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Wastewater treatment plants

Part 3:

Safety principles

Rwanda Standards Board

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In order to match with technological development and to keep continuous progress in industries, standards are subject to periodic review. Users shall ascertain that they are in possession of the latest edition

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Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

RS 126-3 was prepared by Technical Committee RSB/TC 013, *Water and Sanitation*

In the preparation of this standard, reference was made to the following standards:

1) BS 12255-10:20011085, Wastewater treatment plants. Safety principles

The assistance derived from the above source is hereby acknowledged with thanks.

This second edition cancels and replaces the first edition of RS 126-3: 2012, which has been technically revised.

RS 126 consists of the following parts, under the general title Wastewater treatment plants:

— *Part 1: Vocabulary*
— *Part 2: General construction principles*
— *Part 3: Safety principles*
— *Part 4: General data required*

Committee membership

The following organizations were represented on the Technical Committee on Water and Sanitation (RSB/TC 013) in the preparation of this standard.

Ministry of Environment (MoE)

Ministry of Disaster Management and Refugee Affairs (MIDIMAR)

Ruliba Clays Limited

Shine Engineers Multisectoral Company Limited (SEMC Ltd)

Sulfo Rwanda Industries (SULFO)

University of Rwanda/College of Science and Technology (UR/CST)

Water and Sanitation Corporation Ltd (WASAC Ltd)

Rwanda Standards Board (RSB) – Secretariat

Waste water treatment plant — part 3: safety principles

1 Scope

This Rwanda Standard defines safety requirements for wastewater treatment plants to be constructed or reconstructed for the protection of employees involved in wastewater treatment process.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

RS 548-1:2012 *Wastewater Treatment-Part 1: Vocabulary.*

RS 548-2:2012 *Wastewater treatment plants –Part 2: General construction principles.*

3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply.

3.1

sewerage within a wastewater treatment plant

all structures used for collecting, draining or storing of wastewater within a wastewater treatment plant

NOTE Sewerage within a wastewater treatment plant includes:

a) Open and closed channels;

b) pumping stations;

c) Storm water drainage and treatment systems.

3.2

wastewater treatment plant

facility for the physical, biological and chemical treatment of wastewater inclusive of all facilities for the treatment of solid wastes (screenings, grit, and sludge)

3.3

confined spaces

all structures of sewerage and wastewater treatment plants which are in contact with the wastewater, sludge, hazardous chemicals, etc., as far as they are covered or sunken

NOTE Confined spaces also include inspection manholes and other shafts even if they are not in open contact with the wastewater.

4 General requirements

Compliance with safety regulations shall be an integral part of the design, construction and operation of the facilities.

4.1 Confined spaces, hazards and warning systems

4.1.1 Confined spaces

Special consideration is required for confined spaces in wastewater treatment plants which include but not limited to:

a) Conduits;

b) Shafts, inspection manholes, seepage water shafts;

c) Basins (covered or sunken);

d) drop structures;

e) Valve structures;

f) Inlet and outlet structures;

g) Sunken or enclosed screening plants;

h) pumping stations (dry or wet wells);

i) Sludge silos and covered thickeners;

j) Digestion tanks;

k) Gasholders (gasometers);

l) Completely covered plants.

4.1.2 Hazards

Hazards from wastewater treatment plants can arise from solid substances, liquids, vapours, gases and bio-aerosols, micro-organisms and dust particles in various quantity or concentration and through the presence of oxygen-displacing media.

Hazards can also arise from substances being introduced from an external source or can be produced in situ by biological processes (e.g. fermentation, putrefaction) or by chemical reactions (e.g. when different wastewaters are mixed). ~

4.1.3 Sources of hazards

Hazards can arise from the following sources:

a) Gases or vapours which can cause fires or explosions;

b) Oxygen deficiency which can result in suffocation;

c) Toxic, corrosive, irritant, flammable or hot substances, which can cause harm to health by contact, absorption;

d) Through the skin or by ingestion, inhalation, or penetration through puncture wounds;

e) Increase of flow or level of water, e.g. following heavy rain or flooding;

f) Micro-organisms and their metabolic products which can result in infections; and

g) Radioactive substances.

