Coarse screening)

Dewatered sludge belt conveyor:

<u>Identification</u>	203-BC-001
Number:	1
Location	Sludge building – liming room
Model	Double way belt conveyor
<u>Operating conditions</u>	
Purpose	In case of unavailability of one the sludge screw conveyors (203-SW-001 or 002), this equipment will transfer the sludge to the remaining screw.
Ambient environment	Indoor
Ambient temperature	5 to 40°C
Fluid service	Limed sludge between 30 to 35 % of suspended solids concentration and lime
Fluid temperature	10-50°C
Fluid pH	7-14
Fluid specific gravity	1,1
<u>Description</u>	
Capacity	10 wet t/hour
Belt width	800 mm
Approximative Trough length	9 m
Lead angle	0°
Materials	General requirements are indicated in part 2: Products – Components and sub-assemblies.
Gear Motor	Motor : 2,2 kW – 1450 rpm – TRI – 400 V – 50 Hz – IP 55 – F
Accessories	Lateral guide for the belt Lateral edges Adjustable supports

	Torque controller 2 Removable SS sloping plates for sludge transfer from the outlet of the sludge/lime mixer to the belt conveyor.
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1.3.2. OPERATING CONDITIONS

Belts conveyors shall be provided as a completely integrated system designed for continuous and automatic operation.

1.4. QUALITY ASSURANCE

1.4.1. 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.

1.5. SUBMITTALS

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

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

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. FABRICATION

Belt conveyer	Belts : PVC or rubber Frame and edge : stainless steel inox 304L Inlet hoppers : stainless steel 304L Bearing end plates: stainless steel 304L Support Saddles: stainless steel 304 Gear box : cast iron EN JL 1040 and epoxy
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2.2. SPARE PARTS AND SPECIAL TOOLS

The Mandatory Spare Parts are for each belt:

- One belt.
- Four rollers
- One set of end bearings and packing

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 :
- a. Holes position
 - b. Flatness, verticality, horizontality of the embedded parts,
- B.** Erection tolerances:

Refer to Section 01020

3.2.2. DRY TESTS

- a. When the Contractor is satisfied that the unit sets have been properly installed he shall inform the Engineer who will carry out the installation inspection.
- b. The unit 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.

3.2.3. COMMISSIONING TESTS

3.2.3.1. 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. The backdrive shall be modulated and other control inputs simulated for a minimum of 8 hours to provide an initial test of control responses. A controlled shutdown and emergency shutdown cycle shall be included.
- d. All programmed sequence control, protection, alarms, and other specified control features in dewatering units shall be demonstrated. Control logic inputs and outputs shall be simulated for all equipment and devices composed or linked to dewatering units.

3.2.3.2. COMMISSIONING TESTS

Operational test will consist of control the smooth running during dewatering and liming units commissioning tests.

SECTION 15 420

AIR LIFT

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 overall grit extraction system equipment, including but not limited to:

1. Air compressors,
2. Pipes.
3. 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.

4. 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.

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

1.2. RELATED WORKS

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. WORK 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 11210 – Grit Scraper and Suction Bridges;
- D. Section 17100 – Instrumentation

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

Identification number:	103-BL-501/502
Type:	Air Lift
Number:	2
Location:	Grit and grease removal tanks
Capacity:	55 m ³ /h
Motor :	3 kW – 380 V – 50 Hz – IP55
Pipes :	2 suction pipes ND125 and ND150 at the bottom of the tanks 2 air pipes ND26/34 1 connection pipes between the two air-lifts in order to have only one air compression in operation 2 discharge pipes ND125
Materials:	Stainless Steel 304L

1.3.2. OPERATING CONDITIONS

Grit accumulated in the grit chamber well shall be removed by an air lift system.

The mixture of sand, air and water lifted up is conveyed to a grit classifier.

Compressed air is provided by an air compressor located near the grit tank. Each compressor shall operate with one tank.

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

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

- Pressure increasing in bars
- Input flow in m³/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.

1.3.3. 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 in the grit chambers control box with mixers and classifiers 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 these equipments will be connected to the general computer. He shall particularly describe the automatic operation principle he wants to install for the grit extraction control.

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

7. Malfunctions and alarms.

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) 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.
 - a) Welds:

Refer to Section 01020.

1.5. SUBMITTALS

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

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

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. FABRICATION

2.1.1. AIR COMPRESSOR

The air compressor should be equipped with appropriate:

- Inlet dust filter,
- Silencer,
- Discharging pressure valve,
- Pressure protection device
- Pipe flexible joints.
- Motor
- Acoustic housing
- Control box

2.1.2. MOTOR

The motor shall be:

- IP55 protected
- 380 Volts,
- 50-Hertz
- 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.

2.2. PIPES

Inlet and outlet pipes shall be made of stainless steel 304L.

2.3. SPARE PARTS AND SPECIAL TOOLS

The Contractor shall supply the following spare parts:

- Equipment maintenance

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

A. Inspections before and after concreting

1. The following inspections shall be carried out before and after concreting:

- Equipment position
- Flatness, verticality, horizontality of the embedded parts,

2. Erection tolerances:

Refer to Section 01020

B. Dry tests

1. Testing of all operation characteristics during 24 hours and without water:

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

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

2. Examination of paintwork.

C. Commissioning tests

1. Examination of paintwork.

2. Checking of operation conditions for nominal flow and during 24 hours.

3. The supplier shall provide extraction 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 sediment flushing and solid conveying. Each extraction system shall fit individually with requirements.

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.
5. Leakage shall not be observed out of the pipes.

oOo

SECTION 15550 HVAC

1. GENERAL CONDITIONS / REQUIREMENTS

1.1. INTRODUCTION

The General Specifications included as part of this Specification indicates the minimum standard of work, workmanship and materials that will be accepted in the provision of a normal installation. It is not intended to cover the requirements of installations of a specialist nature. The General Specifications shall be read and considered in conjunction with, Particularly Mechanical and Electrical Specifications and Drawings that are issued for and appertain solely to the particular installation concerned; in the event of conflict the more stringent condition shall apply and the Engineer's decision shall be final.

The Contractor shall include for the complete installation, testing and commissioning of the mechanical, associated electrical and plumbing systems outlined on the drawings and described in this specification.

1.2. EQUIPMENT RATINGS

All equipment selected for use on this Contract shall be suitable for continuous and reliable operation under the external design conditions stated. In addition, items of equipment installed in enclosed spaces may be subject to temperatures in excess of those prevailing externally and this shall be taken into account. Where ratings are given in this Specification and/or shown on the Drawings, they are the actual ratings to be achieved after the application of all de-rating factors.

All equipment and enclosures that may be subject to internal condensation shall be fitted with suitably rated electrically operated thermostatically controlled anti-condensation heaters.

1.3. COORDINATION

The Contractor shall be responsible for all aspects of project coordination as set out in the General Conditions.

1.4. EQUIPMENT

All equipment to be installed under this contract shall comply with the requirements of the General Conditions.

1.5. SHOP DRAWINGS

The Contractor shall prepare shop drawings for the installation as per the requirement of the General Conditions.

1.6. RECORD DRAWINGS AND MANUALS

The Contractor shall prepare record drawings and manuals as per the requirement of the General Conditions.

1.7. SERVICES FOR TESTING

All fuel, oil, gas, water and electricity for the purposes of testing and commissioning shall be provided by the Contractor up to the date of the issue of the Certificate of Temporary Acceptance. This shall include the initial charging of all systems and equipment with water, oil and gas, etc.

1.8. SPARE PARTS AND TOOLS

After completion of the Works and during the specified maintenance period the Contractor shall be responsible for the supply and installation at the fixed time recommended by the manufacturers of all spare parts and components, required for the ideal running of all engineering services installation.

The contractor will be responsible to provide the list of recommended spare parts for all equipments used in the project and to provide such spare parts for two years after the maintenance period.

2. STANDARDS

2.1. INTRODUCTION

This General Specification indicates the minimum standard of work, workmanship and materials necessary for the execution of the Contract to the approval of the Engineer and the true intent of this Specification and associated Drawings.

2.2. STANDARDS FOR INSTALLATIONS

The installation shall conform to:

- a) The general and specific requirements of the local water authority, public health officer, local drainage inspectorate and other local statutory authorities.
- b) Local authority by laws and other regulations.
- c) General and specific requirements of the local fire officer.
- d) Health and Safety at Work Act., U.K.
- e) Central supply of liquefied petroleum Gases to Buildings.
- f) Factory Act Requirements and Regulations, U.K.
- g) Relevant codes of practice of the British Standards Institution.
- h) The requirements of the insurance companies concerned.
- i) The regulations for the electrical equipment of buildings, (current edition) published by the Institution of Electrical Engineers, London.
- j) The recommendations of the manufacturers of all materials, plant and equipment.
- k) CIBSE Regulations for water supply and drainage services.

2.3. SAFETY AND FIRE PRECAUTIONS

The Contractor shall ensure that safe methods of working are followed when using any equipment of materials which may involve a danger to life or to property and he is to take all necessary precautions to safeguard against damage by fire or explosion where the execution of the works may involve the presence of flame or sparks.

2.4. CONTRACTOR'S PLANT AND TOOLS

The Contractor, unless otherwise specified, shall provide all materials, tackles, slings, scaffolding, ladders, haulage, labour and apparatus necessary for the supply, delivery and erection of the plant on site.

The Contractor shall be responsible for providing at his own expense, all the requirements such as hand tools, hand lamps, and transformers, where necessary, to carry out the works including all cabling and intermediate connections from supply point to location of work. All wiring, cabling, etc., serving temporary installations are to be designed, installed and operated, as to be safe and in full accordance with the appropriate regulations.

As soon as any part of the Contractor's Site establishment or plant is no longer required for carrying out the Works, the Contractor shall disconnect and remove the same to the satisfaction of the Engineer.

2.5. PIPE WORK CONNECTIONS

The Contractor shall include for all pipe work and connections to all sanitary fittings, and specialist equipment as detailed in the specifications.

2.6. MATERIALS

All materials, plant and equipment shall comply fully with any relevant British Standard Specification or Code of Practice current at the time of tendering.

The Engineer reserves the right to inspect materials, plant and equipment on Site at reasonable times and to reject any of the same not complying with the Specifications.

The cost of dismantling and re-erection of the installation occasioned by the removal of rejected materials, plant or equipment shall be borne by the Contractor.

2.7. STANDARDS

Corresponding parts of all apparatus shall be interchangeable and where mechanical or electrical details are used or which any part of parts are covered by a British Standard Specification, all such parts are to be made in accordance with such specification as shall be issued at the date at which the parts have been ordered.

Except where otherwise specified, all bolts , nuts and stud screws thread shall be metric and all pipe threads to be to B.S. pipe threads standards.

2.8. TRADE CUSTOMS AND PRACTICE

The Contractor shall be entirely responsible for arranging and ensuring that the various classes of work comply with local trade customs and practice and shall provide accordingly in his Works.

2.9. DIMENSIONS

The Contractor shall take his own dimensions on Site for all plant and material to be supplied by him and shall be entirely responsible for the accuracy of his measurements.

2.10. SETTING OUT

The Contractor shall set out the Works in accordance with his installation working drawings.

2.11. NAMEPLATES

All plant and apparatus supplied under this Contract shall be provided with brass nameplates, bearing the maker's name shop or reference number, size, type, test and working pressure, speed and other relevant particulars engraved thereon.

2.12. INTERRUPTION OF SERVICES

The Contractor shall not, without permission of the Engineer interrupt or interfere with the operation of existing services such as water, electric lighting and power, buried cables, sewers, drains, etc., nor, in the case of works of statutory authorities or private owners, without the permission of these authorities or owners.

In the event of any such damage, the Contractor shall be responsible for the making good of same to the satisfaction of the Engineer, authorities or owners, as the case may be.

2.13. MISUSE OF MATERIALS

No materials brought on to Site for incorporation in the Works shall be used for scaffolding or any other temporary purpose.

2.14. VOUCHERS

The Contractor, at the request of the Engineer, must produce invoices, paid or unpaid, or accounts if required as proof that the goods are in all respect as herein specified.

2.15. OBSTRUCTIONS

No extra charge shall be made for moving or circumventing any obstruction or other Contractor's equipment that may be laid on the Site and the Contractor must, therefore, allow in his tender for these and any other contingencies likely to arise.

2.16. INSPECTION, TESTING AND REJECTION

The Engineer shall be entitled during manufacture to inspect, examine and test the materials and workmanship for all plant to be supplied under the Contract, whether at the Contractor's or manufacturer's premises or on the Site. Such inspection, examination or testing shall not release the Contractor from any obligation under the Contract. The whole of the installation shall be tested on completion (in the presence of and to the satisfaction of the Engineer or his representative) in the relevant Sections of this Specification as applied to the particular installation concerned.

The Contractor must furnish certificates of test, in duplicate, to the Engineer, for all plant or materials specified to be tested at maker's works.

The tests on Site specified hereinafter are to be carried out in the presence of the Engineer or his Representative. The accuracy of all tests is to be to the satisfaction of the Engineer, whose decision shall be final.

The Contractor shall provide free of charge on the Site at his own expense and/or the manufacturer's works, such labour, materials, apparatus and instruments as the Engineer may consider requisite from time to time and as may reasonably be demanded to efficiently test the plant, materials or works as far as completed, until the plant is accepted as a whole by the Engineer. The Contractor shall at all times give facilities to the Engineer or his authorized representative to accomplish such testing.

The Contractor shall demonstrate, if required, the accuracy of any instrument used for testing. At least seven days' notice must be given by the Contractor of any test carried out on the Site to enable the Engineer or his authorized representative to be present if they so desire.

Testing of pipes and other apparatus as specified under the various Sections of Specifications may be required to be carried out in parts against testing as a whole and the Contractor must provide accordingly in his tender.

Should the Works on testing not conform to the Specifications, the Contractors must make them so conform at his own expense and, if he fails to do so within a reasonable period, not exceeding fourteen days, the Engineer shall be at liberty to call upon him to remove the defective part and reinstate without cost to the Employer.

2.17. PRESSURE GAUGES

Pressure gauge's shall be Bourdon tube type with 100mm diameter dial with needle pointer, normal operating pointer, brass casing, bronze syphon and bronze gauge cock, all suitable for the working pressure of the system. Each gauge shall be calibrated in kPa from Zero to 1.5 times the working pressure at the point selected, all to the Engineer's approval. All pressure gauges shall be fully tropicalized and fitted with a red indicating needle set to show the normal operating position.

2.18. TESTING AND COMMISSIONING - GENERAL

- At least three (3) working days written notification of all site tests shall be given to the Engineer.
- Fuel, water and electricity necessary for the operation of systems in preliminary runs and for adjustments and tests will be provided free of cost by the Contractor.
- The Contractor shall supply all labour, apparatus and instruments necessary for the prescribed tests. The accuracy of the Contractor's instruments shall be demonstrated if required.

- Any defects of workmanship, materials, performance, design of equipment, maladjustments or other irregularities, which become apparent during the tests, shall be rectified by the Contractor and the tests repeated at the Contractor's expense, to the satisfaction of the Engineer.

2.19. PRE-COMMISSIONING CLEANING

Tubes and all items of equipment shall be delivered stored and maintained in storage with their open ends effectively plugged, capped or sealed. All fittings, valves and sundry items shall be stored in clean bins or bagged and stowed in suitable racks. All such stored items shall be maintained under weatherproof cover to be supplied by the Contractor until they are ready for incorporation in the works. Particular care shall be taken to ensure the electrical equipment and components are kept clean and dry.

Before installations are handed over or subjected to the inspection and tests required the entire installation shall be thoroughly cleaned, both internally and externally.

All water installations shall be flushed out with clean water. This shall be preceded by chemical cleaning. During the flushing out process provision shall be made to exclude filters, pumps and any other items of plant, which could be damaged by the cleaning operation. The entire operation shall be carried out to the satisfaction of the Engineer.

Cold water services shall, after pre-commissioning cleaning and hydraulic testing, be sterilized by the application of chlorine as detailed in BS 6700.

2.20. SITE TESTS

The Contractor shall be responsible for site tests on static systems in order to ensure safe operating conditions consistent with design performance. Such tests shall include inspection and testing of welds and pressure testing for soundness of hydraulic systems.

2.21. COMMISSIONING

All aspects of the commissioning procedure shall follow the recommendations in the relevant CIBSE Commissioning Codes. Commissioning shall include:

- Preliminary checks to ensure that all systems and system components are in satisfactory and safe condition before start up.
- Preliminary adjustments and setting of all plant and equipment consistent with eventual design performance.
- Energizing and setting to work all plant.
- Final regulation and demonstration that the installation delivers the correct rate of flow of fluids at the conditions specified in the Contract Documents.

The entire commissioning procedure shall be performed to the satisfaction of the Engineer. The results of the commissioning shall be recorded by the Contractor and shall be endorsed by the Engineer. The items on the certificate shall be read in conjunction with the appropriate Clauses of this Specification and the design requirements of the drawings and the certified results and statements pertaining to the commissioning procedure shall be interpreted accordingly.

3. VENTILATION

3.1. SCOPE

The works covered under this contract include all the supply, install, test, commission and maintain in good operating condition of the complete ventilation system described in this specification and shown on the drawings in accordance with the drawings, schedule and specification including but not limited the following: -

- To check the design and to undertake the responsibility of giving the design conditions in the occupied areas.
- To provide power supply to all ventilation and AC units.
- To provide complete control wiring.

The following equipment shall be provided:

N°	Type	Service	Capacity / Dimensions
103-FN-001	Pump room exhaust ventilation 2-speed Fan	ambient air	1000 and 350 m3/h
105-FN-001	Pump Gallery exhaust ventilation 2-speed Fan	ambient air	6000 and 2000 m3/h
300-FN-001	2 speed Fan	Foul air	ND 300, 3100 and 2100 m3/h
200-FN-001	Exhaust ventilation 2-speed Fan	ambient air	8000 and 2700 m3/h
200-FN-002	Exhaust ventilation 2-speed Fan	ambient air	8000 and 2700 m3/h
206-FN-001	2 speed Fan	Foul air	ND 400, 8600 and 2800 m3/h

3.2. PRELIMINARIES

The specification and drawing shall be interpreted in accordance with the guidelines of the codes of practice of the CIBSE and ASHRAE Standard where such codes are relevant. Any Detail not shown or specified but necessary for the proper installation and operation shall be included in the work. The contractor shall set sleeves for pipes and ducts accurately before the concrete floors/walls are poured.

3.3. GENERAL SPECIFICATION

3.3.1. DESIGN ELEMENTS

The installation is based on the following design conditions. The capacities and dimensions given in drawings will be considered as the minimum to be accepted.

- Outdoors design condition: refer to General Conditions

- Indoor Design Condition:

Temperature: 10 to 25 °C

Relative humidity: 50 + 5% RH

Noise Level 35 NC

Power Supply: - 380/50/3ph or 220/50/1ph

3.3.2. OPERATION AND MAINTENANCE INSTRUCTIONS

Three sets of operation and maintenance manual of the ventilation, equipment shall be furnished and Handover to the client. The contractor shall also to furnish the name & telephone Nos. of manufacturers in order to expedite the further replacement of the parts.

3.4. EXHAUST (EXTRACT) FANS

Fan casings shall be of rigid and airtight construction, manufactured in materials resistant to corrosion from the operating environment and conditions. Fans shall be tested to BS 848 Parts 1 and 2.

All fans shall be statically balance dynamic balancing shall be included where scheduled.

Fans final duties shall be verified taking into account certified resistances of system components.

Where air filters are included in a system the fans shall be selected to deliver the design air volume against the system resistance including dirty filters.

Fans and motors shall be suitable for continuous operation and any start/stop programmers specified. Motor and fan bearings shall have a minimum design operational life of 40,000 hours with one start and stop per hour.

All cases fan assemblies shall be resiliently mounted to prevent vibration transmission to elements which they are fixed. Centrifugal fan assemblies with indirect drives shall have fan and drive motor mounted on a common and continuous rigid sub-frames resiliently mounted.

Fan scrolls and casings shall have drain plugs and inspection/cleaning doors where specified.

Flexible connections shall be made between the fan outlet and the unit casing in woven fire-retardant material.

Lubricators shall be provided to all fan and motor bearings (except sealed type where accepted or use), be extended if necessary to accessible positions, and have seal caps.

Rigid protective screens of woven steel wire and mesh shall be provided to all inlet and discharge opening for fans not protected by ductwork system connections.

Suspended fans shall be supported on a suspended sub-frame with vibration isolation provisions between the fan (and drive) and the sub-frame.

The assembly shall prevent significant movement of the fan relative to any ductwork system due to fan torque and thrust.

Fans and motors are installed at the (Explosive Areas) shall be of explosion proof type.

3.4.1. MATERIALS OF CONSTRUCTION

Casings

Casings and bearing and motor supports shall be constructed from mild steel to BS 1449.

Axial fan casings shall be of hot dipped galvanized mild steel or aluminum alloy.

Impellers

Multi-vane impellers for centrifugal fans shall be constructed from mild steel to BS 1449.

