Section 8

Package Sewage Treatment Plant
8.1 Definition

A package sewage treatment plant is a form of treatment plant both for fixed film and suspended growth processes. It shall consist of a prefabricated biological treatment system and be limited to the development of the sewage treatment system between the ranges of 150 to 5000 populations equivalent (PE).

The package sewage treatment plant is only applicable to Class 1 and Class 2 STP as defined in Section 4 of this Guidelines. The prefabricated biological treatment system shall have been given approval by the Commission prior to the application.

The major components of a package sewage treatment plant are:

I) Inlet works
   a) Primary screen.
   b) Pump Station (if applicable).
   c) Secondary screen.
   d) Grit and grease chambers.

II) Biological treatment system
   a) Balancing Tank.
   b) Aeration/Anoxic Tank.
   c) Clarifier.
   d) Sludge Holding Tank.
   e) Aeration System including blower house.
   f) Sludge Dewatering System.

III) Outlet works
   a) Disinfection that can be physical, chemical or radiation.

Package sewage treatment plants fall under the category of covered/buried treatment plants.

8.2 Land Area Requirement

The land area requirements for package sewage treatment plants shall comply with those recommended for Class 1 and Class 2 Plants in Section 2 of this Guidelines.

The net area does not include the 10 m buffer zone surrounding each plant, but does include the 5 m set backs and access paths within the plant.
8.3 Design Requirement

a) All calculations regarding the inlet works, outlet works, biological processes and hydraulics shall follow the design criteria as stipulated in the Section 4 and Section 5 of this Guidelines.

b) All units of package sewage treatment plant and foundation shall be designed to meet the extreme case scenario as follows:
   i) When the tanks are fully emptied;
   ii) During high groundwater conditions.

c) The structural design of a tank shall consider all factors that can affect the strength and integrity of the tank, like soil conditions, area of installation, etc. All tanks shall be structurally designed to withstand the maximum earth load and hydrostatic pressure equivalent to a backfill depth of 1 m.

d) All civil works of blower house, pump house and control panel room shall be as recommended in Section 4 and 5 of this Guidelines.

e) The minimum design life span of the components of the package sewage treatment plant shall be as Table 8.1 below:

<table>
<thead>
<tr>
<th>Component</th>
<th>Design Life Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefabricated tank and other structural components</td>
<td>&gt; 50 years</td>
</tr>
<tr>
<td>Civil</td>
<td>&gt; 50 years</td>
</tr>
<tr>
<td>Mechanical &amp; Electrical</td>
<td>10 years</td>
</tr>
</tbody>
</table>

8.4 Components of Package Sewage Treatment Plant

8.4.1 Layout, Piping and Arrangement of Prefabricated Biological Treatment System

The prefabricated biological treatment system shall be packaged in terms of layout, piping, arrangement of the tanks and the biological processes.

The dimension of each tank shall be fixed for each model of the prefabricated system. All these items shall not be changed once approved.

8.4.2 Prefabricated Tanks

The physical properties of the tanks for package plants shall meet the material requirements for STP structures as stipulated in Section 4 of this MSIG. The prefabricated tanks shall come as complete tanks, thus no
welding, jointing, fabrication/moulding of tanks’ components is allowed at site. The route for delivery of tanks shall be planned properly, so as not to cause any damage to road facilities and harm to road users.

8.4.3 Process Treatment Units/Components

The following table provides the recommended number of tanks for each unit process against the PE size. The effective volume consideration is also incorporated in the table.

Table 8.2 Recommended Number of Tanks and Effective Volume Consideration for Various Unit Processes

<table>
<thead>
<tr>
<th>Name of Tank</th>
<th>Max Number of Tanks PE ≤ 1 000</th>
<th>Max Number of Tanks PE &gt; 1 000</th>
<th>Effective Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balancing Tank</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Aeration Tank</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Anoxic Tank</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Clarifier</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Sludge Holding Tank</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
Note: Low water level (LWL) is the minimum submergence level of the pumps to protect it from damage. It is dependent on the type of the pumps, thus the low water level shall be set according to the pump’s manufacturers requirement. Top Water Level (TWL) is the normal operating water level with adequate freeboard provided.

8.5 Appurtenances

8.5.1 Piping system

8.5.1.1 General

a) The piping used shall be an approved product, supplied and manufactured by a supplier/manufacturer approved by the Commission and shall be suitable for the application.

b) The arrangement of the piping system and interconnection pipes in the tanks shall not obstruct maintenance work of the equipment in the tanks.

c) All the buried piping shall be properly bedded and supported with the selected compacted fill material.

d) All the above ground piping shall have a minimum distance of 75 mm from the ground level.

e) It shall be provided with a proper pipe support and bracket. The bracket shall be made of hot dipped galvanised steel.

f) The arrangement/layout of the above ground piping shall minimise obstruction and maneuverability.

g) Any installation or assemblies of pipe support that is attached to the prefabricated tank is not allowed.

8.5.1.2 Inlet and Outlet Pipes

All inlet and outlet pipes of the units of prefabricated biological treatment system must be pre-fitted at the factory. On-site drilling for holes is strictly prohibited. All jointing and pipe holes connection shall be factory fabricated/moulded.

8.5.1.3 Aeration Pipes

a) The air distribution pipe used shall be rigid and can withstand temperatures up to 150 ºC and pressures of 25% more than the design pressure of the blower.
b) The air pipe from the blower to the process unit shall be above ground.

8.5.1.4 Sludge Transfer Pipes

a) No thread union/coupling is allowed at the sludge transfer pump piping. The connection shall be double flange with Grade 304 stainless steel bolt and nut.

b) No bending is allowed for the sewage distribution pipe. A chamber shall be provided for any changing direction of the flow.

