17 SLUDGE THICKENING AND DEWATERING EQUIPMENT

17.1 GENERAL

17.1.1 Scope

1 This part specifies the requirement for the design, manufacture, construction, testing and commissioning of sludge thickening and dewatering equipment.

2 Related Sections and Parts are as follows:

Section 1	General
Section 8	Drainage Works
Section 10	Instrumentation, Control and Automation
Section 13	Building Electrical Works
Section 21	Electrical Works

17.1.2 References

BS 970..... Specification for wrought steels for mechanical and allied engineering purposes; (ISO 683-1 Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Non-alloy steels for quenching and tempering; ISO 683-2 Heat-treatable steels, alloy steels and free-cutting steels — Part 2: Alloy steels for quenching and tempering; ISO 683-3 Heat-treatable steels, alloy steels and free-cutting steels — Part 3: Case-hardening steels; ISO 683-4 Heat-treatable steels, alloy steels and free-cutting steels — Part 4: Free-cutting steels; ISO 683-5 Heat treatable steels, alloy steels and free-cutting steels — Part 5: Nitriding steels; EN 10250-4: Open die steel forgings for general engineering purposes - Stainless steels; EN 10095 Heat resisting steels and nickel alloys; BS PD 970 Wrought steels for mechanical and allied engineering purposes. Requirements for carbon, carbon manganese and alloy hot worked or cold finished steels; EN 10089 Hot rolled steels for quenched and tempered springs. Technical delivery conditions; EN 10277 Bright steel products. Technical delivery conditions; EN 10278 Dimensions and tolerances of bright steel products; EN 10088-1 Stainless steels - List of stainless steels; EN 10088-3 Stainless steels - Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes)

BS 970-1 ..... Specification for wrought steels for mechanical and allied engineering purposes - General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels; (ISO 683-1 Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Non-alloy steels for quenching and tempering; ISO 683-2 Heat-treatable steels, alloy steels and free-cutting steels — Part 2: Alloy steels for quenching and tempering; ISO 683-3 Heat-treatable steels, alloy steels and free-cutting steels — Part 3: Case-hardening steels; ISO 683-4 Heat-treatable steels, alloy steels and free-cutting steels — Part 4: Free-cutting steels; ISO 683-5 Heat treatable steels, alloy steels and free-cutting steels — Part 5: Nitriding steels; EN 10250-4: Open die steel forgings for general engineering purposes - Stainless steels; EN 10095 Heat resisting steels and nickel alloys; BSI PD 970 Wrought steels for mechanical and allied engineering purposes. Requirements for carbon, carbon manganese and alloy hot worked or cold finished steels)

EN 10084 ..... Case hardening steels - Technical delivery conditions; (ISO 683-3 Heat-treatable steels, alloy steels and free-cutting steels — Part 3: Case-hardening steels)

List of 'Approved Suppliers' prepared by the Public Works Authority

17.1.3 Submittals

1 In addition to the requirements of Part 1 of this Section, the Contractor shall reconfirm the information provided in the Technical Submission Schedules submitted with his Tender.

17.2 THICKENING AND DEWATERING

17.2.1 General

1 The approved methods of mechanical thickening of surplus sludge are:

(a) Centrifuge

(b) Gravity belt thickener

2 The approved method of mechanical dewatering of sludge is by centrifuge.

3 Sludge feed systems shall comprise feed pumps complete with electro-magnetic flowmeters, interconnecting pipework and fittings. The number of feed pump sets shall be in accordance with the Contract documentation but as a minimum one duty and one standby pump shall be installed.

4 The feed pumps shall be of the progressive cavity type and shall be fitted with a mechanical speed variator. Speed shall be automatically and manually adjustable to regulate the flow into the thickener according to its performance and variations in the incoming sludge quality. The pumps shall comply with the requirements of this Section 9.

5 Thickened sludge shall discharge to a thickened sludge pump and be pumped to the digestion system unless otherwise specified. A minimum of one duty and one standby pump shall be provided. All necessary pipework and valves shall be provided.

6 Thickened sludge pumps shall be of the progressive cavity type fitted with motors rated IP65. The pumps shall be in accordance with the general requirements of this Section 9.

7 Access platforms and stairways shall be provided to give operators access to all items of Plant requiring maintenance or operation.

8 Polymer preparation and dosing systems shall be provided complete with all interconnecting pipework and fittings. The system shall be in accordance with the general requirements of Section 22.

9 The control equipment shall comprise new FBAs that shall incorporate a PLC section complete with Human Machine Interface (HMI) suitable for connection to SCADA and telemetry in accordance with Section 21 and Section 10 of this Specification.