Axial fan impellers shall be hot dipped galvanized mild steel, aluminum or molded reinforced plastics.

Axial fan impellers, blade and hub assemblies of die cast aluminum alloy shall be X-ray checked for flaws before passing for assembly. Blades shall be of aerofoil section.

Alternative acceptable materials shall be fully inspected.

Shafts shall be constructed from machined bright steel, sized to ensure that the maximum running speed is not more than 60% of the first critical speed determined by the bearing arrangement.

Centrifugal fan impellers may be fixed to shafts with machine or grub screw's or shaft powers less than 750 W provided the screw bear onto machined flats on the shaft.

Impellers with shaft power greater than 1 KW shall be keyed to the shaft.

Shaft ends shall be recessed for tachometer drive.

3.4.2. CENTRIFUGAL FANS

Scrolls

Fan scrolls shall be mild steel with welded joints and welded angle stiffeners. On fans with static pressure of less than 1 kPa the scroll may be formed from mild steel with lock formed joints and spot-welded scroll supports and bases. On fans less than 800 mm diameter and of speeds below 20 Hz, stiffeners may be the folded edges of welded side plates used to form the pedestal and scroll. Arrangements of fan scrolls shall allow removal of the impeller where scheduled. Inlet and discharge connections shall be flanged with an airtight joint between the scroll and flange. Where the difference in static pressure between the fan inlet and surrounding is less than 500 Pa inlet connection may be a plain circular spigot.

Scrolls shall be properly prepared and prime coated and finished with a fully protective paint scheme to prevent corrosion and deterioration.

Kitchen exhaust fans shall have a removable airtight impeller inspection and cleaning door in the casing.

Impellers.

Forward curved impellers for shaft powers below 1 KW may be strip, if the fan efficiency and required impeller balance grade achieved. For shaft powers above 1kw, impeller blades shall mild steel riveted or welded to the cage. Braces shall be bolted, the cage and hub, but stressed wire or screwed stud bracing shall Backward curved impeller blades shall be of mild steel and

have true aerofoil performance, riveted or welded to the cage, except for shaft powers below 1 KW where the impeller may be die-cast aluminum alloy or similar if the fan efficiency and required impeller balance grade can be achieved. Double inlet double width fans shall have two identical impellers mounted back-to-back on a common shaft.

Bearings

Impeller bearings shall be ball or roller (except where specified otherwise) and shall be self-aligning Plummer blocks (or similar split bearing housings) shall be used on fans with shaft powers greater than 10 KW. Bearing shall be replaceable on belt-driven fans of input shaft power 5 KW and above.

Rubber bushed mountings with lateral deflections shall not be used on belt driven fans.

Fans with overhung impellers shall have two bearings mounted on a pedestal to which the fan casing is also rigidly attached. Fans with bearings on both sides of the impeller shall have bearer bars attached to the framework of the scroll stiffening and base. Bearings and bearer bars shall be designed to withstand any end thrust due to aerodynamic forces on the impellers.

Lubricants may be grease or oil. All lubricants used shall be mutually compatible.

Lubrication points shall be self-sealing or have captive dust caps and shall be extended to accessible positions. Oil reservoirs shall be located in positions at the same static pressure as the bearing served.

3.4.3. AXIAL FLOW FANS

Construction

Axial flow fan casings shall be of rigid construction of mild steel treated against corrosion, or aluminum alloy, stiffened and braced where necessary to minimize drumming and vibration. Casings shall be fully airtight and flanged at each end. Mounting feet shall be provided where necessary for bolting to a base or support. For in-duct mounting the length of the fan casing shall be greater than the combined length of the impellers and motors. For open inlet application a bell-mouth inlet shall be fitted. Electrical connections to the motors shall be by means of flexible conduit to an external galvanized mild steel or plastics terminal box secured to the casing.

Provision shall be made for inspection of fan impeller and motor. A removable inspection panel incorporating an air seal shall be fitted to casings 450 mm diameter and above.

Impellers shall be of steel treated against corrosion, aluminum or moulded reinforced plastics. The blades shall be securely fixed to the hub. Alternatively the blades and the hub may be formed in one piece. The hub shall be securely fixed to the shaft. Blades shall be aerofoil section. Where specified pitch adjustment facilities shall be provided.

3.4.4. IN-LINE CENTRIFUGAL AND MIXED FLOW FANS

Fan casings shall be rigidly constructed of mild steel protected against aluminum alloy and shall be stiffened and braced where necessary drumming and vibration.

Mounting feet shall be provided where specified for bolting to a base or supports.

Each inlet and outlet shall terminate in flange to BS 6339 to facilitate removal.

Stator vanes shall be of mild steel or aluminum alloy

Provision shall be made for inspection of fan impeller and motor. Casings shall have an access panel incorporating an air seal to facilitate cleaning and maintenance. A removable access panel incorporating an air seal shall be fitted to casings 450 mm diameter and above.

Fans connected at both ends to ducted systems shall have circular cross section casings which cover the overall length of tile impeller, impeller hub, motor and any inlet cones and discharge straightening vanes.

Impeller shall be mild steel or aluminum with blades welded or riveted 10-impeller hub and shroud. Impellers will) all outside diameter 500 m or less may be die-cast aluminum with a fitted shroud.

Electrical connections to fans with direct drive motors or motors mounted inside the casing shall be through flexible conduit to an external galvanized mild steel or plastics terminal box secured to the fan casing.

Fails driven by externally mounted motors shall have twin ball or roller bearing mounted steel impeller shafts. The drives shall be so arranged to minimize air leakage and allow access to pulleys and belts.

3.4.5. PROPELLER FANS

Propeller fans shall be ring mounted or diaphragm mounted as specified. Impellers shall be of steel, aluminum or plastics and the blades shall be securely fixed to the hub, or the hub and blades shall be formed in one piece. Shafts shall be fitted with lipped slinger rings shaped to suit the fan-mounting attitude. Vertical shaft fans with the impeller mounted above motor shall be fitted with an impeller spinner with a watertight seal against the motor shaft.

3.4.6. ROOF MOUNTED FAN

The roof fan shall meet the appropriate requirements of the preceding clauses relating to fans generally and to particular types of fans. Cowls and bases shall be of materials which are resistant to the weather and solar radiation, and which are appropriate to the location of the fan. Casings shall be complete with integral weather-proofing provisions suitable for direct fixing to the building structure in accordance with the manufacturers instructions. Adequate access to electrical supply terminals and lubrication points shall be provided by means of hinged cowls, or otherwise as appropriate. Back draught dampers and/or fire release dampers shall be provided where specified.

3.4.7. FANS ACCESSORIES

3.4.7.1.1. GUARDS AND DRIVE GUARD

Guards shall comply with BS 5304 and be provided to all fan open intakes and exhausts and all forms of open power transmission systems including belt drives drive shafts and drive couplings.

Rigid removable guards shall be installed to full enclose indirect drive system to prevent inadvertent contact with dangerous parts of machinery. Construction and installation shall ensure strength and rigidity. It shall not be possible to remove any guard or access pane without the use of a tool.

Belt drive guards shall be of galvanized or plastic coated woven- steel wire of not less than 2.5 mm diameter attached to a rigid galvanized or plastic coated steel rod or angle framework. The mesh size and/or the location of the guard shall prevent finger penetration. Alternative construction may be from galvanized sheet steel net less than 0.8 mm thick stiffened as necessary to ensure a rigid enclosure.

Removable access panels shall be provided to permit tachometer readings to be made of motor and driven shafts and belt tension to be tested. The sizes of guards including the dimensions and locations or access panels shall provide for the extreme motor position.

For duplicate motor installation the guard provided shall be arranged to protect both drives. All fixings and mountings shall be installed to facilitate change-over of the drive

Extended fan shafts shall be protected with a galvanized steel wire mesh or sheet metal guard shaped to suit the components and removable for maintenance. Guard construction shall be as for belt drives.

3.4.7.1.2. *SPEED VARIATION UNITS*

Variable speed/variable torque output units shall be of the electromagnetic induction type utilizing a standard, as specified, constant speed, 415V/240V, and 50 Hz squirrel cage motor with an eddy current coupling. The output shaft rotation shall be induced by eddy currents generated in a tube assembly fitted over tow motor output shaft.

The eddy current coupling shall be maintenance free with a single, stationary excitation coil and no brush gear or center bearing. The control board shall be a single printed circuit board.

All separate items shall be fitted in enclosures to IP43 of BS 5420.

3.4.7.1.3. *FREQUENCY CONVERTER*

Frequency converter drives shall be suitable for use on standard squirrel cage motors as specified and be of the pulse width modulation type the control range shall be 0.5 to 120 Hz the motor name plate current shall not be exceeded on start up

Frequency Converter drives shall be capable of connection to a motor already rotating in the correct direction at any speed up to the specified maximum without breaking the motor to a standstill, and connection to motor driven fan wind milling in reverse direction without causing tripping, and resulting the fan correctly to the set conditions of speed and direction

Drives shall withstand 500 milliseconds mains interruption without causing tripping and be fully protected against any electrically induced disorders without operating fuses.

Drives shall be suitable for the local and remote control and provide means of running at a fixed (selectable) speed on closure of a remote volt-free contact, overriding the speed control reference.

Frequency Converters shall have digital display of all operating conditions and recall of design limits. These shall be key board adjustable where applicable.

Volt-free contacts shall be provided to monitor all alarm functions.

4 -20mA analogue output signal shall be provided, programmable for, but not limited to, the following:

- (1) Output frequency
- (2) Reference signal
- (3) Output current
- (4) Motor torque
- (5) Motor power

The manufacturer of the frequency inverter drive shall ensure that the inverter and motor are entirely compatible and shall provide details regarding the production of harmonics, mains borne and airborne (radiated, magnetic or electro-static) interference. Written guarantees shall be given that disturbance levels will not exceed the limits of the EEC Electromagnetic Compatibility (FMC) Standards-Frequency inverters shall comply in all respects with the relevant British and European Standards.

Switched Reluctance Type Motors

Switched reluctance motors shall be designed and be suitable for operation with advanced solid state controllers.

The motor shall have 8 pole stators and 6 pole rotors with no bars or windings on the rotor.

The motor shall have high load capacity bearings which shall be maintenance free and shall be capable of emergency braking (fail safe) without damage to any part of the motor or controller.

The controller shall be suitable for operation on 415V three-phase 50Hz $\pm 6\%$ or an alternative voltage and frequency, details to be as listed on the Equipment –Data Sheets.

The controller shall be suitable for a signal input of 4- 10 mA (20mA \therefore 1500rpm).

The signal shall be positive with reference to earth.

The controller shall have additional outputs for analogue and digital tachometer indication and shall have provisions to alter the acceleration and deceleration ramps (1-10 sees linear) .

3.4.7.1.4. POLE CHANGING AND DUAL WOUND MOTORS

Pole changing (for speed ratios of 2:1) and dual wound motors shall be three-phase. squirrel cage induction type, wound for the speeds required and shall comply with BS 4999. Motor characteristics shall be closely matched to the load characteristics at both speeds (e.g. for fans and pumps the motors shall be variable torque characteristics in which the power output is proportional to the square of the speed).

All motors shall be Class F Insulated. Design C Duty-type SI and Noise Grade N. Motors shall be totally enclosed to designation 1P54-IC 00 41. (Totally enclosed, frame cooled with internal fan, no external fan). If high starting torques are. required to run the load up to speed in a reasonable time then the squirrel cage

shall be deep bar or double cage type.

power factor correction capacitors shall be fitted to maintain a power factor of not less than 0.95 at full load.

3.4.7.1.5. ELECTRICAL CONNECTIONS

All coil ends and tapping connections shall be brought out to terminals in the terminal box. Terminal boxes shall be located in accordance with BS 5000 Part; 10, Clause 5, and shall be readily accessible on the side most convenient for cable entry. Separate terminal boxes or separate entry with insulated barrier shall be provided for non-power connections such as thermistors and BMS wiring Terminal boxes shall be generously sized to accommodate the appropriate number of terminations so that cable terminations can be easily made without constricting the cable. Earthing terminals shall be provided in each terminal box and all terminals, including the earth terminal, shall be complete with shell clamps, washers, lock washers and nuts.

Cable entry shall be by means of flexible conduit from an adjacent fixed terminal box or by direct termination of multi-core cables. Where flexible conduit is used a separate earth wire shall be run, preferably outside the conduit so that the integrity can be readily checked. The appropriate gland plates with glands and armour clamps shall be provided for cables.

Where cables are connected directly to motors or to any plant subject to vibration, suitable bends or loops shall be formed immediately prior to the termination in accordance with the cable manufacturer's recommendations. Sufficient slack shall be provided in cables and in flexible conduit to allow the full range of adjustment with an allowance for easy removal of the motor without straining the connections. Wiring and cable cores shall be colour coded and in addition clearly labeled in accordance with BS 4999. Rating plates corroding alloy shall be fitted to all

motors and shall require by BS 4999 plus blank space equal to one line, as plates shall be positioned where they are easily readable.

3.4.7.1.6. *VIBRATION ISOLATORS*

All vibration isolators shall be spring type of suitably treated and finished steel or steel alloys with rubber, neoprene or glass fiber acoustic pads to suit the application fixed to both the machine and support frame to prevent high frequency transmissions.

The ratio of lateral to vertical stiffness shall be at least 1.2 times the ratio of static deflection to working height.

Isolators with static deflection exceeding 50 mm or fitted to long units shall have dampers or snubbers to prevent excessive movement speed passes through the resonant frequency of the mounting system.

3.4.7.1.7. *COWLS FOR ROOF MOUNTED FANS AND INTAKES AND OUTLETS*

Each cowl shall be designed to handle the scheduled air quantity and directions and velocity of discharge or intake shall be those specified. The loss of total pressure through the cowl (including the discharge velocity pressure and any losses due to bird guards and back draught dampers) shall not exceed the value specified at the design air volume. This loss shall be added to the system resistance in the determination of the fan duty. Cowls shall be manufactured from stainless steel sheet. They shall be assembled with fittings, fixings, nuts, bolts, washers and other similar items manufactured from compatible and non-corroding materials, selected to allow for any contaminants handled.

Roof mounted discharge cowls shall discharge vertically (upwards or downwards), or if mounted at roof slopes less than 30°, in the corresponding directions perpendicular to the slope. Roof mounted intake cowls shall have inlets which face directly at the roof surface or a continuous inlet around the perimeter which faces the roof at an angle not exceeding 45°.

Cowls which discharge humidity or contaminated air from ducted system shall be so constructed that an airtight joint can be made between the throat of the cowl and tile duct. The throat and the discharge space under the weathering cap shall be separated from any internal voids in the cowl and the space between the weathering skirt and throat.

Backdraught dampers shall be fitted to all discharge cowls and shall be suitable for the type and conditions of the gases handled. Automatically controlled openings shall be provided where specified. The dampers shall be rigid, and substantially airtight when closed. Construction shall be in accordance with this Specification. Back draught dampers on vertical discharge cowls shall be protected from cross winds by an external weather-shield. The height of the weather-shield shall be at least 25 mm greater than the open height of the dampers. The dampers shall be a rain roof when closed. Damper hinges shall be positioned outside the perimeter of the discharge jet or shall be positioned over a gutter which drains to the outside of the cowl. The damper blades shall overlap their seating and have lipped edges.

Bird guards with 12-15 mm mesh shall be fitted at all intake cowls. Automatically controlled back draught dampers shall be fitted where specified.

Cowls for roof mounted centrifugal and mixed flow extract fans shall be designed to limit the change of direction of airflow between the impeller discharge and the cowl discharge to an angle not exceeding 105° in a radial plane.

The discharge (or intake) cap of cowls for axial flow roof mounted fan units shall be circular in plan of the distance between the fan impeller and the lower edge of the discharge (or intake)

cap is less than one impeller diameter, the cap shall be fitted with an internal core which gives a smooth 180° change in direction of airflow.

The throat and diaphragm plate of roof mounted propeller fan units shall be dimensioned to meet the requirements of the fan manufacturer, including the optimum relative positioning of diaphragm plate and impeller.

The exterior shape and fixing arrangements of cowls shall be suitable for the wind speed and type of roof .

Kerb mounted cowls shall have a weathering skirt at least 75mm deep which weathers the junctions between the cowl and the kerb seating, the skirt shall not be the fixing member. The cowls shall be suitable for a kerb and up stand with a total height above roof level not less than 150 mm. The fixing may be to the kerb or roof structure.

Purlin mounted cowls shall have a skirt at least 75 mm deep suitable for weathering the overlap of a soaker sheet up stand and (the cowl throat. The cowls shall be fixed to purlins or purlin trimmers and the weight of the cowl shall be distributed over tile upper surface of the purlin and/or trimmers by flanged inlet to the cowl throats. The length of a cowl's throat shall be suitable to the depth of roof structure including at least 75 mm clearance between the skirt and any part of the roof surface.

Soaker sheets shall match the form and colour of the roof surface. Soaker sheet shall have an end lap not less than 150 mm and side laps equivalent to 1 1/2 corrugation or the corresponding standard laps for the roofing surface which the cowl penetrates.

3.5. CONTROL DAMPERS

3.5.1. ISOLATION, DAMPERS

Plain blade isolating dampers shall have position indicator, and spindle ends slotted position a quadrant with a locking device and parallel with the blade to indicate blade.

3.5.2. DAMPER INSTALLATION

Multiple frames shall be used for damper requirements in excess of 300 mm width and /over 200 mm height

Automatic controls and regulating dampers in ductwork systems shall be provided,

Automatic controls dampers shall be fitted with a galvanized mild steel mounting plate rigidly fixed to the easing to support the actuator

Multileaf dampers shall be double skin bladed of stainless steel sheet 0.7mm minimum thickness and be arranged for opposed blade operation unless otherwise Bearings requiring lubrication shall be accessible.

Linkages shall be sufficiently robust to transmit motion to a blades simultaneously leakage from spindles penetrations shall be prevented by side seals.

Damper casings shall be of stainless steel varnized mild steel sheet 2.0 mm minimum thickness of length to extend beyond the blade swing, and formed into a channel section to provide a rigid assembly. Formed flanges shall be drilled to match adjacent connecting flanges and extend to

protect the external blade linkage system. Drilled holes shall be edge-painted with zinc-rich paint immediately after cutting.

Balancing dampers shall be fitted in each branch from a main or sub-main duct, and elsewhere as specified. The required distance from the branch-piece shall be maintained.

3.5.3. CONTROLLING DAMPERS FOR BLOWERS ROOM

When it is cold outside the damper 02 is open. Damper 01 and Damper 03 are closed.

When the temperature in the blower room will increase above 24° C the damper 02 start to close and the dampers 01 and damper 03 starts to open in order to increase the ventilation in the room and keep the temperature on 24° C.

When the damper 02 is totally closed and the damper 01 and damper 03 are quite open and the temperature still wants to increase over 33° C. The Extract Fan starts and damper 04 close. When the temperature will decrease below 24° C the dampers starts to regulate temperature.

3.5.4. MIXING SECTION AND DAMPERS

Dumper framework shall be constructed from 6mm thick rigid PVC extrusions suitably welded together to form a rigid assembly without deflection under all operating conditions. Damper section sizes shall be a maximum of 1500 in x 1500mm to prevent blade and frame deflection. One side of the frame shall be secured

with nylon bolts to allow easy removal for access and maintenance, and easy withdrawal of damper blades.

Mixing box dampers shall be constructed using a number of small dampers suitably connected together to form a composite damper of suitable size for the volume specified.

Damper shall operate with opposed blade action. Blades shall be 25 micrometer anodized aluminum suitable sealed and internally (filled) insulated. Spindles shall be carried in nylon bushes.

Damper blade motion transmission shall be achieved by ABS gear wheels having purpose-made protection shields at both ends. All mounting plates, fixings and actuators shall be supplied and fixed by the back aged unit manufacturer. Wherever possible, damper actuators shall be fitted externally to the unit. Where this is not possible, totally enclosed actuators shall be used.

3.6. AIR FILTRATION

Written Certification of filter efficiency in accordance with the appropriate requirements of BS 6540 shall be provided.

Provision shall be made for full access to all filters for media changing, inspection and general maintenance.

Filter installations shall be complete with an external differential pressure indicating manometer mounted adjacent to the filter bank. Clean and Change Filter indicators shall be fitted.

Filter media and frames shall meet the Local Authority and the appropriate fire Authority's fire and smoke requirements and the requirements of BS 5588:part9,BS 476: part 4 for non-combustibility and BS 8313. Each filter bank shall be housed in a metal frame-All filters shall be provided with metal fixing frames, which shall be treated to prevent corrosion

The following materials are excluded from filter composition:

(1) Material which are generally composed of mineral fibers, either man-made or naturally occurring, which have, a diameter of three microns or less or which contain any fibers not sealed or otherwise stabilized for prevention of migration

(2) Any substances generally know to be deleterious at the time of use.

3.6.1. PANEL FILTERS

Filter banks shall be made up from a number of individual cells of panels of uniform size, retained in a purpose-made steel or aluminum framework by positive action spring clips. Joints in tile frame sections shall be welded or riveted, and individual frames shall be bolted together to form the complete filter bank assembly in a manner or prevent by pass of air. Filter frames shall be suitable for connection to builders work frames, fixing in sheet steel cased air handling plats or suitable ductwork sections.

