Mechanical Works Specifications

Sewage Treatment Plant (STP)
PREFACE

Indah Water Konsortium Sdn. Bhd. (IWK) is the national sewerage services company responsible to plan, design, operate and manage the national sewerage infrastructure in Peninsular Malaysia. Since its inception in 1994, IWK had seen through the steep improvements in the country’s lagging standards in the sewerage sector.

Series of procedures, guidelines, standards, specifications and best practices had been developed and introduced over the past decade to enhance the standards in the sewerage industry. This has resulted in a better planned and well organized development of new sewerage systems to fulfill the whole life infrastructure obligations. This continual effort is important in moving the industry to higher standards which will uplift the image of our local sewerage industry.

This Mechanical Works Specifications have been produced to specify the minimum requirements of mechanical works for a particular equipment in order to achieve optimum performance and to meet our system requirement. These include the mechanical work specifications details on the installation, arrangement, operation, and expected performance of a particular machinery at site. This document will complement with the Product & Material Specifications document. The document should be used during the design and installation stage of STP.

In the preparation of this document, references have been made to Malaysian Sewerage Industry Guidelines (Volume I to V), various internationally accepted codes of practice and standard, and adapting them to local conditions. Considerable assistance and valuable advice have also been derived from a panel of experts and such assistance is hereby acknowledged.

Whilst compliance to these guidelines is strongly encouraged, engineering discretion and best advice need to be sought for betterment in case to case application.

It is IWK’s hope and vision to see a better and sustainable sewerage infrastructure in the coming years.

Prepared by,

Planning and Engineering Department,
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This document was a cooperative effort between IWK Planning & Engineering Department (PED), IWK Operation & Maintenance Department (OMD), and IWK Capital Works & Refurbishment Department (CWRD). To all, PED would like to express recognition and appreciation to the following personnel in developing this document.

Peter Tan (CWRD)
Mohd Lutpee Salleh (OMD- Alam Damai)
Shamsul Hisham Abu Bakar (CA - Southern)
Abdul Rahim Md. Nordin (PED)
Ruzaini Ahmad Jani (PED)
Tengku Shahrul Azlan Tengku Azizan (PED)
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BIBLIOGRAPHY
1.0 PENSTOCK

1.1 General

Penstocks shall be manufactured in accordance with BS 7775 or AWWA C501.

Each penstock shall be suitable for operation in the area in which it is located. The penstocks shall be used for isolating the flow and not for flow control.

All materials used in the construction of the penstocks shall be in accordance with the requirements specified in the IWK’s Product and Material Specifications, unless specified otherwise.

Installation of the penstocks shall be conducted in accordance with the manufacturer’s recommendations/instructions under the direction and supervision of a competent representative of the manufacturer. For installation of large penstock (1500 mm sq. and above) which cannot conveniently be manhandled, a means to facilitate handling of penstock such as lifting davit, chain hoist, mobile crane, etc. shall be provided

1.2 Submittals

Shop drawings and quality control records for equipment and its relevant components shall be submitted to the S.O. prior delivery to site for verification and approval.

1.2.1 Shop Drawings

Shop drawing for equipment shall consist of the following:

a) Detailed equipment drawings indicating its capacity/rating, components, physical dimensions, coatings, power requirement and other pertinent information.

b) Table for material of construction, standard and its grade for each relevant component.

c) Loadings of the equipment for civil and structural design purpose.

1.2.2 Quality Control Records

a) Manufacturer’s Certification of Compliance.

b) Material certificates.

c) Performance test records and certificates.

d) Calibration certificates.

e) Other relevant test records and certificates.

1.3 Storage of Penstock

Proper storage of penstock is necessary to avoid damage to the penstock components which will cause poor performance.

a) During handling, penstock shall be supported by full length in order to avoid structural twisting.

b) Penstock shall be stored in clean and dry environment to prevent distortion.
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c) Preferably, penstock shall be installed inside the room and shall be covered to protect its machined surface.
d) Penstock and its components i.e. stem, headstock etc. shall be stored in sleeping position and shall not be stacked together.
e) Penstock of rubber seating faces and motor shall be stored inside the room.

1.4 Types

1.4.1 Wall Mounted Type

Wall mounted penstocks can be classified into flat back and spigot type. The penstock frame shall be mounted onto the wall and shall be held in position by using cement grout and anchor bolts. A chemical resin bolts consist of stainless steel studs and mortar based epoxy resin can also be used for anchoring purpose.

Fig. 1.1 - Flat back type

Fig. 1.2 - Spigot type

1.4.2 Channel Mounted Type

The penstock frame shall be embedded and anchored in grooves provided in the side walls of the channel.
1.4.3 Weir Gate

Weir gate is a downward opening gate used to control head level by allowing water flows over the slide. The penstock frame shall be mounted onto the wall and shall be held in position by using cement grout and anchor bolts. A chemical resin bolts consist of stainless steel studs and mortar based epoxy resin can also be used for anchoring purpose.
1.5 Installation of Penstock

1.5.1 Wall Mounted Installation

Penstock frame and gate shall be assembled together and shall be installed with the gate in closed position.

Penstock shall be installed with a flush invert feature in order not to obstruct flow and also to prevent the rubbish stay or block at the slot between the bottom of the penstock and the mounted wall.

Recess shall be provided at the tank floor to accommodate the penstock seating in accordance with the manufacturer’s recommendation and shall be grouted after installation of the penstock is completed.

Box outs for concrete anchor bolts and recess for spigot end, if applicable shall be provided. The pockets for anchor bolts shall be large enough to allow movement and adjustment of the bolts. For accurate positioning of the bolt, a template shall be provided to the correct measurement of the penstock frame.

Vertical and perpendicular alignment of the template shall be checked and also the projection of the bolt prior to filling the box out pocket with non-shrink grout. The template is only removed when the grouting is fully cured after 2-3 days, subject to grouting material manufacturer’s recommendation.

The concrete wall surface shall be roughened, where the penstock frame will be sitting before putting in the penstock to the recommended grouting thickness, between the back of the frame and concrete wall. The penstock should be spaced away from the wall using steel packing pieces, to leave a nominal 20-25 mm grouting clearance. In addition to these packing pieces, shims may be used when necessary.

The penstock is located and supported to its correct final position by carefully checking for vertical and perpendicular alignment using a spirit level placed on the surface/seat of the penstock.

The correct level and alignment of the penstock is checked by using a plumb. The frame is secured by tightening all bolts to ensure no movement of the frame during grouting. It is rechecked to make sure that the nuts are not over tightened causing excess strain to the penstock frame. Torque wrench shall be used for this purpose.

Penstock is shuttered up for grouting by using timber faced with a thin neoprene type spongy material to ensure a good, clean seal without undue pressure.

The door and frame faces are checked with feeler gauge (0.1 mm) to make sure that the seating faces are in position. The gauge shall not pass through mating sealing faces.

Penstock alignment is checked again before pouring in fluid grout, and 2-3 days shall be allowed for curing based on the grouting material manufacturer’s recommendation.

When the grout is set, the bolts are re-tightened using a torque wrench in sequence before removing the shuttering and any excess grout or debris from the penstock. Two (2) threads are made available to the bolts upon tightening of the nuts.

The required anchor bolt sizes and torque for the various bolt and nut sizes tightening shall be as tabulated in Fig. 1.7, subject to the manufacturer’s recommendation.
Fig. 1.5 - Flush invert installation

Fig. 1.6 – Wall mounted installation
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Fig. 1.7 – Anchor bolt size and torque requirement

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<td>2100 - 2500</td>
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Torque*: Torque required for nut tightening

1.5.2 Channel Mounted Installation

Grooves shall be provided in the side walls and floor of the channel for the penstock frame to be embedded. Grooves shall sized to allow a nominal 20-25 mm grouting clearance around the penstock frame.

Penstock shall be installed with a flush invert feature in order not to obstruct flow and also to prevent the rubbish stay or block at the slot between the bottom of the penstock and the mounted wall.

Prior to grouting, the grooves surface shall be roughened. Vertical and perpendicular alignment of the penstock shall be checked by using spirit level placed on the surface/seat of the penstock. The door and frame faces are checked with feeler gauge (0.1 mm) to make sure that the seating faces are in position. The feeler gauge shall not pass through mating sealing faces.

1.5.3 Stem and Guides

After the installation of penstock is complete, the stem shall be installed and threaded into thrust nut.

Where stems are furnished in more than one piece, the different sections shall be joined by rigid coupler.

Stem alignment and verticality shall be checked using a spirit level on the stem surface.

Stem guide brackets shall be attached to the concrete walls by sufficient anchor bolts to prevent twisting or sagging under load. The stem guides shall be installed from bottom up as stem is installed.

The stem guide shall be spaced such that the L/R ratio not exceeding 200 (L: spacing between the 2 supports, R: radius of the gyration). Double spindles shall be provided for the rectangular penstock of W/H ratio equal and exceeding 2 (W: width of penstock gate, H: height of penstock gate).

1.5.4 Headstock

Headstock shall be provided with solid base footing for bolting onto the concrete slab or mounting bracket, where civil platform is not available for mounting of headstock.

Headstock bracket shall be mounted to the wall mount by the anchor bolts. Top surface of the bracket shall be checked by using spirit level gauge to ensure it is aligned perpendicularly with the stem passing through the center of the stem slot.

After the headstock bracket is installed completely, the headstock shall be placed on top of the bracket and mounted with four bolts and nuts.
Headstock shall be suitably designed to suit operation mode requirement of the penstock i.e. electric actuator, hydraulic/pneumatic actuator or manual operation. Height of the headstock handwheel from the operating floor level shall be approximately 900 mm for easy operation of the penstock.

The headstock shall be positioned such that it will be accessible for maintenance works. Localise platform allowing 600 mm clearance around headstock and its actuator shall be provided for the headstock to be installed, where the floor slab is not available.

**Fig. 1.8 - Headstock operation mode options**

1.6 Testing at Site

The following tests shall be carried out at site after installation is completed:

1.6.1 Seat Clearance Check

Seat clearance is checked to ensure that 0.1 mm thick feeler gauge will not pass through the mating sealing faces.

1.6.2 Functional Test

Penstock shall be operated by fully opening/closing its gate to confirm the following:

- gate can be fully opened and closed
- free movement of spindle/coupler, does not foul with stem guide
- adequate threaded length is provided for fully opening and closing of the gate
- torque required to operate the gate under maximum operating head
- time to open/close the penstock.
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- Fig. 1.2: Spigot type
- Fig. 1.3: Channel mounted type
- Fig. 1.4: Weir gate type
- Fig. 1.5: Flush invert installation
- Fig. 1.6: Wall mounted installation
- Fig. 1.7: Anchor bolt size and torque requirement
- Fig. 1.8: Headstock operation mode options
2.0 SCREENS

2.1 General

Primary screens shall be provided upstream of pump stations and shall be designed to protect downstream processes and equipment in sewage treatment plant from rubbish such as rags, paper, woods and other debris. The screen shall be capable of handling the flow at maximum depth as specified and shall be designed to withstand the flushing velocity.

The secondary screens shall be provided after pump stations to further screen out the remaining floating debris and finer particles in the sewage that will disrupt the treatment process downstream.

Detailed construction of primary and secondary screens shall comply with the requirements specified in the IWK’s Product and Material Specifications unless specified otherwise.

Installation of the screens shall be conducted in accordance with manufacturer’s recommendations/instructions under the direction and supervision of a competent representative of the manufacturer. For installation of large screen which cannot conveniently be manhandled, a means to facilitate handling of screen such as lifting devices, mobile crane, chain hoist, etc. shall be provided.

2.2 Submittals

Shop drawings and quality control records for equipment and its relevant components shall be submitted to the S.O. prior delivery to site for verification and approval.

2.2.1 Shop Drawings

Shop drawing for equipment shall consist of the following:

a) Detailed equipment drawings indicating its capacity/rating, components, physical dimensions, coatings, power requirement and other pertinent information.

b) Table for material of construction, standard and its grade for each relevant component.

c) Loadings of the equipment for civil and structural design purpose

2.2.2 Quality Control Records

a) Manufacturer’s Certification of Compliance.

b) Material certificates.

c) Performance test records and certificates.

d) Calibration certificates.

e) Other relevant test records and certificates.
2.3  Storage of Screens

Proper storage of screens is necessary to avoid damage to the screen and its components which will cause poor performance.

a) During handling, screen shall be supported by full length in order to avoid structural twisting.
b) Screen shall be stored in clean and dry environment to prevent distortion.
c) Preferably, screens shall be installed inside the room and shall be covered to protect its machined surface.
d) Screen and its components shall be stored in sleeping position and shall not be stacked together.
e) Screen motor shall be stored inside the room.

2.4  Types

2.4.1  Manually Cleaned Bar Screen

The manually cleaned bar screen shall be set into position at an inclination of 30° to 40° to the vertical. The bars shall be fully extended to the floor invert level and shall be extended 75 mm above the collecting tray. Gap between the screen frame and side wall shall be sealed with stainless steel baffle plates welded to the screen frame and bolted to the walls or gasket system manufactured from a material suitable for permanent immersion in sewage or wastewater. The side wall seals shall ensure that no sewage or wastewater in the channel can bypass the screening element.

For fixed screen, the frame shall be bolted or concreted to the wall.

2.4.2  Mechanically Cleaned Screen

2.4.2.1  Mechanically Cleaned Bar Screen

Two types of mechanically cleaned bar screens are raking mechanism and non-raking mechanism type. The raking mechanism type consists of chain driven screen and belt driven screen. Both types operate by means of a bar rack and travelling rake of front-raked or back-raked type.

2.4.2.1.1  Raking Mechanism Type

Two types of raking mechanism screens are front raked and back raked type. The front raked type is suitable for primary and secondary screening application. The back raked type is suitable only for secondary screening application. The rake shall be running at 2 – 4 m/min.

The screen frame shall be set into position at an inclination of 25° to 30° to the vertical.

Sufficient space of about 750 mm clearance shall be allowed around the screen at deck level for accessibility to the motor and other components for maintenance works purpose. Access to the screen components by means of raised platform shall be provided, if height of the screen components exceed 1.5 m from the deck level. Gap between the screen frame and side walls shall be sealed with stainless steel baffle plates welded to the frame and bolted to the walls or gasket system manufactured from a material suitable for permanent immersion in sewage or wastewater.
Before the screen is fixed, horizontality of the screen shall be checked to meet the tolerance recommended by the manufacturer. Shim plates shall be inserted between the frame and floor to align/level the screen.

The screen shall be fixed at both sides of the frame at the deck floor where it rests on and also at the channel floor. Angle bars shall be welded to the screen frame and bolted with wall plugs to the deck floor and channel floor respectively.

The screen discharge chute shall be set to guide all the screenings removed by the screen as efficiently as possible into the container. The chute shall form an integral part of the screen when in operation and shall be steep enough to avoid collection of screenings in the chute.

The container/conveyor shall be positioned below the screen discharge chute to receive screenings. Gap between the discharge chute outlet and the container/conveyor receiver shall be 50 to 100 mm. A minimum clearance of 750 mm shall be allowed between the screen and container/conveyor for accessibility to the screen and container/conveyor components.

Belt and chain tensioning shall be checked and adjusted in accordance with manufacturer’s recommendations.

**Fig. 2.1 - Installation of raking screen**
2.4.2.1.2 Non-Raking Mechanism Type (Step Screen)

Step screen operates by means of the movement of the fixed and the moving lamellas/blades. The step screen is suitable only for secondary screening application where fine screen is required.

The screen shall be installed in the channel at an angle recommended by the manufacturer. Enough space shall be made available around the screen for maintenance works purpose. Minimum clearance to the screen shall be as follows:

- 1 m at the side
- 1.5 m in front of the screen
- 1 m behind the machine/drive motor

Access platform to the screen drive motor shall be provided if height of the motor exceeds 1.5 m from the floor level. Recess for the level probes shall be provided as per manufacturer’s recommendation.

The screen shall be placed into its channel such that the base plate of the screen lies levelly on the channel floor. Adjustment and levelling of the base plate shall be carried out by using shim plates. Gap between the channel wall and the screen frame shall not exceed 25 mm. Otherwise, stainless steel baffle plates shall be mounted on the frame or channel wall or a gasket system manufactured from a material suitable for permanent immersion in sewage or wastewater for sealing the gap.

The screen shall also be fixed at both sides of the frame at the deck floor. Angle bars shall be welded to the screen frame and bolted with wall plugs to the deck floor.

The screen discharge chute shall be set to guide all the screenings removed by the screen as efficiently as possible into the container. The chute shall form an integral part of the screen when in operation and shall be steep enough to avoid collection of screenings in the chute.

The container/conveyor shall be positioned below the screen discharge chute to receive screenings. Gap between the discharge chute outlet and the container/conveyor receiver shall be 50 to 100 mm. A minimum clearance of 750 mm shall be allowed between the screen and container/conveyor for accessibility to the screen and container/conveyor components.

2.4.2.2 Rotary Drum Screen

Rotary drum screen is used to separate floating, suspended and settling solids from sewage or wastewater by means of horizontal screen basket and shall be provided with spray nozzles for cleaning purpose. Two types of rotary screen which is classified by their feeding mechanism: externally fed and internally fed type.

Enough space shall be made available around the screen for maintenance works purpose. Minimum clearance to the screen shall be as follows:

- 1 m at the side
- 1.5 m in front of the screen
- 1 m behind the machine/drive motor
Access platform to the screen drive motor shall be provided if height of the motor exceeds 1.5 m from the floor level. The screen chain/belt adjustment point shall be accessible for maintenance purpose.

The external fed drum screen unit shall be positioned and aligned to match its feeding tank and collecting tank with the influent inlet pipe and effluent outlet pipe respectively.

The screen footings shall be mounted onto a floor. Adjustment and levelling of the screen shall be carried out by using slim plates to the allowable tolerances recommended by the manufacturer. The screen chain/belt tensioning shall be aligned and adjusted in accordance with manufacturer’s recommendation.

The container shall be positioned below the screen discharge to receive screenings. Gap between the screen discharge and the container shall be approximately 50 to 100 mm.

### 2.5 Testing at Site

Functional testing of the screens shall be carried out as follows;

- sequential operation and simulation of protection devices provided (mechanical and electrical type)
- to demonstrate correct operation/rotation with respect to sequence and level
- to demonstrate absence of vibration and noise during operation
- to demonstrate screenings are transferred effectively into collection bin, not passing through downstream side of the screen
- to check and verify raking speed in compliance with its design speed.
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Fig. 2.1: Installation of raking screen
3.0 CONVEYORS

3.1 General

Conveyors shall be used to transport screenings from wastewater or raw sewage to storage or receiving hopper.

Detailed construction of the conveyors shall comply with the requirements specified in the IWK’s Product and Material Specifications, unless specified otherwise. Installation of the conveyors shall be conducted in accordance with the manufacturer’s recommendations/instructions under the direction and supervision of a competent representative of the manufacturer.

3.2 Submittals

Shop drawings and quality control records for equipment and its relevant components shall be submitted to the S.O. prior delivery to site for verification and approval.

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Shop drawing for equipment shall consist of the following:

a) Detailed equipment drawings indicating its capacity/rating, components, physical dimensions, coatings, power requirement and other pertinent information.

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3.2.2 Quality Control Records

a) Manufacturer’s Certification of Compliance.

b) Material certificates.

c) Performance test records and certificates.

d) Calibration certificates.

e) Other relevant test records and certificates.

3.3 Storage of Conveyors

Proper storage of conveyor is necessary to avoid damage to the conveyor and its components which will cause poor performance.

a) During handling, conveyor shall be supported by full length in order to avoid structural twisting.

b) Conveyor shall be stored in clean and dry environment to prevent distortion.

c) Preferably, conveyor and its components shall be installed inside the room and shall be covered to protect its machined surface.

d) Conveyor and its components shall be stored in sleeping position and shall not be stacked together.

e) Conveyor motor shall be stored inside the room.
3.4 Types

3.4.1 Belt Conveyor

Belt conveyor shall be used to transport the screenings, sludge, etc. from the mechanical screens to the storage or dumping location. The conveyor shall be provided with receiving hopper of gravity feed type.

The capacity of the belt conveyor shall be designed with sufficient safety factor and the characteristics of the transported material shall be considered.

3.4.1.1 Installation Works

Belt conveyor shall preferably be installed in horizontal position. Enough space, approximately 1 m clearance shall be provided around the conveyor for maintenance works purpose. Conveyors shall be installed with sufficient headroom above its troughing idlers, subject to the type of screenings to be transported, so as to avoid obstruction for conveyor motion.

Height of the conveyor from the floor level shall be approximately 600 mm. Distance and height of the conveyor to the discharge chute shall be approximately 750 mm and 50 to 100 mm respectively, to provide sufficient space for inspection and maintenance.

The discharge chute shall be set to guide all the transportation materials as efficiently as possible into the container. The chute shall be higher than conveyor level and shall be steep enough to avoid collection of transportation materials in the chute.

For practical reasons, all conveyors with a length more than 6 m shall be delivered in two halves, with support legs, receiving hopper and the power unit demounted. Two support legs shall be provided at each end of the conveyor. Interval and total number of the support legs shall be based on the physical dimensions of the conveyor, loading and also size of the support legs, as recommended by the manufacturer.

Conveyor shall be placed onto its position on a solid level surface of the floor designed to endure both static and dynamic loadings of the conveyor and transported materials. The demounted components shall be assembled according to the installation drawing.

Alignment of the belt system and tensioning shall be carried out in accordance with the manufacturer’s recommendation/instructions.

3.4.2 Shaftless Screw Conveyor

Shaftless screw conveyor is used as transportation device for small particulate solids, sticky and long fibre materials, rags, wires, etc from sewage or wastewater to the storage or dumping location. Screw conveyor shall be provided with water rinsing system for washing purpose and typically equipped with compactor at the discharge end for dewatering screenings before they are discharged.
3.4.2.1 Installation Works

Screw conveyors shall be installed at least 10° from horizontal to provide adequate drainage. Enough space, approximately 1 m clearance shall be provided around the conveyor for maintenance works purpose.

Conveyors shall be installed with 700 mm minimum headroom above the top edge, so as to be able to remove the cover, screw and lining without problems. For extremely sticky conveyed materials, periodic water flushing shall be provided. The trough covers shall then be mounted for easy access and opening.