4.1.4 Warning systems for the safety of persons

Provision shall be made to enable monitoring the atmosphere in confined spaces before entering to make sure that no health risk for persons exists. Fixed or portable monitoring equipment may be employed; portable monitoring shall be operable from places of safety. Fixed monitoring equipment may also be used to actuate emergency systems (e.g. switching on ventilation). The activation of these means shall be indicated by appropriate signals. The monitoring equipment shall be tested to ensure reliability and shall be protected from explosion. There shall be means of communication, e.g. alarm systems, telephone or radio at a wastewater treatment facility

4.2 Vehicular and pedestrian traffic routes

4.2.1 Vehicular and pedestrian traffic routes shall be laid out in accordance with the operational requirements to provide safe access to work places and easy maintenance.

This requirement is adequately satisfied, if:

a) Work places can be reached as directly and conveniently as possible;

b) Paths are even and not obstructed by parts of the plant and there are no obstacles on the paths such as pipeline crossings and they are not obstructed by the operation of valves;

c) Obstacles such as open channels or conveyor belts are bridged over;

d) Floors are easy to clean;

e) Floor coverings, gratings, roads and paths have non-slip surfaces, and collection of water on the surfaces is prevented;

f) Paths are constructed of materials which are resistant against wear and tear;

g) Slabs and pavings are laid even and with narrow joints;

h) Non-slip surfaces allow safe walking in every direction under adverse conditions;

i) Doors of emergency exits open to the outside.

4.2.2 Traffic routes and thoroughfares shall be laid out in such a way as to prevent risks from vehicles during operation.

This requirement is adequately satisfied, if e.g.:

a) Traffic routes are kept free from installations so that they can be used at any time;

b) Traffic routes for vehicles where passing doors, gates, passageways, thoroughfares, or stair-exits shall have a minimum 1, 0 m clearance between the exit and the traffic way. Blind exits shall be protected, e.g. by use of diversion barriers or mirrors;

c) Traffic routes are present in adequate numbers and their layout and dimensions are such that they can be used safely by pedestrians or vehicles according to their function, e.g. adequate turning areas for vehicles;

d) Traffic routes for motorized or rail-mounted means of transport are wide enough to maintain a minimum safety distance of 0.5 m on both sides of traffic routes between the outer edge of the means of transport and the boundary of the traffic route;

e) Lighting equipment on traffic routes is located and designed such that the lighting itself cannot cause any accident hazard; and the intensity of general lighting is at least 5 lux;

f) Speed limits of 20 km/h have been considered.

4.2.3 Passageways shall be a minimum of 2.0 m high and 0.6 m wide. If they are used for transporting loads they should be a minimum of 1.2 m wide.

4.2.4 Steps or ramps shall be provided for height differences of more than 0.2 m. Ramps shall not be steeper than 1: 10 and shall be constructed without steps. Where steps and ramps are not possible see 4.3.1.

4.3 Fixed ladders, manhole steps and staircases

4.3.1 If steps or ramps are not possible for structural reasons, fixed ladders, step irons, staircases or other access facilities shall be provided.

4.3.2 Fixed ladders, manhole steps and staircases shall be of non-slip design and shall offer adequate foot room. Where water, oil or grease may be present, additional means of slip prevention such as profiling or coatings shall be used. Ladders shall have a minimum distance to the wall of 150 mm.

4.3.3 Where there is the danger of falling more than 3 m in height there shall be installed permanent equipment to prevent falling (e.g. safety rails for sledge and safety belt).

4.3.4 Safety cages are not allowed in confined spaces, where they may hinder the rescue of injured persons.

4.3.5 Suitable access aids shall be provided above access points for climbing on and off safely.

This requirement is adequately satisfied if e.g.:

a) Sleeves are built into the manhole cover frames into which projecting positively fixed gripping bars can be inserted which extend a minimum of 1, 1 m above the cover frame;

b) Existing railings provide a handhold;

NOTE: A man-riding winch can be used.