Filter panels shall be suitably reinforced to prevent rupture, and be securely held in cells or frames by spring clips and clamps.

3.6.2. POCKET/BAG TYPE FILTERS

Pockets/flags shall be formed from woven glass fiber cloths, in multiple layers and grades, properly Stitched and sealed or shall be formed from synthetic non-fibrous) material Pockets/bags shall be reinforced as necessary to prevent rupture, and securely held in cells or frames by spring clips and clamps.

The opening of each pocket/bag shall be bonded to a rigid metal frame to fit into the filter bank-retaining framework.

Each ceil shall be provided with an effective perimeter gasket to prevent air bypass. Pocket/Bags shall remain fully inflated to expose maximum filter surfaces at air

velocities related to system design duty. Filter cells formrig a multiple unit bank shall fit into a framework, of some supply, suitable for fixing into a ductwork system . Filter cells shall be completely accessible for inspection and replacement.

3.6.3. SAND TRAP LOUVRES (GRILLS)

Sand trap louvres shall be provided to units as specified to remove heavy particulate contamination from air, acting as a gravity filler.

Louvre blades shall be fabricated from 1 .6 mm mild steel sheets treated to resist corrosion and erosion. Cases shall be of 2.0 mm mild steel, protected as for louver blades.

Louvre blades shall be formed into channel sections and mounted vertically in the case.

Each louvre shall have two rows of blades in offset formation to induce airflow to change direction.

The bottom of the case shall be provided with sand drain holes.

Multiple height cells shall be arranged with a sand chute at transoms to discharge particulate matter from upper cells clear of lower cells.

Louvres shall be arranged for bolting into a structural opening, to intermediate transoms or connecting to an air handling unit.

3.6.4. INSTALLATION OF DUCTWORK

The installation of ductwork shall follow the details set out in the accompanying Tender Drawings and be in accordance with the best accepted English or American practices.

The Drawings are diagrammatic and all contractors shop drawings shall be submitted to the Engineer for approval prior to manufacturing taking place.

All ductwork shall be adequately supported on hangers and / or brackets, according to position, to permit free movement of the ducts due to expansion or contraction and to permit application of insulation .

Ducts shall be positioned and spaced in relation to one another, in the building structure so as not to interfere with any other services and to allow for the required thickness of insulation as specified elsewhere .

All ductwork, silencers, dampers, louvers, grilles, diffusers and all other duct mounted equipment and components shall be erected and connected to all equipment as shown on the Air Ventilation Drawings .

All ducting systems shall be installed to a high standard and when complete shall be rigid and free from any sway, true-to-size, accurately lined up and completely sealed to limit air leakage rates to an acceptable minimum as detailed within SMACNA and ASHRAE standards.

All ducts emerging from the building shall be completely draught proof and watertight with suitable purpose made weathering .

All open ends of ducting left during erection shall be covered, to prevent entry of dust and debris, by means of hessian or stout bitumen backed paper, securely tied into position .

All ductwork shall be blown through by running the fan prior to finally fitting the grilles, and filters and the interior thoroughly wiped out with damp cloths by reaching as far possible into available openings .

All ducts passing through non-fire rated floors, walls or partitions shall have the space around the duct packed and sealed with mineral wool or other material acceptable to the Engineer. The space between the duct and the buildings element shall not exceed 20mm. maximum.

Sealing around fire dampers shall be made with materials approved by the relevant department of the local authorities .

Sleeves in walls and partitions through which ducts pass shall not be used as duct supports .

Duct runs shall be erected on the supports provided and aligned, prior to connection to items of equipment to present a neat and workmanlike appearance with allowance made for all clearances for insulation, etc., and other adjacent services .

Ducts shall be installed parallel to the building structure, plumb where vertical and arranged to present a coordinated and acceptable appearance .

Ducts supports shall be securely anchored to the building structure in an approved manner and installed completely free from vibration under all conditions of operation . Vertical ducts shall be supported at each floor and at intermediate positions as required .

Particular regard must be paid to the prevention of duct movement, preventing consequent noise, potential leakage and strain upon flexible connections. To this end, separation of metallic surfaces shall be provided by flexible packing material and particular attention shall be paid to the interposition of auxiliary flexible joints and anchoring supports, along duct runs.

3.6.5. STAINLESS STEEL DUCTWORK

The duct work shall be constructed from Stainless steel sheet accordance to B.S. accordance, 'Low and High Velocity / Pressure Air Systems , for Rectangular Circular and Spiral Wound

PART 3 – TECHNICAL SPECIFICATIONS

Ductwork, as published by the Heating and Ventilating Contractors Association, with the following exceptions :

The nominal sheet thickness of the ductwork shall increased to the thickness shown below. No ductwork shall be constructed from sheets less than 0.8mm (22.b.g.) .

a. TABLE A : Rectangular Ducts – Low Pressure

DUCT SIZE (Longer Side)	NOMINAL SHEET THICKNESS mm
UP to 400mm.	0.7
401 mm. to 600mm.	0.8
601 mm. to 800mm.	1.0
801 mm. to 1000mm.	1.0
1001 mm. to 1500mm.	1.0
1501 mm. to 2500mm.	1.2
2501 mm. to 3000mm.	1.6

All ducts over 400 mm. longer side shall be stiffened by beading at 300mm centers or cross breaking at not more than 1220mm spacing. Ducts above 800mm longer side to have transverse joints flanged, with maximum spacing of 2000mm.

b. TABLE B : Rectangular Ducts – High Velocity

Max. (Nominal Diameter)-mm	Min. Sheet Thickness- mm
205	0.8
762	1.0
914	1.0
1020	1.2
1525	1.2

c. TABLE C : Plant Connections – All Plant

Duct Size (Longer Side)	NOMINAL SHEET THICKNESS mm
UP to 800mm.	1.6
801mm.to 1000mm.	1.6
1001mm.to 2250mm	1.6
2251mm.to 3000mm	2.0

All low velocity ductwork shall generally be rectangular section, expect where indicated .

PART 3 – TECHNICAL SPECIFICATIONS

Longitudinal joints are to be either lock-seamed (and in all cases the edge of the seam is to be dressed down flush with duct to ensure an airtight joint) or snap lock joints. A suitable thinner, be foreland. Seams should not be visible from below. Transverse joints shall be flanged throughout, or jointed .

Stainless steel angle flanges shall be not less 25× 25mm. section, to be solid welded at four corners, with shearadised hexagon head bolts and nuts .

The overall length of the Stainless steel duct should exceed by 13mm. or 19mm. the dimension over the angles, thereby allowing the material to be edged over the angle iron flange on each of its four sides by 12mm or 6mm. respectively.

All ducts through walls shall have an angle iron masking flange attached to each inside of wall. Where ducts terminate in a builders duct in wall, the 'lead in' to terminate shall be a swept branch or bend with wall spigot and angle iron masking flanges shall be screwed to the wall, ceiling or floor, depending on the position of these, with sufficient clearance to allow slight movement of ductwork .

Slip joints shall not be less than 50mm. long with corners tapered, cutting or notching to achieve this taper shall be made good by welding , All slip joints should be made to lap in the direction of air flow and suitable sealing compound shall be applied in making these joints to prevent air leakage .

Where 'pop' rivets are used (which must always occur if the joint is under tension), these shall be of the 'Imex' sealed type .

Solid rivets shall be of the type suitably treated to resist corrosion and shall be inserted so that the rivet head is on the inside of the duct . Sharp edges or corners on ductwork and angles will not be permitted. After fabrication, all cut edges and bare metal shall be painted with approved zinc rich paint before being transported to site. Any adjustments or modifications made on Site shall also be similarly treated .

Each length of ducting shall be in one piece i.e. no riveted joints to occur between angle flanges. Ducts to be in 1830mm. minimum lengths, except where bends or branches occur.

All ductwork throughout shall be adequately stiffened to prevent drumming.

Internal stiffening will not be permitted. Stainless steel angles used as flanges or stiffeners shall be fixed to the duct by one of the of following:-

- Mechanical closed rivets or bolts at 150mm. pitch.
- Spot welds at 75mm. pitch.

Angle flanges or joints shall be bolted together at 100mm. maximum pitch and fixing bolts shall be provided at each corner, angle size . Bolt sizes shall be as follows:-

25	×	25	mm.	angle	8	mm.	bolts
30	×	30	mm.	angle	8	mm.	bolts
40	×	40	mm.	angle	10	mm.	bolts
50	×	50	mm.	angle	10	mm.	bolts

The joints shall be made using suitable cord sealing compound inserted between flanges to ensure air tightness of joint.

High velocity ductwork shall be jointed by using proprietary heat shrink bands.

Provision shall be made in the main and branch ducts and adjacent all items of plant for testing air flow by means of flow meter.

Such provision shall include the forming of a series of holes in the ductwork to suit the test instrument and arranged as shown in B.S.848, 1980, Part 1. The series of holes in each case shall be suitably covered with Stainless steel cover plates, having rubber gaskets, and fixed to the ductwork with 6mm set screws and wing nuts. The screws shall be fixed permanently to the ductwork and removal of the cover plate shall be effected by removal of the wing nuts only.

Before any plant is put into commission, the ductwork shall be thoroughly cleaned to the satisfaction of the Engineer.

3.6.6. DUCTWORK FITTINGS

Fittings on ductwork shall be installed as follows:-

1) Supports :

Ductwork supports for insulated ducts shall be as detailed in shop drawings, incorporation a rigid insulator between the – support and ductwork. With the insulation vapour seal being continuums through the insulator support and not over the bracketing.

2) Access Doors :

Access doors shall be of double skin construction incorporating 40mm thick isocyanurate foam insulation, secured into a frame in the duct by hand – operated cam latches seated on a rubber gasket. The doors shall be installed proud from the ductwork with the insulation abutted and secured with 0.8 mm thick aluminum angles with mitered corners.

3) Specialized Fittings :-

Where test holes, damper arms, thermostats, etc., are installed in the ductwork, the insulation shall be trimmed to give access and edges shall be vapour sealed and protected from mechanical damage.

4) Flexible Connections :

Ductwork flexible connections to, all fans, Fan Coil Units etc., where a continuation of a vapour seal is required shall be insulated with glass fiber flexible duct insulation, free from short and coarse fibers, bounded with resin and faced with glass fiber reinforced aluminum foil/Kraft paper laminate. The insulation material shall have a thickness of 40 mm. in plant rooms and 40 mm. in ceiling voids etc., The insulation shall be arranged to be easily removable and joints shall be sealed with 100 mm. wide glass reinforced self-adhesive aluminum foil tape to form a vapour seal.

3.6.7. DUCTWORK BRACKETS

Other than specific details being indicated on the shop Drawing, the bracketing shall be of galvanized steel sections and shall be as follows:-

3.6.8. HORIZONTAL DUCTWORK

All ductwork shall be adequately supported by flat mild, steel band strips or mild steel angle bearers and rods. The rods shall terminate to the structure in one of the following manners.

On a solid structure, channel iron rawbolted to same, including holes to accept threaded rods, which will be attached to the structure by nuts and hemispherical washers .

On steelwork, angle iron clips to be fitted across the whole flange and extended beyond the flange. A hole in the extension piece will allow the threaded rod to pass and be attached as above.

On open type steelwork, 2 angle iron sectors placed back to back securely bolted, complete with nuts and washers at maximum spacing of 0.5m with minimum of 2 fixings.

To prevent vibration and drumming, an incompressible insulator shall be sandwiched between the bracket and duct contact face.

3.6.9. VERTICAL DUCTWORK

This shall be supported by cantilever brackets at shop drawing.

Where they are fixed to walls, not less than 150mm. washer plates on the back of the wall and rods shall be fitted. The plates shall be not less than 250mm. in length and shall be of equal width and thickness to the cantilever bracket material .

3.6.10. TESTING THE DUCTWORK

In the course of erection, where the ductwork is being insulated, sealed in roof spaces, or where close to walls, etc. and on completion, this shall be tested with smoke pellets to ensure the air tightness of all joints or any other method being currently used or as directed by the Engineer. All ductwork shall be tested as detailed in HVAC systems.

The Contractor shall include for balancing all control dampers, grilles, volume dampers, etc. to ensure that the circuit plant or equipment is operating with the correct performance temperature, pressure and flow rates in accordance with the performance schedules and system design .

The Contractor shall include for providing a schedule setting out the design pressures and flow rates and actual final commissioning pressure and flow rates, together with all damper and grille settings.

In addition, on ductwork systems, smoke pellets shall be used to demonstrate the air flow pattern in all rooms and pressure and flow shall be recorded and all dampers shall be locked securely in their positions and a wire and lead seal affixed.

Care must be taken in selecting smoke pellets to see that are used in accordance with the manufactures – instructions and that they are suitable for the environment to which the ductwork is supplying or extracting air.

4. AIR CONDITIONING UNITS

4.1. GENERAL

This section should be read in conjunction with all the other relevant sections of the specification and in particular those relating to electrical and mechanical works.

The following equipment shall be provided:

N°	Type	Service	Capacity / Dimensions
402-AC-001	Air conditioning unit	ambient air	100 m3/h, 10oC cooling
400-AC-001	Air conditioning unit Room 1	ambient air	100 m3/h, 10oC cooling
400-AC-002	Air conditioning unit Room 2	ambient air	100 m3/h, 10oC cooling
200-AC-001	Air conditioning unit for electrical room	ambient air	100 m3/h, 10oC cooling

4.2. MINI-SPLIT UNITS

Each split unit shall consist of two parts assembled, tested and ready for operation:

- An outdoor condensing unit
- A decorative type indoor fan - coil unit

The two parts shall be connected together with quick connections recharged and reinsulated refrigerant piping.

All split units to be used shall be used for cooling and heating.

4.2.1. OUTDOORS UNIT

The outdoor condensing unit shall be located as per drawings and shall contain sufficient refrigerant (R-22) for the complete system and shall be equipped with refrigerant line fittings. Brass service valves shall be located at the exterior of the unit. The compressor shall be of the welded hermetic type rotary/reciprocating with internal vibration isolations and shall be located in an isolated compartment of the unit to reduce the noise level. The compressor shall be equipped with safety devices like crankcase heater, thermal and current sensitive overload devices and low-pressure cutout switch. The condenser coil shall be constructed of aluminium fins mechanically bonded to copper tubing. Condenser fan shall be direct driven propeller type and arranged for either horizontal or vertical discharge. Fan hub shall be designed to protect motor shaft, bearing and winding. Fan motor shall be factory lubricated and inherently protected. The whole unit shall be housed in a weatherproof cabinet.

4.2.2. INDOOR UNIT

The indoor unit shall be exposed decorative type calling suspended/wall/floor mounted according to the drawings and Consultant's approval. The unit shall be fabricated from galvanised steel sheet and shall be internally insulated. The cabinet shall be pre-printed with baked enamel paint and provided with adjustable plastic grilles. The fan shall be centrifugal, direct driven, double inlet type with two impellers. The impellers and scrolls shall be made in shockproof material to guarantee maximum stability during transport and installation. The impeller shall be having airfoil blades.

The motor shall be permanent split capacitor type single phase and shall be totally enclosed. The unit shall be complete with remote control kit consisting mainly of three speeds and off switch and a thermostat.

5. COMPRESSED AIR SUPPLY SYSTEM

The supplier/manufacturer will supply pneumatic air supply system complete with all necessary items to ensure that it is fully functional and meets the principal needs. In addition the Contractor shall provide all supporting documentation and installation manuals.

The compressors shall be equipped with the following

- Air storage vessel (accordance to BS 487, Part 1 Class III or equal.)
- Air filters (accordance to BS 2831, or equal.)
- Air dryers (Minimum capacity 10 L/s..)
- Pressure regulators (inlet pressure up to 10 bar at 24° C) , Standard downstream set pressure range (0.35 to 9 bar).
- Pressure gauges (accordance to BS 1780, or equal.)
 - Pressure switches (Ratings : 2HP @ 240 VAC / 1HP @ 120 VAC / 21 AMPS @ 250 VAC).
 - Isolation valves (accordance to BS 3643 or equal.)
 - Safety valves (accordance to BS 1123, or equal.)
- Non return valves (Spring type stainless steel body, designed to withstand pressure up to 140 bar hydrostatic pressure, 10 bar working pressure ,Temperature use range from sub -2 to 120 °C)

All pipings connected to the compressors shall be equipped with the following :-

- Isolation valve
- Open/closed and pneumatic valves at each branch for or maintenance units.
- Condensate traps.
- Automatic oil adding units.
- Quick release coupling.
- Blower guns with plastic hose for cleaning purpose.
- Pressure regulating valve
- Pressure gauge

5.1. AIR COMPRESSORS

Equipment ID	102-BL-001
Manufacture & type:	Oil free compressor type, reciprocating compressor.
Quantity:	1 nos.
Location:	Screenings area (outdoors)
Capacity:	Pressure 8 bar, tank volume 50 L. capacity 3 L/S free emitted air quantity.
Media:	Air.
Purpose	Air purge of solids accumulated in screening channel
Cooling Dryers:	Minimum capacity 3 L/s.
Electrical Power	400 V, 3-phase, 50 Hz electrical motor.

PART 3 – TECHNICAL SPECIFICATIONS

Accessories:	bottom plate with silencing cover
	Liquid removing filter
Maximum noise:	70 dBA, measured 1 m from equipment

Equipment ID	105-BL-501
Manufacture & type:	Oil free compressor type, manufacture Atlas Copco LF 75-10 UV2250S or any other equivalent product reciprocating compressor.
Quantity:	1 nos.
Location:	Sedimentation Tank gallery (indoors)
Capacity:	Pressure 10 bar, tank volume 250 L. capacity 14.4 L/S free emitted air quantity.
Media:	Air.
Purpose	Air actuation of automatic sludge withdrawal valve
Cooling Dryers:	Minimum capacity 10 L/s.
Electrical Power	400 V, 3-phase, 50 Hz electrical motor.
Accessories:	bottom plate with silencing cover
	Liquid removing filter
Maximum noise:	70 dBA, measured 1 m from equipment

5.2. AIR DRYER

Compressed air dryer shall remove moisture, water, oil, solid air particles and other contaminants for compressed air.

It shall have the following features :-

- Cooling Dryers Minimum capacity 3 L/s.
- Max. working pressure : 10 bar
- Pressure drop: 0.2 bar
- Made of Heavy duty aluminum casting
- Two polypropylene coalescer elements at inlet and outlet ports to absorb oil and all solid air particles
- Replaceable self-contained desiccant cartridges to absorb water and condensation from compressed air system.
- Air pressure gauges, safety relief valve and ball valve .
- Automatic timer drain
- Temperature and moisture indicator.

5.3. COMPRESSED AIR FILTER :-

- Efficiency rate 99.99 % for 0.01 µm particles and droplets, oil, water and solids from compressed air
- Flow range : Minimum capacity 10 L/s
- Made of anodized aluminum and stainless steel

5.4. PRESSURE GAUGE

Manufacture/type:	ABB or any other equivalent
Media:	Air
Signal:	4-20 mA
Measuring range:	0- 10 Bar
Limit of error:	Maximum +1%

5.5. PRESSURE SWITCH

Manufacture/type:	IFM electronic or any other equivalent
Media:	Air
Measuring range:	0- 10 Bar
Limit of error:	Maximum +1%

SECTION 15 570

BIOLOGICAL NATURAL SUBSTRATUM ODOUR TREATMENT

1. GENERAL

1.1. WORK INCLUDED

This section deals with technical requirements for the design, manufacture, delivery, off-loading, erection, testing and commissioning of odour control system, namely biological odour treatment system.

To reduce odor on the site, a biological treatment of foul air shall be installed. These devices shall treat the air from the dewatering units, liming room, foul water sumps and sludge storage tanks.

2 polypropylene tanks filled with porous surface substrate set (mineral substrate, peat or shredded wood are generally used) shall be installed:

- one in the solids building to treat the foul air coming from the sludge handling (dewatering units, liming room, foul water sumps),
- one installed outside on a concrete slab, treating the air from the sludge storage and foul water sump in the Areas 103 and 105.

One ventilator per tank and a set of air regulating valves shall ensure the air is extracted from each zone. The ventilators shall be installed indoors in the vicinity of the biofilter tank.

For the unit installed outdoors (area 103-105), proper operation during freezing periods shall be ensured by installing an air heater downstream of the fan to maintain the air temperature at 25° C during winter operation, as the treatment loses its efficiency below 15 ° C. During these freezing periods, the extraction fan shall have the capacity to operate at a reduced speed at 4 air changes per hour instead of 6.