10 All plant and equipment shall be housed in an air-conditioned building.

17.3 GRAVITY BELT THICKENER

17.3.1 General

1 Each gravity belt thickener (GBT) unit shall be a complete package plant and the general arrangement of each belt thickener system shall include:-

(a) Belt thickener
(b) Polyelectrolyte mixing system
(c) Conditioning tank
(d) Drive unit
(e) Sludge scraper and lift blades
(f) Washwater system
(g) Hydraulic power pack
(h) Sludge feed pump
(i) Ventilation

2 Sludge belt thickeners shall consist of an endless dewatering belt passing around a series of rollers.

3 The design of the plant shall permit a controlled feed of sludge to be mixed with a controlled flow of polyelectrolyte in a mixing drum from which it shall go through a flocculation stage prior to discharge onto the dewatering belt. The flocculated sludge shall then travel along the belt before climbing over a ramp and discharging as a thickened sludge from a horizontal stage of the machine.

4 The belt shall be washed automatically using final effluent, and be arranged for ease of threading, alignment and tensioning.

17.3.2 Polyelectrolyte Mixing System

1 A non-clogging, multiple baffle mixing device shall be incorporated into the inlet of the machine. The mixing system shall ensure intimate dispersion of conditioning polyelectrolyte agent with the incoming sludge. The polyelectrolyte dosing position shall be both multiple and variable to suit the type of sludge being treated.

17.3.3 Conditioning Tank

1 Mixed sludge and polyelectrolyte shall pass to a bifurcated upwardly diverging conditioning tank, which shall be suitably sized to enable good floc formation to occur. The outlet of the tank shall be designed such that the flocculated sludge distributes gently and evenly across the full width of the filter belt.

17.3.4 Drainage Section:

1 The drainage section shall comprise a woven mono-filament polyester filter belt horizontally supported on a PVC-U perforated support grid to allow rapid drainage of filtrate to a collection system. The edges of the belt shall be raised by means of guides to prevent sludge overflow during peak flow rates.

2 The belt weave selected shall be suitable for the sludge to be dewatered.

3 The belt shall incorporate a simple quick release to enable belt replacement to be effected with minimal delay.

4 Blades shall be located at the entry position to the drainage section to induce drainage furrows in the sludge blanket.

5 Drainage shall be connected into the works drainage system.

17.3.5 Machine Rollers

1 The machine shall be equipped with the following rollers:-

2 Manually adjustable tension rollers to allow pre-setting of the belt tension. The rollers shall be mounted on the top frame member in plummer blocks fitted to manually adjustable slides.

3 A hydraulically sleeved belt alignment roller. The alignment system shall be automatic. The belt shall be maintained central to the roller system. Should the alignment system fail or lose pressure, excessive wander shall be detected by limit switches and the drive shall stop.

4 A drive roller mounted on the top frame member in plummer blocks.

5 Plummer blocks shall be fitted with heavy-duty bearings. Bearings shall have a guaranteed life in excess of 100,000 hours. Auxiliary seals shall be fitted to bearings to prevent the ingress of water.

6 For maintenance purposes, rollers shall be easily removable from the side of the machine, without the need to dismantle any other components.

17.3.6 Drive Unit

1 The drive roller shall be chain-driven through a set of sprockets and manually adjusted hydraulic speed variator by an induction motor or gear motor unit.

2 Gear motors shall be suitably rated and protected.

3 Gear motors bearings shall have a guaranteed life in excess of 50,000 hours. The AGMA service factor of the gear motor shall not be less than 1.5.

17.3.7 Sludge Scraper and Lift Blades

1 An easily replaceable sludge blade shall be positioned at an angle to the drive roller to ensure that sludge is effectively removed from the filter.

2 An easily replaceable sludge lift blade shall be positioned on the horizontal section of the filter belt immediately prior to the drive roller. The blade shall be capable of being locked in or out of position, as the process requires. The blade height shall be adjustable and shall exert a backpressure on the advancing sludge to cause it to back up over the blade and dewater by self-weight.

3 Sludge shall fall down a stainless steel Grade 316 S31 to BS 970-1 (partially replaced by EN 10084) chute directly to a thickened sludge pump.

17.3.8 Washwater System

1 The belt wash system shall consist of a high-pressure spray pipe fitted with an integral cleaning device for cleaning nozzles without dismantling or interrupting operation. Final effluent shall be used as washwater. The whole belt wash area shall be totally enclosed to prevent release of spray to the atmosphere surrounding the thickener.

2 A break tank and duty/standby booster pumps shall be incorporated as part of the system to serve all the GBT's. The Contractor shall adhere to the appropriate health and safety guidelines, relating to water borne and air borne bacteria arising from high-pressure atomising washwater systems utilising final effluent, in his design.