8.5.1.5 Effluent Pipes

The effluent discharge piping system that passes through/bypasses the disinfection treatment facility shall be designed so as not to cause any nuisance.

8.5.2 Pumping System

The pumps installed in the package system shall meet the requirements as stated in Table 8.3 below:

Table 8.3 Technical Requirements of Pumping System

<table>
<thead>
<tr>
<th>Name of Pump</th>
<th>Transfer Pump</th>
<th>Sludge Transfer Pump</th>
<th>RAS/WAS Pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Area</td>
<td>Balancing Tank</td>
<td>Sludge Holding Tank</td>
<td>Clarifier</td>
</tr>
<tr>
<td>Minimum Throughlet</td>
<td>50 mm</td>
<td>50 mm</td>
<td>50 mm</td>
</tr>
<tr>
<td>Control</td>
<td>Automatic control by float switch</td>
<td>Manual control by timer</td>
<td>Automatic control by timer and solenoid valve</td>
</tr>
<tr>
<td>Number of Pump</td>
<td>1 duty, 1 standby</td>
<td>1 duty for each tank</td>
<td>1 duty for each tank</td>
</tr>
<tr>
<td>Type of Pump</td>
<td>Mechanical Submersible Pump</td>
<td>Mechanical Submersible Pump or Self Priming Pump</td>
<td>PE &lt; 1000 : Air lift, PE ≥ 1000 : Mechanical Pump</td>
</tr>
<tr>
<td>Necessities</td>
<td>Mandatory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessories</td>
<td>All pumps shall be completely installed with duct foot, guide rail and lifting chain made of Grade 304 stainless steel.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Note: 1) Non-submersible pumps shall be provided with parking bay with shade.

2) The duct foot shall be installed and assembled at the factory. No installation/assemblies at site are allowed except for the connection of the transfer pipe and the guide rail. All fasteners of the duct foot shall be watertight.

8.5.3 Diffuser

a) All diffusers must be supported from the tank base. A typical drawing of the diffuser support is shown in Figure 8.1.

b) The diffuser shall not be bolted to the bottom of the tank.

c) The diffuser shall be removable and easy to re-install.

8.5.4 Flow Distribution Chamber

a) Distribution box shall be provided with adjustable features. A typical drawing of the distribution box is shown in Figure 8.2.

b) The design and construction of the distribution chamber shall prevent any sedimentation.

8.5.5 Manhole Cover/Inspection Chamber Cover

The manhole cover shall follow the requirements as in Table 8.4:

Table 8.4 Technical Requirements of Manhole Cover

<table>
<thead>
<tr>
<th>Description</th>
<th>FRP</th>
<th>HDPE</th>
<th>Ductile/Cast Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>600 mm x 600 mm or 600 mm diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation</td>
<td>At any location on top of the tank except at assembly joints, rib or reinforced ring location.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load Bearing Capacity</td>
<td>≥ 3.5 kN/m² (BS EN 12255-1:2002(E))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Deflection Limit</td>
<td>10 mm or the span divided by 200, whichever is smaller (BS EN 12255-1:2002(E))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class</td>
<td>B 125 in accordance to BS EN 124:1994 or equivalent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personnel Load</td>
<td>125 kN (fully walk-able) (BS EN 124:1994)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Safety Factor</td>
<td>4:1 for allowable stresses shall be met for all load combinations (ANSI/ASCE 7-98)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 8.4 Technical Requirements of Manhole Cover (Continued)

<table>
<thead>
<tr>
<th>Description</th>
<th>FRP</th>
<th>HDPE</th>
<th>Ductile/Cast Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Range</td>
<td>27°C – 35°C (to incorporate thermal expansion and contraction)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard colour</td>
<td>Black</td>
<td>Black</td>
<td>Black</td>
</tr>
<tr>
<td>Coating</td>
<td>Aliphatic acrylic polyurethane non-skid coating</td>
<td>NA</td>
<td>- Epoxy coating of 200 µm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Hot dip galvanised of 200 µm</td>
</tr>
<tr>
<td>Resin</td>
<td>Corrosion resistant general purpose polyester</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>UV Protection</td>
<td>Ultraviolet-light inhibitors shall be added to the laminate</td>
<td>Carbon black</td>
<td>NA</td>
</tr>
</tbody>
</table>

Note: 1. The collar of the manhole shall be raised with a minimum height of 100 mm above ground level.
2. The cover shall be equipped with a frame support and hinge, and attached to the manhole opening.
3. Each manhole cover must be properly labeled / marked for ease of identification of the unit process of the system.
4. NA – not applicable

8.5.6 Anchor System Loading

The tank anchor system (straps, cables, turnbuckles, etc.) shall have strength of at least 1.5 times the maximum uplift force of an empty tank without backfill in place. All wire straps, cables and turnbuckles must be made of Grade 304 stainless steel.

8.5.7 Landscaping

The landscaping of the sewage package system shall be in accordance with those recommended in Section 6 of this Guidelines.

8.5.8 Odour Treatment

The odour treatment shall be incorporated into the package sewage treatment plant and shall follow the requirements stipulated in Section 7.4.
8.5.9 Ancillary Facilities

The requirement and criteria of other ancillaries such as lifting facilities, road, water tank, stand pipe, etc shall be in accordance with the design criteria as stipulated in Section 6 and special requirements in Section 7.4.

8.6 Marking and Labelling

Each tank shall at a minimum be marked with the following information:

- Manufacture’s name or trademark
- Manufacturing serial number
- Manufacturing date (MM/YY)
- Diameter and Capacity
- Citation of the standard

The markings shall be printed and adhered to the tank.