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;
- E. Section 14100 – Pipes and fittings;

1.2.2. WORK UNDER THIS SECTION SHALL BE-COORDINATE WITH:

- A.** Concrete work
- B.** Section 15550 – HVAC
- C.** Electrical works

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

Identification number	206-TK-001
Type	Filter in polypropylene for indoor installation
Number	1
Dimensions:	
- Length	6 m
- Width	2,6 m
- Depth of filter bed	2 m
Biological substrate bed	
Type:	Granular peat or lignocellulose medium OR Mineral porous granular substrate
Media volume :	16 m3
Foul Air flow :	8600 m3/h
Spray water flow :	4 m3/h (part time)
Accessories	
2 inlet pipes per filter with valve	
1 decanted water pulverization line per filter with solenoid valve	

Identification number	300-TK-001
Type	Filter in polypropylene for outdoor installation
Number	1
Dimensions:	
- Length	2,9 m
- Width	2 m
- Depth of filter bed	2 m
Foul Air flow :	3100 m3/h Reduced to 2 100 m3/h when freezing conditions
Spray water flow :	4 m3/h (part time)
Biological substrate bed	
Type:	Granular peat or lignocellulose medium OR Mineral porous granular substrate
Media volume :	6 m3
Accessories	
2 inlet pipes per filter with valve	
1 decanted water pulverization line per filter with solenoid valve	

The installation is designed to handle problems of odours for both operating staff inside the works and for the public outside.

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 (apart from nutrient injection) is controlled automatically.

Air extracted from the premises shall pass in succession through one or more:

- supply flues,
- biological substrate boxes,
- outlets to the atmosphere, adapted to the structure.

The equipment to be installed shall include, amongst other things:

- spray boom with supply pumps and fibreglass-reinforced polyester pipes,
- a grating system to support the biological substrate,
- .a system for spraying the biological filter, consisting of sprinklers, pumps and HDPE pipes,
- a drainage system.

The assembly is designed to make operation easy. In particular, the humidifiers and spray booms shall be easy to dismantle, sprinkler nozzles shall be made of metal and removable, sprinklers shall be accessible without having to empty the substrate. Easy-to-open, watertight manholes provide easy access to the humidifying towers and flues.

For the unit installed outdoors, the decanted water pipes for spraying the filter shall be heat traced where exposed to ambient air.

1.4. QUALITY ASSURANCE

1.4.1. DESIGN CRITERIA

The following criteria shall be respected regarding the choice of medium material:

- Maximum speed on the biological filter of 550 m/h,
- Maximum split time of 7s.
- Head loss of the bed less than 100mm of water column.
- Maximum air volume not more than 120 Nm³/h per cubic meter of medium material
- Minimum lifetime of the medium: 5 years

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:

c) The seals and the embedded parts shall be presented separately and unpainted for checking.

d) 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.

e) Welds:

Refer to Section 01020 – Basic mechanical requirements

1.5. SUBMITTALS

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

1. Installation, maintenance and operation manuals with requirements of accuracy
2. Manufacture and quality assurance measures
3. Protective coating list of all parts

4. Commissioning tests list.
5. Assembler details for welding and building connections, foundation requirements and bearing loads for civil structures.
6. Internal wiring diagrams and control principle drawing of control box
7. 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

2.1. FABRICATION

2.1.1. BIOLOGICAL SUBSTRATE BEDS

Type of substrate: granular peat and fibrous lignocellulose medium.

Supports: self-supporting beams and cleats made of 316L stainless steel grating.

2.1.2. FILTER SPRAYING

The spraying system shall include the following in particular:

- A flow rate meter/accumulating meter
- Fine droplet sprinklers with stainless steel nozzles
- HDPE pipes complying with the specifications of Section 14100 – Pipes and fittings
- Locks, bolts and attachments:314 L stainless steel or inert materials

The spraying system is triggered automatically when the relative humidity falls below a set value and by a timer.

2.1.3. INSTRUMENTATION

NH₃ and H₂S sensor shall be provided in each filter upstream of the surge shaft.

A head loss sensor shall be provided in each filter.

2.1.4. DRAINAGE

A pit will collect all the water coming from the humidifier and from the medium material. Collecting pipes and pit will have an easy access. A pump will be fitted in the pit for exhausting water up to the inlet of the secondary treatment basins; the pump will manually and automatically be controlled.

2.2. SPARE PARTS AND SPECIAL TOOLS

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 filter substrate shall be placed for the first time in normal operating conditions. An acceptance report shall be drawn up.

The filter medium is installed in such a way that it can be renewed regularly and easily. It shall be renewed from (or to) a machine by means of watertight devices (trap doors, chutes, etc.) to be provided by the Contractor and installed in the civil works if necessary. Substrate shall be transferred from the machine to the filter bed (and vice versa) automatically.

The Contractor shall provide a detailed description of the filter medium renewal method in his bid.

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:

- f) Equipment position
- g) 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.

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SECTION 15 800

WASTE SKIPS

1. GENERAL

1.1. WORK INCLUDED

1.1.1. SCOPE OF SUPPLY

The Contractor shall supply identical waste skips at all locations where waste skips are required.

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;

1.2.2. WORKS UNDER THIS SECTION SHALL BE CO-ORDINATED WITH:

- A. Section 11 301 Coarse Screening
- B. Section 11 305 Fine Screening
- C. Section 14 410 Screw conveyors

1.3. SYSTEM DESCRIPTION, CHARACTERISTICS AND OPERATING CONDITIONS

1.3.1. DESCRIPTION

Skips for Screenings

Equipment numbers:	101-SK-001/002, 102-SK-001/002
Type:	Skip with mobile cover
Model & Manufacturer::	TL 25 m3 from Eurobenne or equivalent
Number:	4
Location:	Outdoors– Screening
Capacity:	25 m3

PART 3 – TECHNICAL SPECIFICATIONS

Materials:	Steel with epoxy painting
Accessories:	
Watertight hinged back flap for discharging	
Drapery in plastic tarpaulin for skip covering	
2 rails for guidance of the skip, integrated in the bottom floor	
Thrust block (stop) for skip	

Skips for Dewatered Sludge

Equipment numbers:	204-SK-001/002/003/004/005/006
Type:	Skip with mobile cover
Model & Manufacturer::	TL 25 m3 from Eurobenne or equivalent
Number:	6
Location:	Outdoors– Sludge disposal
Capacity:	25 m3
Materials:	Steel with epoxy painting
Accessories:	
Watertight hinged back flap for discharging	
Drapery in plastic tarpaulin for skip covering	
2 rails for guidance of the skip, integrated in the bottom floor	
Thrust block (stop) for skip	

Skips for Grit

Identification numbers:	103-SK-511/512/513
Type:	Skip with mobile cover
Model & Manufacturer::	TL 25 m3 from Eurobenne or equivalent
Number:	3
Location:	Outdoors– Grit Removal
Capacity:	25 m3
Materials:	Steel with epoxy painting
Accessories:	
Watertight hinged back flap for discharging	
Drapery in plastic tarpaulin for skip covering	
2 rails for guidance of the skip, integrated in the bottom floor	
Thrust block (stop) for skip	

Skips for Grease removal

PART 3 – TECHNICAL SPECIFICATIONS

Equipment numbers:	103-SK/501-502
Type:	Skip with mobile cover
Model & Manufacturer::	TL 25 m3 from Eurobenne or equivalent
Number:	2
Location:	Outdoors– Grease Removal
Capacity:	25 m3
Materials:	Steel with epoxy painting
Accessories:	
No back flap (discharge by suction truck)	
Siphoid separation for grease concentration to be welded in place	
Drapery in plastic tarpaulin for skip covering	
2 rails for guidance of the skip, integrated in the bottom floor	
Thrust block (stop) for skip	

1.3.2. OPERATING CONDITIONS

The skips shall be design to be lifted on a transport truck for transport to the landfill. The transport truck shall be provided by the Operator.

The contractor shall provide the Operator with the data sheet of the skips provided to ensure compatibility with the truck prior to purchase by the Operator.

1.3.3. CONTROL AND MONITORING

Not applicable

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) Welds: Refer to Section 01020.

1.5. SUBMITTALS

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

1. Shop drawing of the grease concentration skips showing the siphoid separation for onsite welding.

2. Manufacturer datasheet of the skip, including exterior dimensions, weight and material.

2. PRODUCTS, COMPONENTS AND SUB-ASSEMBLIES

2.1. FABRICATION

The minimum thickness of the walls and bottom shall be 4 mm.

Backfold of 300 mm in front and 800 mm in the back.

The hinged door on the back of the skip shall include the following options:

- Integrated lubrication device on the hinges
- Neoprene watertight seal 30 x 30
- Lateral closing with tensioning ratchet

The following accessories shall be included:

- Ladder on the side
- Ringed back rollers
- Front Lifting ring for hydraulic arm lifting by transport truck
- Lateral rolling cover for closing during transport or when full, with small platform for operator access to the crankset and tensioning ratchet

The following coating requirements shall be met in addition to any other requirements under Section 01010-Corrosion Protection:

- Anti-rust treatment inside and outside
- Inside coating for corrosion protection to lime, ammoniac and other aggressive chemicals.
- Glazed finish painting inside and outside.

2.2. DIMENSION TOLERANCES

Not applicable

2.3. SPARE PARTS AND SPECIAL TOOLS

Not applicable

3. EXECUTION

3.1. INSPECTION BEFORE ERECTION

The two rails installed on the concrete slab to guide the back rollers of the skip shall be parallel.

3.2. FIELD QUALITY CONTROL

The water tightness of the seal around the hinged back flap shall be tested with clean water held during 24h in the skip.

SECTION 16000 HANDLING EQUIPMENT

1. GENERAL

1.1. WORK INCLUDED

The present specification shall apply to the Handling equipment to be installed in the various areas of the plant, including but not limited to:

1.2. 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. Area 101-102:

1. 2 Single beam monorail installed above screen stop logs, each 10 m long and 4 m above the top of wall.
2. Hand operated chain hoists with monorail truck for coarse screens stop log removal. Lifting weight 850 kg.
3. Hand operated chain hoists with monorail truck for fine screens stop log removal. Lifting weight 850 kg.
4. 1 mobile jib crane with hand operated chain hoist for other stop logs removal to be installed on each of the fixing plates adjacent to the stop logs location. Lifting weight 850 kg.

b. Area 103 and 105:

1. 1 mobile Jib cranes with hand operated chain hoists to lift the stop log at the entrance of the grit tanks or the stop logs at the entrance of the sedimentation tanks. A fixing plate for the mobile jib crane shall be installed at all locations adjacent to a stop log. Lifting weight 500 kg.
2. 4 Jib cranes with hand operated chain hoists installed on the scraper travelling bridge for air turbine removal (two on each bridge). Lifting weight 500 kg.
3. 3 Single beam monorail in the sedimentation tank gallery:
 - One 35 m long
 - Two 9.75 m long

4. 3 Hand operated chain hoists on monorail truck for each of the monorails. Lifting weight 500 kg.

1.3. RELATED WORKS

1.3.1. 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;

1.3.2. WORKS UNDER THIS SECTION SHALL BE CO-ORDINATED WITH:

- A. Civil Engineering works and Building works;
- B. Section 09910 – Painting;

1.4. QUALITY ASSURANCE

1.4.1. DESIGN CRITERIA

According to the FEM rules:

- Mechanisms: Group 1 am
- Structures: Group 1

1.4.2. 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 in particular:
 - Load test of 125% rated load with operation of lifting up and down, cross travelling.

1.5. 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 galvanised 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 manoeuvre, several lengths are used, the tension on each cable shall be equally distributed by means of pulleys or 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, endsocket and other attachments for fastening the cables shall be galvanised and capable of with standing 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. 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.

2.3. 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.

2.4. SPECIAL TOOLS AND SPARE PARTS

Refer to General Requirements

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 manoeuvres, the following items shall be checked:

- Correct operation and efficiency of brakes and limit switches.
- Vertical and horizontal travelling distances and approach measurement.
- Synchronisation of pulley operation when several hoists are used.
- Operating speeds.
- Operation and characteristics of manual and emergency control.
- Examination of paintwork.

c. Commissioning and acceptance tests

1. 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.

2. 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 or detrimental temperature rise. Translational movements of the handling mechanism shall be tested under the same conditions as above.

During these manoeuvres, the following shall be checked:

- correct behaviour 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 loaded 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.

PART 3 – TECHNICAL SPECIFICATIONS

- The operating speed.
- The lifting and lowering movements, which shall be made in a continuous smooth manner so that all manoeuvres 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 17050

FUNCTIONAL DESCRIPTION

1 GENERAL

This section presents the functional description of the WWTP area by area.

2 AREA 101, 102 - SCREENING

2.1 STONE PIT

The following instrumentation and controls will be implemented:

- The float level sensor (101-FL-001) will indicate a high level alarm in the stone pit
- The ultrasonic level sensor upstream of the coarse screen (101-UF-001) will indicate if the emergency bypass weir is used, based on the water level transmitted.
- Stop logs will be positioned manually by the operators for planned bypasses.

2.2 SCREENS

The automatic screens will be operated continuously. However, in order to avoid sedimentation of solids in the channel during the low flow events, the sluice gates (or Penstocks) to each channel will be closed or opened according to the following control philosophy:

- Coarse screen channel 1 (or 2) shall be closed by the motorized sluice gate (101-SG-101 or 201) from 9 pm to 6 am (operator adjustable), alternating which channel is closed every night.
- Fine screen channel 1 (or 2 or 3) shall be closed by the motorized sluice gate (102-SG-101 or 201 or 301) from 9 pm to 6 am (operator adjustable), alternating which channel is closed every night.
- If the level upstream of the coarse screens (101-UF-001) reaches the level “HIGH” then the gate to coarse channel 1 (or 2) and the gate to Fine screen channel 1 (or 2 or 3) will open even if the timer control indicates it should be closed.
- The screens will work automatically with the conveyors and will be controlled by the manufacturer’s control box. The following information will be transmitted to the SCADA:
 - ON/OFF status of each equipment
 - Alarms

- The SCADA will indicate to the manufacturer control box which screen should be in standby.
- Alarms shall be reported when the water levels exceeds the set points upstream of the fine screen or upstream of the coarse screen indicating excessive blockage.

An optional air compressor shall be turned ON by the Operator from the SCADA. When turned ON, the air flow shall be automatically directed to one of the four discharge areas by opening one of the following solenoid valve at a time: 101-SV-001 ; 101-SV-002; 102-SV-001 OR 102-SV-002. The time cycle for the opening of each valve shall be fully adjustable by the Operator from the SCADA System.

2.3 FLOW METER

In case of maintenance on a flow meter 103-MF-001 (or -002), the Sluice gate 102-SG-001 (or -002) shall be closed and the wastewater contained in the pipe and grit tanks entrance area shall be pumped to the grit tank remaining in service. The Flow meter can then be dismantled and maintained as necessary.

3 AREA 103 – GRIT AND GREASE REMOVAL

3.1 GRIT TANKS

Each bridge will travel at a constant speed and will be equipped with a ON/OFF/ AUTO switch. When the bridge is traveling then:

- The air compressor for the airlift grit removal is turned ON.
- The grease scraper on each bridge is lifted when the bridge is travelling upflow and lowered when the bridge is traveling in the flow direction.

When a bridge is OFF:

- The air compressor for the airlift grit removal is turned OFF.
- The grease scraper on each bridge is OFF.

The motorized sluice gates at the entrance of each ND 1400 pipe (102-SG-001 (or -002)) will be equipped with an OPEN/CLOSE/ AUTO switch. In AUTO Mode, the following controls will be available

- Both sluice gates are normally open (open in case of power outage)
- One sluice gate will be closed from 9 pm to 6 am (operator adjustable) to allow for energy savings. The two closed tanks will alternate. Under this condition:
 - the corresponding bridge will be turned OFF.
 - the submerged air turbines will be turned OFF

The air turbines in the tanks will be equipped with one ON/OFF/ AUTO switch controlling all turbines of one tank, located in the pump room. A total of four switched shall be provided, one for each Tank. The air turbines will normally be in Auto mode, so that they can be automatically turned off when a tank is closed.

If a single tank is isolated for maintenance (with a stoplog) then

- the corresponding bridge will continue to run, but the air lift to the isolated tank will be manually closed
- the air turbines in the isolated tank can be manually turned OFF

3.2 GRIT PUMPS AND CLASSIFIERS:

The grit chamber is filled by the airlift continuously except when the bridge reaches the end of the tank, where it rests for 1 or 2 minutes.

Grit Pump 103-PP-501 is normally dedicated to grit classifier 103-GC-511 and Grit Pump 103-PV-502 is normally dedicated to grit classifier 103-GC-513. Both pumps can pump the grit water to classifier 103-CG-512, by manually opening and closing valves orientation. One grit classifier is a standby. The operator will ensure that the standby unit alternates so that the run times on each classifier remain similar.

For each Grit transfer Chamber:

- If the capacitive level sensor 103-LS-501 (or 502) indicates Level High, then the Pump 103-PP-501 (or -502) is turned ON.
- If the capacitive Level sensor indicates Level Low 103-LS-501 (or 502), then the Pump 103-PP-501 (or -502) is turned OFF.
- If capacitive Level sensor 103-LS-501 (or 502) indicates Level High High, then the Airlift 103-BL-501 (or -502) on the corresponding bridge shall be turned OFF and an ALARM is triggered.

3.3 FOUL WATER SUMP

Pump 103-SP-001 and -002 shall be operated alternatively at every Pump ON-OFF cycle, so that the run times on each pump remains similar.

- If the capacitive level sensor indicates Level High, then the duty Pump for the chamber is turned ON.
- If the capacitive Level sensor indicates Level Low, then the operating Pump is turned OFF.
- If the capacitive Level sensor indicates Level High High, then turn both pumps ON and ALARM.

The discharge pipe from the sump pumps shall be directed to the entrance of the grit tanks. Normally the flow will be directed to the Tanks 1 and 2 entrance. However, in case on maintenance on these tanks, a valve may be manually closed on the Tank1&2 discharge and the valve to Tanks 3&4 manually opened.

4 AREA 104 – FUTURE COAGULATION - FLOCCULATION

No specific equipment is planned at this stage. The future extension is planned at the North and South side of the lamellar Tanks.

5 AREA 105 – LAMELLAR SEDIMENTATION

5.1 SCRAPER THICKENER MECHANISM

The scrapers/thickener mechanisms in each Tank shall operate continuously, at constant speed. There shall be an ON/OFF/Auto switch for each scrapers/thickener mechanism installed in the pump gallery between the tanks. In Auto Mode, the scrapers/thickener mechanism shall be turned ON or OFF by the SCADA system.

5.2 OVERFLOW AND LAMELLAR TANK BYPASS

The distribution channel on each side of the tanks shall be equipped with a motorized downward opening overflow gate. If the incoming flow, as measured by the flow meters 103-FM-001 and -002, is higher than 4,9 m³/s, the downward opening gates shall be lowered on each side so that the flow in excess of 4,9 m³/s is directed to the lamellar tanks outlet chamber via the bypass pipes (one on each side), each equipped with a flow meter (105-FM-001 and -002). The level of opening of the downward opening gate shall be adjusted to divert only the flow in excess of 4,9 m³/s, via an Iterative Control Loop using the flow meter signals.

5.3 SLUDGE WITHDRAWAL

The sludge extraction is controlled by the opening of the pinch valve on the sludge piping. The sludge flows by gravity to the sludge holding tank, which water surface level is 4 m lower than the sedimentation tank water surface. The opening of the pinch Valves (105-PV-501,-502,-601,-602) can be controlled by three control modes, as selected by the operator at the Scada:

1. A time cycle set by the SCADA and adjustable by the operator.
2. The sludge layer level in the lamellar settling tank,
3. The volume extracted, as measured by the magnetic flow meters (105-FM-501,-502,-601,-602)

If the level in the storage tank is too high, the SCADA will not authorize the extraction from the sedimentation tank. An alarm will appear.

Under all control modes, the operator shall visualize on the Scada interface screen:

- The level of the sludge layer in each tank
- The volume of sludge extracted from each tank
- The extrapolated wastewater flow coming into each tank

5.4 SLUDGE STORAGE AND BUFFER TANKS

One Mixer in each Tank shall be operating based on a time cycle determined by the operator (continuous operation or intermittent operation for several minutes an hour).

A capacitive level sensor, shall switch off the mixer if the sludge level is too low.

The sludge extraction to dewatering shall be controlled by the pumps (105-PC-701, -702, -703) turning ON and OFF. Pumps turning ON or OFF shall be enslaved to the operation of the dewatering facilities and will be controlled as follows:

- Each pump is dedicated to a dewatering line.
- The dewatering line operation will be automated from 5 am to 9 pm. When started, the SCADA control program will call for the feed pumps to start operation with several minutes delay between each dewatering line start up time, the delay shall be set by the operator on the SCADA.
- According the level in sludge storage tank, two or three units will be turned on at 5 am.

Then the operator will check the extraction cycle from the primary settling tanks and adapt the sludge extraction from the sedimentation tanks in order to store a minimum volume at the end of the day.

The sludge flow rate treated by each dewatering unit shall occasionally be manually adjusted by the operator by changing the gear on the pumps (105-PC-701, -702, -703). The sludge flow rate treated by each dewatering unit shall be measured by the flowmeters (105-FM-701, -702, -703).

If the capacitive level sensor in the tank indicates Level Low (this value shall be adjustable by the operator) or level high an alarm will be sent. The operator may then choose

- to reduce or increase the extraction from the primary settling tanks or
- turn off a dewatering unit line or
- manually change the speed of one or more of the pumps (105-PC-701, -702, -703).