17.3.9 Hydraulic Power Pack

1 An hydraulic power pack shall be supplied to provide drive and control for each GBT. This shall be floor mounted adjacent to the thickener.

2 The hydraulic power pack shall comprise:-

(a) A hydraulic fluid tank fitted with filler cap, strainer, fluid level gauge and fluid temperature gauge, bund and lockable drain.

(b) An electric motor driven hydraulic pump. The pump speed shall not exceed 1500 rpm.

(c) Hydraulic accumulator, filter, pressure regulators and control valves.

17.3.10 Machinery Construction and Materials

1 The machine frame shall comprise structural steel channel and angle sections welded and bolted to form a rigid framework. The frame shall incorporate fabricated steel stops to allow operators to view the horizontal section of belt.

2 Filtrate troughs, filtrate tanks, conditioning tanks, etc., shall be constructed of stainless steel plate to BS 970 Grade 361 S31 or shall be of glass reinforced plastic.

3 The sides of the machine shall be enclosed within easily removable GRP or PVC-U panels. Guards and splash plates shall be of steel or PVC-U materials. Guards shall be placed over moving parts of the machine.

4 Scraper, thickening and furrow blades shall be of high-density plastic, to avoid damage to the filter belt.

5 The equipment shall be self-contained, hydraulic power packs, actuating mechanisms and drive units shall be mounted on the structural framework.

6 All steelwork other than stainless steel shall be galvanised.

17.3.11 Sludge Feed Pumps

1 Each GBT's shall have a dedicated duty/standby sludge feed pump

17.3.12 Ventilation

1 A ventilation hood and curtain system shall be provided to isolate the thickener from the surrounding building and ensure that high rate ventilation is concentrated on the machines. A ventilation system shall be provided to ensure that odour/gasses are contained within the hood. The ventilation system shall be designed for connection to an odour control unit.

17.4 CENTRIFUGE

17.4.1 General

1 Centrifuges shall be of the horizontal decanter type and consist of a high speed rotating bowl containing a scroll conveyor. The scroll shall be designed to rotate in the same direction as the bowl but at different speed. The bowl and the scroll shall be balanced independently. The speed differential will be provided and controlled by using two motors with variable speed control system.

2 The centrifuge shall be designed for use with wastewater sludges. The bowl, scroll and bearing hub of the centrifuge shall be manufactured in duplex stainless steel SAF 2205 or higher grade. The bowl shall be centrifugally cast. All other parts in contact with sludge shall be constructed of stainless steel Grade 316 S31to BS 970-1 (partially replaced by EN 10084).

3 Inlet and outlet parts, rotating parts and wear zones shall be designed with either replaceable wearing parts or from abrasion resistant materials. Inlet and outlet parts, rotating parts and wear zones shall be designed such that replacement or adjustment can be completed easily within a single working day. The edge of the screw conveyor shall be protected by spray-on tungsten carbide alloy or tungsten carbide tiles.

4 The centrifugal force at the inner surface of the bowl shall be a minimum of 2500g for thickening centrifuges and 2900g for dewatering centrifuges. For torque based back drive systems, the pond depth in the centrifuge bowl shall be adjustable through the use of replaceable or adjustable dam plates at the liquid discharge end.

5 The solids discharge shall be fitted with field replaceable stellite bushes.

6 The differential speed adjustment between the bowl and the scroll conveyor shall be an energy efficient system driven by an electric motor. Differential speed adjustment of scroll speed shall be infinite within the range of ± 1 to 15 rpm with an accuracy of +/- 0.05 rpm via an electric motor and inverter. The adjustment of the differential speed to accommodate changes in solids content of the feed shall be fully automatic.

7 Torque experienced by the back drive shall be monitored continuously. Two stages of high torque alarm shall be provided. Stage one shall initiate feed shut off. If the torque drops below the torque alarm, the control system shall automatically open the feed. Stage two high high torque alarm initiates the centrifuge shut down sequence. The centrifuge scroll shall be kept running to clear the bowl when the decanter is slowing down under normal shutdown or a high high alarm shutdown sequence.

8 The sludge feed tube shall be designed to allow the dosing of polymer directly into the scroll distribution ports. The sludge inlet zone shall be low shear design to minimise floc destruction.

9 The centrifuge shall be balanced and factory tested with a vibration level less than 5mm/s. The centrifuge shall be equipped with rubber vibration dampers to minimise the transfer of vibration to structures. The centrifuge shall be continuously monitored for vibration, with a two stage alarm. Stage one shall initiate a high vibration alarm warning displayed on the control panel and through the telemetry system. Stage two shall signal a high high vibration alarm and initiate the automatic centrifuge shutdown sequence.