Height of the conveyor from the floor level shall be approximately 600 mm. Distance and height of the conveyor to the discharge chute shall be approximately 750 mm and 50-100 mm respectively, to provide sufficient space for inspection and maintenance. The discharge chute shall be set to guide all the transportation materials as efficiently as possible into the container. The chute shall be higher than conveyor level and shall be steep enough to avoid collection of transportation materials in the chute.

For practical reasons, all conveyors with a length more than 6 m shall be delivered in two halves, with support legs, feeder boxes and the power unit demounted.

Conveyor shall be placed onto its position on a solid level surface of the floor designed to endure both static and dynamic loadings of the conveyor and transported materials. The demounted components shall be assembled according to the installation drawing. The transmission shall be turned so that the motor lies in the same direction as on the installation drawing.

Conveyors delivered in two sections shall be assembled on a level surface to obtain correct alignment. The troughs shall be screwed together at the “U” flanges provided for the purpose. The lining joints shall be evened up if necessary to prevent the spiral screw from striking the lining edges, causing high wear and reduced service life.

Spiral screw sections shall be welded together according to the manufacturer’s recommendation/instructions. Straightness and alignment of the sections shall be checked prior to welding works. Three runs of welding on each side are recommended for a full strength weld. Maximum misalignment for a finished welded spiral screw shall be 5 mm/m, subject to the manufacturer’s recommendation.

Support legs shall be positioned in place and bolted to the trough mounting so that the top edge of the trough mounting touches the outward flanges of the U-shaped trough. The trough shall be checked if it is correctly aligned to the specified tolerances, so that the cover fits levelly, without being distorted.
Support legs shall be provided at the drive end and tail end of the trough plus intermediate supports with spanning not more than 3 m. Each support leg for 400 mm diameter screw or less shall be provided with two bolting holes for anchoring onto the floor. For a screw larger than 400 mm diameter, four bolting holes shall be provided.
3.5 Testing at Site

Functional testing for the conveyors shall be carried out as follows;

- sequential operation and simulation of protection devices provided (mechanical and electrical type)
- to demonstrate correct operation/rotation.
- to demonstrate absence of vibration and noise during operation.
- to demonstrate screenings are transported effectively into receiving hopper
- to demonstrate belt and motor speed in compliance with the design speed
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4.0 PUMPS

4.1 General

4.1.1 General for pumps

Construction of pumps shall comply with the requirements specified in the IWK’s Product and Materials Specifications, unless specified otherwise. All pumps, where possible, shall be of the same manufacturer and design to simplify spare requirements and maintenance.

All pumps shall be installed in accordance with the manufacturer’s recommendations/instructions under the direction and supervision of a competent representative of the manufacturer. Generally, pumps shall be mounted on common base plates with the drive motor where applicable and each base plate shall be mounted on a concrete plinth as specified below.

The pumps shall be positioned so that a positive suction condition is obtained within the full curve of operation. The net positive suction head required (NPSHR) curve for the full range of operation shall be compatible with the net positive suction head available (NPSHA) to enable the pump to operate without cavitation over the full range of flows at all liquid levels.

For multiple pumps operation, pumps shall be arranged for parallel operation. At least 750 mm clearance shall be allowed between the pumps so as to provide sufficient working space for maintenance/service works.

Each pump shall be complete with all necessary ancillary equipment and fittings to render the unit complete and immediately ready for service. This shall include isolating valves, non-return valves, lubrication water pipework, air release pipework, pressure gauges, holding down bolts, access platforms and other items as appropriate. Valves and accessories for the pumps shall be installed and positioned such that they will be accessible for maintenance purpose.

Pump sump and pump house shall be provided with lifting devices to facilitate installation and removal of pumps for maintenance works. Electric overhead crane shall be provided for the pump sump and pump house for handling pump of more than 1 tonne weigh.

4.1.2 Concrete plinths

Concrete plinth shall be provided for the pump base plate to be anchored onto. The concrete for plinth construction shall be to Grade C30.

Concrete plinths shall be dimensioned to provide a minimum of 100 mm clearance all round pump base plate and bolt pockets will be provided for holding down bolts. Height of concrete plinth shall be minimum 100 mm above the floor level. The maximum height of the plinth shall be set such that the pump and associated pipe centrelines will not be more than 1 m high from the floor level for accessibility purpose.
4.1.3 Piping

Piping shall be installed to conform the following requirements:

a) Piping shall be arranged neatly and run the route near the floor level in general. Space for future pipe installation work shall be considered.

b) Inspection and maintenance space for the piping shall be considered.

c) The piping must be easily disassembled and removed for test and inspection if required.

d) The supports for piping and valves shall not be taken from the equipment to avoid damage to the equipment, in general.

e) Piping support shall be designed so as to be rigid structure together with pipe and support. Support of heavy valves such as check valve, gate valve 200 mm diameter or larger, etc. shall be designed to support such equipment independently as possible.

f) Interval between supports on straight piping shall be within 3m.

g) All pipes shall be flange joint type.

h) All pipes shall be sound and clean before installation.

i) Piping shall run parallel or at right angle to wall, unless noted otherwise. Minimum distance from the pipe flange to the wall shall be 150 mm.

j) All piping shall have a sufficient number of joints to allow convenient removal of piping.

k) Pipe installed shall not cause stress or strain in the line.

l) All piping shall be rigidly supported from the structures by approved hangers, brackets or concrete/steel supports with adequate provisions for expansion and construction. Pipe to be fastened to its support by U-bolt complete with rubber pad.

m) All pipes, after installation, shall be coloured according to each function. The colour shall be in accordance with IWK requirements.

n) All pipes shall have necessary drain trap to be approved by the Engineer.

o) The gap between all pipe surface and concrete structure shall be perfectly sealed with non shrink grout material and finished when they pass through the concrete structure.
p) If required, vent valves and/or drain valves shall be provided on the piping where the air or drains are accumulated, at such place as top of piping or bottom of piping.

q) The piping shall have a slope to drain water easily by gravity, if required. Also sampling connection shall be installed on the piping, if required.

r) Where a pipe passes through a wall which may subject to differential water pressure or subject to thrust, it shall incorporate a puddle flange.

Pump with suction pipework shall be provided with isolating valve. Pump delivery pipework shall be provided with non-return valve after pump discharge taper and followed by isolating valve.

A straight short piece shall be provided between non-return and isolating valve to accommodate flange adaptor. Valve flange adaptors of tied type shall be provided on the suction and delivery pipework valves to facilitate installation and dismantling of the valves from the line.

Adequate supports shall be provided for the valves and pipework. Pipes and valves shall be supported firmly on concrete foundations or steel supports so that their weight will not act on a pump body which may cause misalignment and damage to the pumps. Where there is a change in pipe direction, a thrust block or suitable anchor shall be provided for the pipe. On all changes of direction, long elbow shall be used. Short elbows may only be used where physical problem arises.

Valves and accessories for the pump pipework shall be installed at the level where they will be accessible for maintenance works. Where the pipe is run at high level, the pipe shall be installed at 2 m above the floor level. Where pipe is run at low level, a raised walkway with steps shall be provided above the pipe for crossing the pipes.

Flow velocities in the suction pipe and discharge pipe of a pump shall not exceed 1.5 m/s and 2.5 m/s respectively when the pump is operating within its specified duty range.

4.1.4 Setting of pump

Pump with common base plate shall be mounted on flat steel packings of thickness selected to take up variations in level of the concrete plinth, and such that there is nominally 30 to 50 mm space under the frame for grouting.

The packings shall be bedded by chipping or grinding of the concrete surface.

One packing only of selected thickness shall be used at each location which shall be adjacent to each holding down bolt. The number of shims shall not exceed two at each location and the thickness of each shim shall not exceed 3 mm.

Bolt pockets shall be provided with grout lead-ins and shall be formed to suit the requirements of the pump anchor bolts.

When the pump has been erected, the bolt pockets and final screeding shall be completely filled using non-shrink grout.

The pump shall be aligned, levelled and pulled down by the nuts of the holding down bolts with a spanner of normal length and no grout shall be applied until the pump has been run and checked for stability and vibration.
The pump shall be run once the mortar has hardened. When so directed, the Contractor shall complete the grouting operation by filling the space between the top of the concrete and the underside of the pump base plate.

### 4.2 Submittals

Shop drawings and quality control records for equipment and its relevant components shall be submitted to the S.O. prior delivery to site for verification and approval.

#### 4.2.1 Shop Drawings

Shop drawing for equipment shall consist of the following:

a) Detailed equipment drawings indicating its capacity/rating, components, physical dimensions, coatings, power requirement and other pertinent information.

b) Table for material of construction, standard and its grade for each relevant component.

c) Loadings of the equipment for civil and structural design purpose

#### 4.2.2 Quality Control Records

a) Manufacturer’s Certification of Compliance.

b) Material certificates.

c) Performance test records and certificates.

d) Calibration certificates.

e) Other relevant test records and certificates.

### 4.3 Storage of Pumps

Proper storage of pump is necessary to avoid damage to the pump and it components which will cause poor performance.

a) During handling, pump shall be supported by full length in order to avoid structural twisting.

b) Pumps shall be stored in clean and dry environment to prevent distortion.

c) Preferably, pumps shall be installed inside the room and shall be covered to protect its machined surface.

d) Pump motor shall be stored inside the room.

### 4.4 Pump Types

Pump types are classified based on their operating principles i.e. centrifugal pump, axial flow pump, positive displacement pump and special type pump.

#### 4.4.1 Centrifugal Pumps

##### 4.4.1.1 Submersible Pumps – Wet Pit

The pumps shall be suitable for continuous or intermittent use in fully and partially submerged conditions and capable of handling raw sewage without undue wear and tear.
The pump shall be installed such that its minimum submergence required is always lower than the pump sump minimum water level.

Pump discharge elbow and guide rail shall be properly installed in accordance with allowable tolerance specified by the pump manufacturer before the pump is lowered into the sump.

A gap of 25 mm gap shall be allowed between the sump floor and discharge elbow for grouting purpose.

Facilities such as tapers, nuts, etc. shall be provided in the anchor bolt holes for adjustment purpose of discharge elbow. Upper surface of the discharge elbow shall be horizontal within the allowable tolerance of 0.1 mm/m, subject to manufacturer’s recommendation.

Bolt holes and gap between the floor and discharge elbow shall be filled with non-shrink grout.

The pump shall slide down onto the discharge elbow through double guide rails by using the pump lifting chain suspended from the hoist hook. The guide rails shall match with the pump sliding guide size specified by the pump manufacturer so that the pump shall automatically connect and seal the discharge pipework, when it reaches the guide rail lower end. If the pump is not connected properly to its discharge elbow, severe vibration will be observed when the pump is in operation.

Guide rails shall be vertically aligned and held by guide holder just below deck level. Alignment of guide rails shall be verified against the allowable tolerance of 0.5 mm/m, subject to manufacturer’s recommendation. When the guide rails are too long (over 4 m), it is necessary to support the guide rails to pump discharge pipe by the brackets of 2 m intervals.

Pump lifting chain and cable shall be hanged on the hook and hanger respectively mounted on the wall below the floor level. The strength of the hook and hanger shall be sufficient to bear the weight of chain and cable respectively.

![Fig. 4.2 – Wet Pit Installation](image1)

![Fig. 4.3 - Discharge Elbow](image2)
4.4.1.2 Submersible Pump – Dry Pit

The pump shall be suitable for continuous or intermittent use in dry condition.

The pump shall be provided with suction elbow and support frame that will be anchored onto the floor/plinth.

A gap of 25 mm shall be allowed between the sump floor and support frame for grouting purpose.

Facilities such as tapers, nuts, etc. shall be provided in the anchor bolt holes for adjustment purpose of support frame. Upper surface of the support frame shall be horizontal within the allowable tolerance of 0.1 mm/m, subject to manufacturer’s recommendation.

Bolt holes and gap between the floor and support frame shall be filled with non-shrink grout.

Inlet pipe to pump suction shall be provided with isolating valve and shall be installed to fulfil the following requirements to avoid excessive vibration and noise:

1) Sufficient NPSH Available with respect to the NPSH Required by the pump
2) Minimize friction losses
3) Minimize number of elbows
4) Eliminate high points to prevent air entrainment into the pump
5) Ensure correct piping alignment

To accelerate the inflow smoothly into the inlet pipe and reduce inlet losses, the inlet pipe shall be provided with a bell-mouth recommended by the pump manufacturer.

If required, vent valves and/or drain valves shall be provided for the piping where the air or water are accumulated, at such place as top of piping or bottom of piping respectively.
4.4.1.3 Screw Impeller Submersible Pump

The pump shall be suitable for continuous or intermittent use in fully and partially submerged conditions. The pump shall be capable of handling raw sewage, sludge, long fibrous materials and large solids without clogging the pump.

Installation works for the screw centrifugal pump shall be similar to submersible pump of wet pit type.

The pump shall slide down onto the discharge elbow trough guide rails by using the pump lifting chain suspended from the hoist hook. The pump shall automatically connect and seal the discharge pipework, when it reaches the guide rail lower end.

4.4.1.4 Non-Submersible Pump (Horizontal Shafts)

The foundation and bolt holes for the pump shall be constructed in accordance with the plan. Cement pad shall be constructed and flat liner shall be positioned close to the bolt holes for the pump base plate temporary placement.

Reference lines for the pump and motor installation levels shall be set and marked accordingly. Pump shall be installed using the making lines as reference with the foundation bolts in suspension.

Primary alignments shall be carried out for base alignment and coupling alignment. Base alignment shall be adjusted using tapered liner within 0.1mm/m of the reference. Coupling alignment shall be carried as specified elsewhere, following which anchor grout shall be applied into the bolt holes and the foundation bolts shall be tighten temporarily.

Secondary alignment shall be carried out to reconfirm the pump installation level with respect to the reference lines, prior to tightening of foundation bolts in accordance with manufacturer’s recommendations. Non-shrink grout shall be used to grout the space between the pump base plate and the foundation.
4.4.1.4.1 Coupling Alignment

Coupling alignment shall be performed as part of primary alignment.

Coupling alignments (parallel and angular) between pump and motor shall be carried out by using a dial gauge. Adjustment for parallel and angular shall be carried out by adjusting taper liners.

Tolerances for parallelism and angular run out shall be 0.05mm and 0.1mm respectively, subject to manufacturer’s recommendations.

Coupling bolts shall only be fixed after the motor has been given an uncoupled test run.
4.4.2 Positive Displacement Pumps

4.4.2.1 Progressive Cavity Pumps

The pump shall be suitable to be used for sludge and slurry medium transfer application.

Pump shall be mounted on common base plate with its drive motor. The foundation (base) for pump shall be of adequate size and vibration proof. Flexible coupling shall be used between the pump shaft and its driven machine.

Spacing between the pumps shall be at least 750 mm, to provide sufficient working space for inspection and maintenance works. Space for pump installation shall take into account length of the pump and also minimum working space of 750 from the pump to the wall or to the nearest obstruction.

Pump shall be installed onto the concrete plinth of 100 mm high minimum. Clearance of minimum 100 mm shall be provided all round the pump support for the plinth.

The pump suction and discharge pipe shall be arranged such that when the pump is not running, the medium will always be present before and after the pump, in order to lubricate the pump during restart.

A removable distance piece shall be provided between the pump discharge end flange and isolating valve to facilitate dismantling of the pump stator/rotor for service and maintenance purpose. The removable piece shall have a minimum length in accordance with the pump’s manufacturer recommendation.

Compensators between the pump and the pipework shall be considered, in order to avoid risk of damage to the pump housing from pipeline resting on the pump and also to avoid risk of damage to the pump housing through vibrating pipeline.

![Fig. 4.7 – Progressive cavity pump removal distance piece installation](image)

4.4.2.2 Screw Pump (Archimedean Pump)

The pump shall be suitable to be used for large volume of sewage and sludge transfer application.

The angle of inclination of the screw pump to the horizontal shall be within the range of 30 to 40 degrees, subject to the angle recommended by the pump manufacturer for best pumping efficiency at the specified head and maximum flowrate.
Prior to installation, the pump sump shall be checked that it has been constructed in accordance with the plan and tolerances recommended by the pump manufacturer. The pump sump shall also be free from debris and liquids. Plinths for the bearings, base plates and supporting frames shall be roughened and fitted with starter bars for grouting purpose later.

The initial concrete trough shall be roughly formed to within approx. 30 mm clearance to the final screw diameter, i.e. the diameter of the trough should be approx. 60 mm larger than the diameter of the screw, subject to manufacturer’s recommendations.

Datum points on the inside of each screw pump trough for the chute point and the filling point shall be marked to allow the screw to be installed the correct level. The screw shall be supported on packer plates in the concrete trough and shall be adjusted to the correct position.

The bottom and upper bearings shall be positioned and levelled to the tolerances recommended by the pump manufacturer. The foundation bolts shall be fitted protruding downwards to the bearing foundations. The bearing anchor bolts shall be spot weld to the starter bars to prevent disturbance when grouting.

After the bearing plinths have been grouted and cured, the screw shall be turned manually to ensure it is running freely. The driver base plate shall be positioned in the correct position relative to the top bearing and coupling assembly after they have been installed and checked for alignment. Belt tensioning and alignment shall be checked and adjusted to the manufacturer’s instruction/recommendations for the driver gear reduction unit of belt system.

Screeing shall be carried out in accordance with manufacturer’s instruction. It is recommended to perform the screeing operation at night to avoid high temperatures and fast drying times and wherever possible the same personnel be used for each of the screw pumps. This will lead to a smoother operation with the personnel being familiar with their respective duties.

![Fig. 4.8 – Screw pump installation](image-url)
Section 4 – Pumps

4.4.2.3 Metering Pumps

Metering pumps shall be used for transferring chemical to the point of application.

Metering pumps shall be selected taking into account the chemical being pumped, form of chemical, wear, leakage, resistance to corrosion and, accuracy of dosing necessary.

Pump and its drive motor shall be mounted on a robust common baseplate. Setting of the pump onto its plinth shall be carried out as specified in Clause 4.1.4. The pump plinth shall be approximately 750 mm high from the floor level to accommodate vertical piping and to allow comfortable access to the pump.

Enough space around the pump shall be provided (approximately 750 mm clearance) so as to give access to the pump accessories and enable maintenance and adjustment works. If room is available, it is desirable to locate pumps parallel to the walls where both electrical control/wiring and liquid end piping can be easily supported or wall mounted.

Pump suction and delivery piping shall be independently supported so that undue stress is not put on the liquid chamber or valve connections. Interval between supports on straight piping shall be within 800 mm.

The pump shall be installed as close as possible to the suction point and the piping shall be as short and as direct as possible. The suction point shall also be located above the pump so as to provide positive suction for the pump.

Each metering pump shall be provided with inlet and outlet isolating valves, back pressure valve and pulsation dampener to be installed as close to the pump discharge connection as possible to suit the application and depending on downstream conditions.

A relief valve shall be incorporated in the delivery line between the pump and the back pressure valve under conditions where the pump discharge pipe can be shut off or where pressure may rise to an excessive point. Relief valves when used on pumps handling non-hazardous chemicals shall discharge the vented liquid to be piped back to the suction tank, otherwise, to be piped to the waste system.

Back pressure valve shall be sized and provided as recommended by the pump manufacturer. A pressure gauge shall be provided on the pump delivery. Air cocks shall be provided at high points along the line for release of air or gases where necessary.
4.5 Testing at Site

Performance test shall be conducted at site in accordance with the Standard specified for all pumps. It shall be tested at the duty points and over its full working range, including closed valve condition.

All relevant measuring instrument that will be used for the testing shall be calibrated and certified by an independent testing authority. Pump rotation, speed, vibration and noise level shall also be checked and measured during the performance test and shall be verified against the relevant Standards.

Pump performance curve shall be plotted to verify against the Standard specified and also to compare with the factory performance curve. If the pumps fail to meet the requirements of the Standard specified, the Contractor shall carry out investigation and take remedial measures to improve the performance of the pumps.

For submersible pumps (wet pit) installed with guide rails and discharge elbow, the pump shall be demonstrated such that it will slide down freely on the guide rail and will automatically connect and seal the discharge pipework when it reaches the guide rail lower end, by its own weight.
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5.0 MIXERS

5.1 General

Mixers shall be used for liquid mixing application for homogenisation and suspension of liquids in order to avoid formation of surface crusts and bottom deposits.

Detailed construction of the mixers shall comply with the requirements specified in the IWK’s Product and Material Specification, unless specified otherwise. Installation works of the mixers shall be carried out in accordance with the manufacturer’s recommendation under the direction and supervision of a competent representative of the manufacturer.

Lifting devices shall be provided for mixer installation works and also for future maintenance works.

5.2 Submittals

Shop drawings and quality control records for equipment and its relevant components shall be submitted to the S.O. prior delivery to site for verification and approval.

5.2.1 Shop Drawings

Shop drawing for equipment shall consist of the following:

a) Detailed equipment drawings indicating its capacity/rating, components, physical dimensions, coatings, power requirement and other pertinent information.
b) Table for material of construction, standard and its grade for each relevant component.
c) Loadings of the equipment for civil and structural design purpose

5.2.2 Quality Control Records

a) Manufacturer’s Certification of Compliance.
b) Material certificates.
c) Performance test records and certificates.
d) Calibration certificates.
e) Other relevant test records and certificates.

5.3 Storage of Mixers

Proper storage of mixers is necessary to avoid damage to the mixer and its components which will cause poor performance.

a) During handling, mixer shall be supported by full length in order to avoid structural twisting.
b) Mixer shall be stored in clean and dry environment to prevent distortion.
c) Preferably, mixer and its components shall be installed inside the room and shall be covered to protect its machined surface.
d) Mixer and its components shall be stored in sleeping position and shall not be stacked together.
e) Motor shall be stored inside the room.

## 5.4 Type

There are 2 types of mixers, agitator (non-submersible) and submersible mixer.

### 5.4.1 Agitators

Agitators are classified based on type of entry into the tank, top entry and side entry.