If the capacitive level sensors in the tanks indicates Level low low the pumps (105-PC-701, -702, -703) will be switch off.

If the capacitive level sensor in the tank indicates Level high high extraction from primary settling tanks won't be allowed. The operator may decide to increase the speed on the dewatering feed pumps (105-PC-701, -702, -703).

Dry running protection devices and overpressure pressure protection devices shall protect the pumps.

6 AREA 200 – SLUDGE DEWATERING

6.1 AREA 201 – POLYMER PREPARATION

The arch breaker and screw feeder shall operate automatically in association with the automatic polymer preparation. A level sensor, shall switch the equipment off if the polymer level in the big bag is too low, or if

the polymer level in the hopper is too high. Specific protection devices shall turn off the archbreaker and the screw if a jam is detected.

Four levels sensors shall regulate the equipment.

An electric enclosure supplies and controls every piece of equipment and centralizes default information.

The automatic preparation unit shall be turned off in case of:

- Low level in the hopper,
- No water provided,
- High level in storage compartment,
- Mixer defaults,
- All dewatering lines turn off.

Turning ON and OFF shall be enslaved to the operation of the dewatering facilities. Flow rate shall be set by the operator with the mechanical variable geared motor. To facilitate flow control, magnetic flowmeters shall be installed on outlet pipes.

The polymer flow rate shall be adjustable by the Operator based on the primary sludge flow rate coming to each of the dewatering units. Note that the sludge and polymer flow may be different from one dewatering unit to the other. The Polymer unit control panel shall display the polymer and sludge flow rate for each dewatering unit.

Dry running protection devices shall protect the pumps.

The level sensor in the polymer preparation unit shall switch off the polymer pumps if the level is too low.

6.2 AREA 202 – THICKENING AND DEWATERING

The combined thickening and dewatering units are equipped with their own electrical and control panel. This panel shall display the polymer and sludge flow rate for each dewatering unit.

Turning ON and OFF shall be enslaved to the operation of:

- wash water pumps,
- air compressors,
- liming and limed sludge transport facilities,
- the polymer pumps
- the liquid sludge feed pumps

Several level sensors in dewatering units will inform in case of dysfunction of the Equipment and trigger appropriate alarms.

6.3 AREA 203 – LIMING AND SLUDGE STORAGE

Units are equipped with their own electrical and control panel, including the control of the silos, lime dosing screws, lime conveyor screws, and lime sludge mixers. The dosing of the lime in the dewatered sludge shall be automatically adjusted based on the liquid sludge flow rate to each dewatering unit (105-FM-701, -702, -703). The system shall provide for the future addition of a fourth lime sludge mixer.

Turning ON and OFF of the Lime mixers shall be enslaved to the operation of:

- The dewatering units,
- Limed sludge conveyors,
- Lime dosing system (lime silo and dosing screw)

Each lime mixer (203-SM-101, -201, -301) is dedicated to each dewatering unit (202-BT-101, -201, -301 and 202-FP-101, -201, -301), respectively.

Lime mixers 203-SM-101, -201 shall normally operate with the skip feeding screw conveyor 203-SW-001, and Lime mixers 203-SM-301 (and future -401) shall normally operate with the skip feeding screw conveyor 203-SW-002.

In case of failure of 203-SW-001 or -002, the belt conveyor (203-BC-001) between the two screw conveyors shall be manually turned on to allow diverting all the sludge to one single skip feeding screw conveyor.

Several level sensors and anti-block devices on the lime dosing system shall inform the SCADA and shall stop the unit in case of dysfunction.

The limed sludge screw conveyors (203-SW-001, -002) shall each discharge to two sludge storage skips via a waste distribution device with manual rotation.

Two storage skips shall be in standby, so that the operator can remove the full skip and place the empty skip as necessary.

7 AREA 110 – SERVICE WATER

7.1 WELL WATER

The well water pump (existing, 110-SP-001) shall be turned ON or OFF based on the Float sensor information in the well water tanks (110-TK-001, -002):

- Turn ON when level is Low
- Turn OFF when Level is High
- Trigger and Alarm when Level is High High

If Well water level is low in the Tank and the well water pump (existing, 110-SP-001) does not turn ON, an Alarm shall be triggered. The operator may decide to manually switch the washwater supply of the dewatering unit to the decanted water supply.

7.2 EMERGENCY DECANTED WATER SUPPLY FOR DEWATERING UNITS

If the operator switches the “Emergency Decanted Water Supply for dewatering units” mode ON, the pump 105-PP-801, shall be enabled to be turn ON from the SCADA and the valve to the washwater supply line shall be manually switched to the decanted water tank by the Operator.

The operator shall then clean the particulate filters (105-FT-801 and 802) several times a day by manually switching the flow from one filter to the other.

7.3 DECANTED WATER SUPPLY FOR ODOUR TREATMENT UNITS

The pump 105-PP-802, shall be always be turned ON in Auto mode. The solenoid valves (105-SV-811; -812) shall alternately be switched ON or OFF in order to direct the flow to the Sludge area odour treatment or to the area 300 odour treatment. The time cycle for each valve to be opened shall be fully adjustable by the Operator from the SCADA system. One of the two valves shall always be opened, unless the pump 105-PP-802 is turned off.

The particulate filters installed on the discharge of pump 105-PP-802 shall be manually cleaned twice a day by the operator.

8 HVAC

Room Ventilation shall continuously operate in automatic mode at the low fan speed. When operators are present in the room, they shall switch the fan speed to “High” with a switch on the wall indicating the speed change to the SCADA.

The heating or cooling in each room shall be triggered by a local thermostat. The SCADA shall receive the indication from Heaters and AC units when they turn ON.

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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.

1.1. WORK INCLUDED

This contract includes for the provision of a SCADA (Supervisory Control And Data Acquisition) system for the monitoring and control of Aeratsia Wastewater Treatment Plant.

The SCADA system shall be implemented as an operational management tool, i.e. shall provide with facilities to undertake the day to day monitoring and control of the Wastewater Treatment Plant and the production of general management information.

A Supervision and Control system will be installed to manage the new installation.

The SCADA system database will be configured to include:

- a) 1000 database points.
- b) 50 mimic displays.
- c) 30 trend displays.
- d) 15 reports.

The SCADA will consist of the following:

- a) One supervision operator Control station installed in one of the offices of the existing administration building.
- b) One local control station in the Electrical Room (Area 402).
- c) One local control station in the Grit Pump Room (Area 103).
- d) One local control station in the Transformer Building (Area 400).
- e) One local control station in the Electrical Room of the Sludge Building (Area 200).

All these control stations will be connected through an optical fiber ring network. (See Control System Block Diagram)

1.1.1. CONTROL STATIONS

1.1.1.1. FIELD CONTROL STATION

Field control stations are installed in the vicinity of each equipment drive.

The field control stations have the highest priority. The station shall be equipped with a selector switch “Local/Off/Remote” and an adequate number of push buttons to operate a drive.

In “Local” mode the drives can be operated locally via push buttons. All other control levels shall be disabled. Protection interlocks shall be hard-wired.

Each drive shall be equipped with a separate emergency lock stop push button, which is hard-wired directly into the drive contactor control circuit.

1.1.1.2. SUPERVISION OPERATOR CONTROL STATION

The supervision operator Control Station installed in one of the offices of the existing administrative building will consist of the following:

- a) One Ethernet/Fiber optic switch.
- b) One Remote Terminal Unit (RTU).
- c) One industrial PC, with Armenian Keyboard and optical mouse.
- d) One Screen 23 inches.
- e) One colour printer.
- f) One Uninterruptible Power Supply (UPS) Unit.

If the selector switch at the field control station is set to “REMOTE” and the selector switch at the Low Voltage Power Distribution (LVPD) is set in “AUTO”, the operation from the corresponding RTU in automatic or in manual mode by SCADA will be possible.

By switching from automatic to manual the drives will hold the actual state of operation, i.e. an operating drive keeps on running, a switched off drive is not started.

1.1.1.3. LOCAL CONTROL INTERFACE

Each local control Interface installed in the electrical room will consist of the following:

- a) One Ethernet/Fiber optic switch.
- b) One Remote Terminal Unit (RTU) with modules of I/O. (Analogic and Digital).
- c) One Human Machine Interface (HMI).
- d) One Uninterruptible Power Supply (UPS) Unit.
- e) The instrumentation converters.

The Remote Terminal Units (RTU) will ensure the redundancy of the system.

The Remote Terminal Units (RTU) are located at the following places:

- a) RTU 1 – In the Electrical Room (Area 402)
- b) RTU 2 – In the Grit Pump Room (Area 103).
- c) RTU 3 – In the Transformer Building (Area 400).
- d) RTU 4 – In the Electrical Room of the Sludge Building (Area 200).

1.1.1.4. INPUTS / OUTPUTS REQUIREMENTS

1.1.1.4.1. Screening Areas (101 & 102), Well Water (110) & Electrical Room (402)

RTU 1 – Screening Areas (101 & 102), Well Water (110) & Electrical Room (402)							
Item	Description	Source	Number	Digital Input	Digital Output	Analogue Input	Analogue Out put
101	Inlet / By-pass / Coarse Screening						
FL001	High Level	Switch	1	1			
TI001	Temperature Meter	Transducer	1			1	
UF001	Level Meter	Transducer	1			1	
SG101	Sluice Gate	Motor	1	3	1		
SG201	Sluice Gate	Motor	1	3	1		
BS101	Automatic Coarse Screen 40mm	Motor	1	3	1		
BS201	Automatic Coarse Screen 40mm	Motor	1	3	1		
BC001	Belt Conveyors	Motor	1	3	1		
HTR901	Heat Tracing	Switch	1	1			
SV001	Solenoid Valve	Switch	1	1			
SV002	Solenoid Valve	Switch	1	1			
102	Fine Screening						
UF001	Level Meter	Transducer	1			1	
SG101	Sluice Gate	Motor	1	3	1		
SG201	Sluice Gate	Motor	1	3	1		
SG301	Sluice Gate	Motor	1	3	1		
SG001	Sluice Gate	Motor	1	3	1		
SG002	Sluice Gate	Motor	1	3	1		
BS101	Automatic Coarse Screen 10mm	Motor	1	3	1		
BS201	Automatic Coarse Screen 10mm	Motor	1	3	1		
BS301	Automatic Coarse Screen 10mm	Motor	1	3	1		
SW001	Screw Conveyor and Compactor	Motor	1	3	1		
BL001	Air Compressor	Motor	1	3	1		
UF002	Level Meter	Transducer	1			1	
SV001	Solenoid Valve	Switch	1	1			
SV901	Solenoid Valve	Switch	1	1			
SV902	Solenoid Valve	Switch	1	1			
SP801	Submersible Pump Drainage Sump	Motor	1	3	1		
110	Well Water						
SP001	Existing Artesian Well Pump	Motor	1	3	1		
402	Electrical Room						
AC001	Air Conditioning Unit	Motor	1	3	1		
	Control Panel Board		1	4	2		
	Power Measurement		1			1	
	Allocated I/O Count			65	20	5	
	Spare (Mimimum 20%)			13	4	1	

	Total I/O Count		78	24	11	
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1.1.1.4.2. **Grit and Grease Removal Tank (103), Primary Settling Tank (105) & Odor Control (300)**

RTU 2 – Grit and Grease Removal Tank (103), Primary Settling Tank (105) & Odor Control (300)							
Item	Description	Source	Number	Digital Input	Digital Output	Analogue Input	Analogue Out put
103	GG Removal Tank						
BL100	Submerged Air Turbine	Motor	8	24	8		
BL200	Submerged Air Turbine	Motor	8	24	8		
BL300	Submerged Air Turbine	Motor	8	24	8		
BL400	Submerged Air Turbine	Motor	8	24	8		
SR102	Surface Scraper	Motor	1	3	1		
SR202	Surface Scraper	Motor	1	3	1		
SR302	Surface Scraper	Motor	1	3	1		
SR402	Surface Scraper	Motor	1	3	1		
BL501	Air Lift Compressor	Motor	1	3	1		
BL502	Air Lift Compressor	Motor	1	3	1		
TB101	Traveling Bridge	Motor	1	3	1		
TB401	Traveling Bridge	Motor	1	3	1		
HTR901	Heat Tracing	Switch	1	1			
HTR902	Heat Tracing	Switch	1	1			
HTR101	Heat Tracing	Switch	1	1			
HTR102	Heat Tracing	Switch	1	1			
HTR103	Heat Tracing	Switch	1	1			
HTR104	Heat Tracing	Switch	1	1			
FL001	High Level	Switch	1	1			
FL002	Low Low Level	Switch	1	1			
LS001	Level Meter	Transducer	1			1	
SP001	Pump Submersible	Motor	1	3	1		
SP002	Pump Submersible	Motor	1	3	1		
LS501	Level Meter	Transducer	1			1	
LS502	Level Meter	Transducer	1			1	
PP501	Grit Pump	Motor	1	3	1		
PP502	Grit Pump	Motor	1	3	1		
PI501	Pressure Sensor	Transducer	1			1	
PI502	Pressure Sensor	Transducer	1			1	
PI503	Pressure Sensor	Transducer	1			1	
PI504	Pressure Sensor	Transducer	1			1	
GC511	Grit Classifier	Motor	1	3	1		
GC512	Grit Classifier	Motor	1	3	1		
GC513	Grit Classifier	Motor	1	3	1		
HT001	Electro Heating	Switch	1	1			
FN001	Exhaust Ventilation	Motor	1	3	1		
SG001	Sluice Gate	Motor	1	3	1		
SG002	Sluice Gate	Motor	1	3	1		
MF001	Flowmeter	Transducer	1			1	
MF002	Flowmeter	Transducer	1			1	
105	GG Removal Tank						
SG001	Sluice Gate	Motor	1	3	1		
SG002	Sluice Gate	Motor	1	3	1		
MF001	Flowmeter	Transducer	1			1	
MF002	Flowmeter	Transducer	1			1	

PF101	Primary Settling Tank PF	Motor	1	3	1		
PF201	Primary Settling Tank PF	Motor	1	3	1		
PF301	Primary Settling Tank PF	Motor	1	3	1		
PF401	Primary Settling Tank PF	Motor	1	3	1		
FL101	High Level	Switch	1	1			
FL201	High Level	Switch	1	1			
FL301	High Level	Switch	1	1			
FL401	High Level	Switch	1	1			
HTR901	Heat Tracing	Switch	1	1			
HTR902	Heat Tracing	Switch	1	1			
HTR903	Heat Tracing	Switch	1	1			
HTR904	Heat Tracing	Switch	1	1			
SV501	Solenoid Valve	Switch	1	1			
SV502	Solenoid Valve	Switch	1	1			
SV601	Solenoid Valve	Switch	1	1			
SV602	Solenoid Valve	Switch	1	1			
MF501	Flowmeter	Transducer	1			1	
MF502	Flowmeter	Transducer	1			1	
MF601	Flowmeter	Transducer	1			1	
MF602	Flowmeter	Transducer	1			1	
IM501	Immersed Mixer	Motor	1	3	1		
IM601	Immersed Mixer	Motor	1	3	1		
LS501	Level Meter	Transducer	1			1	
LS601	Level Meter	Transducer	1			1	
MF701	Flowmeter	Transducer	1			1	
MF702	Flowmeter	Transducer	1			1	
MF703	Flowmeter	Transducer	1			1	
PC701	Progressing Cavity Pump	Motor	1	3	1		
PC702	Progressing Cavity Pump	Motor	1	3	1		
PC703	Progressing Cavity Pump	Motor	1	3	1		
LS701	Level Meter	Transducer	1			1	
SP801	Submersible Pump	Motor	1	3	1		
HT001	Electro Heating	Switch	1	1			
HT002	Electro Heating	Switch	1	1			
PP801	Decanted Water Pump	Motor	1	3	1		
PP811	Decanted Water Pump	Motor	1	3	1		
PI801	Pressure Sensor	Transducer	1			1	
PI811	Pressure Sensor	Transducer	1			1	
SV811	Solenoid Valve	Switch	1	1			
SV812	Solenoid Valve	Switch	1	1			
BL501	Air Compressor	Motor	1	3	1		
SBL101	Sludge Basket Level	Transducer	1			1	
SBL201	Sludge Basket Level	Transducer	1			1	
SBL301	Sludge Basket Level	Transducer	1			1	
SBL401	Sludge Basket Level	Transducer	1			1	
FN001	Exhaust Ventilation	Motor	1	3	1		
300	Odor Control						
FN001	Speed Fan	Motor	1	3	1		
HT001	Heater	Motor	1	3	1		
PI001	Pressure Sensor	Transducer	1			1	
HTR901	Heat Tracing	Switch	1	1			
SV001	Solenoid Valve	Switch	1	1			
	Control Panel Board		1	4	2		

	Power Measurement		1			1	
	Allocated I/O Count			235	70	29	
	Spare (Mimimum 20%)			47	14	6	
	Total I/O Count			282	84	35	

1.1.1.4.3. **Decanted Water Area (110) & Transformer Building (400)**

RTU 3 – Decanted Water Area (110) & Transformer Building (400)							
Item	Description	Source	Number	Digital Input	Digital Output	Analogue Input	Analogue Out put
110	Well Water						
FL101	Low Level	Switch	1	1			
FL102	High Level	Switch	1	1			
FL103	Alarme HH	Switch	1	1			
FL201	Low Level	Switch	1	1			
FL202	High Level	Switch	1	1			
FL203	Alarme HH	Switch	1	1			
PP011	Surpression Pump	Motor	1	3	1		
PP021	Surpression Pump	Motor	1	3	1		
FL111	Low Level	Switch	1	1			
FL112	High Level	Switch	1	1			
FL113	Alarme HH	Switch	1	1			
400	Transformer Building						
AC001	Air Conditionning Unit	Motor	1	3	1		
AC002	Air Conditionning Unit	Motor	1	3	1		
	Control Panel Board		1	4	2		
	Power Measurement		1			1	
	Allocated I/O Count			25	6	1	
	Spare (Mimimum 20%)			5	2	1	
	Total I/O Count			30	8	2	

1.1.1.4.4. **Sludge Building (200) & Outlet Chamber (107)**

RTU 4 - Sludge Building (200) & Outlet Chamber (107)							
Item	Description	Source	Number	Digital Input	Digital Output	Analogue Input	Analogue Out put
107	Outlet Chamber						
SP801	Submersible Pump	Motor	1	3	1		
200	Sludge Building						
AC001	Air Conditionning Unit	Motor	1	3	1		
FN001	Exhaust Ventilation	Motor	1	3	1		
FN002	Exhaust Ventilation	Motor	1	3	1		
HT001	Electroheating	Motor	1	3	1		
HT002	Electroheating	Motor	1	3	1		
HT003	Electroheating	Motor	1	3	1		
HT004	Electroheating	Motor	1	3	1		

HT005	Electroheating	Motor	1	3	1		
201	Sludge Conditioning						
BF001	Polymer Vibrator	Motor	1	3	1		
SW001	Screw Conveyor	Motor	1	3	1		
DS001	Dosing Screw	Motor	1	3	1		
FL005	Stemming	Switch	1	1			
MX001	Vertical Slow Mixer	Motor	1	3	1		
MX002	Vertical Slow Mixer	Motor	1	3	1		
FL001	Alarme HH	Switch	1	1			
FL002	High Level	Switch	1	1			
FL003	Low Level	Switch	1	1			
FL004	Alarme LL	Switch	1	1			
PC101	Progressing Cavity Pump	Motor	1	3	1		
PC201	Progressing Cavity Pump	Motor	1	3	1		
PC301	Progressing Cavity Pump	Motor	1	3	1		
MF101	Flowmeter	Transducer	1			1	
MF201	Flowmeter	Transducer	1			1	
MF301	Flowmeter	Transducer	1			1	
MF102	Flowmeter	Transducer	1			1	
MF202	Flowmeter	Transducer	1			1	
MF302	Flowmeter	Transducer	1			1	
MV101	Motorized Valve	Actuator	1			1	1
MV201	Motorized Valve	Actuator	1			1	1
MV301	Motorized Valve	Actuator	1			1	1
SV101	Solenoid Valve	Switch	1	1			
SV201	Solenoid Valve	Switch	1	1			
SV301	Solenoid Valve	Switch	1	1			
SUR001	Surpression Pump	Motor	1	3	1		
202	Sludge Dewatering						
BT101	Gravity Belt Thickener	Motor	1	3	1		
BT201	Gravity Belt Thickener	Motor	1	3	1		
BT301	Gravity Belt Thickener	Motor	1	3	1		
FP101	Belt Filter Press	Motor	1	3	1		
FP201	Belt Filter Press	Motor	1	3	1		
FP301	Belt Filter Press	Motor	1	3	1		
SW101	Screw Conveyor	Motor	1	3	1		
SW201	Screw Conveyor	Motor	1	3	1		
SW301	Screw Conveyor	Motor	1	3	1		
PP101	Wash Water Pump	Motor	1	3	1		
PP102	Wash Water Pump	Motor	1	3	1		
PP103	Wash Water Pump	Motor	1	3	1		
CP101	Air Compressor	Motor	1	3	1		
CP201	Air Compressor	Motor	1	3	1		
CP301	Air Compressor	Motor	1	3	1		
FL101	Stemming	Switch	1	1			
FL201	Stemming	Switch	1	1			
FL301	Stemming	Switch	1	1			
203	Sludge Liming						
DF101	Lime Storage Dust Filter	Motor	1	3	1		
DF201	Lime Storage Dust Filter	Motor	1	3	1		
DF301	Lime Storage Dust Filter	Motor	1	3	1		
AB101	Lime Archbreaker	Motor	1	3	1		
AB201	Lime Archbreaker	Motor	1	3	1		
AB301	Lime Archbreaker	Motor	1	3	1		