4.3.6 Rest platforms shall be provided in maximum interval of 6 m on all steps or fixed ladders with a length of more than 10 m in such a way that the rescue of injured persons and the transport of tools and materials will not be hindered.

4.3.7 The clearance on the user's side of fixed ladders shall be not less than 0, 65 m for vertical ladders and not less than 1,1m for sloping ladders.

4.4 Falling preventions and covers

4.4.1 Work places and traffic routes adjacent to a vertical drop or other dangerous areas shall have permanent guardrails to prevent persons falling or entering these dangerous areas. For the maximum allowable vertical drop height not prevented by those guardrails etc., see national regulations. When there is no special risk of falling into open channels or basis tensioned chains, ropes or nets may be used.

4.4.2 Suitable protection against falling is provided e.g. by a minimum of 1.1 m high permanently fixed railings or enclosing walls.

4.4.1 The protective barriers shall be constructed so as to prevent persons falling through. In the case of protective barriers with vertical intermediate bars, the clear distance between the bars shall not exceed 0.18 m. For protective barriers with one or more knee-height rails, the distance between toe board and rail, between rail and hand-rail or between two intermediate rails shall not exceed 0.5 m. In the absence of toe boards the distance between ground and knee-height rail shall not exceed 0. 3 m. Toe boards shall be a minimum of 0.1 m high and shall be installed above all working-places and traffic routes, independent of the structure of protective barriers.

4.4.1 The protective barriers shall be constructed and fixed so they can withstand a horizontal force of 1 000 N/m at their upper edge. Alternatively, a design load of 500 N/m is sufficient for protective barriers on platforms or stairways and walkways with vertical traffic loads of maximum 5 000 N/m, or of 300 N/m for barriers in areas or on routes which are only used for control and maintenance purposes (e.g. tank roofs, inspection apertures on furnaces) and on vehicles and for slot-in railings.

4.4.1 The values quoted are design load values for the static calculation of the protective barrier. Suitable trees, bushes and hedges can provide means of fall prevention on slopes with an incline up to 1: 1.

4.4.2 If removable safety barriers are required, they shall be of the hinged, slidable or slot-in type. Removable safety barriers may be necessary, for example, at access points to ladders and stairways or at installation access apertures.

4.4.3 Covers shall be handled safe, protected against unintentional displacement and shall withstand the operational and climatic stresses.

This requirement is adequately satisfied if e.g.:

a) Covers can be opened from safe standing positions;

b) Hinged covers can be secured in the open position;

c) Heavy covers are additionally equipped with counterbalances, hydraulically actuated lifting devices or

d) Pneumatic springs.

4.5 Emergency exits

Tanks shall be equipped with permanently installed emergency exits in every self-contained basin section.

Ladders, manhole steps and staircases, reaching down a minimum of 1, 0 m below the lowest operational water level, may be used as emergency exits. Open tanks with sloped walls with inclines up to 1: 2 may be equipped with other means (e.g. ropes) for assisting climbing out.

4.6 Work places, work platforms and maintenance platforms

Work places, work platforms and maintenance platforms shall be arranged, set up and designed free of obstacles and so that it is possible to work safely on them, even if wet or icy. This applies in particular with regard to the material, their spaciousness, strength and stability, surface, non-slip qualities, illumination and ventilation and with regard to avoiding harmful environmental effects and hazards caused by third parties.

The requirement for non-slipperiness also includes the requirement that gratings and standing positions shall where possible be located safe from flooding.

4.7 Lifting equipment

Suitable and sufficient lifting equipment shall be available for the handling of heavy loads.

This requirement is adequately satisfied if e.g.:

a) A lifting device is installed;

b) A support for a mobile hoist is built in;

c) A tripod and portable lifting hoist are used with safety devices to prevent the legs shifting or splaying out;

d) An adequate standing area is available, designed in size and in load-bearing capacity for a vehicle with

e) Pivoted and telescopic jib (crane boom);

f) Safe use is possible of multi-purpose lifting appliances, e.g. equivalently equipped lorry-mounted lifting

g) Devices, forklift trucks, small hydraulic excavators, etc.