#### 5.4.1.1 Top entry mixer

The mixer driver shall be supported on a solid steel base plate sitting on the concrete plinth. For a prefabricated tank, a steel service platform across the tank shall be provided for accommodating mixer driver that will be sitting on pedestal. The mixer shaft shall be lowered into the tank and coupled to motor shaft which is mounted on the baseplate. A minimum clearance of 50 mm shall be provided between the mixer propeller and tank floor, subject to manufacturer’s recommendation.

Shaft parallel and angular alignments shall be checked and verified. Allowable tolerance for shaft alignment shall be in accordance with manufacturer’s recommendation.

Bolt tightening of the mixer shall be carried out by using torque wrench in compliance with torque recommendation by the manufacturer.

For polymer mixing process, the mixer shall be of non-shear type. The mixer shall be provided with gear reduction unit which gently agitates the polymer solution not exceeding 300 rpm rotational speed.

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**Fig 5.1 - Top entry mixer installation**

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#### 5.4.1.2 Side entry mixer

The mixer driver shall be rigidly supported to avoid distortion and breakage of the mounting pad and also to prevent vibration. Mixer shaft length shall not be more than 1 m, to avoid vibration problem under overhung condition.

A minimum clearance of 150 mm shall be provided between the mixer propeller and tank floor. Distance between the impeller to the side wall shall be about 0.6 times of the propeller diameter, subject to manufacturer’s recommendation.
Section 5 – Mixers

For multiple mixers installation, the number of mixers and spacing between them shall be positioned to circulate liquid evenly throughout the tank subject to manufacturer’s recommendation.

Bolt tightening of the mixer shall be carried out by using torque wrench in compliance with torque recommendation by the manufacturer.

5.4.2 Submersible mixer

Submersible mixer shall be capable of continuous operation under submergence condition and shall be mounted on a guide rail system.

5.4.2.1 Installation of submersible mixer

Minimum submergence requirement for submersible mixer shall be maintained in accordance with manufacturer’s recommendation in order to avoid vortex formation during operation, which will affect mixing process and also life span of the mixer. Clearance and spacing between the mixers and to the walls/floor shall comply with the requirements specified in the IWK’s Product and Material Specification.

If the mixers to be installed at a fixed point in the tank, a vibration rubber damper shall be provided to avoid excessive vibration of the mixer. Safety stop shall be provided to prevent over travel of the mixer during hoisting down to its intended position.

Cable clamp complete with cable hook shall be provided at the deck level for securing cable from being caught up in the mixer propeller.
5.4.2.2 Guide Rail System

The guide rail system shall be provided to allow the mixer to slide down to its intended position by means of a sliding bracket. A lifting davit with manual hoist shall be provided for lifting and lowering the mixer. The whole system shall permit the working angle of the mixer to be adjusted horizontally and vertically and also full adjustment of the depth and direction of the mixer. Generally, 45 degree working angle of the mixer shall be adopted for efficient mixing process, subject to manufacturer’s recommendation.

Hoisting rope attached to the mixer shall be parallel to the lifting davit position so that the mixer can be slid freely on the guide rail.

The guide rail shall be strong enough to avoid deformation under the forces created by the submersible mixer running under designed load conditions. Maximum deflection allowed is 3 mm.

Guide rail shall be provided with bottom footing for anchoring onto the tank floor. For a long guide rail, stainless steel wall brackets shall be provided at 2 m interval for mounting guide rail to the tank wall to avoid deflection of guide rail.

Fig. 5.3-Submersible mixer installation
5.5 Testing at Site

Functional testing of mixers shall be carried out as follows:

- Free rotation of the mixer to ensure the joints are secured
- Sequential operation and simulation of protection devices provided (mechanical and electrical type)
- To demonstrate correct operation/rotation with respect to sequence and level
- To demonstrate absence of vibration and noise during operation
- To demonstrate motor speed in compliance with its design speed and mixing type
- To demonstrate submersible mixer can be sliding freely on the guide rail
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- **Fig 5.2:** Side entry mixer installation
- **Fig. 5.3:** Submersible mixer installation
6.0  GRIT AND GREASE REMOVAL

6.1  Grit Removal System

6.1.1  General

The grit removal system shall be designed to separate, collect, remove, classify and deposit grit at the indicated point of its discharge, within the area and at the elevations indicated. Equipment for the grit removal system shall comply with the requirements specified in the latest edition of IWK’s Product and Material Specification, unless specified otherwise.

One of the following types of system shall be selected for the grit removal system:

a) Aerated Grit Removal System  
b) Longitudinal Grit Removal System  
c) Vortex Type Grit Removal System  
d) Grit Scraper and Collector System  
e) Square Horizontal Flow Grit Chamber/Degritor

a. Aerated Grit Removal System

Grit shall be separated in an aerated grit chamber. Collection and removal of grit shall be by horizontal screw conveyor and bucket elevator, horizontal screw conveyor and inclined screw conveyor, horizontal screw conveyor and grit pump, chain and bucket equipment, or airlift pump. Classifying equipment shall be a cyclone or screw-type classifier.

Fig. 6.1 – Typical Aerated Tank
b. Longitudinal Grit Removal System

Grit shall be separated in a longitudinal grit chamber. Collection and removal of grit shall be by horizontal screw conveyor and bucket elevator, horizontal screw conveyor and inclined screw, horizontal screw conveyor and grit pump or chain and bucket equipment. Classifying equipment shall be a cyclone or screw-type classifier.

![Fig. 6.2 – Typical Longitudinal Grit Tank](image)

... 

![Fig. 6.3 – Typical Mechanical Vortex Grit Chamber](image)

c. Vortex Type Grit Removal System

Grit shall be separated in a vortex type grit removal system. Removal of grit shall be by grit pump or airlift pump. Classifying equipment shall be a cyclone or screw-type classifier.
Section 6 – Grit & Grease Removal

d. Grit Scraper and Collector System

Grit shall be separated in a rectangular horizontal grit flow chamber by a chain and flights scraping mechanism and removal of grit shall be by horizontal screw conveyor and bucket elevator, horizontal screw conveyor and inclined screw conveyor, horizontal screw conveyor and grit pump, chain and bucket equipment, or airlift pump. Classifying shall be a cyclone or screw-type classifier.

Fig. 6.4 – Typical Grit Scraper and Collector System

![Diagram of a Grit Scraper and Collector System]

e. Square Horizontal Flow Grit Chamber/Degritor System

Grit shall be separated in a square horizontal grit chamber by a rotating grit raking mechanism and removal of grit shall be by a reciprocating rake mechanism that also performs grit washing/classifying.

Fig. 6.5 – Typical Circular Scraper Grit Collector

![Diagram of a Square Horizontal Flow Grit Chamber/Degritor System]

6.2 Submittals

Shop drawings and quality control records for equipment and its relevant components shall be submitted to the S.O. prior delivery to site for verification and approval.
6.2.1 Shop Drawings

Shop drawing for equipment shall consist of the following:

a) Detailed equipment drawings indicating its capacity/rating, components, physical, dimensions, coatings, power requirement and other pertinent information.

b) Tabulation for material of construction, standard and its grade.

c) Loadings of the equipment for civil and structural design purpose

6.2.2 Quality Control Records

a) Manufacturer’s Certification of Compliance.

b) Material certificates.

c) Performance test records and certificates.

d) Calibration certificates.

e) Other relevant test records and certificates.

6.3 Delivery and Storage

i) All equipment shall be skid mounted and crated and delivered to protect against damage during shipment.

ii) All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completion and the units and equipment are ready for operation.

iii) All equipment and parts shall be properly protected against any damage during a prolonged storage period at the Site. The motor for each equipment shall be supplied with a space heater installed inside the motor enclosure. In order to maintain the Temperature of the motors well above the dew point and thus prevent condensation of moisture within the motor enclosure, the Contractor shall energize the space heaters as soon as the motors are delivered to the Site. These heaters shall remain energized by the control circuit.

iv) Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the S.O.

v) Finished surfaces of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted thereto.

vi) Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

vii) No shipment shall be made until approval by the S.O. in writing has been given.

viii) All part of the shall be shipped to the site adequately palletized and protected from breakage and dirt. All loose fittings, pipe supports, etc. shall be adequately boxed and palletized. All equipment shall remain palletized and boxed until the time of installation.
6.4 Separation Equipment

6.4.1 Aerated Grit Separation Equipment

Aerated grit separation equipment shall include air piping and valves, swing diffusers holder assembly, header pipes, lifting equipment, diffusers and blower. Baffles shall be epoxy coated structural steel plate, 50 mm thick chengal wood or approved manufacturer’s standard.

6.4.2 Inclined Bottom Grit Separation Equipment

Inclined bottom grit separation equipment shall have chamber bottom inclined to move grit by gravity to the point of removal.

6.4.3 Longitudinal Grit Separation Equipment

Velocity control device in the grit chamber shall be a velocity control regulator or proportional weir.

6.4.4 Vortex Type Grit Separation Equipment

Separation and collection equipment shall be installed in a concrete chamber. Equipment shall include motor drive assembly, paddle drive tube and control box.

6.4.5 Grit Scraper and Collector Separation Equipment

Separation and collection equipment shall be installed in a horizontal chamber. The equipment shall include a chain and flights scraper, drive assembly, chain links, sprockets and guide hold.

6.4.6 Degriter Separation Equipment

Separation equipment shall be installed in a square horizontal flow chamber. The equipment shall include a rotating raking mechanism which sweeps the grits to a collection sump.

6.5 Grit Removal Equipment

6.5.1 Screw collector / Bucket Elevator

A unit utilizing the bucket chain of the elevator as a drive chain for the screw collector shall be provided. Unit shall include screw shafts and bearings, liner plate, chain, sprockets, grit buckets, drive assembly, housing and overload protection.

6.5.2 Screw Collector and Conveyor

Collector and conveyor shall include screw assembly, motor drive assembly, liner plates and trough and appurtenances.
6.5.3  **Chain and Bucket Elevator Collector**

Chain and bucket equipment shall include housing, motor drive assembly, chain, shafting, sprockets, grit buckets and overload protection.

6.5.4  **Grit Pump**

Grit pump shall be by vortex type submersible pump or by airlift pump.

6.5.5  **Airlift Pump**

Airlift type pump shall include an air pipe, eductor, foot piece, tail pipe, air separator and a vent pipe. The air pipe to the eductor shall be of adequate size to discharge the required amount of liquid without excessive pressure drop. An air control valve shall be provided on the air pipe to provide accurate adjustment of the airlift discharge rate. Dedicated air blowers (duty and standby) shall be provided for air lifting and aeration respectively.

6.6  **Classifying / Dewatering Equipment**

6.6.1  **Screw Type Classifying Equipment**

Equipment shall include washing tank, steel screw conveyor mounted in housing, drive unit and supporting substructures. See Fig. 6.6.

6.6.2  **Fine Static Screens**

Equipment shall include steep angle fine screen, feed tank, overflow weir, discharge tank and grit collection bin.
6.7 Installation

The grit handling equipment and accessories specified shall be installed in accordance with approved shop drawings and manufacturer’s recommendations. All lubricants shall be provided for initial operation.

6.7.1 Tank Dimensions Verification

To ensure the equipment supplied can function correctly, the civil works, particularly the tank dimensions shall be verified before commencing installation of the equipment based on the following criteria:

i) The floor and deck levels of the tank shall be within the tolerance stipulated by the equipment manufacturer.

ii) The width, length and height of the tank shall be as per the dimensions required for the particular equipment, within the tolerances recommended by the equipment manufacturer.

iii) The sizes and locations of all the civil requirements such as openings, plinths box-outs, concrete, diffusers, etc. shall be in accordance with the approved civil guide drawings, and within the tolerances recommended by the equipment manufacturer.

6.7.2 Installation of Horizontal Screw Conveyor (submerged)

Screw conveyors shall be installed horizontally longitudinally in the grit chamber. Enough space, approximately 1 m clearance shall be provided around the conveyor for maintenance works purpose.

Height of the conveyor from the floor level shall be approximately 100 mm or to suit the type of grit removal equipment used. The discharge chute shall be set to guide all the transportation materials as efficiently as possible into the container. The chute shall be higher than conveyor level and shall be steep enough to avoid collection of transportation materials in the chute.

For practical reasons, all conveyors with a length more than 6 m shall be delivered in two halves, with support legs, feeder boxes and the power unit demounted.

Conveyor shall be placed onto its position on a solid level surface of the floor designed to endure both static and dynamic loadings of the conveyor and transported materials. The demounted components shall be assembled according to the installation drawing. The transmission shall be turned so that the motor lies in the same direction as on the installation drawing.

Conveyors delivered in two sections shall be assembled on a level surface to obtain correct alignment.

Spiral screw sections shall be welded together according to the manufacturer’s recommendation/instructions. Straightness and alignment of the sections shall be checked prior to welding works. Three runs of welding on each side are recommended for a full strength weld. Maximum misalignment for a finished welded spiral screw shall be 5 mm/m, subject to the manufacturer’s recommendation.
The drive motor shall be housed in a separate compartment with shield to protect the motor from the weather. The penetration through the tank wall for shaft connection shall be sealed for watertightness. The installation shall be carried out in accordance with the manufacturer’s written instruction.

### 6.7.3 Installation of Chain and Bucket Grit Collector

Before erecting the chain and bucket grit collector, the concrete plinth on which the bucket casing will be installed shall be checked. The anchor bolts shall be correctly positioned and the projection must be as shown on the general arrangement drawing. The boot section shall be placed over the anchor bolts. The anchor bolts shall be firmly embedded in concrete at least 72 hours before erection of the chain and bucket equipment. Checks shall be carried out to ensure that the boot section is level horizontally and vertically. Shimming and grouting as required shall be carried out to level the boot section. The boot shall then be secured by tightening down the anchor bolts.

The casing sections shall be joined together on the ground in a horizontal position and shall then be hoisted into position as a unit. Lifting eyes shall be provided for easy handling and lifting.

The maximum out of plumb tolerance between the boot section and head section shall not exceed the value as recommended by the manufacturer.

The head assembly shall be assembled and placed level and parallel with the idler shafts. To achieve this condition it may be necessary to shim under the bearings.

The drive equipment shall be mounted and alignment checked.

**Chain Installation**

The chain shall be installed strictly in accordance with the manufacturer’s written instructions with emphasis on correct alignment and tension (take-ups) adjustment.

**Bucket Installation**

The buckets shall be assembled to the chain with the head of the mounting bolt inside of the bucket.

The following typical torque values (subject to the manufacturer’s recommendation) shall be applied to the bucket bolts before the initial run and prior to welding the nuts to the bolts after the initial run.

<table>
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<th>Bolt Diameter</th>
<th>Torque Values</th>
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<tr>
<td>8 mm</td>
<td>17.6 Nm</td>
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<tr>
<td>9.5 mm</td>
<td>31.2 Nm</td>
</tr>
<tr>
<td>13 mm</td>
<td>77.3 Nm</td>
</tr>
<tr>
<td>16 mm</td>
<td>150.5 Nm</td>
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After an initial run of about 8 hours or time period recommended by the manufacturer, the nuts shall be retightened. To reduce the possibility of the nuts becoming loose, the nuts shall be welded to the bolts.
After the take-ups have been adjusted to provide proper tension to the chain, the chain and bucket grit collector shall be run without load for about eight (8) hours or time period recommended by the manufacturer. During this time, the following shall be checked:

i) Loud or unusual noise  
ii) Excess vibration  
iii) Bearing over-heating  
iv) Drive unit over-heating  
v) Evidence of contact or scrubbing between inside of sidebars and traction wheels or sprockets.

The chain and bucket grit collector shall be operated at speed based on the manufacturer’s recommendation, typically 1.5 m/min to 4.5 m/min.

6.7.4 Airlift Pump

The vertical pipe or updraft tube with auxiliary air pipes shall be installed vertically with verticality tolerances within ±6 mm. A globe valve or ball valve shall be provided for air control. The control valve shall be located at the deck level for easy access.

The discharge pipe level shall be set in accordance with the design. The vertical pipe shall be supported by an end flange which shall be bolted securely to the deck concrete.

Eductor shall be provided with a clean-out above the water level. Fig. 6.7 shows a typical airlift pump installation.

![Fig. 6.7 – Typical Airlift Pump](image)

The airlift pump shall be installed so as to permit easy removal for maintenance.

Piping shall be installed in alignment and supported with pipe hangers and supports. Flanged joints shall be made tight; care being taken to avoid undue strain on flanges, valves, fittings and other equipment and accessories. Bolts shall be tightened in an organised sequence, i.e. diametrically opposite to ensure that the gasket is pulled up evenly. Full size bolts for the bolt holes shall be used; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose shall not be permitted.
Section 6 – Grit & Grease Removal

Flanged pipe shall be installed such that the adjoining flange faces are not out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. Screwed joints shall be made up tight with PTFE pipe thread tape, pipe cement and oil; or PTFE powder and oil, applied to the male threads only. Threads shall be full cut, not more than three threads on the pipe shall remain exposed. Joints for PVC pipe shall be made with solvent cement conforming to BS EN 1452.

6.7.5  Vortex Type Grit Separation Equipment

6.7.5.1  Tank Dimensions Verification

To ensure the equipment supplied can function correctly, the civil works, particularly the tank dimensions shall be verified before commencing installation of the equipment based on the following criteria:

i)  Tank shape irregularities shall be identified.

ii)  The true centre of the minimum circle of the tank shall be established and the diameter of this circle checked to make sure it is within the acceptable tolerance for proper functioning of the scraper. Remedial works on the concrete tank shall be carried out if necessary by hacking, grinding off protruding wall and plastering up areas with insufficient concrete.

6.7.5.2  Installation

i)  A centre drive platform shall be provided for access and maintenance of the centre drive units.

ii)  The torque/central shaft shall be suspended from a drive assembly, which shall be centrally mounted. To achieve this at least 10 points shall be taken all round the perimeter and the distance measured. If any difference is found, the drive assembly shall be shifted until the distances are all the same. The maximum tolerance allowed shall be ±10 mm.

iii)  After fixing the twin scimitar blades to the drive torque tube, the assembly shall be statically and dynamically balanced before installation. The blades shall be bolted together around the drive torque tube using stainless steel bolts.

iv)  The drive torque tube shall be made of stainless steel with a stainless steel flange welded to its top end. The drive torque tube shall be bolted to the slew ring bearing and shall rotate with the bearing.

v)  The whole assembly shall be installed with consideration for easy access, space for maintenance, ease of removal and structural stability.

6.7.6  Chain and Flight Grit Removal Equipment

6.7.6.1  Tank Dimensions Verification

To ensure the equipment supplied can function correctly, the civil works, particularly the tank dimensions shall be verified before commencing installation of the equipment based on the following criteria:

i)  Tank shape irregularities shall be identified.
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ii) Two (2) planes – Plane A (vertical on tank centreline) and Plane B (horizontal on water level) shall be introduced and shall serve as reference planes for the horizontal chain and flight sludge collector or horizontal travelling sludge collector.

iii) These planes (A & B) shall be defined using a Theodolite or other accurate instruments and shall be clearly marked on the tank walls and tank floor (refer to Figure 6.8).

iv) The maximum rectangle of the tank on the plan section and vertical section shall then be defined and checked, with reference to Planes A & B, as illustrated in Figures 6.9 and 6.10.

Fig. 6.8 Fig. 6.9 Fig. 6.10

6.7.6.2 Installation

Before installation, the tank bottom shall be checked for levelness. The concrete floor shall be rectified by patching or grinding where necessary to meet the dimensional tolerances stipulated by the manufacturer.

All chemical bolt holes for the drive wheel and idler wheels shall be drilled using diamond coring machine to ensure holes are free from obstruction of reinforcement bar. Over-drilling shall be avoided. When drilling a template shall be provided to ensure all the holes are perpendicular to the tank wall and floor.

Chemical bolts shall be provided and sufficient time shall be allowed for curing, as recommended by the manufacturer prior to mounting the brackets.

Both the drive shaft and non-drive shaft ends shall be checked to ensure they are on the same level. The drive pins shall also be checked to ensure they share a common centreline. The deviations shall be within the maximum tolerances recommended by the manufacturer.

The alignment of the drive wheel and the idler wheel shall be checked.

The drive shaft deflection at the middle point shall be checked against allowable tolerance as stated by the manufacturer.

After mounting the idler wheels onto the idler shafts, a level gauge shall be used to check to verify that the middle point of the drive wheel sprocket and the middle point of the idler wheel are aligned and inline, before putting on the lock ring.

The distance from the end of the wall to the edge of the idler wheel shall be checked to ensure that sufficient room has been provided for the passage of the flight in the event of chain elongation which will occur after some time in operation.
The return rails shall be installed in accordance with the manufacturer’s recommendations. Sufficient support brackets shall be provided, typically at 2m intervals with the first bracket being placed not more than 400 mm from the centre of the idler wheel. Long holes in the bracket shall be provided for level adjustment.

The rails shall be placed on the support brackets and aligned accordingly. The rails shall then be spot welded onto the support brackets. At the joint sections of the adjacent rails, it shall be ensured that the surface is level and that welding shall be done over the entire width of the rail and that welds shall be ground flat to ensure smoothness of chain travel.

The bottom rails shall be installed in accordance with the manufacturer’s recommendations. The rails shall be installed with an equal distance from the tank centreline on either side. The deviation shall be within ±5 mm typically or as allowed by the manufacturer.

The rails shall be checked for levelness and the difference in level between adjacent rails shall be maintained <5mm. If necessary stainless steel shim plates shall be used to raise the rail of the lower floor level up to the required level. The shim shall be positioned under the rail and additional screw nails shall be used to fasten the shim onto the floor to prevent movement of the shim.

The collector chains shall be installed in accordance with the manufacturer’s guides. Both adjacent chains shall be checked to ensure that equal number of links has been connected.

The flights shall be equally spaced for the entire length of the chain loop. An equal number of chain links shall be ensured on both sides of the chain between the two adjacent flights.

The mounting positions of the chain guard, idler shaft and chain tensioner with respect to the drive shall be established using a Theodolite. The alignment shall be checked against the drive wheel sprocket to ensure the complete assembly is properly aligned.

The gear of the driver unit shall be inline with the gear unit of the drive wheel and shaft assembly.

The level of the drive unit assembly as well as the chain positioning in relation to the chain guard and chain tensioning device shall be checked.

The adjustable screw on one side of the drive unit assembly shall be tightened and adjusted to the correct tension as recommended by the manufacturer.