DS101	Screw Dosing	Motor	1	3	1		
DS201	Screw Dosing	Motor	1	3	1		
DS301	Screw Dosing	Motor	1	3	1		
SW101	Lime Screw Conveyor	Motor	1	3	1		
SW201	Lime Screw Conveyor	Motor	1	3	1		
SW301	Lime Screw Conveyor	Motor	1	3	1		
SW102	Screw Injector	Motor	1	3	1		
SW202	Screw Injector	Motor	1	3	1		
SW302	Screw Injector	Motor	1	3	1		
FL101	Stemming	Switch	1	1			
FL201	Stemming	Switch	1	1			
FL301	Stemming	Switch	1	1			
SM101	Sludge Lime Mixer	Motor	1	3	1		
SM201	Sludge Lime Mixer	Motor	1	3	1		
SM301	Sludge Lime Mixer	Motor	1	3	1		
SW001	Skip Feeding Screw Conveyor	Motor	1	3	1		
SW002	Skip Feeding Screw Conveyor	Motor	1	3	1		
BC001	Stand-by Belt Conveyor	Motor	1	3	1		
HT001	Electroheating	Motor	1	3	1		
HT002	Electroheating	Motor	1	3	1		
204	Sludge Storage						
HTR901	Heat Tracing	Switch	1	1			
205	Sludge Building Foul Water Pit						
LS001	Level Meter	Transducer	1			1	
FL001	High Level	Switch	1	1			
FL002	Low Level	Switch	1	1			
SP001	Submerged Sump Pump	Motor	1	3	1		
SP002	Submerged Sump Pump	Motor	1	3	1		
206	Odor Control – Sludge Building						
FN001	Speed Fan	Motor	1	3	1		
PI001	Pressure Sensor	Transducer	1			1	
SV001	Solenoid Valve	Switch	1	1			
207	Electrical Room						
	Control Panel Board		1	4	2		
	Power Measurement		1			1	
	Allocated I/O Count			199	58	12	3
	Spare (Mimimum)			40	12	3	1
	Total I/O Count			239	70	15	4

1.1.2. SCADA SYSTEM FEATURES

1.1.2.1. SCADA Mimics

The following mimics are anticipated for Aeratsia control screens:

Tabl. 1 - List of SCADA Mimics

MIMICS	Quantity
SCADA Network Status Schematic	1

MIMICS	Quantity
WWTP Geographical Overview	1
WWTP Process Schematic Overview	1
Inlet Structure	1
Coarse Screening	1
Fine Screening	1
Grit and Grease Removal (General)	1
Grit and Grease Removal (Individual)	2
Grease Pit	1
Foulwater PS	1
Lamellar Tanks (General)	1
Lamellar Tanks (Individual)	2
Sludge storage	1
Polymer preparation and dosing	1
Dewatering (General)	1
Dewatering (Individual)	3
Liming (General)	1
Dewatered sludge conveyors and storage skips	1
Foul water Pumping Station	1
Odor Treatment	1
Incoming MV supply	2
LV Distribution System	2
A contingency for the following number of additional mimics shall be included	20%

1.1.2.2. ALARM FACILITIES

The facility shall be fitted to enunciate user definable alarms that have been accepted within a user definable period via the klaxon and lights associated with each control panel. The klaxon and light at each panel shall be reset on acceptance of the alarm.

1.1.2.3. HISTORIC INFORMATION

The SCADA system will automatically save the current day's historic data and delete any data greater than 365 days old at midnight. The facilities shall be provided to recover data greater than 365 days old from the archive device.

1.1.2.4. REPORT GENERATION

The SCADA will allow for simple reports generation summarizing statistical information relating to the operation and performance of the WWTP station.

1.1.2.5. SCADA SYSTEM DATABASE CONFIGURATION

The SCADA database will be configured to include all input/output requirements. This shall include, but not be limited to:

- a) Descriptions.

- b) High, High-High, Low-Low and Low alarm levels.
- c) Alarm text.
- d) Alarm priorities.
- e) Dead-bands.
- f) Persistency (How long the signal must be in alarm condition before alarm is raised).
- g) Historic data for trending of inputs etc.
- h) Scanning intervals.

The following shall be saved to disc, for display on the SCADA system:

- a) Hours run for each item of plant, including pumps, screens, washers, compactors, conveyors, scrapers, mixers, blowers, presses and transporters, etc.
- b) Flowmeter readings for incoming flow to treatment, return sludge and excess sludge, etc.
- c) Total outlet flows to treatment (per hour, day, month and year).
- d) Ditto for the return sludge.
- e) The total daily sludge capacity shall be calculated using the measured excess flow, the amount of dry substance returned and the amount of dry substance de-watered for each day, month and year.
- f) The instantaneous and integrated power consumption for the WWTP.

In addition the following elements dependent upon the Consumption of Power:

- a) The instantaneous and integrated power consumption for the Hydraulic Load.
- b) The instantaneous and integrated power consumption for the “Time dependent” power consumers.

1.1.3. DETAILED FUNCTIONAL DESCRIPTION

The functional description and control logic for each process area is described in Section 17050.

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 Employer 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 equipments.
- 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) Employer'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 centre should be established inside the existing Operations Building in which a location shall be agreed to 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 centralised Dispatcher processing function, complete with standby facilities and local workstations.
- b) Distributed intelligence using microprocessor based Programmable Logic Controllers (RTU's) for monitoring and data logging. Under normal operating conditions, the RTUs 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 RTUs 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 RTU shall be capable of holding 8 days worth of data as follows:

- a) Analogue, totalised and derived signals - on significant change/15 minute intervals.
- b) Digital signals on change of state.
- c) The data gathered from the RTUs shall be incorporated into the Dispatcher database and shall also be made available to applications programs written by the client.
- d) Where RTUs are programmed to perform local control of plant it shall be possible for the programmes, 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 RTU control schedules via the control centre, e.g. to implement remedial action when an alarm occurs.

SCADA Control shall be effected at two levels, these being:

- a) RTU local control via programs stored locally at the RTU, e.g. pump start, fallback control.
- b) Supervisory control from the control centre. An authorised user, at the control centre shall be able to modify the control routines at any RTU 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.

There shall be a requirement to download control programs and schedules to the RTUs from the dispatcher via the communications network.

The preferred method of communication with site based RTU's is cable with low power UHF radio 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.

The system shall operate using 'management by exception' techniques. The RTU shall monitor and control the site and record operational data. When an alarm condition is detected the RTU 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 centralised SCADA Dispatcher shall be provided for the SCADA system unless otherwise specified.

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. RTUs, 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.

Synchronisation 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 RTUs.
 - All remote equipment.

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) DVD burner- 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 23 inch (minimum) Visual Display Units (VDUs) capable of displaying graphical and alphanumeric characters in at least sixty-four colours 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 Printer:
 - To provide a hard copy log of all alarms and significant events, e.g. operator sign-on or control override issued a medium speed dot matrix printer shall be provided. The printer shall be capable of 300 characters per second, 132 characters per line, multiple colours (to differentiate alarms and level of alarms from events) and operating on continuous fan fold stationery.
- b) Colour Printer:
 - To provide high quality printed output for report summaries, programme development, copies of mimic displays, historical trends etc., issued a high speed colour ink-jet printer 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 Employer requires a low risk system supplied with proven software.

5.2. SYSTEM ACCES

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.

5.3. COLOUR GRAPHICS DISPLAYS

The following display types shall be available on all colour 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.

5.3.1. 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.

5.3.2. DISPLAY OF VARIABLES

Variables can be considered as digital on/off parameters, analogue or totalisors.

Digitals may be either status (e.g., running/stopped) or alarm points, and shall be displayed by:

- a) Text changing.
- b) Symbol colour 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 colours/shapes can have operational meaning. For example, a pump may be shown in four colours 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 totalisors 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. Colour changes shall be used to indicate further information about a point, e.g. if an alarm limit has been exceeded.

5.3.3. DISPLAY ATTRIBUTES

Using the display facilities described above, the mimic diagrams shall indicate the following attributes for analogue, digital and totaliser points:

<u>Attribute</u>	<u>Point Type</u>
Status On/Off	Digital Status
Alarm/Normal	Digital Alarms
1 st Stage Alarm (High, Low)	Analogues
2 nd 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

5.3.4. 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 colour 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.

5.4. 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.

5.5. 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 colours.

The system must be easy to use, with automatic default facilities so that only a minimum of instructions need 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.

5.6. 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.

5.7. 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 programme. This programme 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".

5.8. 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.

6. 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.

6.1. ALARM FACILITIES

6.1.1. 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.

6.1.2. 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.

6.1.3. 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.

6.1.4. 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 RTU.

- b) Digitals:
 - Delay before initial alarm.
 - Minimum alarm repeat interval.
 - Logical suppression of new alarm if other conditions are presents.

Users, subject to authorisation (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.

6.1.5. 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).

6.2. HISTORIC INFORMATIONS

6.2.1. RTUS

RTUs 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.

6.2.2. 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 shall be , at a minimum:

- Wastewater Flow integrated as m³/h with 1 value recorded every hour
- Wastewater Flow temperature integrated as average temperature per day with 1 value recorded every day
- Liquid Sludge flow to dewatering, integrated as m³/day with 1 value recorded every day
- Power usage for each area, separating HVAC power usage, as kWh per day with 1 value recorded every day for each area.

6.3. CONTROLS

6.3.1. 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 organised select check and execute system is required.

6.3.2. 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 RTU 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, totalisers, controls from a keyboard, set-point input from a keyboard.
- Output from functions to be available as digital, analogue or totaliser points, or transmitted to any RTU 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).

6.4. 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.

6.5. 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.

6.6. 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.

6.7. 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 + 2 hours, but automatically displayed in the appropriate local time adjusted for daylight saving.

6.8. 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 authorised 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 RTU 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).

6.9. 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 RTU	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 displays and event lists shall from the completion of the operator request.	10
7	Time to perform screen dump from completion of the operator request	30

7. EQUIPEMENT

7.1. REMOTE TERMINAL UNIT (RTU)

7.1.1. QUALITY CRITERIA

Equipments installed within the framework of this project of remote processing will have to answer particularly the following criteria:

- a) A very big reliability to guarantee a maximal availability of the remote processing, even on very exposed sites.
- b) An important sustainability of the solutions proposed for allow to realize easily a future extensions with the best cost.

A big simplicity of implementation and use to minimize the times of putting into service and assure the control of this tool by the staff concerned without specific training.

7.1.2. ASSEMBLY IN CUPBOARD

The RTU can have risen in face before of an electric cupboard to reach the data of the RTU on the graphic screen without having to open the cupboard.

7.1.3. MATERIAL

7.1.3.1. RELIABILITY AND MODULARITY

To guarantee the reliability of equipments, the proposed RTU must be conceived with components allowing a high protection EMC (Electromagnetic Compatibility); that is the level 4 for the following standards:

- a) **IEC EN 61000-4-4:** Testing and measurement techniques - Electrical fast transient/burst immunity test.
- b) **IEC EN 61000-4-5:** Testing and measurement techniques - Surge immunity test.

Every RTU will have to have modular architecture:

- a) On one hand, to fit at best the configuration of the post to the need for the installation.
- b) On the other hand, to allow extensions a lesser cost.

Finally the modularity will allow to facilitate the maintenance: the cards being independents, the one compared with the others, the diagnosis will be faster and the replacement of a defective card will be made very easily.

7.1.3.2. ELECTRONIC CARDS

The not exhaustive list of cards below can constitute a RTU following the needs for the site to be equipped:

- a) Inputs/Outputs Cards.
 - Digital Input Card.
 - Analogic Input Card.
 - Digital Output Card + Guard dog.
 - Analogic Output Card (If later need).
- b) Cards of Communication.

- GSM Modem.
- RTC Modem.
- Card for connections LS / LP.
- Card for connections Ethernet.
- Card for connections Radio.
- Serial Interfaces RS232 / RS485.
- Card for badge reader (Access control).

To facilitate the cabling, all the cards must be equipped with disconnectable terminal blocks.

Cards for the acquisition of the Analogic Inputs will have to be capable of feeding directly the sensors 4-20 mA, without requiring the appeal to an external power supply. This power supply must be protected from the short circuits.

Cards for the acquisition of the Digital Inputs will have to be of the type " in dry contact ": they will have to supply an opto-insulation and the power supply of the contacts via an isolated power supply besides with the equipment.

7.1.3.3. POWER SUPPLY OF THE RTU

The power supply of the RTU is a sensitive part. The group constituted by the power supply card and the safety power supply (battery / UPS) will have to answer the following characteristics:

- a) A battery charger (plan a battery offering a minimal autonomy of 12 hours).
- b) A device against the deep discharges to protect the life expectancy of the battery during prolonged power break.
- c) A protection against the inversions of polarity.
- d) A presence detection battery.
- e) A periodic test of capacity of the battery.

This last function guarantees the efficiency of the battery while optimizing maintenance costs (the battery will be only replaced on detection of insufficient capacity).

7.1.3.4. GSM MODEM

The modem GSM of the PLT is also an essential element because he assures the link with the control centre and the distant users. He will thus have to be of a big reliability and have a guarantee of sustainability.

The modem GSM will thus have to be integrated into the RTU. He cannot involve an office automation modem or an external modem of the business the characteristics of which are not adapted at the applications of remote processing.

7.1.4. FEATURES

The RTU proposed will have to assure the following functions:

- a) Acquisition of inputs - outputs.
 - Digital status (on/off, defaults, ...).
 - Measures (level, pressure, ...).

- Countings (Flow, time of functioning, ...).
- Command (opening/closing, ...).
- Regulations (Instruction of Flow, ...).

The acquisition of inputs-output will be made or by means of cards of integrated or external inputs-output in the RTU.

b) Treatment of the acquired information

- Measures (level, pressure, ...).
- Warning levels.
- Temporizations of the alarms.
- Calculation of balance sheets.
- Complete module for the archiving of the information and the events:
 - For the measures : periodic archiving of the value and on variation if the measure evolves in a significant way between 2 archivings.
 - For the Digital inputs - output: archiving in every change of state.
 - For the countings : periodic archiving or in the form of balance sheets.

All these treatments will have to be configurable by the user, via an interface operator. This interface operator, schedules no requiring IT programming.

c) Transfert of alarms

The alarms will have to be able to be transmitted by GSM in the form of vocal messages, of SMS or of Emails towards on-call agents, or towards control centre.

The authorized people will have to be able to at any time consult at a distance the information of the installation via the voice server or by SMS, so authorizing a big freedom of movement.

d) Communication with other equipments

For the future evolutions, the RTU will have to be capable of communicating with other equipments by using a standard protocol as the MODBUS or MODBUS-TCP.

e) Interface Operator of exploitation

For the local exploitation, the RTU will have to integrate a graphic screen allowing the consultation of states, alarms, values archived in the form of curve, and the positioning of the instructions (according to the seizure of a password).

For the remote exploitation, the RTU or GSM will have to have a voice server allowing the management of the alarms, the consultation of states and the activation of commands.

Finally the RTU will have to be totally accessible, in local and remote, via a simple Internet browser, on PC.

f) Interface Operator of configuration

To assure its control by the concerned users, the tool of configuration will have to be particularly intuitive and call on to simple notions of "questions-answers" using the usual terms of the job (no specific language of programming). This tool of configuration will have to work on a standard PC and call on to graphical interfaces easy to treat.

g) Automatism

The RTU will have to have a function allowing to realize simply combinations between digital inputs, or to make an elementary automatism. On the other hand, to answer needs for more elaborate automatisms (regulation, permutation / management of pumps, the RTU will have to have a language of standard automatism (according to the standard IEC1131-1) and libraries of functions ready for the use.

8. COMMUNICATIONS

8.1. 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.

8.2. EMPLOYER LIAISON

The Employer will be responsible for the processing the licences 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.

8.3. SCAN TIMES

The Contractor shall prepare a detailed assessment of the RTU scan times for his system and submit this to the Engineer for approval. The assessment shall assume the use of UHF polling to gather operational data from RTUs located at remote sites.

The longest scan time for RTUs with radio communications shall not exceed two minutes under full system utilisation.

8.4. 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.
- b) UHF Radio network: 1200 Baud.

8.5. 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.

8.6. 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.

8.7. LIGHTNING PROTECTION

8.7.1. LIGHTNING PROTECTION DEVICES

The Contractor shall provide lightning and surge protection devices at each RTU 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 metres: 10 sq. mm.
- b) Cables greater than 6 metres: 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 utilise 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 metres.

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.

8.7.2. 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.

8.7.3. 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 metres 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 metres.

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 non ferrous 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.

8.8. 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 radio 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.

8.9. RADIO EQUIPEMENT

8.9.1. STANDARDS REQUIREMENTS ANS APPROVAL

All equipment shall comply with the appropriate CCIR recommendations and shall be approved by the national licensing agency. The equipment shall comply with the most recent editions of the appropriate National and International Standards Specifications and Recommendations.

Type approval numbers issued by the National Frequency Allocation Committee in the country of manufacture shall be supplied, together with appropriate CCIR recommendations, appropriate National and International Standards Specification met by the equipment at the time of Tender.

8.9.2. RADIO SYSTEM

The radio system shall conform to the latest regulations and requirements current at the time of delivery. The radio system shall be of the following type:

- a) Frequency: UHF as allocated by the Frequency Committee.
- b) Modulation : FM.
- c) Base Mode: Full Duplex.
- d) RTU Mode: Two-Frequency Simplex.
- e) Channel Spacing: 12.5 Khz.

8.9.3. RADIO PATH PROFILES

The Contractor shall provide path profiles and subsequent technical examinations prior to detailed design of the radio system.

8.9.4. PCL RADIO TRANSMITTERS/RECEIVERS

RTU transmitter/receiver radio units shall be units with standby facilities. These units shall have sufficient battery backup for the system to function for 4 hours in the event of mains failure. The units may either be wall mounted or installed in the RTU enclosure (the preferred option).

The alarm signal shall be transmitted to the SCADA system when a changeover occurs due to a radio failure.

The R.F. output of the radio units shall be variable from maximum down to 0.5 watt. Attenuation pads shall be provided in the transmit leg only, and the radio output set to maximum in the final system configuration.

8.9.5. BASE STATION RADIO TRANSMITTERS/RECEIVERS

Base station transmitter/receiver radio units shall be located adjacent to the Works Control Centre (WCC) and shall be of a dual main/standby type with auto-changeover of the duty units.

The Contractor shall supply within the tender document an explanation of how this is to be accomplished. An alarm signal shall be transmitted to the SCADA system when a changeover occurs. The base station shall be provided with power supply equipment, including: nickel cadmium battery and 230 volts 50 Hz a.c. mains fed battery charger and have sufficient battery backup to allow the system to operate for eight hours on the event of mains failure. The charger shall be capable of recharging the battery to full capacity within 8 hours while the radio equipment continues to operate at full duty.

The alarm signal shall be transmitted to the SCADA system when a changeover occurs due to a radio failure.

The R.F. output of the radio units shall be variable from maximum down to 0.5 watt. Attenuation pads shall be provided in the transmit leg only, and the radio output set to maximum in the final system configuration.

The base station radio shall be forced to change the duty radio at a user definable interval (normally every 24 hours).

8.9.6. AERIAL AND AERIAL STRUCTURES

The Contractor shall supply and install all aeriels and aerial support structures and shall provide typical drawings to show how each type of aerial mast is to be mounted (including free standing, guyed stub etc.) with the tender document. The base station shall have omni-directional aeriels plus any associated duplexers.

RTUs shall have a single 12 element, yagi aerial with a gain of 12dB with respect to a half wave dipole on the corresponding base station.

The aerial and support structure shall be capable of withstanding winds gusting to 160 km/hour without damage. The Contractor shall provide all supporting calculations.

The Contractor shall supply to the Engineer all necessary calculations and information to demonstrate the aerial wind performance and structural integrity of it's support and all necessary documentation and calculations to enable the appropriate planning approvals to be obtained for the aerial and it's support structure.

The Contractor shall supply and install all necessary low loss coaxial down leads for connection to the radio unit and lightning protection for the aerial system. The aerial masts shall be earthed in accordance with BS CP 326. The lightning protection system shall include use of aerial elements at earth potential, the aerial support structure, the test link and the earth rods/spikes.