4.8 Ventilation

Confined spaces in wastewater treatment plants, in which dangerous substances, explosive atmosphere or aerosols can accumulate in the breathing air in concentrations harmful to the health or in which an oxygen deficiency can arise, shall have effective ventilation. It shall be possible to measure the efficiency of the ventilation from a safe position. Natural ventilation can be effective, if e.g. the design of the opening provides sufficient ventilation without dead zones and the ventilation openings cannot be shut. Ventilation openings which are located only at the top or bottom of a door and windows shall not be deemed effective means of ventilation. Forced ventilation shall be provided if natural ventilation is not sufficient.

4.9 Areas at risk from explosions

4.9.1 Danger of explosions in wastewater-systems can arise e.g. by illegal introduction of inflammable substances or by anaerobic degradation processes, e.g. methane from sludge digestion. Confined spaces in wastewater treatment plants shall be constructed and equipped in such a way as to prevent the formation of an explosive atmosphere. If it is not possible to prevent the formation of an explosive atmosphere, the ignition of explosive atmospheres shall be prevented by additional protective means, e.g. ventilation or permanent installation of gas warning devices to initiate emergency procedures.

Permanent gas warning devices should have pre-set concentrations, e.g.:

a) At 20 % lower explosive limit (LEL) preliminary alarm (e.g. switching on the technical ventilation, opening of Doors);

b) At 50 % LEL initiation of emergency functions (e.g. switching off ignition sources. Areas of wastewater treatment plants with explosion hazards shall be clearly marked and access to them shall be prevented except for authorized workers. Structural measures can limit the areas at risk from explosion. Structural measures include e.g. adequately gas-tight walls made of non-combustible material and gas-tight ducts and conduits. Brick walls plastered on both sides and reinforced concrete walls are sufficiently gas-tight in this sense. Rooms above ground level, where an explosive atmosphere may arise under exceptional circumstances, shall be isolated from adjoining rooms by automatically shutting gas-tight doors.

Explosion prevention measures which prevent the emergence of explosive atmosphere shall generally be considered in the early design stage.

4.9.2 Traffic routes for motor vehicles shall be located outside areas where explosion hazards may exist.

4.10 Hygienic facilities

The extent to which hygienic facilities are necessary will depend upon the size and location of the treatment plant.

These should include:

a) washing protective clothing including shoes and boots;

b) Personal washing (hand-basins and showers);

c) eating of meals and preparation of beverages;

d) Storage of personal effects;

e) First aid materials.

Some facilities may be provided on a vehicle and others on a suitable location.

4.11 General warning signs

Signs indicating warnings should be placed well visible at all entrances of areas with increased risk, e.g.:

a) Electrical hazards;

b) High noise level;

c) Automatically operated moving equipment;

d) Presence of dangerous gases and possible explosion hazard;

e) Oxygen deficiency;

f) Hazardous chemicals.

Signs indicating an obligation or requirement shall be placed at the entrance of the appropriate areas, e.g.:

a) No smoking;

b) Use of safety glasses;

c) Use of hard hats;

d) Use of ear protection;

e) Use of escape or full breathing apparatus;

f) permit to work requirements.

Signs referring to safety and fire preventing equipment shall have information directing to the equipment location,

e.g.:

a) Emergency exits;

b) Fire extinguishers;

c) rescue equipment;

d) First aid boxes.

5 Special requirements

5.1 Systems for separating solids from wastewater

5.1.1 Screening and filtration equipment and installations for dewatering the screenings as well as grit chambers and grease traps shall be designed so as to minimize contact by persons with the solids and to ensure safe removal of the solids.

5.1.2 In aerated grit chambers with spiral flow and water depths exceeding 1,35 m, a suitable holding fixture for self-rescue shall be provided on the downward flow side over the whole length of the chamber.

Safety ropes or bars shall be installed at the water level around rotating equipment. In aerated grit chambers with horizontal flow, emergency exits should be installed downstream.