10 The centrifuge noise level shall not exceed 75 dBA when measured one metre from the machine in any direction.

11 The bearings shall be designed for a L10 life of 100,000 hours. Bowl bearings shall be continuously monitored for temperature with a two stage alarm. Stage one shall initiate a high temperature alarm warning displayed on the control panel and through the telemetry system. Stage two shall signal a high high temperature alarm and initiate the automatic centrifuge shutdown sequence.

12 The main bearings on the centrifuge scroll and gears shall be lubricated for life.

13 The centrifugal bowl assembly and drive system shall be mounted on a base frame. The base frame shall be able to support all the static and dynamic loading. The base frame shall be fabricated from carbon steel with painting and corrosion protection in accordance with Section 8 Part 8.

14 Centrate from the centrifuges shall be discharged directly into the site drainage system.

17.4.2 Sludge Feed Pumps

1 Each centrifuge shall have a dedicated duty and standby feed pump.

17.4.3 Sludge Discharge Arrangements

1 The thickening centrifuges shall have a thickened sludge pump dedicated to each centrifuge outlet with standby pumping facilities that can be immediately utilised for any centrifuge without affecting the flow from any other centrifuge.

2 Dewatered sludge from the dewatering centrifuges shall be transported by a system of conveyors to a sludge loading area outside the building.

3 The Contractor shall size the conveyer system to handle all dewatered sludges from the centrifuges at up to 25% dry solids.

4 The conveyor system shall incorporate an adjustable high level cut out which shall inhibit flow from the centrifuge to prevent overflow.

5 If any one conveyor fails it must still be possible to operate the necessary number of duty centrifuges using the remaining conveyors.

6 Emergency off buttons shall be provided adjacent to each conveyor.

7 The conveyor system installed under this contract shall permit the installation of further duty centrifuges in future.

8 The conveyor system shall be of proprietary manufacture with the detailed arrangements, including the controls, designed by the supplier or a specialist in such equipment.

9 The body and helical screw of screw conveyors shall be of stainless steel construction and the system shall be heavy duty and robust in construction with ample features that will allow for ease of operation, maintenance and repair

17.4.4 Ventilation

1 A sealed inlet and outlet arrangement shall be installed to prevent the emission of gasses from the system into the building. The ventilation system shall be designed for connection to an odour control unit.

2 The Contractor shall assess the need for ventilation for maintenance purposes in accordance with the centrifuge manufacturers recommendations and provide an appropriate system to protect personnel and equipment from harmful effects of sewage sludge gasses, whilst the centrifuge is either not in use or is being maintained.

17.4.5 Washwater System

1 Each centrifuge shall incorporate a wash system, which shall consist of an automatically operated injector nozzle designed to displace sludge through the process in preparation for when the centrifuge is being shut down. A further manual hose shall be provided for manual washing of the centrifuge during maintenance. Final effluent shall be used as washwater. A break tank and duty/standby booster pumps shall be incorporated as part of the system.

17.5 INSTALLATION AND COMMISSIONING

17.5.1 Installation and Commissioning

1 The equipment delivered to Site shall be examined by the Engineer to determine that it is in good condition and in conformance with the approved working drawings and certification. All equipment shall be installed in strict accordance with Part 1 of this Section 9, the relevant Parts of this Section 9 for ancillary equipment installed and the manufacturer's instructions.

17.5.2 Testing

1 Test Procedures shall be in accordance with Part 1 of this Section 9 and in addition those listed below.

2 Unless otherwise stated in the Contract Documents, performance prior to Taking Over shall be judged against the following criteria.

3 Sludge thickening – four spot samples shall be collected each day of the feed sludge and the thickened sludge over a period of 7 days. The quantity of polyelectrolyte used over this period shall also be recorded. The thickening plant will be considered acceptable if during this period the thickened sludge has a dry solids content equal to or greater than stated in the Tender Submission and the quantity of polyelectrolyte used does not exceed the quantity stated in the Tender Submission.

4 Sludge Dewatering – four spot samples shall be collected each day of the feed sludge and the dewatered sludge over a period of 7 days. The quantity of polyelectrolyte used over this period shall also be recorded. The dewatering plant will be considered acceptable if during this period the dewatered sludge has a dry solids content equal to or greater than stated in the Tender Submission and the quantity of polyelectrolyte used does not exceed the quantity stated in the Tender Submission.

5 Sample collection and analysis shall be undertaken by an approved independent laboratory at the Contractor's cost.

END OF PART