8.9.7. MAST STRUCTURES

The Contractor may use the following mast types, however the Contractor shall assess the requirements for the mast structure and suitable alternatives for approval may be provided:

- a) 3m or 5m Pole
 - A 50mm diameter aluminium pole with a 300mm stand-off bracket kit for building mounting, aerial clamps and 15 metres of low loss coaxial cable.
- b) 6m pole
 - A free standing circular or octagonal column aluminium finish with bottom flush fitting door opening, tamper proof lock and stainless steel earth stud. Poles may be flange mounted or cast in a concrete foundation. A 35mm diameter PVC duct shall be installed between the pole and the RTU building. 25 metres of low loss coaxial cable shall be allowed at each 6m pole.

- c) Guyed pole
 - A 50mm diameter aluminium pole secured by stainless steel guyed lines mounted on a concrete base. A 35mm diameter PVC duct shall be installed between the pole and the RTU building. 25 metres of low loss coaxial cable shall be allowed at each guyed pole.
- d) Lattice
 - Lattice structures shall be constructed of steel and shall be hot dip galvanised to BS 791/71 to provide a maintenance free finish. The coaxial down-lead shall be enclosed within a galvanised steel conduit to a height of 2m above ground level. A 35mm diameter PVC duct shall be installed between the pole and the RTU building. 25 metres of low loss coaxial cable shall be allowed at each lattice structure.

8.10. PSTN COMMUNICATIONS

8.10.1. 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 authorised 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.

8.10.2. MODEMS

The Contractor shall supply and install all modems and interconnecting wiring to the SCADA system and telephone equipment as appropriate.

RTU equipment modems shall form part of the RTU 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.

8.10.3. ON SITE COMMUNICATIONS CABLES

On-site communications networks shall be Optical Fiber Cable.

9. 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.

9.1. FACTORY ACCEPTANCE TEST

9.1.1. 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 RTUs 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 this specification.
- c) Test 1 - Simultaneous occurrence of:
 - The control centre polling outstations in normal (i.e. daytime) operational mode receiving 50% of data from each RTU 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 utilisation conditions.

The Contractor shall record the following:

- a) DISPLAY RESPONSE: This shall be no greater than as specified.
- b) PERCENTAGE CPU UTILISATION.
- 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.

e) The RTU to demonstrate:

- All control and failure recovery sequences, simulating all digital and analogue inputs and outputs on each system.

f) The communications system to demonstrate:

- Full simulation utilising all interface nodes, with RTUs 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.

9.1.2. 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.

9.1.3. 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.

9.1.4. 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.

9.1.5. 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).

9.1.6. 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.
 - Orderly system shut-down.
 - Synchronisation of the Master Station and outstations.

9.1.7. 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 RTUs.
- c) The maintenance of RTU 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.

9.1.8. 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.

9.1.9. 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 RTU.
- e) The inhibition of data collection from an individual point.
- f) The editing of stored data (subject to correct level of access).

9.1.10. 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.

9.1.11. 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 inhibit for an individual point.

9.1.12. 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.

9.1.13. RTU PROGRAMMING

These tests shall exercise the RTU sequence programming procedures, including:

- a) Sequence program editing, compilation and loading.
- b) The ability to load new sequences on demand by a privileged operator.

9.1.14. 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.

9.2. 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.

9.3. 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.

10. 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 Operator'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 the WWTP as detailed within the General Conditions. However some courses may be held at the manufacturer's works as agreed to by the Employer.

The Contractor shall provide all course materials and equipment needed.

The training shall be organised such that the Employer's Operator shall be able to operate and maintain the SCADA scheme following completion of all training courses.

10.1. SYSTEM OPERATORS

The Contractor shall provide for 10 attendees selected by the Employer in accordance with the General Conditions.

This purpose-designed course is to be held at the Works Control Centre. Training must be provided in advance of commissioning to enable the Operator's 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 familiarise 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 synchronisation of the system database.
- g) SCADA system interrogation facilities - alarm lists, log printouts select mimic and trend displays etc..
- h) Alarm acknowledge accept/delete.
- i) Control actions, e.g. start pump, close valve.
- j) All functions associated with each access level of the SCADA system.

10.2. SYSTEM SUPERVISOR PERSONNEL

The Contractor shall provide a five-day course for 4 attendees selected by the Employer in accordance with the General Conditions 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.

10.3. SYSTEMS DEVELOPERS/PROGRAMMERS/ENGINEERS

The Contractor shall provide 1 no. five day course for 2 attendees selected by the Employer in accordance with the General Conditions 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 RTUs.
- g) Advanced operating features.

10.4. SITE TRAINING

The Contractor shall liaise with the Engineer and the Employer 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 Employer 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 Operator's personnel, as necessary, with any technical difficulties.

11. OPERATIONS & MAINTENANCE DOCUMENTATION

11.1. 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 to with the Employer. 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.

11.2. 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 displays etc.
 - Alarm acknowledge 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 synchronisation of the system database.

11.3. 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.

11.4. HARDWARE MANUALS (2 NO. COPIES)

The Contractor shall provide documentation for all equipment supplied within the Contract.

11.5. RTU PROGRAMMING DOCUMENTATION (1 NO. COPIE)

The Contractor shall provide a copy of all necessary RTU programming documentation as supplied by the RTU manufacturer.

12. QUALITY ASSURANCE

12.1. GENERAL

The SCADA Contractor shall be registered to ISO9001.

12.2. QUALITY PLAN

The Contractor shall provide a quality plan within 4 weeks of award of the contract.

12.3. SOFTWARE DEVELOPMENT

All software development shall be carried out under an EU-recognised quality system compatible with ISO 9001 that is defined in the quality plan.

12.4. PRODUCT AUDIT

The Engineer shall have the right to audit the product at any time during the contract period.

12.5. 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.

12.6. ACCESS FOR THE ENGINEER'S REPRESENTATIVE

The Employer shall have the right to audit the project at any time during the contract period.

12.7. 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.

12.8. DELIVERY AND INSTALLATION

12.8.1. SCOPE

The Contractor shall be responsible for all costs involved with the delivery and installation of the equipment for the system.

12.8.2. DELIVERY

The Contractor shall provide all personnel and equipment necessary to unload the equipment and transport the equipment to its' final location.

12.8.3. 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 RTU, for some specified period.

The Contractor shall make due allowances for this in his costing and programming of his installation and commissioning works.

12.9. 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.

12.10. 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) Printer ribbons/ink cartridges.
- c) Storage media.
- d) Cleaning materials.

12.11. SPARES AND TEST EQUIPMENT

The Contractor shall provide a list of recommended list of spares and test equipment required to the SCADA system.

oOo

SECTION 17200 INSTRUMENTATION, MONITORING AND CONTROL 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 instrumentation, monitoring and control equipments, and shall be applicable to these works.

1.1. WORK INCLUDED

Various types of detectors and measuring instrument must be installed in the various areas of the process.

They are listed below :

1. Electromagnetic flow meter.
2. Capacitive Level Sensor.
3. Level Switch.
4. Ultra Sonic Level Sensor.
5. Temperature Sensor.
6. Sludge Blanket Level Detector.
7. H₂S Detector.
8. NH₃ Detector.

1.2. ELECTROMAGNETIC FLOW METER

The electromagnetic flow meters are located according to the table below:

Tabl. 1 - List of electromagnetic flow meters

Area	Description	Quantity
Primary Settling Tanks	Electromagnetic Flow meter for pipe DN 150	4
	Electromagnetic Flow meter for pipe DN 350	4
Sludge Building	Electromagnetic Flow meter for pipe DN 50	1

1.3. CAPACITIVE LEVEL SENSOR

The capacitive level sensors are located according to the table below:

Tabl. 2 - List of capacitive level sensors

Area	Description	Quantity
Inlet / By-pass / Screening	Capacitive level sensor	1
Grit and grease removal tanks	Capacitive level sensor in grease tank	1
	Capacitive level sensor in grit chamber	1
	Capacitive level sensor in foul water sump	1
	Capacitive level sensor in decanted water sump	1
Primary Settling Tanks	Capacitive level sensor for storage tanks	2
	Capacitive level sensor for lamellar tanks	4
Sludge Building	Capacitive level sensor for foul water tank	1

1.4. LEVEL SWITCH

The level switches are located according to the table below:

Tabl. 3 - List of level switches

Area	Description	Quantity
Primary Settling Tanks	Level Switch Alarm High High for storage tanks	2
	Level Switch Alarm Low Low for storage tanks	2
Sludge Building	Level Switch Alarm High High for foul water tank	1
	Level Switch Alarm Low Low for foul water tank	1

1.5. ULTRA SONIC LEVEL SENSOR

The ultra-sonic level sensors are located according to the table below:

Tabl. 4 - List of ultra-sonic level sensors

Area	Description	Quantity
Inlet / By-pass / Screening	Ultra sonic level sensor	3
Grit and grease removal tanks	Ultra sonic level sensor in well water storage	1

1.6. TEMPERATURE SENSOR

One temperature sensor is located according to the table below:

Tabl. 5 - List of temperature sensors

Area	Description	Quantity
Inlet / By-pass / Screening	Temperature sensor	1

1.7. SLUDGE BLANKET LEVEL DETECTOR

Sludge blanket level detectors are located according to the table below:

Tabl. 6 - List of sludge blanket level detectors

Area	Description	Quantity
Primary Settling Tanks	Sludge blanket level detector in lamellar tanks	4

1.8. GAS DETECTOR

The H₂S and NH₃ detectors are located according to the table below:

Tabl. 7 - List of gas detectors

Area	Description	Quantity
Primary Settling Tanks	H ₂ S detector	1
Sludge Building	H ₂ S detector	1
Sludge Building	NH ₃ detector	1

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:

1. 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.
2. Liaison between subcontractors to ensure complete compatibility of all equipment at both component and system interface levels.

3. Overall systems engineering to ensure that all equipment, components and systems together form a consistent, rational and fully integrated monitoring and control installation.
4. Ensuring that each system is handed over complete in all detail and in perfect working order.
5. 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.
6. Compatibility with existing monitoring and control installation of Stage 2, Phase 1, to ensure that all new and existing equipments will form a rational and integrated installation.

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:

1. Such that routine and occasional maintenance through its life shall be a practical minimum, compatible with the preservation of maximum reliability.
2. To withstand the electrical, mechanical, thermal and atmospheric stresses to which it may be subjected under operational conditions, without deterioration or failure.
3. 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:

1. IP54 for internal applications.
2. IP55 for equipment in pumping stations and similar locations.
3. IPW55 for external applications.
4. 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.

Further to Clause in Volume 2 Part 1.4, the drawings, diagrams and schedules to be submitted for approval at an early stage in the contract shall include the following:

1. System block diagrams.
2. Fully detailed P & I diagrams.
3. Control schematic diagrams showing clearly the operation of each system.
4. Analogue loop diagrams showing all relevant detail including instrument reference and loop impedances.
5. Power distribution diagrams for all instrumentation and control supplies.
6. Certified drawings and technical data for all instruments.
7. Drawings showing the location and relevant installation details for all panels and enclosures.
8. Instrument installation and hook-up drawings.
9. General arrangement drawings (internal and front panel) showing finish and relevant construction details for all panels and enclosures.
10. 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.
11. Complete alarm schedules including legends, initiating contacts or equipment, and alarm grouping.
12. Cable specifications, cable route drawings and comprehensive cable schedules.
13. Interconnecting cable termination details.
14. 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:

1. A battery/charger unit, typically of 24 volt nominal output, but under no circumstances exceeding 48 volts nominal output.
2. A double wound transformer having a fused primary, a 55-0-55 volt secondary with the centre point earthed and each secondary line fused.
3. 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 stabilisation 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 energised 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 centres 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 colour 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 IP54.

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 fibreglass, 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.

Colour impregnated gel coats backed by coloured resin shall be used to ensure maintenance free and “colour fast” finishes. The finish colour, 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 fibreglass 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 centres 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 derating 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 moulded 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 centre 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 Armenian.

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 mouldings 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 IP52.

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 outgoing 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 $\pm 1\%$ of nominal.
- An adjustable ac output voltage of $\pm 5\%$ at nominal dc input voltage.
- A maximum deviation of ac output voltage of $\pm 2\%$ 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:

1. Be supplied complete with an annunciator having two lamps to each light box.
2. 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.
3. 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.
4. 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.
5. 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:

1. have manual reset facilities and be complete with “Reset”, “Alarm Accept” and “Lamp test” push buttons.
2. 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.
3. 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 centre, and is normally located in the administration building.

The central alarm system shall comply with the requirements of chapter 2.10.1 and shall:

1. have automatic reset facilities and be complete with “Alarm Accept” and “Lamp Test” push buttons,
2. have an additional output for each alarm channel to provide signals to a possible future event recorder or data logger,
3. 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 mains 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 energised under normal conditions, and de-energised 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. FLOW MEASUREMENT THROUGH PIPELINES

2.11.1. MAGNETIC FLOW METERS

Magnetic flow meters shall be provided in accordance with the following:

1. Meters shall be of the short form, having a modulated, direct current excitation and inherent total zero stability.
2. The power consumption shall not exceed 16 watts per 100 mm of diameter.
3. The output shall be 4-20 mA and the system accuracy shall be within $\pm 0.5\%$ of rate. Test certificates shall be provided.
4. The field coils shall be fully encapsulated.
5. The equipment shall be guaranteed suitable for the ambient and process liquid temperatures.
6. 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.
7. Primary units shall be suitable for accidental submergence to a depth of 3 metres.
8. The Contractor shall provide primary units having flanges in accordance with the relevant mechanical clauses relating to pipes, flanges, fittings, etc..
9. The Contractor shall ensure that all primary units are rated well in excess of the maximum possible process fluid pressure, including possible surge pressures.
10. 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.

11. The Flow meter equipment shall be supplied complete with amplifier (converter), drive unit (if applicable) and all cable for connecting between the components.
12. The amplifier/converter shall be fully screened to prevent interference from adjacent equipment.
13. The amplifier/converter shall incorporate voltage stabilisation to ensure maintenance of system accuracy with a supply variation from 85 to 260 VAC.
14. 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.
15. 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 detailed under item o) 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:

1. Meters shall be of the probe type fitted on welded sleeve.
2. The power consumption shall not exceed 5 Watts for any pipe diameter.
3. The output shall be 4-20 mA and the system accuracy shall be within $\pm 2\%$ of rate. Test certificates shall be provided.
4. The probe shall be of draw-out type and shall be removable without interrupting the service.
5. The equipment shall be guaranteed suitable for the ambient and process liquid temperatures.
6. 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.
7. Primary units shall be suitable for accidental submergence to a depth of 3 metres.
8. The Contractor shall provide carbon steel sleeves having flanges in accordance with the relevant mechanical clauses relating to pipes, flanges, fittings, etc.
9. The Contractor shall ensure that all primary units are rated well in excess of the maximum possible process fluid pressure, including possible surge pressures.
10. 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.
11. The Flow meter equipment shall be supplied complete with amplifier (converter), drive unit (if applicable) and all cable for connecting between the components.
12. The amplifier/converter shall be fully screened to prevent interference from adjacent equipment.

13. The amplifier/converter shall incorporate voltage stabilisation to ensure maintenance of system accuracy with a supply variation from 20 to 30 VDC.
14. 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 detailed under item o) shall be provided on the basis of one for every four (or part thereof) primary units.

2.12. ULTRA-SONIC LEVEL

2.12.1. 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 hoseproof with environmental protection to IP55 or IP67, 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 $\pm 0.1\%$ 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 metres 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.

2.12.2. 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.

2.13. 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 2.12, but shall, in addition, include a lineariser either as a separate matching unit or incorporated within the control unit.

The lineariser 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 linearising equipment shall be within $\pm 0.2\%$ of the instrument span.

2.14. 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:

1. Be of modular style and totally enclosed except for the front panel mounted terminals, controls and indications.
2. Have all live parts at a voltage in excess of 55 volts to earth completely shrouded and complete with warning labels.
3. Have an output relay with double pole changeover contacts of suitable material for the application.
4. Have all internal equipment tropicalised, but without potting on the printed circuit boards.
5. Have a light emitting diode mounted on the front panel to indicate when the relay is energised.
6. Have a lockable sensitivity control potentiometer.
7. Be designed for operating from a 230 volt a.c. supply.
8. Be capable of operating at a distance of up to 100 m from the electrodes.
9. Have a voltage on the electrodes not exceeding 25 volts.

The electrodes and holder shall comply with the following:

1. The electrode holder shall be fully weatherproof, constructed from die-cast aluminium and provided with a mounting flange having a minimum of 4 No. fixing holes.
2. The electrode holder shall be designed to allow a minimum of 75 mm adjustment of the electrode length.
3. The electrode shall have glazed ceramic insulator cemented to the metal housing.

4. 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.
5. Cable entry shall be via a standard screwed gland entry.
6. 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.
7. 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.

2.15. 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 minimise 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.

2.16. TEMPERATURE MEASURING EQUIPMENT

2.16.1. 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 pressurised-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.

2.16.2. 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 $\text{Alpha} = 0.00385$. 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.

2.16.3. THERMOCOUPLES

Thermocouples shall be of the mineral-insulated type and unless otherwise specified shall be of the chromel-alumel (nickel-chromium v nickel-aluminium) 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.

2.16.4. 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.

2.17. GAS H₂S SENSOR

2.18. GAS NH₃ SENSOR

2.19. PRESSURE TRANSDUCER LEVEL MEASURING EQUIPMENT

2.19.1. 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:

1. Have a single moulded 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.
2. Be suitable for continuous immersion on all wastewater applications including raw sewage, primary sludge, secondary sludge and thickened sludge.
3. 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.
4. Incorporate automatic temperature compensation.
5. Withstand a continuous overpressure of up to 400% without sustaining permanent deformation or calibration change.

The controller/transmitter shall:

1. Be suitable for mounting within a control panel.
2. Accept the signal from the transducer and provide a 4-20 mA output proportional to level (gauge pressure), for indication and control.
3. Include independent zero and span adjustment.

The complete system shall:

4. Operate with up to 100 m of cable between transducer and controller/transmitter.
5. Provide an accuracy within $\pm 0.1\%$ of the span with a linearity better than $+0.1\%$.

2.19.2. 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.

2.20. APPLICABILITY

2.20.1. 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.

2.20.2. GENERAL REQUIREMENTS

All meters and meter relays:

1. 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.
2. Shall have a linear scale with clear graduations and markings.
3. Shall have the units of the measured variable and any multiplying factor clearly marked on the scale plate.
4. Shall have an external zero adjustment.
5. Shall be flush mounting with matt or semi-matt black bezel.
6. Shall match all other instruments on the same panel or on similar panels in the same room as regards style, finish and appearance.
7. Intended for installation within a control room shall be fitted with anti-glare or low reflectivity glass.
8. 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.
9. 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.
10. 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.

2.20.3. INDICATING METERS - RECTANGULAR

These shall comply with chapter 2.17.2:

1. Shall have a rectangular format of not less than 48 x 96 mm.
2. Shall be multifunctional one channel display with universal input, loop power supply, limit monitor and analogue output.

2.20.4. LEVEL/CONTENTS INDICATIONS

Meters indicating levels, tank contents and Indicators similar quantities shall comply with chapter 2.17.2, 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.

2.20.5. POSITION INDICATION

Indicator lamps for valves and penstocks indication position shall comply with chapter 2.17.2.

2.20.6. METER RELAYS

Meter relays shall comply with chapters 2.17.3 or 2.17.4 but shall additionally 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.

2.21. INTEGRATORS AND COUNTERS

2.21.1. 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.

2.21.2. 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 energised when the preset quantity is reached. The relay shall remain energised for approximately 10 seconds, following which the counter shall automatically reset and start counting again.

The accuracy shall be $\pm 0.2\%$ of span or better.

2.22. 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.

2.23. STATUS INDICATOR LAMPS

2.23.1. 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.

2.23.2. D.C. OPERATED LAMPS

On all mimics and elsewhere as practicable, indicators shall be by light boxes or illuminated LED incorporating two lamps. Multi-colour, 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.

2.24. 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 colours and indicating sequence, but the screens shall be engraved “opened” and “closed”.

All indicator lamps shall be included within a lamp test facility.

2.25. TRIP AMPLIFIERS

Trip amplifiers shall operate on various analogue signals and shall:

1. Operate from a 230 VAC or 24 VDC.
2. 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:

1. Have switched outputs with changeover contacts of suitable material and rating for the application.
2. Have set points which is infinitely variable over the whole input range by means of a lockable knob calibrated 0-100%.
3. Have a dead band of not less than 2.5% of input span.
4. Have a trip repeatability of $\pm 0.25\%$ of span.

2.26. 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:

1. Operate reliably over the range +10% to -15% of the nominal supply voltage.
2. Be of the plug-in type complete with plastic cover and retaining clip.
3. Have vacuum impregnated coils and be suitably treated for operation under the specified environmental conditions.
4. Have contact material suitable for each application.
5. 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.

2.27. 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.

2.28. OPERATION OF CONTROL PENSTOCKS AND VALVES

2.28.1. 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.

2.28.2. 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".

2.28.3. 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.