**6.7.7 Grit Pump**

The pump complete with driver and motor shall be mounted on a heavy duty base. The base shall be complete with machined undersurface mounting pads and lifting brackets. The complete unit shall be installed in accordance with the recommended procedure for the relevant type of pump proposed as given in Section 4. Installation shall include providing oil and grease for initial operation in accordance with the manufacturer’s recommendations.
6.7.8 Grit Classifier

The installation of grit classifier shall generally follow that for screw conveyor.

i) Upon verification of the civil works and the correct position of the equipment, the classifier shall be placed in its final position on a level surface. The unit assembly shall be verified in accordance with the installation drawing.

ii) The mounting position of the speed reduction gearbox shall be checked so that the motor lies in the same direction as that shown on the installation drawing.

iii) The support legs shall be firmly supported and the floor anchors installed.

iv) The electric motor shall be wired up as per manufacturer’s instructions.

v) Care shall be taken to ensure no debris are left in the spiral screw conveyor and grit classifier.

vi) The classifier shall be turned by hand to make sure nothing is obstructing.

vii) The direction of rotation shall be checked and corrected if necessary.

viii) Suitable lubricant such as soap water solution shall be applied to friction and noise on initial start-up.

ix) The grit classifier is now ready for putting into operation.

6.7.9 Cyclone

i) Upon verification of the civil works, the cyclone shall be placed in its final position on a level surface. The unit assembly shall be verified in accordance with the installation drawing.

ii) The support legs shall be firmly supported and the floor anchors installed.

iii) The motor drive shall be connected as per manufacturer’s instructions.

iv) The direction of rotation shall be checked and corrected by inter-changing two of the cable connections if necessary.

v) The cyclone is now ready for use.
6.8 Grease Removal System

6.8.1 General

The grease removal system shall be designed to skim, collect, remove and drain grease and oil to a container or skip for disposal at the location indicated in the drawing. Equipment for the grease removal system shall comply with the requirements specified in the latest edition of IWK’s Product and Material Specification.

One of the following types of system shall be selected for the grease removal system:

a. Floating Weir Skimmer
b. Surface Scum / Oil Skimmer
c. Rotating Pipe Skimmer (Rectangular Tank)

6.8.2 Floating Weir Skimmer - Floating Type

Grease shall be skimmed by using an adjustable weir to set the overflow depth below the grease layer surface. The installation shall allow for the separated grease to accumulate for a number of deep and to be skimmed in a single operation. The discharge shall be via a flexible hose which is connected to the skimmer at one and to a cast-in puddle drain pipe at the other end for gravity flow or to a grease pump for pumped flow. The floating weir skimmers shall be constructed of plastic or stainless steel.

6.8.3 Surface Scum/Oil Skimmer

Grease removal shall be achieved by the inclusion of automatically operated surface skimmers which shall trap the grease on a beanching platform and a sweeping mechanism shall be provided to remove the grease into a container or skip for disposal.

6.8.4 Rotating Pipe Skimmer (Rectangular Tank)

The rotating pipe skimmer or horizontal tipping trough skimmer shall consist of lever operated slotted skimming pipes and valves lever operators, pipe support brackets and necessary appurtenances for a complete and functional installation. All components of the oil/scum collectors shall be carbon steel or stainless steel grade 316. Each skimmer shall be of sufficient length to span the width of the tank. The pipe diameter shall allow ample capacity for gravity drainage of the skimmed oil to a sump. The diameter shall be large enough to allow each edge of the open slots to be rotated well above and below the water level, in order to allow adjustment or termination of the skimming rate.

6.8.5 Installation

6.8.5.1 Floating Weir Skimmer

The flexible hose connecting bottom port on the floating weir (or skimmer head) to the point of discharge shall be securely fixed by using male/female type quick connection. The male quick connection shall be located on the bottom back of the skimmer head while the female quick connection on the hose attaches to this port. The hose shall be of sufficient length for moving the floating weir around the tank. The grease pump, where applicable shall be installed on concrete plinth of minimum 150mm height and located next to the grease removal tank. The pump shall be shielded from the weather.
6.8.5.2 **Surface Scum/Oil Skimmer**

The surface scum/oil skimmer shall be installed in accordance with the written recommendation/instruction of the manufacturer.

The drive chain and skimmer flights shall be installed properly aligned and tensioned within the tolerances as stipulated by the manufacturer. The level of the weirs shall be checked and confirmed by using accurate survey instruments.

6.8.5.3 **Rotating Pipe Skimmer**

The rotating pipe shall be supported at each end in such a manner that a slight vertical or horizontal misalignment shall not interfere with the smooth operation of the pipe. The pipe shall be supported by and revolve in a rolled 316 grade stainless steel collar which shall be welded to an adjustable steel plate. The rotating pipe shall rotate in the wall mounted bearings. The bearings shall be replaceable and made of UHMW material. The open and support shall have segments welded to the internal periphery of the collar to provide ample bearing surface for the pipe without crushing the seal. The level of the pipe shall be accurately checked and confirmed using accurate survey instruments. The difference in levels along the pipe shall be maintained typical within $\pm 2$ mm, in order to maintain even flow distribution along the whole length of the pipe.

The actuation equipment which the motor gear reducer and actuation arm shall be supported and fixed onto a concrete plinth of minimum 150mm height.

The actuation arm shall be connected by an adjustable linkage with turnbuckle to the collector pipe with chain or bolted or ball joint. Lever shall permit rotation of collector pipe at least 30 degrees either side of the vertical axis.

A suitable watertight seal shall be provided between the rotating pipe and the wall mounted bearing. The seal shall be effective even with some slight misalignment of the pipe and collar. The seal shall be readily replaceable without removing the pipe from the supporting brackets.

6.8.6 **Testing at Site**

6.8.6.1 **Grit Removal Equipment**

Functional testing of the grit removal equipment shall be carried out as follows:-

- sequential operation and simulation of protection devices provided (mechanical type and electrical type)
- to demonstrate correct operation/rotation
- to demonstrate equipment speed (such as chain and motor speed, chain and bucket speed, conveyor speed, cyclone speed, etc) in compliance with the design speed
- to demonstrate absence of excessive noise and vibration during operation
- to demonstrate absence of overheating of bearings and motors

6.8.6.2 **Grease Removal Equipment**
Functional testing of the grease removal equipment shall be carried out as follows:-

- sequential operation and simulation of protection devices provided
- to demonstrate correct operation/rotation
- to demonstrate absence of abnormal noise and vibration during operation
- to demonstrate even distribution of flow into the pipe and no leakage at the seals (for rotation pipe skimmers)
- to demonstrate the flexible hose is of sufficient length for the duty intended
- to demonstrate correct motor speed of the surface skimmer.
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7.0 AIR BLOWER

7.1 General

Air blower shall draw air from within the building space and deliver into pipework connected to the air system pipework. Each unit shall incorporate as a minimum requirement the following accessories:

a) inlet filter
b) inlet silencer
c) discharge silencer
d) discharge non-return valve
e) flexible connections
f) discharge pressure relief valve (safety valve)
g) discharge isolating valve
h) pressure gauge

Pressure relief valves shall be capable of discharging the maximum air flow rate delivered by the blower. The valves shall be installed downstream of non-return valves and as close as possible to the blower delivery flange.

Pressure gauge shall be silicon filled, fitted with snubber and shall be provided with isolating cock.

Blower noise level shall be less than 85 db(A) when measured at 1 m from any point of the blower.

Detailed construction of the air blower shall comply with the requirements specified in the IWK’s Product and Material Specification, unless specified otherwise. Installation of the air blowers shall be conducted in accordance with the manufacturer’s recommendations/instructions under direction and supervision of a competent representative of the manufacturer.

Fig. 7.1-Air blower and accessories arrangement

7.2 Submittals
Shop drawings and quality control records for equipment and its relevant components shall be submitted to the S.O. prior delivery to site for verification and approval.

### 7.2.1 Shop Drawings

Shop drawing for equipment shall consist of the following:

a) Detailed equipment drawings indicating its capacity/rating, components, physical dimensions, coatings, power requirement and other pertinent information.
b) Table for material of construction, standard and its grade for each relevant component.
c) Loadings of the equipment for civil and structural design purpose.

### 7.2.2 Quality Control Records

a) Manufacturer’s Certification of Compliance.
b) Material certificates.
c) Performance test records and certificates.
d) Calibration certificates.
e) Other relevant test records and certificates.

### 7.3 Storage of Air Blowers

Proper storage of blowers is necessary to avoid damage to the blower and its components which will cause poor performance.

a) During handling, blower shall be supported by full length in order to avoid structural twisting.
b) Blower shall be stored in clean and dry environment to prevent distortion.
c) Preferably, blower and its components shall be installed inside the room and shall be covered to protect its machined surface.
d) Motor shall be stored inside the room.

### 7.4 Type

Two common types of air blower used for sewage treatment plants are positive displacement and centrifugal types.

The positive displacement blower type is divided into rotary lobe and regenerative categories. Rotary lobe blower (surface) is widely used in the sewage treatment plant because of its range of capacity suits most of applications. The centrifugal blower type is used for large air capacity requirement.

Generally, all types of the complete assembled air blowers are mounted on a common base frame for placing onto concrete plinths.

### 7.5 Installation Works
7.5.1 Location

i) The blower shall be installed in a sufficiently lighted and ventilated room or building.

ii) Air blower room shall be large enough to accommodate air blower unit and its accessories with sufficient working space all round.

iii) Minimum clearance of 1000 mm shall be provided between the air blower and side walls and all round the blower in order to provide sufficient space for periodic inspection and maintenance of the air blower and its accessories.

iv) Sufficient forced ventilation shall be provided to maintain the air blower room temperature at no more than 40°C.

v) Access door of the air blower room shall be sized 400 mm larger than air blower physical dimensions to cater for removal of air blower unit into and from the room without obstruction.

vi) Lifting facilities shall be provided in the air blower room for handling purposes during maintenance and replacement works as follows:

<table>
<thead>
<tr>
<th>Air blower (tonne)</th>
<th>Lifting facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 tonne</td>
<td>Manual monorail hoist</td>
</tr>
<tr>
<td>More than 1 tonne</td>
<td>Electric overhead crane</td>
</tr>
</tbody>
</table>

7.5.2 Foundation Work

i) Concrete plinth shall be of sufficient mass to provide a solid and firm support for the base frame of the complete assembled blower units. The concrete for plinth construction shall be to Grade C30.

ii) Concrete plinth shall be dimensioned to provide a minimum 100 mm clearance all round the base frame. Height of the plinth shall be approximately 100 mm from the floor.

iii) The Contractor shall ensure that the positions of foundations for blower plinthts and holding down bolts and the setting of the blower units are in accordance with the installation drawings.

iv) Sufficient time shall be allowed for curing and hardening of the concrete plinths before installation of the blower units.

v) Top surface of concrete plinth shall be finished flat and smooth.
7.5.3 Installation

i) Air blower and its drive motor shall be placed on a common base frame for fixing onto the concrete plinth.

ii) The base frame set shall be properly levelled in horizontal plane (1/1000 slope) and mounted on vibration isolators. Wedges or shim plates shall be placed near the base frame bolts for alignment and levelling purpose.

iii) At least 4 vibration isolators shall be provided for each air blower unit. Vibration isolators to be fastened to concrete plinth using anchor bolts.

iv) Belt drives shall be aligned such that motor and blower pulleys are parallel to each other in the same plane. Misalignment shall be less than 1 mm, subject to manufacturer’s recommendation.

v) Belt tensioning shall be checked and adjusted to be within the allowable limit recommended by the manufacturer. The allowable limit is specified in terms of belt deflection with respect to the belt type, tension force applied and size of the pulley.
7.6 General Air Piping Requirements

Air piping shall be installed to conform the following requirements:

a) Piping shall be arranged neatly and run the route near the floor level in general. Minimum distance from the floor to the pipe flange shall be approximately 150 mm. Space for future pipe installation work shall be considered.

b) Inspection and maintenance space (600 mm clearance) for the piping shall be considered.

c) The piping must be easily disassembled and removed for test and inspection if required.

d) The supports for piping and valves shall not be taken from the equipment to avoid damage to the equipment, in general.

e) Air piping shall have its own supports which will not impose any loads to the blower. Generally, interval between supports for air straight piping shall be as follows:

<table>
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<tr>
<th>Pipe diameter (mm)</th>
<th>Interval</th>
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<tbody>
<tr>
<td>Less than 300</td>
<td>within 3 m</td>
</tr>
<tr>
<td>300 to 600</td>
<td>within 4 m</td>
</tr>
<tr>
<td>More than 600</td>
<td>within 5 m</td>
</tr>
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</table>

f) Piping support shall be designed so as to be rigid structure together with pipe and support. Support of heavy equipment, etc. shall be designed to support such equipment independently as possible.

g) All pipes above 150 mm diameter shall be flange joint type.

h) All pipes shall be sound and clean before installation.

i) Piping shall run parallel or at right angle to wall, unless noted otherwise. Minimum distance from the wall to the pipe flange shall be 150 mm.
j) All piping shall have a sufficient number of joints to allow convenient removal of piping.

k) Pipe installed shall not cause stress or strain in the line.

l) All piping shall be rigidly supported from the structures by approved hangers, brackets or concrete/steel supports with adequate provisions for expansion and construction. Pipe to be fastened to its support by U-bolt complete with rubber pad.

m) All pipes, after installation, shall be coloured according to each function. The colour shall be in accordance with IWK requirement.

n) All pipes shall have necessary drain trap at the lowest position to be approved by the Engineer.

o) The gap between all pipe surface and concrete structure shall be perfectly sealed with non-shrink grout material and finished when they pass through the concrete structure.

p) If required, vent valves and drain valves shall be provided for the piping where the air and water are accumulated, at such place as top of piping or bottom of piping.

p) Where a pipe passes through a wall which may subject to differential water pressure or is subject to thrust, it shall incorporate a puddle flange.

All submerge pipes shall be made of uPVC Class D minimum and headers above water level shall be galvanized steel pipe or mild steel pipe coated with epoxy paint. Finish colour for the pipes shall be subject to IWK’s requirements.

The diameters of the air system piping shall be large enough and shall never be smaller than the diameter of the air blower openings, to handle maximum volume with minimum friction losses. Air pipe shall be sized such that air velocity in the delivery pipeline is not exceeding 20 m/s.

Flexible joint shall be installed between the blower and the piping. Abrupt changes in pipe direction shall be avoided especially for the initial run of the main pipe.

On all changes of direction, long elbows shall be used. Short elbows may only be used where physical problem arises.

Valves and relevant accessories and instruments for air piping shall be installed and positioned such that they will be accessible for maintenance works.

Where the pipe is run at high level, the pipe shall be installed at 2 m above the floor level. Where pipe is run at low level, a raised walkway with steps shall be provided above the pipe for crossing the pipes. Piping inside the room shall not be obstructing access to the room.

Sufficient joints shall be provided to allow for expansion and contraction of the pipework due to the operating temperature.

Each dropper pipe of air diffuser system shall be provided with tap-off point with isolating cock suitably sized for pressure gauge installation as a means of measuring pressure in the line.
7.7 Guarding of Pipework at Blowers

Any exposed pipework, valves and fittings that could be subjected to a surface temperature greater than 50°C under any normal operating condition shall be guarded to prevent contact with personnel. The guarding shall comprise cages of open mesh type panels supported in framework fixed to the floor.

Panels and framework shall be removable for access and maintenance of pipework fittings. All guard materials shall be positioned at a suitable distance from hot pipework surfaces to avoid their surfaces exceeding 50°C. Guard materials shall be any that are corrosion resistant and have sufficient rigidity for this application.

7.8 Testing at Site

Functional testings for the air blowers shall be carried out as follows;

- sequential operation and simulation of protection devices provided (mechanical and electrical type).
- to demonstrate correct operation/ start-up/ on/off/ change-over/ rotation
- to demonstrate absence of vibration during operation in accordance with ISO 10816 or approved International Standards
- to demonstrate noise level generated by blower less than 85 dB(A) specified
- to demonstrate noise level generated by blower less than 65 dB(A) from the STP boundary.
- to demonstrate safety valve operation at the initial start up to be sure it is adjusted to relieve at the maximum pressure 1.1 times the blower operating pressure.
- To check blower rotational speed in compliance with the specified speed.

Performance test shall be conducted to verify and confirm the blower capacity as per manufacturer’s recommendations. All relevant instruments that will be used for the test shall be calibrated and certified by approved independent testing authority.
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- Fig. 7.1: Air blower and accessories arrangement
- Fig. 7.2: Air blower installation
- Fig. 7.3: Pulley Alignment
- Fig. 7.4: Belt Tensioning
8.0  AIR DIFFUSER SYSTEM

8.1  General Requirements

The Contractor shall ensure that his equipment for the air diffuser system including the related system components and accessories will deliver the oxygen to the wastewater required by the process and that the minimum air flow to maintain solids in suspension is provided at all times.

The construction of diffuser and related system components and accessories shall comply with the requirements specified in the latest edition of IWK’s Product and Material Specifications.

The type of diffusers selected shall be appropriate to the process requirements.

The air diffuser system shall consist of but not limited to the following major components:

- Aeration System - Air Blowers
- Air Distribution System - Pipework and Valves
- Diffusers
- Instrumentation and Control

8.2  Submittals

Shop drawings and quality control records for equipment and its relevant components shall be submitted to the S.O. prior delivery to site for verification and approval.

8.2.1  Shop Drawings

Shop drawing for equipment shall consist of the following:

a) Detailed equipment drawings indicating its capacity/rating, components, physical, dimensions, coatings, power requirement and other pertinent information.

b) Tabulation for material of construction, standard and its grade.

c) Loadings of the equipment for civil and structural design purpose

8.2.2  Quality Control Records

a) Manufacturer’s Certification of Compliance.
b) Material certificates.
c) Performance test records and certificates.
d) Calibration certificates.
e) Other relevant test records and certificates.

8.3  Delivery and Storage

i) All equipment shall be skid mounted and crated and delivered to protect against damage during shipment.
Section 8 – Air Diffuser System

ii) All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completion and the units and equipment are ready for operation.

iii) All equipment and parts shall be properly protected against any damage during a prolonged storage period at the Site. The motor for each blower shall be supplied with a space heater installed inside the motor enclosure. In order to maintain the temperate of the motors well above the dew point and thus prevent condensation of moisture within the motor enclosure, the Contractor shall energize the space heaters as soon as the motors are delivered to the Site. These heaters shall remain energized by the control circuit.

iv) Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the S.O.

v) Finished surfaces of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted thereto.

vi) Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

vii) No shipment shall be made until approval by the S.O. in writing has been given.

viii) All part of the air diffusion equipment shall be shipped to the site adequately palletized and protected from breakage and dirt. In particular, all uPVC air laterals (complete with diffuser assemblies as well as uPVC and stainless steel air headers shall be crated and supported in a wooden framework and covered completely and securely with black polyethylene (5 mm thick). All loose fittings, pipe supports, etc. shall be adequately boxed and palletized. All equipment shall remain palletized and boxed until the time of installation.

8.4 Aeration System – General Description

The aeration system shall include air blowers, together with local control stations, located in Blower Building, a single air main delivering to a manifold located on the aeration tanks walkway and diffusers in the tanks. Two or more parallel aeration tanks shall be provided each treating a separate process stream. At the manifold, separate air mains shall deliver air to diffusers in each aeration tank. A typical schematics diagram of the pipework arrangement is shown in Fig. 8.1.
Air shall be supplied via the primary air main which passes underground or runs overhead from the Blower Building to the aeration tanks. Air from the main will be supplied from the manifold to the separate longitudinal secondary air mains, each provided with an actuated control valve. Air shall be separately supplied to the aeration tanks by these secondary air mains which shall pass along the top of the partition walls between the tanks. From the secondary air main dedicated for each aeration tank air will be supplied to 2 or more drop legs (downpipes) to the floor main manifolds of each tank and distributed via the floor distribution pipes (lateral pipes) to the diffusers.

8.5 Aeration Pipework – General

The Contractor shall provide pipework, valves and fittings associated with the installation of aeration plant specified in Clause 8.4 and to the extent shown on the Drawings.

The pipework shall form a complete air system consisting of blower room bus main, delivery air main including buried or overhead run sections, main manifold, longitudinal secondary air mains, aeration tank drop legs (downpipes), tank floor pipework and terminating in diffusers, all as specified elsewhere in Clause 8.4.

The complete pipework system shall be sized to handle the installed blower capacity.

The complete system shall be designed to create an equal pressure at all diffusers, for the complete range of blower’s output, based on design air flow of each diffuser. To achieve this, the piping connecting the delivery main to the diffusers shall be laid out such that the difference between the pressure drop to the furthest diffuser and the nearest diffuser is as small as possible.
Section 8 – Air Diffuser System

Pipework arrangements shall allow for misalignment of fixed termination points by 25 mm in any direction. All pipework shall be adequately supported and fastened so that stress is not placed on any plant due to the weight or fixing of the pipework.

All nuts, bolts and washers for fixing shall be stainless steel.

Fixing of pipework to concrete structures shall be by stainless steel resin anchor bolts.

All pipework shall be galvanised iron (GI) or galvanised mild steel (GMS), except where otherwise stated. All steel pipes shall comply with BS EN 10255, BS 534 & BS 729. All joints shall be flanged and be rated to PN16.

Flanges shall conform to BS 4504 and drilled in accordance with the appropriate pressure rating.

Where a pipe passes through a wall, retaining wall or is subject to thrust it shall incorporate a puddle flange which shall conform to the dimensions stated in BS 4504 but remain undrilled.

Selection of adapters and couplings shall make due allowance for the thickness of any pipe coating.

Where used flexible couplings for each size of pipe shall be capable of withstanding the shear force applied by the weight of a 4 m length of pipe of that diameter full of water suspended between two couplings.

Detachable flexible couplings shall be provided with central register ribs or locations plugs when so detailed on the Drawings.

Flange adapters shall have flanges as specified for flanged joints.

Sufficient joints shall be provided to allow for expansion and contraction of the pipework due to the operating temperature.

All supports and incidental work to air pipework indicated above shall form part of the Mechanical Works.