These emergency exits shall not be located in the vicinity of the grit hoppers and shall be within reach of the holding fixture. Suitable holding fixtures for self-rescue can be for example, grippable pipes, stay bars or tightly stretched cables.

5.1.3 Sunken loading bays for vehicle containers shall be equipped on the approach side with a raised edge to Prevent the vehicle wheels falling in when reversing. A suitable raised edge would be a barrier a minimum of 0, 25 m high painted in yellow/black contrasting colours.

5.2 Wastewater pumping stations

5.2.1 In order to avoid hazards from dangerous substances, wet wells shall only have access from outside of the buildings and are not allowed to be connected with other rooms.

5.2.2 Permanent provision for man entry to wet wells is not required if there is no need for man entry either for Cleaning or maintenance purposes.

Access is not required if e.g. the deposition of solids is prevented by mechanical equipment or if cleaning and Maintenance work can be carried out effectively from safe standing places.

5.2.3 Pumps even when installed in wet wells and electrical equipment shall be so designed, that ignition energy can be released if they are used in locations where explosion hazards may occur. This requirement is adequately satisfied, if e.g. explosion-protected submersible motor-pumps are used, or if the pump motors are completely submerged during the whole pumping cycle.

5.2.4 Pumps shall be designed and installed so that they can be maintained easily and safely. Each pump shall be capable of being hydraulically isolated while other pumps of the station are still operating. In the case of screw pumps in addition it shall be taken into account that:

a) The screw can be cleaned safely;

b) The standing places over the inlet are situated clear of the highest water level.

5.3 Aeration tanks

5.3.1 Aeration and mixing devices shall be so designed that maintenance work can be carried out safely.

This requirement is adequately satisfied if e.g.:

a) In basins equipped with compressed air aeration the aeration equipment can be lifted or swivelled out of the Liquid; or

b) Basins can be emptied for maintenance purposes.

5.3.2 Surface aerators and mechanical mixing devices shall be equipped with emergency shut-offs. These emergency shut-offs shall be located next to the aeration or circulating devices and be within easy reach.

Depending on the arrangement of surface aerators or mechanical mixing devices (flow generators), one or more emergency shut-offs may be required.

5.3.3 In aeration tanks with spiral flow and water depths exceeding 1,35 m, a suitable holding fixture for self-rescue shall be provided on the downward flow side over the whole length of the tank.

Safety ropes or bars should be installed at the water level around horizontal rotors. In aeration tanks emergency exits should be installed.

5.4 Digestion tanks, low-pressure gasholders

5.4.1 Digestion tanks and low-pressure gasholders shall be equipped with frost-protected devices to prevent the pressure exceeding the maximum or falling below the minimum permissible operating pressure.

The pressure safety devices shall be designed to reset automatically or to give an alarm to a monitoring in case of low pressure.

5.4.2 There shall be a minimum of two man entry points one above ground level and the other on the top. One of the man entry points to the digestion tanks shall have a minimum clear width of 0, 8 m.

5.5 Digester gas pipes

5.5.1 Pipes and fittings carrying digester gas shall be designed to withstand the mechanical, chemical and thermal stresses to be expected in operation.

The requirement for mechanical and chemical durability is adequately satisfied, e.g. by suitable materials such as stainless steel.

Mechanical stresses due to subsidence, temperature differences and vibrations are to be absorbed by suitable structural design of the pipelines, e.g. pipe loops or installation of extension compensating members.

5.5.2 Pipes carrying digester gas shall be equipped with shut-off devices at the digester tank and before the gasholder.

5.5.3 Pipes carrying digester gas shall be equipped upstream of gas consuming devices, desulphurizers and Suction pipes of compressors with fittings to prevent an unintended extension of flames. These can be, for example, flame arrestors or shut-off devices with flow measurement equipment. The effectiveness of the equipment must be confirmed against national regulations.

5.5.4 Pipes carrying digester gas which lead into enclosed rooms shall be equipped with shut-off devices situated in safe places outside these rooms.