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PART 4 – DRAWINGS – REFER TO VOLUME 3

PART 5 – GEOTECHNICAL INVESTIGATIONS

«HAYR EV VORDI TITIZYANNER» LTD

Rehabilitation of Yerevan WWTP Engineering-geological and
Geotechnical investigations Program

Report

Contract № 3

Client

«ARTELIA» Group



Chief Executive Officer

V. Titizyan

Geologist

H. Titizyan



Content

Introduction

1.Engineering-geological conditions

2.Natural Soil physical-mechanical charecteristics

3.The results of field penetration

4.The exploration of the boreholes geological-lithologic description and staple's Photos

5.The results of Soil slide resistance reasearch

6. Conclusions and Suggestions

7. References

Table 1 (Labor researches for natural soil's physical-mechanical properties)

Introduction

According to << Artelia>> Group given technical task the rehabilitation of Yerevan WWTP geotechnical investigations program should be done. On april-may 2013 engineering investigation program has been completed by the geologists of << Hayr ev Vordi Titizyanner>> Ltd. During the investigation following researches have been done

1. Column-mechanical drilling-110.0 running meter
 - ❖ 2 boreholes drilling each 30 running meter deep
 - ❖ 1 borehole 20 running meter
 - ❖ 1 borehole 30 running meter deep(20 running meter deep Piesometer installation)
2. Determine physical-mechanical characteristics for 15 taken samples
3. CPT implementation experiment (each on 1.5 m deep) during of the continuous drilling
4. Report preparation

Field engineering-geological investigation program has been done by H. Titizyan. Labor researches have ben done by << Hayr ev Vordi Titizyanner>> Ltd.

Research field is located in Aeracia block, Shengavit district in Yerevan, Republic of Armenia.

Geomorphologically it's located on a high space left side from Hrazdan river.From morphological viewpoint the area characterized as flat area (absolute characters 885-890m).

Area's climate mostly characterized with mild winters and hot summers. The average annual air temperature flaps from 12 till 14 C, the average annual amount of precipitation is 350-4000mm: Snow shelter saved till 1.0-1.5 month. power is not higher than 0.2-0.4m, cooling zone maximum is -0.4-0.5m.

The area's geological structure is represented by four-aged class cobblestone sediment, capacity higher than 30 meters. The area's seismic zone coincides with the 3rd seismic zone of nine-point intensity (by MSK-64 table,maximum horizontal acceleration $A_{max}=0.4g$, speed $V=32cm/second$)

In the area till 30 meters deep no ground water were found .

1. Engineering-geological conditions

For ascertaining features for Aerecia block , Shengavit District, Yerevan republic of Armenia investigative browser and labor researches have been done resulting that the area is separated into 4 layers.

Layer №1^a Padding natural soil pebble-cobblestone sediment natural soil till 25% sand filling, capacity 4.0-4.5m.

Layer №1 dusty sand-claysand natural soil till 15 % sand content, capacity 3.5-5.0m.

Layer №2 Lower fourth-aged class cobblestone-pebble sediment natural soil till 25% sand filling, capacity 8.0-15m.

Layer №2^a Lower forth-aged class pebble- cobblestone sediment natural soil till 40% claysand and sand filling, capacity 2.0-17.0m.

2. Natural Soil physical-mechanical charecteristics

In the results of dynamic penetration of the samples taken during the field geological investigation drilled borehole research , the area's layer sequence from the upside down is divided into following natural soils.

Layer №1^a Padding natural soil cobblestone-pebble sediment natural soil till 25% sand filling, capacity 4.0-4.5m. Is given construction order 4, because it's not going to be used as structure base.

Layer №1 dusty sand-claysand natural soil till 15 % sand content, capacity 3.5-5.0m. The layer has following physical-mechanical characteristics.

Solid particle density	2,36g/cm ³
Natural density	1,55g/cm ³
Natural Humidity	46%
The Skeleton Volume weight	1,05g/cm ³
Porosity	55%
Porosity Index	1,23
Internal friction angle	10°30'
Coherence	0,0225 Mpa
Deformation module	52 kg/cm ²

Allowable tension	0,5kg/cm ²
Plasticity	
Slide upper limit	64,6%
Slide lower limit	54%
Plasticity number	10,6
Ground seismic category	III-IV

The procedure for construction for collections №1 and №3- 33b/33b 2nd category

Particle-size distribution

Sand 14.74%

Dust 66.68%

Clay 18.58%

The natural soil is presented by particle-size distribution and plasticity number. In seismic terms it is able to dissolve and lose its durability.

Chemical analysis of the soil

Cl	0,213%
PH	6,9%
SO ₄	0,186%
CaCO ₃	2,85%
Dense refuse	0,211%

Layer №2 Lower forth-aged class cobblestone-pebble sediment natural soil till 25% sand filling, capacity 8.0-15m. The layer has the following physical-mechanical characteristics

Solid particle density	2,69g/cm ³
Natural Density	2,13g/cm ³
Natural Humidity	9%
The skeleton Volume Weight	1,95g/cm ³
Porosity	27,5%
Porosity Index	0,38
Internal friction angle	31°30'
Coherence	0,001 Mpa
Deformation module	420 kg/cm ²
Allowable tension	4kg/cm ²
Ground seismic category	II

The procedure for construction HSH IV-2-82 for №1 and №3- 6g/9g- IV category

Particle size distribution

Boulder	11,25%
Cobblestone	45,30%
Pebble	17,14%
Sand	24,13%
Dust	1,4%
Clay	0,78%

Chemical Analysis of the Soil

Cl	0,018%
PH	7,0%
SO ₄	0,046%
CaCO ₃	2,00%
Dense refuse	0,105%

Layer №2^a Lower forth-aged class cobblestone sediment natural soil till 40% claysand and sand filling, capacity 2.0-17.0m. The layer has the following phisical-mechanical characteristics

Solid particle density	2,70g/cm ³
Natural Density	1,99g/cm ³
Natural Humidity	12,4%
The Skeleton Volume Weight	1,77q/cm ³
Porosity	34%
Porosity Index	0,51
Internal Friction Angle	25 ⁰
Coherence	0,007 Mpa
Deformation module	266 kg/cm ²
Allowable tension	3,3kg/cm ²
Ground seismic category	II

The procedure for construction for HSSH IV-2-82 for №1 u №3- 6^g/9^g- IV category.

Particle size Distribution

Boulder	6,35%
Cobblestone	33,29%
Pebble	23,08%
Sand	31,08%
Dust	3,99%
Clay	2,21%

Chemical analysis of the Soil

Cl	0,115%
PH	7,0%
SO ₄	0,105%
CaCO ₃	2,20%
Dense refuse	0,148%

3.The results of field penetration

During the drilling in 1.5 meters deep in boreholes there has been field dynamic penetration with the hammer weight $P=65$ kg and from the $H=80$ cm high stroke from 50mm calipers to 10cm recession. In the results of experiment accordingly for this interval the deformation module for the natural soil has been determined(R. Hayfells, G. Amberg and A. Moose)by resolution.

$$E = \frac{R}{S}$$

E – is the deformation module for the natural soil kg/cm^2

S – is the area of the probe cm^2

R – is the power of dynamic stroke kg , which is counted by the following resolution

$$R = \frac{n \times P \times H}{h} + P$$

n - is the number of the strokes

P – is the weight of the hammer -65 kg

H – is the height of the hammer

h – is the recession of the probe 10 cm

The particle size distribution has been determined till the 0.25mm calipers for mechanical netting bolts, deeper than that the particle size distribution of samples has been determined in labor conditions: The physical-mechanical characteristic standards made in field and labor conditions are summarized in Table 1.

Below are represented the boreholes structures, their lithological description, the results of dynamic penetration, the numbers of taken samples and their intervals, also the photos of borehols's boxes.



4. The exploration of the boreholes geological-lithologic description and staple's Photos

Borehole №1

Located in: WWTP

Start date: 15/04/2013

Absolute mark: 885.72` X=4442821.36, Y=451511.15

End date: 21/04/2013

Scale 1:200	Layer Number	Depth/ m	Capacity/ m	Conventional Signs	Drilling Calipers	Lithologic Description	Penetration		Geologic Age
							depth	Stroke number	
2	1 ^a	4,0	4,0		d=151 mm	Padding natural soil cobblestone-pebble sediment natural soil till 25% sand filling			Q _{IV}
4									
6	2	8,0	4,0		d=151 mm	Cobblestone-pebble sediment natural soil till 30% sand filling	6,0	15	
8									
10	2 ^a	11,0	3,0		d=151 mm	Pebble-cobblestone natural soil till 30-35% claysand filling	9,0	8	
12									
12	2	12,6	1,6		d=151 mm	Cobblestone-pebble sediment till 25% sand filling	12,0	17	
14	2 ^a	20,0	7,4		d=132mm	Pebble-cobblestone natural soil till 30-35% claysand filling	13,5	9	
16									
18									
20									
22	2	25,0	5,0		d=132mm	Cobblestone-pebble natural soil till 20% sand filling	21,0	16	
24									
26	2 ^a	30,0	5,0		d=112mm	Pebble-cobblestone natural soil till 20 % claysand filling	22,5	17	Q _I
28									
30									
30									

Are Taken sample 1` (6,0-7,0m), sample 2` (8,0-11,0m), sample 3` (11,0-12,0m), sample 4` (15,0-18,0m), sample 5` (23,0-24,0m), sample 6` (28,0-30,0m)









Borehole №2

Located in: WWTP

Start date: 21/04/2013

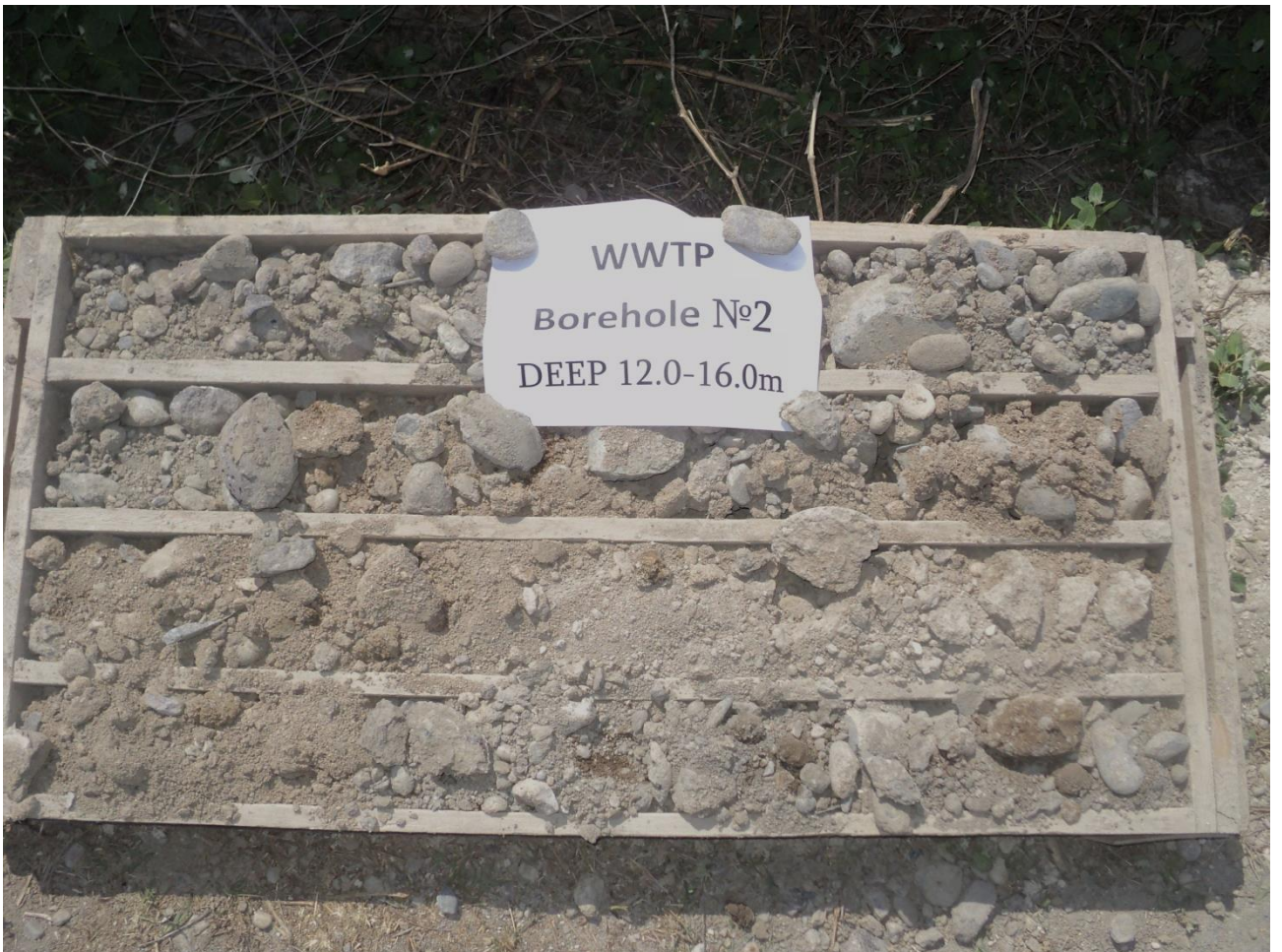
Absolute mark: 885.17 ` X=4442782.40, Y=451539.46

End date: 29/04/2013

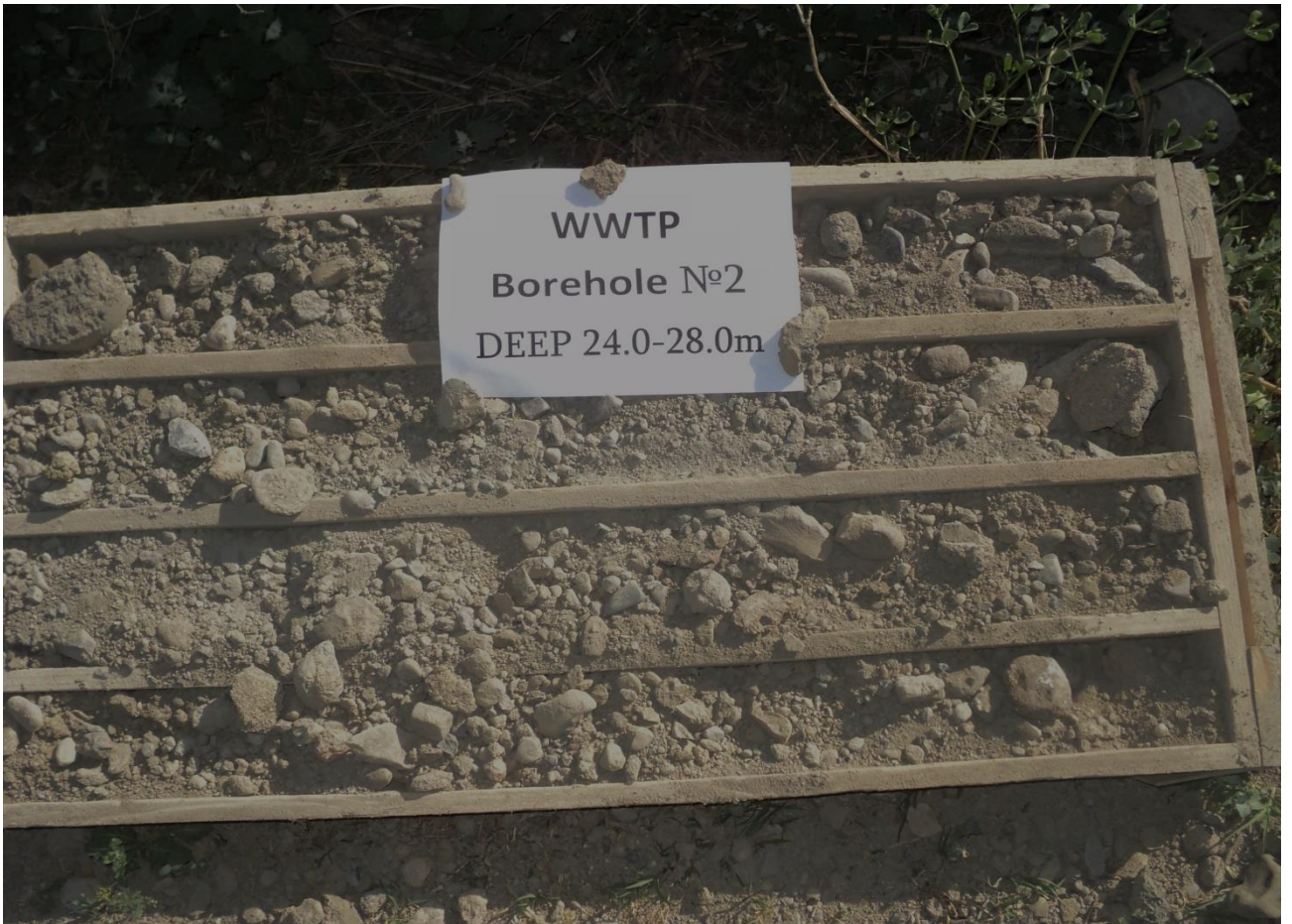
Scale 1:2 00	Layer Number	Depth/ m	Capacity/ y/m	Conventional signs	Drilling Calipers	Lithologic Description	Penetration		Geologic Age
							Depth	Stroke number	
2	1 ^a	4,5	4,5		d=151 mm	Padding natural soil cobblestone-pebble sediment natural soil till 25% sand filling, with 0.3m asphalt sheath			Q _{IV}
4									
6									
8	2 ^a				d=151 mm	Pebble-cobblestone natural soil till 30-35% claysand filling	6,0	6	Q _I
10							7,5	7	
12							9,0	8	
14							10,5	8	
16							12,0	8	
18							13,5	8	
20							15,0	8	
22							16,5	8	
24							18,0	9	
26							19,0	14,5	
28	21,0	15							
30	22,5	16							
	24	17							
	2				d=112mm	Cobblestone-pebble natural soil till 25% sand filling	25,5	15	
							27,0	14	
							27,5	8,5	
	2 ^u	30,0	2,5		d=112mm	Pebble-cobblestone till 30-35% claysand	28,5	9	
							30,0	9	

Are taken sample 7` (6,0-9,0m), sample 8` (10,5-14,0m), sample 9` (15,0-18,0m), sample 10` (21,0-24,0m) and Sample 11` (27,0-30,0m),









Borehole №3

Located in:WWTP

Start date: 29/04/2013

Absolute mark: 890.95` X=4442882.32, Y=451677.65

End date: 2/05/2013

Scale 1:200	Layer number	Depth/m	Capacity/m	Conventional signs		Drilling calipers	Lithologic Description	Penetration		Geologic Age
								Depth	Stroke number	
2	1	2,0	2,0			d=151 mm	Padding natural soil			Q _{IV}
4	1						Solid structure sandclay natural soil	3,0	3	Q _I
6		7,0	5,0					4,5	2	
8								6,0	3	
10	2					d=132mm	Cobblestone-pebble natural soil till 30% sand filling	7,5	12	
12								9,0	15	
14								10,5	14	
16								12,0	16	
18			18,0	11,0					13,5	
	2					d=112m m	Pebble-cobblestone natural soil till 40% claysand	15,0	12	
20								16,5	13	
								18,0	6	
						d=93m m		19,5	10	
20		20,0	2,0							

Are taken Sample 12` (4,0-4,5m), sample 13` (5,0-5,5m), sample 14` (9,0-12,0m), sample 15` (18,5-20,0m),





Borehole №4

Located in: WWTP

Absolute mark: 885.86` X=4442800.85, Y=4515602.64

Start date:3/05/2013

End date: 18/05/2013

Scale 1:200	Layer Number	Depth/m	Capacity/m	Conventional signs	Drilling Calipers	Lithologic Description	Borehole clip	Peasometer installation	Geologic Age
2	1	3,0	3,0		d=168mm	Solid structure dusty sandclays containing till 10-12% sand	Is clipped a pipe d=146 mm length till 20m depth	Have been installed d=50mm calipers Peaso meter with plastic pipe	Q _{IV}
4	2	16,0	13,0			Cobblestone-pebble natural soil till 25% sand filling			
6									
8									
10									
12	2 ^a	24,0	8,0		d=151µm	Pebble-cobblestone natural soil 40% claysand			
14									
16									
18									
20	2	26,0	2,0		d=132µm	Cobblestone-pebble natural soil till 20-30% sand filling			
22									
24	2 ^a	30,0	4,0		m	Pebble-cobblestone natural soil till 40 % claysand			
26									
28	2 ^a	30,0	4,0		m	Pebble-cobblestone natural soil till 40 % claysand			
30									

It has been reduced plastic pipe(Peasometer L=20 m deep,inch which L6m is strainer) . The borehole is filled from down till 17 m by washed sand,d=1-2mm, after that 1m capacity bentonite clay ,and higher filled with sand and on top is located iron pipe with valve.









5. The results of Ground slide resistance reasearch

Internal friction angle and coherence quantities have been №1^a done by the M - 10 tool with d=300mm calibers circuits for not connected soil (Layer №2nd Layer №2^a and for conneced soil(Layer №1) slide resistance has been determined by GGP-2 tool,regulatory tensions till $\sigma=400\text{kpa}$: The results are presented below