1 no. condensate trap shall be provided in the delivery air main. It shall operate automatically and discharge condensate to a sump in the floor. The trap shall comprise cast iron or carbon steel body and cover, stainless steel float, float holder, strainer, pivot plug, valve ball, valve stem and valve seat faced with stainless steel / stelite.

Manually operated moisture blowouts with respective isolation valves capable of discharging above top water level shall be provided at the extremity of each grid to remove condensation from the diffuser pipes. All metallic parts of the moisture purge devices shall be stainless steel grade 304. The devices shall be located for ease of operation and shall be securely fixed by stainless steel brackets.

As a means to minimise vibration transmission, a vibration isolator of bellow type design to the approval of the S.O. shall be provided not more than 300 mm from the outside face of the blower building.
8.6 Air Delivery Main

The delivery main from the blowers to the air supply assemblies shall be galvanised iron. All buried or exposed main header pipe from external of the blower building to the aeration tanks shall be galvanised iron with ball valves to control the flow to stainless steel dropper feed pipes to individual uPVC or other approved diffuser distribution pipes which shall be securely fixed to the walls and floors of each aeration tank. It shall be routed including the buried or overhead sections in the manner shown on the Drawings between the blower room and aeration tank.

The buried section of the air delivery main shall be laid and supported in accordance with the general specified requirements of buried air pipelines and as shown on the Drawings. For overhead runs the delivery main shall be supported on bridge structure which shall have a minimum height clearance of typically 6m for easy movement of vehicles.

The delivery main shall be connected via flanged joints to the secondary longitudinal air mains via flow proportioning valves as described below.

8.7 Longitudinal Secondary Air Mains (Header)

The longitudinal branch mains or header shall be of galvanised iron.

Flow proportioning between the air main and longitudinal secondary air mains shall be effected by flow proportioning valves (butterfly or ball valves) complete with an isolating guard valve described elsewhere in Clause 8.4. Flange adapters shall be provided to allow removal of these valves.

Eccentric reducers shall be provided at each change in air main diameter. The crown of the main shall be maintained at the same elevation for the full length of the tank.

The longitudinal secondary mains shall be routed in the manner shown on the Drawings (Fig. 1) between the flow proportioning valves and along the aeration tank walkway. Platforms and stairways (described elsewhere) for personnel access to and adjacent to these mains shall be provided as part of the Mechanical Works to the extent indicated on the Drawings.

Longitudinal secondary mains shall each include a vortex type flowmeter and isolating valves where indicated on the Drawings. Flange adapters shall be provided to allow removal of the flowmeters and valves.

Longitudinal secondary mains shall be connected via flanged joints to tank downpipes as described below.

8.8 Aeration Tank Downpipes

The downpipes shall be of stainless steel Type 304.

Each downpipe shall be provided with an isolating ball valve and a control ball valve at walkway level in the positions indicated on the Drawings. Each downpipe shall incorporate an orifice type flowmeter also positioned at walkway level.
The handrailing on the aeration tank walkway shall be provided to suit the Contractor’s design for the downpipes/longitudinal mains arrangement. The Contractor shall note, however, that only minor modifications to the handrailing shown on the Drawings will be accepted by the S.O.

Downpipes shall be connected via flanged joints to the tank floor pipework as described below.

### 8.9 Aeration Tank Floor Pipework and Diffuser System

Air pipework within the aeration tanks and the diffuser equipment shall be supplied by one diffused air equipment manufacturer and shall be for use in aeration tanks for the activated sludge process. The equipment shall be suitable for treating sewage in the climate and conditions of Malaysia.

The equipment to be supplied shall be complete and shall include all necessary parts, fittings, etc. to form a complete diffused air system for use in the aeration tanks.

The aeration tank floor pipework from each downpipe shall consist of a floor distribution manifold and distribution pipes (laterals) not less than 100 mm diameter arranged in a grid to feed air to the diffusers and be complete with diffusers, spare diffuser connections, joints, gaskets, pipe stands and moisture blowouts.

The floor distribution manifold shall connect to the downpipe and have sufficient branches to supply the number of diffuser pipes necessary in each grid. The manifold shall be fixed to the floor of the aeration tank to prevent flotation. This shall be achieved by means of stainless steel resin anchor bolts suitable for pipe flanges and straps of similar material and protection. Pipe supports shall be grade 304 stainless steel.

The distribution pipes (laterals) shall be suitable to carry air diffusers arranged in suitable disposition over the floor of the tank. The pipe shall be uPVC of minimum class D grade treated to prevent degradation by ultra-violet light or stainless steel and shall be secured to the floor to prevent flotation. Provision shall be made to adjust the height of the pipe above the floor by a minimum of 25 mm to ensure diffusers are set level in the tank. The distribution pipes shall be supported at intervals not greater than 1.75 m and provision for expansion shall be made at least every 3 m. The permissible elevation tolerance for the air distributor pipe centreline shall be typically ±6 mm.

### 8.10 Aeration Tank Diffusers

#### 8.10.1 General

The Contractor shall provide diffusers of the specified type in the aeration tanks. The diffusers shall be arranged throughout each aeration tank, in the manner described below. The quantity of diffusers required shall be determined by the Contractor to suit the process requirements but in any event to satisfy the installed blower capacity. The diffusers shall comply to the requirements as given in the latest edition of IWK’s Product and Material Specification.

The diffusers shall be mounted horizontally on the pipe such that air distribution is even over the horizontal surface. The air rate per square metre of diffuser horizontal surface shall be based on the mid-range of the maximum rated diffuser capacity. Each diffuser shall have a fixed control orifice to regulate the air supply and assist in providing an even distribution over the tank surface.
Section 8 – Air Diffuser System

Diffuser shall be spaced symmetrically with the spacing as recommended by the manufacturers in a grid pattern in each tank so as to provide even and complete mixing throughout the tank. Diffusers shall ensure proper mixing of the raw sewage, mixed liquor and RAS and provide a consistent dissolved oxygen concentration throughout each tank as required by the design.

The Contractor shall ensure that the diffusers have a sufficient turn-down capability to prevent diffuser fouling when only one blower is operating at minimum speed for long periods.

The Contractor shall provide evidence at the time of tendering of oxygen transfer tests carried out by a recognized authority on their equipment showing a transfer efficiency of at least 22% in clean water at 20°C, at a depth not exceeding 5 m and an air flow rate per diffuser not less than that determined at the peak air requirement.

The entire system shall be designed with sufficient supports and allowance for expansion, contraction, thrust, uplift, etc. and all forces to be encountered in this operation and at the depth of water expected.

All stainless steel pipework shall be of Type 304. All plastic pipework shall be chlorinated uPVC of minimum class D to BS 3506, BS 4346, MS 978 and MS 979 and treated to prevent degradation by ultra-violet light.

The liquor temperature in the aeration tank will be 26°C to 32°C. All pipework shall be rated to perform without deterioration within the ranges of liquor temperature and actual conveyed air temperature.

The complete diffuser assemblies shall consist of a diffuser, diffuser holder, sealing gasket, air control orifice and retaining device. The diffuser holder shall be factory welded onto the air distribution pipes. The retaining device together with the gasket shall prevent air leakage from the circumference of the gasket. The retaining device shall be a PVC retaining ring of diffuser discs.

There shall be a minimum clearance of 150 mm between the bottom of the floor pipes and the tank floor.

8.10.2 Types

The types of diffuser shall comply to the requirements of the latest IWK’s Product and Material Specifications.

The diffusers commonly used are:

a) Disc Diffusers  
b) Tube Diffusers  
c) Panel Diffusers

8.10.2.1 Disc Diffusers

Disc diffusers shall be fine bubble or coarse bubble type and the material of construction shall be porous ceramic, membrane or thermoplastic type. Fine bubble diffusers shall be able to produce fine bubbles less than 3 mm diameter. Coarse bubble diffusers shall be able to produce bubbles more than 3 mm diameter.

The disc diffuser shall consist of diffusing surface, base plate and retaining ring.
8.10.2.2 Tube Diffusers

Tube diffuser shall be made of porous ceramic, silicon membrane or EPDM membrane. The tube diffuser shall consist of a main body, diffuser membrane clamp ring and threaded rod, adaptor and end cap.

8.10.2.3 Panel Diffuser

Panel diffuser shall be made of minimum EPDM membrane or proprietary thermoplastic material. The panel diffuser shall consist of stainless steel base plate, peripheral strip and air connection.

8.11 Valves for Air Pipework

The Contractor shall provide flow proportioning, isolating and non-return valves to the extent shown in the Drawings (plus further isolating valves required for flow proportioning valves), and for the pipework system as described in the Specification. Any valves necessary for the installation that are not covered herein shall be suitably selected for the particular application.

Valves shall be provided as follows:

a) Non-return valves

All non-return valves shall be fitted with external lever arms with proximity switches rated to IP 55. The switch shall be positioned to indicate “Closed” condition. Cabling from the switch shall be terminated remotely.

Non-return valves shall be of the double-flanged type and shall be installed in horizontal pipework only. Valve bodies shall be cast iron with type 316 stainless steel hinge pins. Valves and seals shall be rated for temperatures up to 120°C.

Valve lids shall be bossed and tapped and fitted with 1” BSP reducing to a ½” BSP isolating cock suitable for pressure gauge connection.

The Contractor shall allow for head losses through non-return valves when selecting blowers.

b) Isolating valves

Isolating valves in pipework shall be of the solid wedge gate type except where specified otherwise below. Valves shall comply with BS 5150 and be provided with a corrugated periphery handwheel requiring a maximum combined push-pull effort of 26 kgf. Where necessary, additional gearing shall be provided on the valve actuator to limit the push-pull effort at the rim of the handwheel to 26 kgf total. Valves and seals shall be rated for temperatures up to 120°C.

Valve bonnets shall be removable for maintenance by removal of bonnet/body bolts.

Where handwheels are provided, the direction of rotation shall be indicated by an arrow and the words ‘OPEN’ and ‘SHUT’ cast on the rim.
Valves bodies shall be manufactured from cast iron and have metal faces and seats. Valves shall close in a CLOCKWISE direction and have non-rising spindles.

All valves shall be suitable for manual operation by handwheel, either mounted on the body or at high level (with headstocks) where indicated.

Where headstocks are used they shall have a valve position indicator, handwheel 1000 mm above local floor level, be of grade 12 cast iron and have grade 304 stainless steel fixing down bolts. The position and size of holes or ducts through floors for extension spindles associated with headstocks will be provided by others in accordance with the Contractor’s instructions.

The Contractor is at liberty to propose the use of butterfly valves as isolating valves at the time of tendering. Butterfly valves shall in this case comply with the requirements for flow proportioning valves except that an electric actuator is not required.

In positions where the flange to flange dimensions of a wedge gate (or butterfly) valve exceed the space available, sliding plate or knife gage valves with narrower bodies may be utilized subject to the S.O.’s approval.

c) Flow proportioning valves

The flow proportioning valves fitted between the delivery main and the longitudinal branch mains shall be butterfly valves. Each valve shall be provided with an electric actuator suitable for frequent modulating duty where required by design. The electric actuators shall be as described elsewhere in the specification.

Each flow proportioning valve shall be provided with an upstream manually operated isolating valve. Handwheels for isolating and flow proportioning valves shall be positioned at approximately 1000 mm above floor level.

Butterfly valves shall comply with BS 5155 and be mounted such that shafts are horizontal. All valves shall be fitted with indicators to show the position of the disc. Valves shall not contain any brasses containing more than 5% zinc. Gunmetal to BS 1400 Grade LG2, aluminium bronze or nickel components any be used for internal components. The body and disc shall be of spheroidal or grey cast iron. In general, the materials chosen shall be corrosion resistant to the specified duty and media. Valves shall have rubber seals.

Flow proportioning valves shall be used to control the proportion of the total air supplied to each aeration tank (normally equal) to maintain the dissolved oxygen level within the pre-set range (s).
8.12 **Installation of Diffused Air System**

The Contractor shall allow for providing the services of a competent person in the supervision of the installation, testing and commissioning of the diffused air system. The competent person shall be certified by the manufacturer of the diffused air systems as being of sufficient knowledge and skill to install the systems to their requirements.

The Contractor shall submit to the S.O. a detailed description of the diffused air system manufacturer’s recommended installation procedure. The procedure shall be strictly followed by the Contractor.

The following shall be observed prior to starting of the installation works:

i) The aeration tank must be cleaned from all rubbish, concrete residual and temporary scaffolding to avoid obstruction.

ii) The tank must be kept empty of water and maintained dry during installations.

iii) Proper access must be provided for transferring of the air distribution pipes and accessories into the aeration tank.

iv) Verify the level differential of the aeration tank floor and determine the level of the aeration diffuser. Maximum differential permitted is ±40 mm.

**8.12.1 Dropleg and Manifold Installation**

1. The upper stainless steel portion of the dropleg shall be attached to the air main header with space allowance for fixing of a guard valve, a control valve and a flowmeter. Refer Fig. 8.2.

![Fig. 8.2 – Typical Installation of Dropleg](image)

2. The installed stainless steel upper dropleg and the approved installation drawings shall be used to locate and layout the centreline of the aeration grid manifold. Refer Fig. 8.3.
3. The approved installation drawings and parts list shall be used to locate all the manifold anchors and supports.

4. The approved installation drawings and manufacturer’s installation instructions shall be used to layout and install the manifold anchors. The manifold supports may be repositioned if it is necessary to avoid interference but the maximum support spacing shall be held to within 2.5m.

5. The elevation of the manifold centreline shall be accurately set and maintained the same for all the manifolds to a maximum permissible level difference of $\pm 6$ mm.

6. The grid manifolds shall be level and aligned properly to a maximum permissible tolerance of $\pm 6$ mm.

7. All pipe section shall be flushed clean with water prior to installation.

8. The connection between the upper stainless steel portion and the lower uPVC portion of the dropleg shall be made by flanged connection.

Fig. 8.4 – Typical Section of Tank Floor Pipe Manifold of Distribution Pipe
8.12.2 Air Distributor and Drain line Installation

(It shall be noted that separate drainlines are permanently used on fine bubble systems with raised manifolds. Nearly all systems with in-line manifold will not have separate drainlines as the manifold serves as the drainline. See Fig. 8.5 and the approved installation drawings).

Fig. 8.5 – Typical Arrangements of Drainlines

1. The alignment and elevation of the centreline of the air distributors (or laterals) shall be accurately set and maintained throughout the whole tank to a maximum permissible level difference of ± 6 mm.

2. The horizontal alignment of the air distributors (or laterals) shall also maintain within a maximum tolerance of ± 6 mm.

3. The pipe supports shall be evenly spaced or adjusted as required but the maximum spacing shall be held to 2.3 m typically or to the recommendation of the manufacturer.

4. The anchors and supports base shall be installed in accordance to the installation drawings and anchor manufacturer’s installation instructions.

5. All air distributors shall be flushed clean with water before installation.

6. Each of the air distributors shall be provided with an expansion joint to take up any movement of pipe due to thermal expansion / contraction.

7. The diffuser shall be installed such that it is level and the tolerance shall be not more than 0.5mm/m, or as recommended by the manufacturer.

8.12.3 Purge System Installation

The purge system shall consist of a sump and evacuation pipe. The pipe shall extend over the top water level.

The sump for systems using in-line manifolds shall be built into the manifold pipe.
8.12.4 **Diffuser Installation**

1. The diffusers shall be installed just prior to the scheduled start-up of the aeration basin.

2. The diffuser holder shall be thoroughly cleaned prior to diffuser installation

8.13 **Testing at Site**

Field Installation Testing of Diffusers

i) On completion of the installation in each independent unit of the aeration tanks the Contractor shall demonstrate that the diffused air system is laid to the correct level and alignment, within a maximum tolerance of ±6mm.

ii) Before turning on air all the pipes shall be flushed clean with water. Each unit shall then be filled with clear water to a level just below the baseplates rim. Air shall then be turned on to check for leaks in the pipework.

iii) On completion of the above test he shall fill the unit with clear water to submerge the diffusers and turn on the air supply to check that the air is diffused evenly along the unit and no leakage is present. Any diffuser that does not provide a good throughput of air shall be removed and replaced. All cost incurred shall be borne by the Contractor and no claim shall be made against the Client.

iv) The Contractor shall repeat these tests until all unacceptable conditions have been rectified by him.

8.14 **Commissioning Tests for Diffuser Air System**

On completion of tests specified above the Contractor shall fill the aeration tanks with potable water up to normal operating level and shall conduct tests to the satisfaction of the S.O., to demonstrate the Standard Oxygen Transfer Efficiency (SOTE) of the installed diffused air system. Determination of the diffuser efficiency and oxygen transfer rate into clean water shall be carried out, as a minimum, for both the maximum operational air and the peak installed capacity.

If the oxygen transfer efficiency or overall oxygen transfer rate specified or quoted by the Contractor in the schedules are not achieved, then the Contractor shall make modifications to the system at his own expense and the procedure shall be repeated until satisfactory results are obtained.

Further details of diffused air system commissioning tests shall be as follows:


ii) The distribution of air to the different zones of each aeration tank shall be demonstrated by measuring the airflow down each riser pipe.
iii) Tests and testing procedures shall be mutually arranged and coordinated with the Client’s plant personnel and representatives. The Contractor shall schedule his testing procedures with the full knowledge and consent of the S.O.

iv) The commissioning tests shall be made by the Contractor under the supervision of a qualified representative of the diffused air system manufacturer and in the presence of and as directed by the S.O. Written test procedures shall be submitted to the S.O. for approval 30 days prior to testing.

v) The Contractor shall allow in his rates for the cost of all equipment and chemicals required for the tests. Calibration certificates for all gauges and measuring instruments shall be provided.

vi) A written report shall be submitted to the S.O. giving details of the equipment tested, test results, calculations, problems encountered and any corrective action to be taken within two weeks after test completion.

vii) The exposed uPVC pipework and diffusers shall be properly covered to avoid degradation due to exposure to sunlight.
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9.0 AERATION EQUIPMENT

9.1 General

All aeration equipment shall comply with the requirements specified in the IWK’s Product and Material Specifications.

The mechanical aerators provided shall be able to maintain the contents of the tank in a uniformly mixed state while transferring the specified amount of oxygen to the system. In addition, the mechanical aerators shall be designed to have a sufficient power/liquid volume ratio to maintain the solids concentration in suspension for the specified tank geometry.

9.2 Submittals

Shop drawings and quality control records for equipment and its relevant components shall be submitted to the S.O. prior delivery to site for verification and approval.

9.2.1 Shop Drawings

Shop drawing for equipment shall consist of the following:

a) Detailed equipment drawings indicating its capacity/rating, components, physical, dimensions, coatings, power requirement and other pertinent information.
b) Tabulation for material of construction, standard and its grade.
c) Loadings of the equipment for civil and structural design purpose

9.2.2 Quality Control Records

a) Manufacturer’s Certification of Compliance.
b) Material certificates.
c) Performance test records and certificates.
d) Calibration certificates.
e) Other relevant test records and certificates.

9.3 Storage of Aerators

Proper storage of aerator is necessary to avoid damage to the aerator components which will cause poor performance.

a) During handling, aerator shall be supported by full length in order to avoid structural twisting.
b) Aerator shall be stored in clean and dry environment to prevent distortion.
c) Preferably, aerator shall be installed inside the room and shall be covered to protect its machined surface.
d) Aerator and its components shall not be stacked together.
e) Aerotor motor shall be stored inside the room.

9.4 Types of Aerator

i) Low speed surface aerators
ii) High speed surface aerators
iii) Aspirating Aerators
iv) Submersible Aerators (Submerged Turbine Draft Tube Aerators)
v) Brush Aerators

9.4.1 Low Speed Surface Aerators

9.4.1.1 General

This type of aeration system creates surface agitation to provide oxygen transfer and imparts a velocity to the wastewater by the swirling action created by the impeller.

Each unit shall be complete and include an electric motor, a gear reducer, shaft and impeller driven at a constant speed, and all necessary fasteners, stabilizers, anchoring devices and other mechanical and structural appurtenances necessary for the mounting and operation of the units. The aerators shall be designed for continuous operation.

9.4.1.2 Installation

9.4.1.2.1 Verification of Tank Dimensions

To ensure the equipment supplied can function correctly, the civil works shall be verified before commencing installation of the equipment based on the following criteria:

i) The tank platform shall be generally level for mounting of equipment.

ii) Dimension of concrete supports for machine footings shall be as structural design (based on the loadings supplied by the equipment manufacturer).

9.4.1.2.2 Marking of Tank Water Levels

i) Upon accepting the tank, a qualified surveyor shall use accurate instruments (Dumpy Level and Theodolite) to mark the correct top water level and minimum water level as dictated by the design.

ii) The levels shall be confirmed and marked with permanent ink on the wall for height determination of the immersion depth of the discs or rotors.

The low speed surface aerator shall be mounted by either of the following methods:

i) Fixed Bridge Structure

ii) Floating Support Structure

Fig. 9.1 – Fixed bridge structure mounting
X = Distance between the top of the impeller blade and the minimum water level
Y < Maximum submergence

9.4.1.2.3 Fixed Bridge Structure

A structural bridge of steel or concrete bridge and support assembly designed to mount each aeration unit shall be constructed as indicated. The bridge assembly shall be structurally anchored to the basin walls. To ensure the most efficient operation of the aeration system, the aerator shall be mounted with the top of the impeller blades at a distance from the minimum water level and shall not be submerged more than the maximum submergence as recommended by the manufacturer.

The following installation procedure shall be observed:

i) By using accurate level instrument, the top water and minimum water levels shall be marked on the wall of the basin.

ii) The jacking screw hole locations (minimum 4 nos.) shall be marked on the supporting steel or concrete platform. The holes of diameter one size bigger than the screw diameter of minimum 25 mm shall be made.

iii) The jacking screws which shall have sufficient length for a minimum 150 mm vertical travel adjustment shall be fixed by tightening the top back nuts. The base plate lower back nuts shall be in place at the mid-point of each screw jack.

iv) By using site cranage, the assembled aerator unit excluding the impeller shall be placed in position by slotting the jacking screws through the base plate holes, supported by the base plate lower back nuts and washers.

v) The impeller shall be fixed to the shaft in accordance with the manufacturer’s instructions.
vi) Using a hand level and dumpy level instrument the base plate back nuts shall be adjusted such that the top of the impeller blades shall be at a distance above the minimum water level as recommended by the manufacturer and the unit is truly vertical within ± 1 mm tolerance.

vii) The base plate upper back nuts and washers shall be placed in and tightened diametrically until the unit is securely fixed.

viii) Anchor bolts shall be used for fixing.

