Construction of the **Sewage Network and Waste Water Treatment Plant (WWTP) in the Municipality of Berane**

Volume 3 –1 Employer’s Requirements

Section 3 General Specifications for Mechanical Works

June 2015

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# Introduction

These General Specifications for Mechanical Works are part of the **Employers Requirements (Vol 3-1)** which are divided into 5 sections as follows:

* Section 1 General Requirements for Execution of Works
* Section 2 Particular Design and Process Requirements
* Section 2 General Specifications for Mechanical Works
* Section 3 General Specifications for Electrical Works and SCADA
* Section 4 General Specifications for Civil Works

The following clauses shall specify general mechanical requirements and standards of workmanship for equipment and installations. These general specification clauses shall be considered as minimum and apply where appropriate except where particularly redefined in the Particular Specification.

## List of Abbreviation and Terms

|  |  |  |
| --- | --- | --- |
| % | shall mean | per cent |
| c | shall mean | centre |
| CA | shall mean | Contracting Authority |
| CESWI | shall mean | “Civil (Engineer)ing Specification for the Water Industry”, 5th Edition” published by UKWIR Ltd., WRc plc, Franklin Road, Blagrove, Swindwon, Wiltshire, SN5 8YF |
| Day | shall mean | Calendar Day |
| DD | shall mean | Detailed Design |
| DIN | shall mean | German Standard |
| DN | shall mean | nominal diameter |
| EN | shall mean | European Standard |
| FFL | shall mean | Final floor level |
| h | shall mean | hour |
| HDPE | shall mean | High density extruded polyethylene |
| ISO | shall mean | International Standards Organization. |
| kg | shall mean | kilogram |
| km | shall mean | kilometer |
| kW | shall mean | kilo Watt (1000 Watts) |
| l | shall mean | liter |
| L.S. | shall mean | lump sum |
| m | shall mean | meter |
| m/d | shall mean | man-day |
| m² | shall mean | square meter |
| m³ | shall mean | cubic meter |
| mASL | shall mean | Meters abobe see level |
| mm | shall mean | millimeter |
| mm² | shall mean | square millimeter |
| Month | shall mean | 30/31 Calendar Days |
| MSDS | shall mean | Material Safety Data Sheet |
| pcs | shall mean | pieces |
| PE | shall mean | Population Equivalent |
| PM | shall mean | Project Manager |
| PVC | shall mean | Polyvinyl chloride |
| QAS | shall mean | Quality Assurance System |
| RC | shall mean | Reinforced Concrete |
| t | shall mean | tone (1000 kg) |
| TA | Shall mean | Technical Assistant |
| TR | shall mean | Technical Requirements |

# General Requirements

The whole of the Works, machinery and apparatus shall be new and of first class manufacture and in every way suitable for wastewater works purposes and shall be supplied generally in accordance with the intent of the requirements and the conceptual design wherever appropriate standard equipment of proven proprietary design shall be supplied.

The Works shall consist of newly manufactured materials only. Materials specification describes the minimum required qualities.

In selecting materials, which differ on the electrolytic scale, the dangers of these being in close proximity shall be addressed by the Contractor in his design and suitable preventative measures taken.

The Contractor is responsible for the protection of Works until the date of Final Acceptance. Suitable measures such as temporary timber covers or plastic sheeting shall be used to protect the Works.

Each item of Works shall bear, in an easily readable position, an identification plate with text in local and the language of the Country of Origin stating the name of the manufacturer, year of manufacture and type and serial numbers.

Pipelines shall be identified with flow arrows together with a colour identification bands, all in accordance with related standard. The Contractor shall provide the Engineer with details for approval. Top finish colour coats shall be determined in agreement with the Engineer. Colour samples shall be submitted if so required.

The Contractor is liable for the first fill of oil and grease for all mechanical Works and equipment.

Lifting equipment shall be provided for all Works items over 50 kg (where not specified elsewhere, under the lift area of overhead cranes).

Where the Contractor includes bought-in manufactured items, then full details shall be submitted to the Engineer for approval prior to incorporation in the works.

# Certificates

Certified suppliers will be approved, only. All manufacturers shall be certified in accordance to ISO 9001.