5.5.5 Facility shall be provided for the safe discharge of condensate occurring in digester gas systems.

This requirement is adequately satisfied by e.g.:

a) Automatic condensate discharge systems;

b) Locks with double shut-off fittings.

Digester gas pipes should be clearly identified.

5.6 Desulphurizing plants

Desulphurizing plants shall comply with the gas safety equipment. In addition, arrangements shall be made to ensure that:

a) Air cannot enter the digester gas pipe and digester gas cannot enter the air pipe;

b) The air supply is interrupted before a dangerous explosive atmosphere can develop;

c) the temperature of the gas in the desulphurizing tank does not exceed 60 °C.

5.7 Gas engine rooms and gas engines

5.7.1 Gas engine rooms shall be provided with sufficient natural or forced ventilation

5.7.2 Gas engine rooms and air intake pipes of gas engines shall be so constructed that no gas can enter during operation or in the event of faults. This requirement is adequately satisfied if e.g.:

a) When the gas engine stops no gas can escape into the engine room. This can be achieved by installing an

b) Automatic gas shut-off valve (with redundant control);

c) Crankcase ventilating pipes are led into the open air or the exhaust gases are reinjected into the closed

d) System;

e) Ventilation openings to gas engine rooms are not located near crankcase ventilating pipes or the entrance of

f) Air suction or exhaust pipes of gas engines;

g) Air suction pipes of gas engines are led in from outside.

5.7.3 The ignition system of gas engines shall remain inactive until engine and exhaust system have been adequately flushed with air.

5.8 Gas flares

Gas flares shall be constructed and positioned in such a way that persons are not at risk by gases, flames or hot components. Gas flares shall be equipped with automatic ignition devices, flame arrestors and flame monitoring equipment.

5.9 Sludge dewatering

5.9.1 Sludge dewatering plants, in which gases and vapours can accumulate in noxious concentrations, shall be equipped with effective ventilation devices to exhaust gases and vapours from the source. During sludge dewatering, hazardous gases such as ammonia, hydrogen sulphide or methane may be produced depending on the process or conditioning method. Hazardous gases may continue to be produced by dewatered sludge. Thus, rooms in which dewatered sludge is stored shall be well ventilated.

5.9.2 Mechanically operated sludge dewatering plants should be fitted with automatic cleaning equipment.

5.10 Installations for storage and handling of chemicals and hazardous substances

Systems for the delivering, filling, storage, mixing and addition of chemicals and hazardous substances shall be designed so that there is no risk to persons or the environment from liquids, gases, vapours and dust. This requirement is adequately satisfied if e.g.:

a) The surface of the area where the chemical is delivered and transferred to facilities is sealed and the

b) System is designed so that accidental spills can be recovered without danger;

c) Tanks containing chemicals are made of adequately resistant material, connections for filling and

d) Discharging are tight-sealing and the filling level and nature of the contents can be checked from the

e) Outside, overfilling can be reliably prevented, leaking liquids can be collected safely (collecting bunds,

f) double-walled tanks or containments) and the correct safety code is marked on the outer walls of tanks or Access doors to storage rooms;

g) Lime silos and their filling and extraction equipment are of dust-tight construction and are marked clearly;

h) Lime-milk mixing systems are tightly sealed and inspection holes cannot be opened during the mixing

i) Process;

j) A self-closing and locking security cabinet is available for the storage of small quantities of combustible,

k) Fire-assisting or toxic or corrosive hazardous substances at the work place (laboratories, workshops);

l) Separate lockable storage rooms with safety equipment (e.g. fire and explosion protection, ventilation and Means for collecting leakages) and adequate safety marking are available for the storage of larger

m) Quantities of hazardous substances (e.g. lime, corrosive substances) as used in operating wastewater

n) Treatment plants;

o) Provisions are made to prevent environmental impact in case of leakage. A second emergency

p) Containment shall be provided (e.g. double underground pipes, double tank walls, tanks in bunds which

Have a minimum capacity of 110 % of the single largest tank) and sensors shall be installed which provide an alarm when the first containment is leaking.

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