9.4.1.2.4 Floating Support Structure

The aerator unit shall be supported on a floating support structure which shall include tripod pontoons, framework and access platform.

The following installation procedure shall be followed:

i) By using accurate level instrument, the top water and minimum water levels shall be marked on the wall of the basin.

ii) A flat working space shall be cleared next to the basin for field assembly.

iii) The supporting arms, support framework, pontoons, platform and safety handrailings shall be assembled by bolting.

iv) The aerator shall be fixed following the steps and described for Fixed Bridge Mounting.

v) The whole assembled aerator unit shall then placed in the basin using the site lifting equipment.

9.4.2 High Speed Surface Aerator

9.4.2.1 General

The high speed surface aerator shall be vertical axis updraft flow type and mounted on a fixed rigid platform or floating on a pontoon. The aerator shall consist of motor, diffuser head, shaft and propeller, volute and intake cone.

9.4.2.2 Installation

9.4.2.2.1 Verification of Tank Dimensions

To ensure the equipment supplied can function correctly, the civil works shall be verified before commencing installation of the equipment based on the following criteria:

i) The tank platform shall be level for proper mounting of the aerator.

ii) Dimension of concrete supports for machine footings shall be as structural design (based on the loadings supplied by the equipment manufacturer).

9.4.2.2.2 Marking of Tank Water Levels
Section 9 – Aeration Equipment

i) Upon accepting the tank, a qualified surveyor shall use accurate instruments (Dumpy Level and Theodolite) to mark the correct top water level and minimum water level as dictated by the design.

ii) The levels shall be confirmed and marked with permanent ink on the wall for height determination of the immersion depth of the discs or rotors.

The high speed surface aerator shall be mounted by 2 methods:

i) Floating support structure
ii) Fixed platform structure

The installation procedure shall generally follow that for low speed surface aerator as given in Section 9.2.1.

9.4.3 Aspirating Aerator

9.4.3.1 General

The aspirating aerator shall consist of a propeller which creates a low pressure zone at the propeller hub. This draws air through the draft tube air inlet hole down to the propeller. Action of the propeller shall mix the air stream with the water resulting in tiny bubbles. The air and water mixture is forced away from the propeller both horizontally and vertically effectively mixing and oxygenating the water.

9.4.3.2 Installation

9.4.3.2.1 Verification of Tank Dimensions

To ensure the equipment supplied can function correctly, the civil works shall be verified before commencing installation of the equipment based on the following criteria:

(i) The tank water levels shall be within ±10mm of the design values. The mounting bracket shall be adjusted to ensure correct immersion depth of the impellers.

i) Dimension of concrete supports for machine footings shall be as structural design (based on the loadings supplied by the equipment manufacturer).

9.4.3.2.2 Marking of Tank Water Levels

i) Upon accepting the tank, a qualified surveyor shall use accurate instruments (Dumpy Level and Theodolite) to mark the correct top water level and minimum water level as dictated by the design.

The levels shall be confirmed and marked with permanent ink on the wall for height determination of the immersion depth of the propeller.

The aspirating aerator shall be mounted by 2 methods:

i) Floating pontoon (Fig. 9.2)
ii) Wall mount (Fig. 9.3)

Fig. 9.2 - Typical floating pontoon  Fig. 9.3 - Typical mounting by wall bracket
The aspirating aerator shall have a mounting cradle which is bolted to the motor mounting pins. The mounting cradle shall be such that the aerator can be mounted from a nearly vertical position to a nearly horizontal position. The angle of inclination shall normally set at 45 degree.

For installation with floating pontoon, the floats shall be moored to posts on shore. The mooring cable shall be stainless steel SS304 and wrapped around the post several times and secured with two wire rope clips. A typical setup shall use a 2.1m long, 100mm diameter schedule 40 galvanised pipe which shall be filled with concrete and buried 1.5m to 1.8m deep with 0.6m wide concrete footing. See Fig. 9.4.

Fig. 9.4 – Typical Mooring Post Installation

There shall be minimum 2 mooring cables for each aerator and the minimum cable size shall be as follows:

Fig. 9.5: Typical selection chart for mooring cable
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The mooring cables shall be supplied with the necessary accessories such as wire rope clips (cable clamps), thimbles, eye bolts, turnbuckle, extension spring and quick links for proper installation.

All power cables shall be provided with floats.

For wall mounted installation, the mounting bracket shall be designed and fabricated such that the optimal immersion depth as recommended by the manufacturer shall be achieved typically with a $45^\circ$ inclination angle. The maximum height of the mounting bracket shall be 600 mm from the bottom of the bracket. The size and number of anchor bolts shall be sufficient to withstand the dynamic loading of the aerator unit.

### 9.4.4 Submersible Aerators

#### 9.4.4.1 General

The submersible aerator shall be downward discharge or upward discharge type, self-aspirating or pressured type and shall be complete and include blowers, drive unit, impeller and supports, air supply pipe, diffusion port and all appurtenances necessary for the proper operation of the equipment.

#### 9.4.4.2 Installation

The installation procedure shall be similar to that for installation of submersible pump with respect to the concrete plinth support and fixing as given in Section 4.

For air pipe installation, the length of the first air pipe which is connected to the aerator shall be limited to not more than the height of the aerator.

The air pipes shall be joined by bolted flanges for ease of dismantling and lifting of the aerator for maintenance.

A lifting equipment with capacity at least 25% more than the weight of the aerator shall be provided and installed at suitable location for lifting of the aerator.

### 9.4.5 Brush Aerators

#### 9.4.5.1 General

This type of aeration system creates surface agitation to provide oxygen transfer and imparts a horizontal velocity by the rotation of the unit.

The brush aerator shall be provided as indicated. The units shall be complete and include disc or rotor assemblies, shaft, or torque tube, drive unit, bearings, supports and all appurtenances necessary for the proper operation of the equipment.

#### 9.4.5.2 Installation
9.4.5.2.1 Verification of Tank Dimensions

To ensure the equipment supplied can function correctly, the civil works shall be verified before commencing installation of the equipment based on the following criteria:

i) The tank platform levels, particularly the effluent weir level shall be within ±10mm of the design values, to ensure correct immersion depth of the discs or rotors.

ii) Dimension of concrete supports for machine footings shall be as structural design (based on the loadings supplied by the equipment manufacturer).

iii) The difference in platform level between the two walls shall be within ± 6mm.

9.4.5.2.2 Marking of Tank Water Levels

i) Upon accepting the tank, a qualified surveyor shall use accurate instruments (Dumpy Level and Theodolite) to mark the correct top water level and minimum water level as dictated by the design.

ii) The levels shall be confirmed and marked with permanent ink on the wall for height determination of the immersion depth of the discs or rotors.

9.4.5.2.3 Installation

i) The assembled aerator unit and the loose items shall be unloaded and set to one side.

ii) After verification of the civil works including the plinth support dimensions, the assembled aerator shall be transferred to its final location.

iii) A template shall be used to plant the chemical bolts for anchoring. Curing time shall be allowed before bolt tightening.

iv) The effluent weir level shall be checked and adjusted such that an optimal range of immersion depths as recommended by the manufacturer is achieved.

9.5 Testing at Site

Functional testing of aerators shall be carried out as follows:

- Dry run the aerator to demonstrate correct direction of rotation of the impeller and ensure mechanical integrity.
- Test run the aerator completely submerged to check for proper amps reading.
- Test run the aerator completely submerged to check for vibration levels and noise.
- Pressure testing of air pipe (for submersible aerator)
9.6 Commissioning Tests for Aerator

On completion of tests specified above the Contractor shall fill the reactor tanks with potable water up to normal operating level and shall conduct tests to the satisfaction of the S.O., to demonstrate the Standard Oxygen Transfer Efficiency (SOTE) of the installed aerator system. Determination of the aerator efficiency and oxygen transfer rate into clean water shall be carried out, as a minimum, for both the maximum operational air and the peak installed capacity.

If the oxygen transfer efficiency or overall oxygen transfer rate specified or quoted by the Contractor in the schedules are not achieved, then the Contractor shall make modifications to the system at his own expense and the procedure shall be repeated until satisfactory results are obtained.

Further details of submersible aerator commissioning tests shall be as follows:


ii) Tests and testing procedures shall be mutually arranged and coordinated with the Client’s plant personnel and representatives. The Contractor shall schedule his testing procedures with the full knowledge and consent of the S.O..

iii) The commissioning tests shall be made by the Contractor under the supervision of a qualified representative of the submersible aerator’s manufacturer and in the presence of and as directed by the S.O. Written test procedures shall be submitted to the S.O. for approval 30 days prior to testing.

iv) The Contractor shall allow in his rates for the cost of all equipment and chemicals required for the tests. Calibration certificates for all gauges and measuring instruments shall be provided.

(v) A written report shall be submitted to the S.O. giving details of the equipment tests, test results, calculations, problems encountered and any corrective action to be taken within two weeks after test completion.
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- **Fig. 9.2:** Fixed bridge structure mounting
- **Fig. 9.2:** Typical floating pontoon (aerator not shown)
- **Fig. 9.3:** Typical mounting by wall bracket
- **Fig. 9.4:** Typical Mooring Post Installation
- **Fig. 9.5:** Typical selection chart for mooring cable
10.0 EFFLUENT DECANTERS

10.1 General

The Contractor shall furnish and install effluent decanters of type specified, complete and operable, in accordance with the Specification.

All materials used in the manufacture of the decanters shall be in accordance with the requirements specified in the latest edition of the IWK’s Product and Material Specification, unless specified otherwise.

Installation of the decanters shall be conducted in accordance with the manufacturer’s recommendations/instruction under the direction and supervision of a competent representative of the manufacturer.

10.2 Submittals

Shop drawings and quality control records for equipment and its relevant components shall be submitted to the S.O. prior delivery to site for verification and approval.

10.2.1 Shop Drawings

Shop drawing for equipment shall consist of the following:

i) Detailed equipment drawings indicating its capacity/rating, components, physical, dimensions, coatings, power requirement and other pertinent information.

ii) Tabulation for material of construction, standard and its grade.

iii) Loadings of the equipment for civil and structural design purpose

10.2.2 Quality Control Records

i) Manufacturer’s Certification of Compliance.

ii) Material certificates.

iii) Performance test records and certificates.

iv) Calibration certificates.

v) Other relevant test records and certificates.

10.3 Delivery and Storage

a) All equipment shall be skid mounted and crated and delivered to protect against damage during shipment.

b) All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completion and the units and equipment are ready for operation.

c) All equipment and parts shall be properly protected against any damage during a prolonged storage period at the Site. The motor for each equipment shall be supplied with a space
heater installed inside the motor enclosure. In order to maintain the temperate of the motors well above the dew point and thus prevent condensation of moisture within the motor enclosure, the Contractor shall energize the space heaters as soon as the motors are delivered to the Site. These heaters shall remain energized by the control circuit.

d) Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the S.O..

e) Finished surfaces of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted thereto.

f) Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

g) No shipment shall be made until approval by the S.O. in writing has been given.

h) All part of the equipment shall be shipped to the site adequately palletized and protected from breakage and dirt. All loose fittings, pipe supports, etc. shall be adequately boxed and palletized. All equipment shall remain palletized and boxed until the time of installation.

10.4 Types of Decanter

10.4.1 Surface Skimming Decanter

The surface skimming decanter for withdrawing the uppermost supernatant from the reactor basin shall consist of a decanting trough complete with an integral floating scum baffle/guard, decanting down pipes, effluent discharge pipe, rotating joint, hydraulic seal and bearing assemblies, extension rod and driving unit. The driving unit shall consist of the following:

i) Electric motor with a gear reducer, or

ii) Direct driven with variable speed drive (VSD)

10.4.2 Floating Decanter and Fixed-Pipe Decanter

The floating decanter assembly for removing an upper fluid layer from a wastewater treatment reservoir in a reactor basin shall comprise of:

10.4.2.1 Floating Decanter

a) float and mooring cables where applicable and

b) a discharge conduit (or flexible hose) connected to the float having a liquid receiving opening surrounded by a flange; the float maintaining the opening at a generally constant depth relative to the upper fluid level in the reservoir; and
c) Electrically-actuated valve assembly attached to the outlet of the discharge pipe. (Note: Some designs are without the valve and use automatic closing mechanisms based on gravitation and flow).

10.4.2.2 Fixed-Pipe Decanter

The fixed-pipe decanter is attached to the basin wall to the bottom water level elevation and the draw-off level is fixed.

10.4.3 Siphon Decanter

The siphon decanter shall consist of a horizontally supported pipe with suction nozzles. The pipe shall be connected to a discharge pipe via a U-shaped pipe arrangement and complete with a siphon valve located at the top of the vertical pipe.

10.5 Installation of Decanter

10.5.1 Surface Skimming Decanter

10.5.1.1 Civil Works Verification

To ensure the equipment supplied can function correctly, the civil works shall be verified before commencing installation of the equipment based on the following criteria:

i) The basin platform levels shall be within ±10 mm of the design values.

ii) Dimension of concrete supports for the actuator and discharge pipe bearing shall be as per structural design (based on the loadings supplied by the equipment manufacturer).

iii) The cast in discharge pipe level shall be at least 200 mm above the downstream water level.

iv) The cast in discharge pipe shall have protrusion of typically 300 mm for weir length of 900 mm to 1800 mm, or in accordance with the manufacturer’s recommendation/instruction.

10.5.1.2 Marking of Basin

i) Upon accepting the basin, a qualified surveyor shall use accurate instruments (Dumpy Level and Theodolite) to mark the correct position of the decanter.

ii) The top water level shall be confirmed and marked with permanent ink on the wall for height determination of the actuator mounting.

10.5.1.3 Installation

A. Small Decanters (Typically have weir lengths from 450mm to 1800mm)

i) The correct sequence of installation works as recommended by the manufacturer shall be strictly followed.
ii) Generally no site welding shall be allowed. Emphases shall be placed on levelling, alignment and balancing of the decanters.

iii) Wall pipe plate flange shall be checked to ensure that it is plumb within ±1.5 mm. This is essential for maintaining a level weir.

iv) Care shall be taken to ensure that, in the course of erection, before confirmation of level and alignment, the decanter shall be loosely bolted to the wall pipe flange and the decanter shall be temporarily supported.

v) The actuator support pivot bracket shall be connected to the actuator base plate and actuator support base with the hardware provided by the manufacturer. In addition, the connecting rod flange shall be temporarily bolted to the actuator jackscrew flange.

vi) Referring to the manufacturer’s installation drawing, the anchor bolt locations for the actuator support shall be marked.

vii) The cast-in wall discharge pipe shall be puddle flanged. The pipe shall be sealed with mastic compound and grouted with non-shrink grout.

viii) The holes in the actuator support base shall be lined up with the marks made in step (iv). The actuator shall be stroked out by hand as required to line up the marks and the holes.

ix) The actuator and the decanter shall be checked for proper alignment and balancing using theodolite or laser instrument and adjustment made as necessary. Once the alignment is verified, the holes shall be back-drilled for the anchors.

x) The actuator shall be disconnected from the connecting rod and actuator support base. The actuator support base anchors shall be installed per the anchor bolt manufacturer’s instructions, allowing for the necessary cure time. At this stage the actuator support base shall not be grouted until a manufacturer’s representative has confirmed the installation and level of the assembly.

xi) Sufficient time shall be allowed for curing of the anchors. Upon setting of the anchors the actuator shall be permanently connected to the connecting rod and actuator support base. All hardware shall be wrench-tightened. A pull-out test shall be done for one anchor bolt.

xii) The weir shall be level at the Park and Bottom Water Level position according to the following typical tolerances:

<table>
<thead>
<tr>
<th>Weir Length</th>
<th>Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1500 mm</td>
<td>± 5 mm</td>
</tr>
<tr>
<td>= 1800 mm</td>
<td>± 6 mm</td>
</tr>
</tbody>
</table>

xiii) The unit at the wall pipe and downcomer flanges shall be adjusted, as necessary, to achieve the above tolerances. Once the weir is level, all hardware shall be wrench-tightened.

xiv) The unit is now completely installed and any temporary supports, rigging, etc. shall be removed.

xv) The limit switches and local decanter control panel shall be installed, following strictly the manufacturers instruction.
xvi) Using the local decanter control panel, the decanter shall be lowered and raised several times to check level at the Park and Bottom Water Level positions.

xvii) The decanter assembly is now ready for commissioning by a manufacturer’s representative.

B. Large Decanters (Typically have weir lengths above 1800mm)

The installation instructions shall generally follow that for small decanters with considerations for variations in the design of the following:

i) Whether discharge via an elbow piece or to an effluent box.

ii) The provision of the seal and bearing assembly which is bolted to the discharge elbow.

iii) Floor-mounted pedestal support instead of wall-mounted support for the actuator.

iv) Single or dual unit decanter

v) Single or multiple downcomers.

The installation procedures shall strictly follow the manufacturer’s recommendations/instruction.

The bearing support normally provided on one end of the collect pipe shall be properly anchored using chemical anchor bolts.

The concrete bearing support pedestal supporting the bearing assembly shall be constructed according to structural design based on the loading provided by the decanter manufacturer. The concrete shall have a minimum Grade 30 mix.

For floor-mounted pedestal support for actuator, the concrete base shall be constructed with sufficient reinforcement according to structural design based on the loading provided by the decanter manufacturer. The concrete base support shall have a minimum Grade 30 mix.

The limit switches for the actuation rod shall be properly set in accordance with the manufacturer’s instructions.
10.5.1.4 Pipework

The flanged joints shall be made up tight, taking care to avoid undue strain on flanges. Bolt holes for each flanged joint shall be aligned properly. Bolts shall be tightened in an organised sequence, i.e. diametrically opposite to ensure that the gasket is pulled up evenly. Full size bolts for the bolt holes shall be used; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose shall not be permitted. Flanged pipe shall be installed such that the adjoining flange faces are not out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. The cast-in wall pipe shall be puddle flanged and the pipe shall be sealed with mastic and grouted with non-shrink grout to prevent seepage or leakage.

10.5.2 Floating Decanter

10.5.2.1 Civil Works Verification

To ensure the equipment supplied can function correctly, the civil works shall be verified before commencing installation of the equipment based on the following criteria:

i) The basin platform levels shall be within ±10 mm of the design values.

ii) The cast in discharge pipe level shall be at least 200 mm above the downstream water level.

10.5.2.2 Marking of Basin

i) Upon accepting the basin, a qualified surveyor shall use accurate instruments (Dumpy Level and Theodolite) to confirm the TWL and BWL which shall then be marked with permanent ink on the wall.
10.5.2.3 Installation

10.5.2.3.1 Valve Actuator

The valve actuator shall be electrically-operated type mounted on a gate valve or a butterfly valve which is mounted on the outlet of the discharge pipe. The actuator shall be securely fastened with stainless steel bolts. The power and control cables shall be run above the water level.

10.5.2.3.2 Flexible Hose

The flexible hose shall be securely connected on both ends using quick couplings for ease of installation and maintenance. The length of hose shall be such to allow easy movement of the floating decanter between the Top Water Level and Bottom Water Level, without imposing undue strain on the coupling joints. To ensure that the hose does not detach from the connection to the decanter, the connecting piece on the decanter shall be double grooved for positive engagement of the quick coupling.

10.5.2.3.3 Mooring

The number and size of cables required for mooring of the floating decanter shall be as per manufacturer’s recommendation. A typical mooring post installation (Fig. 10.2) shows the preferred way to secure mooring cable. The cable shall be wrapped around the post several times and secured with two wire rope clips. A typical setup shall use a 1 m long, 50 mm diameter schedule 40 galvanized pipe which shall be fixed to concrete floor.

Fig. 10.2 – Typical Mooring Post Installation
10.5.3 Fixed Pipe Decanter

10.5.3.1 Civil Works Verification

To ensure the equipment supplied can function correctly, the civil works shall be verified before commencing installation of the equipment based on the following criteria:

i) The basin platform levels shall be within ±10 mm of the design values.

ii) The cast in discharge pipe level shall be at least 200 mm above the downstream water level.

10.5.3.2 Marking of Basin

i) Upon accepting the basin, a qualified surveyor shall use accurate instruments (Dumpy Level and Theodolite) to confirm the TWL and BWL which shall then be marked with permanent ink on the wall.

10.6 Testing at Site

Functional testing of decanters shall be carried out as follows:

- to demonstrate proper functioning of the decanter and actuator;
- to demonstrate smooth operation without excessive vibration and noise during operation;
- to demonstrate correct alignment and level; and
- simulation of protection devices provided (limit switches, over-torque, over-travel, etc.)
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Fig. 10.1: Typical Installation of Surface Skimming Decanter
Fig. 10.2: Typical Mooring Post Installation
11.0 CLARIFIER SCRAPER

11.1 General

The Contractor shall furnish and install clarifiers consisting of sludge collector and skimming equipment at the clarifiers, complete and operable, in accordance with the Specification.

All materials used in the manufacture of the clarifiers shall be in accordance with the requirements specified in the latest edition of the IWK’s Product and Material Specifications, unless specified otherwise.

Installation of the clarifiers shall be conducted in accordance with the manufacturer’s recommendations/instruction under the direction and supervision of a competent representative of the manufacturer.

11.2 Submittals

Shop drawings and quality control records for equipment and its relevant components shall be submitted to the S.O. prior delivery to site for verification and approval.

11.2.1 Shop Drawings

Shop drawing for equipment shall consist of the following:

a) Detailed equipment drawings indicating its capacity/rating, components, physical, dimensions, coatings, power requirement and other pertinent information.

b) Tabulation for material of construction, standard and its grade.

c) Loadings of the equipment for civil and structural design purpose.

11.2.2 Quality Control Records

a) Manufacturer’s Certification of Compliance.

b) Material certificates.

c) Performance test records and certificates.

d) Calibration certificates.

e) Other relevant test records and certificates.

11.3 Delivery and Storage

a) All equipment shall be skid mounted and crated and delivered to protect against damage during shipment.

b) All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completion and the units and equipment are ready for operation.

c) All equipment and parts shall be properly protected against any damage during a prolonged storage period at the Site. The motor for each blower shall be supplied with a space heater.
installed inside the motor enclosure. In order to maintain the temperate of the motors well above the dew point and thus prevent condensation of moisture within the motor enclosure, the Contractor shall energize the space heaters as soon as the motors are delivered to the Site. These heaters shall remain energized by the control circuit.

d) Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the S.O.

e) Finished surfaces of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted thereto.

f) Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

g) No shipment shall be made until approval by the S.O. in writing has been given.

h) All part of the equipment shall be shipped to the site adequately palletized and protected from breakage and dirt. All loose fittings, pipe supports, etc. shall be adequately boxed and palletized. All equipment shall remain palletized and boxed until the time of installation.

11.4 Types of Clarifier

11.4.1 Circular Clarifier

The clarifier shall have center driven or peripheral driven scraper. The design shall be center feed/peripheral overflow type or peripheral feed/peripheral overflow type.

11.4.2 Rectangular Clarifier

The clarifier shall have chain and flight sludge collector or horizontal travelling sludge collector (reciprocating type) which has a bridge travelling sludge collector or a multiple horizontal travelling solid collector configuration.

11.5 Installation of Clarifier

11.5.1 Circular Clarifier

11.5.1.1 Tank Dimensions Verification

To ensure the equipment supplied can function correctly, the civil works, particularly the tank dimensions shall be verified before commencing installation of the equipment based on the following criteria:

a) Tank shape irregularities shall be identified.

b) The true centre of the minimum circle of the tank shall be established and the diameter of this circle checked to make sure it is within the acceptable tolerance for proper functioning
of the scraper. Remedial works on the concrete tank shall be carried out if necessary by hacking, grinding off protruding wall and plastering up areas with insufficient concrete.

c) The gradient of the floor is correctly done.

11.5.1.2 Installation

i) All the bridge crane components from the girder shall be unloaded and set to one side.

ii) The central column of the tank shall be checked to make sure it is perfectly in the centre and that it is level with the whole surrounding perimeter.

iii) The thrust bearing shall be positioned. Before fixing the position shall be checked carefully to ensure it is perfectly in the centre of the tank. To achieve this at least 10 points shall be taken all round the perimeter and the distance measured. If any difference is found, the thrust bearing shall be shifted until the distances are all the same. Once this is achieved, the bearing shall be fixed to the concrete structure with the fixtures provided.

iv) The girder of the bridge crane shall be hooked in 2 points and lifted and placed to one side near the tank on which it is to be installed.

v) After connecting the electrical cabling, the bridge crane shall be lowered into working position.

vi) The scraper components shall be joined and positioned inside the tank.

vii) After checking alignments, the couplings of the scrapers shall be connected to the descending ways.

11.5.1.3 Surfacing of Clarifier Tank Floor

Following installation of the clarifier mechanism, the tank floor shall be brought to finish grade by means of cement-mortar grout surfacing swept into place by use of the sludge collector arms. The surfacing operation shall not begin until after the installed equipment has been inspected by the engineer representative of the manufacturer and scraper arms and scraper blades have been adjusted to give correct clearance above final floor elevation typically 50 mm. The surfacing operation shall be performed in accordance with the approved recommendations of the manufacturer of the clarifier equipment. A cement-mortar grout composed of one (1) part cement and three (3) parts fine aggregate with sufficient water as needed for conditions of placement and with one teaspoon of powdered aluminium added per 20 kg bag of cement.

Immediately before the surfacing operation, the tank floor shall be cleaned of all dirt, soil and other substances which would prevent the proper bonding of the surfacing to the concrete sub-floor. The grout surfacing shall be brought to finish grade as near as possible by hand of skilled worker. If the manufacturer’s recommended procedure calls for use of straightedges attached to scraper arms, a 50 mm by 150 mm metal clad wooden straightedge shall be fastened to each scraper arm approximately 6 mm below the scraper blade to form a suitable screed; the scraper arms shall be rotated manually to complete the surfacing operation; use of drive unit to move the arms shall not be permitted. Care shall be taken to prevent grout from entering sludge cone; any grout which falls in the sludge cone or on tank walls shall be removed immediately. Immediately after surfacing operation is complete, the tank floor and circular clarifier equipment shall be cleaned of deposits of excess grout. The temporary screeds shall then be removed and squeegees installed.
11.5.1.4 Pipework

The flanged joints shall be made up tight, taking care to avoid undue strain on flanges. Bolt holes for each flanged joint shall be aligned properly. Full size bolts for the bolt holes shall be used; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose shall not be permitted. Flanged pipe shall be installed such that adjoining flange faces are not out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. Hangers and supports shall be provided where necessary to support piping. For buried piping, push-on joints or mechanical joints shall be used.

The anchor bolts shall be stainless steel grade 304 and the minimum size shall be 12 mm diameter.

11.5.1.5 Weirs

For mounting of the weir plates, care shall be taken to ensure that the several fixing on the one plate are in alignment with each other and central to the weir plate slot.

The optimum weir plate level shall be determined and marked on the tank wall for each fixing. The bolt hole positions shall be marked accurately and holes drilled accordingly. The weir plate shall be installed, ensuring that rubber gasket is fitted between plate and wall to seal weir against civil work.

11.5.1.6 Pier and Drive Mounting Plate (Applicable to Circular, Peripheral Feed Clarifiers)

i) The pier shall be anchored to the concrete base with sufficient numbers and amply-sized anchor bolts. The contractor shall obtain a template from the equipment manufacturer to accurately locate these anchor bolts.

ii) The drive mechanism mounting plate shall be set plumb with the pier centreline. The drive unit shall be positioned, shimmed, levelled and grouted in place.

11.5.2 Rectangular Clarifier

11.5.2.1 Tank Dimensions Verification

To ensure the equipment supplied can function correctly, the civil works, particularly the tank dimensions shall be verified before commencing installation of the equipment based on the following criteria:

i) Tank shape irregularities shall be identified.

ii) Two (2) planes – Plane A (vertical on tank centreline) and Plane B (horizontal on water level) shall be introduced and shall serve as reference planes for the horizontal chain and flight sludge collector or horizontal travelling sludge collector.

iii) These planes (A & B) shall be defined using a Theodolite or other accurate instruments and shall be clearly marked on the tank walls and tank floor (refer to Figure 1).

iv) The maximum rectangle of the tank on the plan section and vertical section shall then be defined and checked, with reference to Planes A & B, as illustrated in Figures 2 and 3.
11.5.2.2 Installation

Before installation, the tank bottom shall be checked for levelness. The concrete floor shall be rectified by patching or grinding where necessary to meet the dimensional tolerances stipulated by the manufacturer.

All chemical bolt holes for the drive wheel and idler wheels shall be drilled using diamond coring machine to ensure holes are free from obstruction of reinforcement bar. Over-drilling shall be avoided. When drilling a template shall be provided to ensure all the holes are perpendicular to the tank wall and floor.

Chemical bolts shall be provided and sufficient time shall be allowed for curing, as recommended by the manufacturer prior to mounting the brackets.

Both the drive shaft and non-drive shaft ends shall be checked to ensure they are on the same level. The drive pins shall also be checked to ensure they share a common centrel ine. The deviations shall be within the maximum tolerances recommended by the manufacturer.

The alignment of the drive wheel and the idler wheel shall be checked.

The drive shaft deflection at the middle point shall be checked against allowable tolerance as stated by the manufacturer.

After mounting the idler wheels onto the idler shafts, a level gauge shall be used to check to verify that the middle point of the drive wheel sprocket and the middle point of the idler wheel are aligned and inline, before putting on the lock ring.

The distance from the end of the wall to the edge of the idler wheel shall be checked to ensure that sufficient room has been provided for the passage of the flight in the event of chain elongation which will occur after some time in operation.

The return rails shall be installed in accordance with the manufacturer’s recommendations. Sufficient support brackets shall be provided, typically at 2m intervals with the first bracket being placed not more than 400 mm from the centre of the idler wheel. Long holes in the bracket shall be provided for level adjustment.

The rails shall be placed on the support brackets and aligned accordingly. The rails shall then be spot welded onto the support brackets. At the joint sections of the adjacent rails, it shall be ensured that the surface is level and that welding shall be done over the entire width of the rail and that welds shall be ground flat to ensure smoothness of chain travel.
The bottom rails shall be installed in accordance with the manufacturer’s recommendations. The rails shall be installed with an equal distance from the tank centreline on either side. The deviation shall be within ±5 mm typically or as allowed by the manufacturer.

The rails shall be checked for levelness and the difference in level between adjacent rails shall be maintained <5mm. If necessary stainless steel shim plates shall be used to raise the rail of the lower floor level up to the required level. The shim shall be positioned under the rail and additional screw nails shall be used to fasten the shim onto the floor to prevent movement of the shim.

The collector chains shall be installed in accordance with the manufacturer’s guides. Both adjacent chains shall be checked to ensure that equal number of links has been connected.

The flights shall be equally spaced for the entire length of the chain loop. An equal number of chain links shall be ensured on both sides of the chain between the two adjacent flights.

The mounting positions of the chain guard, idler shaft and chain tensioner with respect to the drive shall be established using a Theodolite. The alignment shall be checked against the drive wheel sprocket to ensure the complete assembly is properly aligned.

The gear of the driver unit shall be inline with the gear unit of the drive wheel and shaft assembly.

The level of the drive unit assembly as well as the chain positioning in relation to the chain guard and chain tensioning device shall be checked.

The adjustable screw on one side of the drive unit assembly shall be tightened and adjusted to the correct tension as recommended by the manufacturer.

11.5.2.3 Installation of Bridge Travelling Sludge Scraper

These shall be some variations in the installation procedure depending on whether the scraper unit is running on wheels or on rails supported on the side walls, but the procedure shall generally be common for installation of the bridge girder, scraper mechanism and cable system.

i) Upon verification of the civil works tank dimension, typically to tolerances of ±20 mm, the bridge crane shall be hooked by a crane and lowered on the surface on which it travels, taking care not to knock the gear motors against other objects. All the components shall be unloaded from the catwalk and positioned close to the tank in which the bridge crane is to be installed. Refer Figure 8 for the end view of a typical bridge crane.

ii) The bridge crane shall be temporarily lifted by a crane, to remove the pipe that holds the connecting shaft and the four strike wheels (guard wheels).

iii) The shafts, the O rings and the blocking nuts shall be connected to the pipe that holds the connecting shaft.

iv) Once this has been done, the bridge crane shall be raised, taking care to turn the translating gear motor towards the sludge collection trough and keeping the connecting shafts on the opposite side.
v) The bridge crane sliding wheels shall be checked and adjusted to make sure they are parallel to the walls. A point along the whole length of the tank at which the distance between the walls is shortest shall be found using a Theodolite. The bridge crane shall be taken to this point, so that all adjustments shall be carried out at the tightest point of the tank.

vi) The previously removed strike wheels (guide wheels) shall be assembled and adjusted so that all four wheels are leaning against the wall. Upon confirmation that the bridge crane is truly perpendicular to the walls, the strike wheels shall then be fixed using the supplied bolts.

vii) The scraper boom, frame and scraper shall be assembled in the tank and attached to the shaft by transoms in accordance with the manufacturer’s instructions.

viii) The bottom scrapers shall be inserted into the tank and positioned so that the sliding wheels face the side opposite the sludge collection trough. Using the adjustable attachments, the shafts shall be fixed to the bottom scrapers, then all the bolts shall be fixed tightly.

ix) The cable winders for surface frame and the bottom scraper transom shall be installed in accordance with the manufacturer’s instructions.

11.5.2.4 Rails Installations (Application to Bridge Travelling Sludge Collector Running on Track)

The rails shall be installed at the same level on top of both sides of the tank walls in the longitudinal direction. Checks shall be made at least 5 points along the rail tracks to ensure that the distance between the rails on both sides of the tank is kept constant within the tolerances of the wheels, typically ± 20 mm.

11.5.2.5 Installation of Multiple Horizontal Travelling Solid Collector

The scraper shall consist of a hydraulic cylinder, a lever system and a number of wedge shaped sections welded together to form a single unit which functions like a moving floor on the bottom of the tank.

The tank bottom dimensions shall be checked and verified based on the maximum deviations as recommended in Figure 4.
The placement and welding of the crossing bars to the scraper profile, the welding of the push/pull holders and rods, the fabrication of the guide rod brackets shall be done strictly in accordance with the manufacturer’s recommendations. The entire scraper structure shall be constructed such that the guide rod sits in the centre of the tank, as well as parallel to the tank floor.

### 11.6 Testing at Site

Functional testing of the clarifier scrapers shall be carried out as follows:

- Sequential operation and simulation of protection devices provided (mechanical and electrical type).
- To demonstrate correct operation/rotation of the motors.
- To demonstrate absence of excessive vibration and noise during operation.
- To demonstrate correct alignment of rail tracks.
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Fig. 11.2:
Fig. 11.3:
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12.0 SUPPORTING ACCESSORIES

12.1 Handrailing

12.1.1 Galvanized Steel Handrailing

The galvanized mild steel handrailing shall be of circular hollow section complying with the relevant requirements of BS 4, BS EN 10255, BS EN 10296, BS EN 10297 and BS EN 10305 or alternatively handrailing shall consist of solid (parallel) galvanised mild steel section satisfying the requirements of BS 449, BS 7668, BS EN 1009, BS EN 10025 and BS EN 10210.

Handrailing shall include galvanized mild steel kick plates, 150 mm high by 3 mm thick fixed securely to the stands. All handrailing on elevated walkways and stairways shall include infilled panels of galvanised mild steel mesh.

Stands and handrails shall not be less than 60 mm in diameter. Horizontal handrails shall be 1100 mm high with an intermediate rail 500 mm high. Handrail height shall be measured vertically from finished floor level to the top of handrail. Stands shall be spaced at not more than 1800 mm apart.

Handrailing and fixings shall be designed to withstand a horizontal force at handrail level of 740 N/m run. The deflection of rails shall not exceed 0.8% of their span between standards and the deflection of standards shall not exceed 0.8% of their height.

The handrail stand mounting shall be approximately 150 mm sq. by 8 mm thick. Four holes shall be provided for fixing 16 mm diameter anchor bolts onto the floor. Primer coating shall be applied onto the welding parts prior to application of galvanized paint, where welding is done at site.

All ladders, stairways or other openings shall be guarded on all sides by handrailing conforming to the requirements stated above. Access to the ladders shall be further guarded by two galvanized hanging chains which shall be secured at one end and detachable at the other. Access to openings shall be closed with lockable hinged gates.

Fig.12.1 – GMS Handrailing
12.1.2 FRP Handrailing

Fibre Reinforced Polymer (FRP) handrailing shall be used for corrosive environment and for fire retardant requirement, where specified.

The FRP handrailing shall be of pultruded construction type. All pultruded components shall be tested and comply with the requirements of BS 476 Part 7 and ASTM E84 Flame Retardant Standards. The resin used in the manufacture of FRP handrail shall be suitable for the chemical environment.

The FRP handrailing shall be made of square tube (50 mm x 50 mm x 6 mm) comprises 2 horizontal rails minimum. Height of the handrailing shall be approximately 1 m and shall be provided with 100 mm high by 3 mm thick kick plates. Vertical posts shall be spaced at not more than 1800 mm apart.

The lower end of handrail vertical post shall be provided with removable base with 4 bolt holes floor mounting bracket.

Fig. 12.2 – FRP Handrailing
12.2 Ladders

12.2.1 Aluminium Ladder

Aluminium ladder shall be designed for heavy duty application and shall be made of C-channel frames (65 mm x 28 mm x 3 mm thick) and non skid D-rungs (25 mm x 40 mm x 3 mm thick). Rungs shall be positioned at 300 mm centres and shall not be less than 250 mm from the wall. Height of rung from the floor shall not be more than 300 mm. Width of the ladder shall be at least 450 mm. Bottom end of the ladder shall be provided with mounting plate for fixing onto the floor.

All aluminium ladders more than 5 m high shall have safety cages which shall be constructed of four flat vertical strips supported by flat hoops with a diameter of 700 mm. The hoops shall be at approximately 1000 mm centres and the first hoop shall be approximately 2200 mm above ground or platform level.

Mounting brackets of the ladder to the wall shall be provided at not more than 1800 mm interval. Where the rise exceeds 6 m, an intermediate landing shall be provided. Aluminium ladder shall be provided with 1000 mm high by 600 mm wide handhold at the upper landing. The handhold shall be provided with mounting plate for fixing onto the floor.

Fig. 12.3 – Aluminium Ladder
12.3 Walkway

12.3.1 Steel Walkway

Walkway shall be constructed from structural steelwork conforming to the requirements of BS 5950. The width of walkway shall be at least 1200 mm. Walkway shall be made up by open mesh or chequer plate flooring.

Open mesh flooring and gratings shall generally comply with BS 4592 except where otherwise specified. Such flooring and gratings shall be of non-slip, galvanised mild steel, rectangular mesh and shall be provided with curbing at the edge of walkways. Where necessary, intermediate support members shall be provided and fixed.

Kick plates of 100 mm high by 3 mm thick shall be provided around all cut-outs except where otherwise ordered by the Engineer.

Both the load bearing and transverse bars in rectangular flooring panels shall be positioned symmetrically around the centre lines of the panels in both directions, so that when the panels are fixed in extensive areas or in long runs, the bars of all panels are in line.

Chequer plate flooring shall be of the non-slip type and not less than 6 mm thick excluding the raised pattern. The flooring shall be secured to its frame by stainless steel countersunk set screws.

All flooring shall be designed to carry a loading of 7.5 kN/m² and the deflection shall not exceed 0.2% of the span.

All flooring shall be removable and set flush in frames of similar material. Where frames are to be fixed over openings the frames shall be provided with lugs for building in.

Flooring shall be provided in sizes suitable for lifting and removal by one man and with the appropriate cut outs to permit its removal without disturbing or dismantling spindles, supporting brackets, cables or pipework. Intermediate supporting members to give the required rigidity to the spanning edges of individual flooring sections over the wider openings and trenches shall be provided and bolted to suitable built-in fixings. The members shall also be removable to afford clear access to the openings and trenches.

12.3.2 FRP Grating

Fibre Reinforced Polymer (FRP) grating shall be used for corrosive environment and for fire retardant requirement, where specified.

The FRP grating shall be of pultruded type constructed from assembly of pultruded structural load bars and tie rods. The resin used in the manufacture of FRP grating shall be suitable for the chemical environment. All pultruded components shall be tested and comply with the requirements of BS 476 Part 7 and ASTM E84 Flame Retardant Standards.

The FRP grating shall be made of pultruded bearing bars held together by cross tie components. The FRP grating shall be a flush top configuration and anti skid surface. Thickness of the grating shall be at least 25 mm for a span not more than 750 mm long, subject to manufacturer’s recommendation.
The FRP grating shall be designed for heavy duty application of 7.5 kN/m² and the deflection shall not exceed 0.5% of the span.

Prior to installation, the allowable span and load for the FRP grating shall be checked against the manufacturer’s recommendation values. The grating shall be attached to the support structural with anchoring devices supplied by the manufacturer. All cut or sanded surfaces shall be coated with resin furnished by the manufacturer and applied in accordance with the manufacturer’s recommendation.

12.4 Hoist

12.4.1 General

The safe working load of the hoist shall be 20% greater than the individual weight of the heaviest equipment or parts to be handled.

The hoists shall conform to BS EN 13001 Class 2 ‘medium duty’ and meet the specified operational requirements. Runway rails for the hoist shall constructed from structural steel I-beam.

Lifting hooks shall be safety hooks made from Grade 30 carbon steel to BS EN 1677 or equivalent, and capable of swivelling through 360 degrees.

An identification plate shall be provided on all hoists indicating the manufacturer's name, SWL, serial number, BS number, and year of manufacture.

12.4.2 Electric hoist

For electrically operated hoists drive motors shall be fitted with an automatic electromagnetic break to prevent overtravel of the hoist on interruption of the power supply.

Safety disc brakes shall be incorporated to hold the suspended load instantly, securely and automatically, in the event of the current being cut off. Facilities for override for the disc brake for hand release of the load shall be incorporated.

Means of manoeuvring hoists manually from the floor shall be provided for use in the event of a power failure.

Power feed to the electric hoist shall be through a close looped flexible cable catenary suspension system with carriers sliding along a track along the full length of the building.

All hoist functions shall be controlled from a single pendant unit. The pendant unit shall be suspended using a non-metallic cord and not the control cable. The pendant shall operate from a low-voltage source, incorporate a key-operated switch to prevent unauthorised operation, and indicators to indicate all hoist movements. Interlocks shall be provided to prevent simultaneous lift and travel.

Limit switches to cut-off the raising and lowering motion when the hook reaches its maximum limit of travel shall be provided.
12.4.3 Manual hoist

Manually operated chain hoists shall be arranged for close lift with two falls to the lifting hook, geared travel, and shall be in conformity with BS EN 13157.

The load chain shall be of alloy steel Grade 80 and the hand chains shall be mild steel. The load chain wheel shall have pockets and a chain guide to align the chain with pockets to prevent the chain from jumping off the wheel.

Hoist units shall incorporate a brake which shall be applied automatically when effort on the hand chain is released. The applied brake load shall be proportional to the load on the hook.

12.4.4 Testing at Site

The following tests shall be conducted at site to conform the hoist installation works:

i) Functional tests to demonstrate smoothness of travel motion, limit switches, safety devices, etc.

ii) Load test to the requirements of JKKP/DOSH.

12.5 Guide rail

Guide rail shall be provided to allow equipment to slide down to its intended position from the deck level.

The guide rail shall be strong enough to avoid deformation under the forces created by the equipment under overload condition. The maximum allowable deflection shall be 3 mm.

Guide rail shall be provided with brackets for mounting to the wall/floor. For a long guide rail, stainless steel wall brackets shall be provided at 2 m interval for mounting to the wall to avoid deflection of guide rail.

Vertical alignment of guide rail shall be checked and adjusted to comply with the allowable tolerance specified by the equipment manufacturer.
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- Fig. 12.3: Aluminium Ladder
- Fig. 12.2: FRP Handrailing
- Fig. 12.1: GMS Handrailing
13.0 PIPING AND ANCILLARIES

13.1 General for Piping

Piping system shall include pipes, fittings, valves, supports and all necessary appurtenances. Unless otherwise approved by the S.O., a single manufacturer shall supply each type of pipe and its related specials and fittings.

Pipes and fittings shall be designed and manufactured to the following standards or approved equivalent:

<table>
<thead>
<tr>
<th>Pipe</th>
<th>Standards</th>
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<tbody>
<tr>
<td>Ductile iron</td>
<td>BS 4772</td>
</tr>
<tr>
<td></td>
<td>BS EN 598</td>
</tr>
<tr>
<td></td>
<td>BS EN 545</td>
</tr>
<tr>
<td>Steel</td>
<td>BS 534</td>
</tr>
<tr>
<td></td>
<td>BS 4515</td>
</tr>
<tr>
<td></td>
<td>BS 3601</td>
</tr>
<tr>
<td></td>
<td>BS 4504</td>
</tr>
<tr>
<td>Stainless steel</td>
<td>ASTM A312/A312M</td>
</tr>
<tr>
<td></td>
<td>ASTM A182/A182M</td>
</tr>
<tr>
<td></td>
<td>ASTM A778</td>
</tr>
<tr>
<td>uPVC</td>
<td>BS 3506</td>
</tr>
<tr>
<td></td>
<td>BS 4346</td>
</tr>
<tr>
<td></td>
<td>MS 978</td>
</tr>
<tr>
<td></td>
<td>MS 979</td>
</tr>
</tbody>
</table>

The following shall be clearly marked on each pipe and fitting delivered to site:

a) Project owner ‘Indah Water Konsortium Bhd’
b) The date of manufacture
c) The name and trademark of the manufacturer
d) Length, diameter, branch diameter for tees and angles for bends
e) The material and weight of the pipe and fitting
f) The strength category that the pipe and fitting conforms to
g) Factory test pressure (as relevant)
h) Manufacturing standard compliance
i) SIRIM or other certification logo as approved

13.2 Submittals

Shop drawings and quality control records test certificates for pipes and fittings shall be submitted to the S.O. prior delivery to site for verification and approval.
13.2.1 Shop Drawings

a) Detailed pipe fabrication or spool drawings showing pipes and fittings, dimensions, coatings and other pertinent information.

b) Layout drawing showing location of each pipe section and each special length.

c) Drawings of piping support system locating each support, brace, hanger, guide, anchor etc.

13.2.2 Quality Control Records

a) Manufacturer's Certification of Compliance.

b) Laboratory Testing Equipment : Certified calibrations, manufacturer’s product data and test procedures.

c) Certified welding inspection and test results.

d) Qualifications :

   i) Weld Inspection and Testing Agency : Certification and qualifications

   ii) Welding Inspector : Certification and qualifications

   iii) Welders:

- List of qualified welders and welding operators.
- Current test records for qualified welder(s) and weld type(s) for factory and field welding

e) Weld Procedures: Records in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s) or approved equivalent.

f) Nondestructive inspection and testing procedures.

g) Certified weld inspection and test reports

h) Test logs

13.3 Handling and Storage

Every precaution shall be taken to prevent damage to the during handling, transporting and storage. Pipe shall be handled by means of approved hooks on ends of sections, by means of fabric slings, or other methods strictly in accordance to the manufacturer's recommendation for the type of pipe used and as approved by the S.O. Dropping or bumping of pipe will not be permitted. Damaged pipe shall be replaced or repaired by the Contractor at his expense and such repairs shall be to the approval by the S.O. Pipes shall not be dragged over the ground and, if rolled shall be rolled only over adequate timber bearers to prevent damage.
Pipes are preferably stored inside the room to avoid damage to the pipes. Pipes may be stored in the open, but shall be placed on adequate timber bearers to prevent damage to sheathing or sockets. Pipes may be stacked one above the other up to the height as recommended by the manufacturer subject to the approval of the S.O. provided suitable protective packing is placed between them. If any pipes or fittings shows signs of corrosion or deterioration during storage they shall immediately be treated at no extra charge by the Contractor as the S.O. directs to arrest and prevent the corrosion. If different classes of pipes are kept in the same stacks, the heaviest class shall always be at the bottom.

Pipes and fittings made of plastic material, e.g. uPVC pipes shall be protected from high temperature and direct sunlight and shall be stored inside the room.

Coated pipes shall be lifted and moved only by wide non-abrasive slings or other means acceptable to the S.O. Wire ropes, chains and hooks shall not be permitted to come into contact with the coating. Coated pipes shall not be rolled or dragged along the ground.

Coated pipes shall be stacked in one layer only at pipe storage yards approved by the S.O. or strung along the pipeline route and in such manner that the coating is not damaged. Adequate packing between pipes for this purpose shall be supplied by the Contractor. Coated pipes shall be kept clear of the ground and rested on padded sleepers or supports.

Care shall be taken with elastomer joint rings or gaskets and washers to ensure that they are kept in weather-proof storage away from direct sunlight. They shall not be stored at low temperature to prevent them from becoming rigid and losing their flexibility.

The ends of all pipes and fittings shall be suitably protected against damage during storage and transportation with straw contained in hessian secured to the pipe ends. All flanges shall have wooden discs temporarily bolted on. Threaded or socket end pipes shall be fitted with metal, wood or plastic plugs/caps for protection purpose. Pipes and fittings shall be wrapped or cushioned so that no load is taken directly on the external coating.

### 13.4 Piping Layout

Piping layout requires a practical understanding of complete piping system including material selections, jointing methods, equipment connections and shall take into account the following aspects:

1. Pipes, fittings, supports and all necessary equipment locations and dimensions shall be ascertained to develop piping layout.
2. Piping shall be arranged neatly and run the route near the floor level in general.
3. Piping layout shall utilize the surrounding structure for support where possible. Horizontal and paralleled pipe runs at different elevations shall be adequately spaced for branch connections and for independent pipe supports.
4. Interference with structural work, electrical conduit and cable tray runs, building services equipment and other equipment not associated with the piping system shall be avoided.
5. Lay lengths and all relevant equipment restrictions and constraints shall be considered. Equipment manufacturer’s instruction and recommendations shall be consulted for specific requirements.
6. Piping layout shall also consider accessibility for maintenance purpose, clearance for working space, hydrostatic test fill, drain ports at low points, air vents at high points for testing and start-up operation, safety aspect and also space for future installation works.

13.5 Pipe Joints

All piping shall have a sufficient number of joints to allow convenient removal of piping. Pipe joints shall not be encased in concrete.

13.5.1 Flanged joints

All metal pipes of 150 mm diameter and above shall be flanged joint type. Flanged joints shall be applied for pipes and fittings associated with equipment above ground to facilitate installation and removal and shall not be used for buried pipes.

Flanges shall conform to the requirements of BS 4504 unless otherwise specified and shall be adequate to withstand test pressure for the fittings to which they are attached. They shall be of the raised face type and truly faced over their whole width.

All materials required for use in making of flanged joints including bolts, nuts, washers and joint gaskets shall be supplied by the Contractor. Joint gaskets shall be contained within the bolt pitch circle and shall be made of 4.5mm rubber to BS 1154 Class 73 reinforced with two layers of fabric in accordance with BS 5292. The gasket shall be compatible with the fluid to be conveyed in the pipe.

Each bolt shall be installed with a nut and two washers and each bolt shall be sufficient length to show at least two threads past the nut when in the fully tightened condition.

Bolts, nuts and washers shall be stainless steel for joints in wet wells, other locations where the joint is within the splash zone or subject to submergence in liquid or exposed to a corrosive atmosphere. All bolts, nuts and washers for flanged joints of dry application shall be hot dip galvanised.

Flange shall be properly aligned before any bolts are tightened. Torque wrench shall be used to ensure uniform bearing and proper bolt tightness to manufacturer’s recommendation.
13.5.2 Threaded joints

All metal pipes smaller than 150 mm diameter shall be of threaded joint type. Pipe threads shall be in accordance to BS 21 or approved equivalent standards.

Sufficient thread length shall be provided to ensure full engagement when screwed in fittings. Threaded joints shall be sealed with Teflon sealing or other approved sealing compound. Connections shall not expose more than three threads.

13.5.3 Solvent Joints

All uPVC pipes and fittings joints shall be made with solvent cement supplied by the pipe manufacturer. The pipe and its matching socket surfaces shall be cleaned using primer fluid to the prior to application of solvent cement.

Unions or other easily dismantling joints shall be provided for connection to the valve end to facilitate removal of valve.

13.5.4 Welded joints

Where jointing of steel pipes and specials by welding is approved by the S.O. it shall be by means of an external circumferential electrical arc weld at each joint.

The weld shall be of the convex full fillet type, the length of each leg being not less than the thickness of the metal of the pipe. The weld shall be made manually by the metalled are process using approved types of electrodes, and all shall be carried out in two stages, one root pass followed by one more weave cover passes. Each time the arc is started it shall be manipulated to obtain complete fusion of the weld with the pipe metal and any previously deposited weld metal. All slag shall be completely removed and the weld metal and the adjacent pipe metal shall be cleaned by wire brushing.
Section 13 – Piping and Ancillary

All welds shall be subject to visual inspection by the S.O. and shall comply with the requirements of BS 5950 : Part 1 : 2000, BS EN 1011 and BS 4872 for freedom from undercutting, fusion penetration and soundness.

i) Welding procedure

All electric arc welding equipment shall comply with BS 638. The Contractor shall submit details of the welding procedure which he proposes to adopt for the S.O.’s approval. Details shall include:

- Make, type and gauge of electrodes
- Size, shape and number of runs in welded joint
- Current strength

The Contractor shall demonstrate his chosen welding technique on a pipe and joint of the same metal and thickness as the pipeline to be welded. Bare steel shells and joints shall be supplied by the Contractor free of charge for this purpose. Test specimens shall be prepared and tested in accordance with BS 2633. Only procedures approved in writing by the S.O. shall be adopted in welding on the pipelines, and change from one procedure to another will not normally be permitted without submitting the new procedure for re-testing.

ii) Welding personnel

Only competent and certified welders shall be employed on the Works, and every welder before commencing any joint welding shall prepare specimens for testing in accordance with BS 2633 for each welding procedure proposed by the Contractor.

The Contractor shall make test specimens which shall be tested in the presence of the S.O. for each welding procedure proposed.

The S.O. will advise the Contractor in writing which welders the S.O. considers produce satisfactory test specimens. Only these welders will be allowed to joint pipes in position and the S.O. shall be at the liberty to withdraw his approval to any welder responsible for making joints which fail to meet the required standard.

The Contractor shall supply all materials and labour for preparing the test specimens and shall allow for their cost and for laboratory test charges in the unit rates for welding.

iii) Radiographic examination of welded joints

Welded joints for large diameter pipes of 1200 mm diameter and above shall be radiographed at random as directed by the S.O. At least 2 strips each for internal and external welds shall be sampled for quality check for a slip joint. The Contractor shall make all the necessary arrangement apparatus and equipment and a specialist to carry out the test. The analytical report in duplicate shall be submitted to the S.O. three days after the test. If the weld does not meet the requirements of the Specification, the weld will have to be gouged out and made good. The repaired welds shall be radiographed again at no extra cost to the Employer. The frequency of radiographic examination for welded joints shall be one in every fifty.
iv) Completion of external coating at welded joints

After each length of pipeline has been laid the external coating shall be made good.

Bare metal shall be thoroughly cleaned to bright metallic finish and it shall be immediately coated with a primer solution. The primer shall be applied cold by brush.

As soon as the primer has set, the coating shall be completed by running hot coal tar enamel or bitumen, whichever is compatible with the external coating, into a metal mould placed over the joint and overlapping the coating by 75 mm for the buried pipes.

For the pipes above ground, two layer of final coat of zinc chromate primer shall be applied.

v) Completion of internal lining at welded joints

For steel pipes larger than 600 mm diameter, on completion of the external coating, the steel exposed by the gap in the internal lining together with the adjacent lining shall be thoroughly cleaned and wire brushed. The adjacent lining shall be wetted with thick cement slurry but not accumulations of water in the gap shall be allowed.

The internal lining shall then be made from one volume of cement to two volumes of five aggregate to ensure smooth continuous lining throughout the pipeline.

13.5.5 Mechanical flexible coupling

Mechanical flexible coupling shall be used for jointing plain ended pipes and shall be fixed in accordance with manufacturer’s instruction / recommendations.

Mechanical flexible coupling shall be provided for the following piping systems:

a) Piping to be installed between different pipe support conditions, e.g. underground piping after passing through the concrete structure or the like.

b) Piping having expansion and contraction caused by temperature change to reduce piping stress.

Each coupling shall be capable of withstanding without leakage twice the working pressure. Coupling shall also be capable of maintaining watertight joint over a range of axial movement between the pipe ends of at least 9.5 mm and with up 3 degrees angular deflection between the longitudinal axis of the pipe. Two couplings shall be used and a short piece of pipe shall be allowed between the couplings to take up lateral displacement and angular deflection for buried piping.

Couplings shall be supplied complete with all necessary coupling rings, sleeves, bolts, nuts, washers and rubber rings. The sleeves shall be 1.5 mm thicker than the pipe shall thickness. Bolts, nuts and washers shall be stainless steel for joints in wet wells, other locations where the joint is within the splash zone or subject to submergence in liquid or exposed to a corrosive atmosphere. All bolts, nuts and washers for joints of dry application shall be hot dip galvanised.
Pipe supports shall be provided upstream and downstream of the flexible coupling joints for piping above ground. Coupling installed for pumping mains shall be tied type complete with tie rod boltings between the two pipe ends.

The number and size of boltings shall be designed by the manufacturer. The recommended torque for coupling boltings shall be as stated below, subject to manufacturer’s recommendation.

<table>
<thead>
<tr>
<th>Bolt Size</th>
<th>Torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2”</td>
<td>50 to 65</td>
</tr>
<tr>
<td>5/8”</td>
<td>95 to 120</td>
</tr>
</tbody>
</table>

**Fig. 13.2 - Mechanical flexible coupling**

**13.5.6 Flange Adaptors**

Flange adaptors shall be used for jointing plain end pipes to fittings and shall be fixed in accordance with manufacturer’s instruction / recommendation.

Each flange adaptor shall be capable of maintaining of watertight joint over a range of axial movement of at least 4.8 mm and angular deflection of not less than 1.5 degrees. All flanges shall be drilled to BS 4504 to match with fitting flanges. Each flange adaptor shall also be capable of withstanding twice the working pressure.

Flange adaptor shall be supplied complete with all necessary adaptor rings, bolts, nuts, washers and rubber rings.

Bolts, nuts and washers shall be stainless steel for joints in wet wells, other locations where the joint is within the splash zone or subject to submergence in liquid or exposed to a corrosive atmosphere. All bolts, nuts and washers for joints of dry application shall be hot dip galvanised.

The number and size of boltings shall be designed by the manufacturer. The recommended torque for boltings shall be as stated below, subject to manufacturer’s recommendation.

<table>
<thead>
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<tr>
<td>1/2”</td>
<td>50 to 65</td>
</tr>
<tr>
<td>5/8”</td>
<td>95 to 120</td>
</tr>
</tbody>
</table>
13.6 Pipe Support

The design, selection and installation of pipe supports shall follow the Manufacturer’s Standardization Society of the Valve and Fitting Industry standards, e.g. MSS SP58, MSS SP69 and MSS SP89 or approved equivalent.

Piping shall be rigidly supported from the structure by hangers, bracket or supports with adequate provisions for expansion and construction. Valves, flowmeters and other miscellaneous fittings which contribute concentrated loads to the piping system shall be supported independently. The mounting points where pipe supports are attached shall be able to accommodate the loads from the supports.

Pipe supports shall be positioned such that they will not interfere with other design considerations. Pipe supports shall be positioned at changes in direction or in elevation, adjacent to flexible joints and couplings of the piping. Pipe fittings, e.g. bends, tapers, tees and other points where thrust will occur shall be supported with concrete block designed by the Engineer.

Allowable spacing or span between pipe supports shall be based on the maximum amount that the pipeline may deflect due to loading. Typical maximum support/hanger spacing requirements for various pipes materials are tabulated below for reference.

<table>
<thead>
<tr>
<th>Steel/Ductile iron pipe size (mm)</th>
<th>Maximum Support/Hanger Spacing (m)</th>
<th>Minimum Hanger Rod Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less 100</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>100 - 300</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>350 - 500</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>550 - 600</td>
<td>5</td>
<td>32</td>
</tr>
</tbody>
</table>

Table 13.2 - Stainless Steel Pipe Support Spacing
### Table 13.3 - uPVC Pipe Support Spacing

<table>
<thead>
<tr>
<th>uPVC Pipe Size (mm)</th>
<th>Maximum Support Spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less 50</td>
<td>0.5</td>
</tr>
<tr>
<td>50 - 80</td>
<td>1.0</td>
</tr>
<tr>
<td>100 - 150</td>
<td>1.5</td>
</tr>
<tr>
<td>200 - 300</td>
<td>2.5</td>
</tr>
</tbody>
</table>

### Table 13.4 – Type of pipe support

<table>
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<th>Piping Arrangement</th>
<th>Type of Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal suspended piping</td>
<td>Hanger system</td>
</tr>
<tr>
<td>Horizontal piping supported from walls</td>
<td>Wall mounted framing support system with anchoring device.</td>
</tr>
<tr>
<td>Horizontal piping supported from floors</td>
<td>Concrete support - for pipes of 100 mm diameter and above</td>
</tr>
<tr>
<td></td>
<td>Floor mounted channel framing support system with anchoring device - for pipes smaller than 100 mm diameter</td>
</tr>
<tr>
<td></td>
<td>Pedestal type, adjustable with stanchion, saddle and with anchoring flanges. Vibration isolation pad shall be placed underneath anchor flanges.</td>
</tr>
<tr>
<td>Vertical piping supported from walls</td>
<td>Wall mounted framing support system with anchoring device.</td>
</tr>
</tbody>
</table>

The hanger and framing support systems shall be submitted for S.O.’s approval. The size and type of the hanger and framing support systems shall in accordance with manufacturer’s recommendations, subject to loading of the piping and fittings.
13.7 General Installation Works

The pipes shall be accurately installed to the lines, levels, grades and positions set out by the Contractor as shown on the drawings. The piping shall be arranged neatly and run the route near the floor, parallel to building or column lines in general.

Group piping wherever practical at common elevations shall be installed to conserve building space and not interfere with use of space and other works.

Pipes shall be installed such that clearances are provided as follows:

i) Over walkways and staircase: Minimum 2200 mm, measured from the surface of walkway or stair tread to the lowest extremity of piping systems, e.g. flanges, hanger/support systems, etc.

ii) Between equipment or equipment piping and adjacent piping: Minimum 900 mm (3 feet), measured from equipment extremity and extremity of piping systems, e.g. flanges, equipment body, supports, etc.

iii) Between wall or floor: Minimum 150 mm, measured from the wall or floor surfaces to the extremity piping systems, e.g. flanges, equipment body, etc.

iv) Headroom in front of openings, doors and windows shall be at least 100 mm above the top of the openings.

Piping shall not be routed:

i) In front of or to interfere with access ways, ladders, stairs, platform, walkways, openings, doors or windows.

ii) Over, around, in front of, in back of or below electrical equipment including control panels, switches, terminal boxes or other similar electrical works.

Generally, for buried pipe of 1000 mm diameter and below, the cover to the top of pipes shall be at least 1000 mm.

The uPVC pipes laid under direct sunlight shall be shaded where possible otherwise, the pipes shall be coated with UV protective paint. The uPVC pipes shall not be placed adjacent to boilers, hot water or stem lines where the temperature of the pipe may exceed the design temperature of the pipe system.

Pipes passing through the wall or floor which requires waterproof or subject to differential water pressure or thrust shall be provided with puddle flange.

The gap between wall pipe surface and concrete surfaces of the opening shall be perfectly sealed with non-shrink grout material.

All pipes, after installation, shall be painted to the colour according to each function. The pipe finish colour shall comply with IWK’s standard.
13.8 Ancillary Equipment

Ancillary equipment for piping shall be installed where required and shall be made accessible for testing and maintenance purposes.

13.8.1 Drain

All low point in piping system shall be provided with drain valves to allow flushing of sediment or draining of the lives when required. The drain valve size shall be about 1/3 of the pipe diameter.

13.8.2 Sampling port

Sampling ports shall be installed along the pipeline where required. Piping for sampling shall be as short as possible and easily accessed. The number of sampling ports and their locations shall be subject to S.O.’s approval. The minimum size for sampling port shall be 15 mm. Valve for sampling port shall be quick opening / closing of ball type or equivalent.

13.8.3 Air vent

Air vent points shall be provided at all high points in the piping system where air can collect. Typically, air release valve are installed at high points for venting any air that accumulates in the piping system while the system is in operation and under pressure. The size of air release valve shall be in accordance with manufacturer’s recommendations.

Air release valve shall be installed with an isolation valve, between the air release valve and the piping system for maintenance purpose.

13.8.4 Pressure relief

Pressure relief devices shall be installed in the piping system where required. The device shall protect the piping system by releasing excess pressure. Size of the pressure relief devices, location of installation and predetermine pressure for relief shall be in accordance with manufacturer’s recommendations.

13.9 Testing at Site

The Contractor shall provide all things necessary for carrying out cleaning and testing including pumps, gauges, pipe connections, stop ends and all other temporary works. Piping shall be properly completed and supported before being put under test.

The Contractor shall submit for the S.O.’s approval details of his proposed methods and programme for testing including details for test equipment. All test shall be conducted in accordance with the requirements of MS 1228: 1991 or approved equivalent standards.

Hydrostatic test shall be carried out at 1.5 times the maximum working pressure for a period of at least 1 hour to verify the pipe strength and leakage. During period of testing the pressure shall not change / drop from its original pressure reading. Should any drop in pressure be noted during the test period, the test shall be stopped until the cause of pressure drop has been investigated and rectified. The pipes shall then be retested until satisfactory result is obtained.
Every section of the pipeline shall be tested and connected with tested sections so that no element of the pipes is left untested. For air pipeline, dry air or nitrogen shall be used for the testing.

The Contractor shall take adequate precautions to strengthen and secure joints, bends, tees, etc. so that they are not damaged during the tests.
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