The electro-/mechanical equipment (MEICA[[1]](#footnote-1)) *must be provided with the certification “CE”* in accordance to Machinery Directive *98/37/EEC*, in particular the following directives shall be considered:

* Machinery Directive 98/37/EEC
* Low Voltage Directive 73/23/EEC
* EMC Directive 2004/108/EC
* And others as required by Directive 98/37/EEC

In addition the following documentation shall be included for each individual machines and/or apparatus:

* Certificate of Conformity in acc. to EN 10204/2.1
* Manufacturers Test Certificate in acc. to EN 10204/2.2[[2]](#footnote-2)
* Manufacturers Work’s Test Certificate in acc. to EN 10204/2.3[[3]](#footnote-3)

All certificates are subject to approval from Engineer. Expenditures for certification of equipment are to be included in the Contractors prices.

# Existing Cables and Pipelines

## Authorized Institutions

The Authorities are public institutions responsible for the public utility services of electricity, water, sewerage, drainage, gas, telephone or other telecommunication facilities and roads.

## Information and Instructions

Further information and instructions on measures to be taken before and during the execution of the Works will, to the extent known to the Authorities, be submitted to the Contractor by the Employer / Beneficiary or the Engineer in co-operation with the relevant Authorities.

As soon as a service pipeline or cable is encountered in the excavation whether previously located or discovered during the course of the excavation for the works, the Contractor shall immediately inform the Engineer who will then inform the Authorities concerned. In urgent cases the Contractor shall inform the relevant Authority directly in absent of the Engineer

In this case, the Contractor shall follow the instructions given by the Beneficiary, the Engineer or the relevant Authorities. If necessary, precautions shall be taken by the Contractor to protect the systems during the execution of the works.

## Precautions

No excavating machines shall be used in the immediate surroundings of cables and/or pipelines unless approved by the Engineer

Special care shall be taken to ensure that the existing facilities are accessible in the case of an emergency.

Temporary Works which have to be made in the vicinity of the existing facilities during the execution of the Works shall be maintained by the Contractor and shall be removed as soon as practicable.

The Contractor shall be responsible for maintaining all such utilities encountered by him in the construction of the Works and shall bear the cost of making good any damage caused directly by his activities.

# Standards and Materials for Works

## Scope

This part of the Specification sets out the general standards of design and materials to be supplied and the work to be carried out by the Contractor in connection with Works. Mentioning of any specific material or Works does not necessarily imply that such is to be included in the Works.

All component parts of mechanical works, the installations and the ‘supply’ shall, unless otherwise specified, comply with the Section 1 of these Employer’s Requirements.

The names of the manufacturers of materials and equipment proposed for incorporation in the Works together with performances, capacities, certified test reports and similar information, shall be furnished at the times specified in these ER or when requested by the Engineer who shall have power to reject any parts which, in his opinion, are unsatisfactory or not in compliance with the Specification.

## Adherence to Standards

National (Project country) Standards or harmonised EU-Standards in their latest Edition shall be used throughout this Contract, generally. Authoritative are all standards that are valid at the location of the Plant during the time of implementation.

**As a minimum the EU-harmonized local i.e National (Project country) standards (NS) and codes shall always be satisfied.**

EU-harmonized German DIN-Standards (DIN EN) and British (BS) EN-Equivalent are prevailing if not stated otherwise.

The conditions specified in these general mechanical specifications are minimum requirements for all deliveries and performances. If special requirements are given for particular items they apply only to these particular items.

The Contractor shall propose Standards for the execution of the works, which shall be approved by Engineer. A list of relevant Standards is included in these ER.

In referring to the Standard Specifications the following abbreviations are used:

ATV Abwasser Technische Vereinigung - German Association for Water, Wastewater and Waste (see DWA)

DWA Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall - German Association for Water, Wastewater and Waste (former ATV)

ISO International Organisation for Standardisation

EN European Standards

DIN Deutsches Institut für Normung e.V. - German Institute for Standardisation

BS British Standard

BSCP British Standard Code of Practice

CEE International Commission of Rules for the Approval of Electrical Equipment

DVGW Deutsche Vereinigung des Gas- und Wasserfachs e.V. - The German technical and scientific organisation on Gas and Water

IEC International Electrotechnical Commission

STAS Standard de Stat (Asociaţia Română de Standardizare, ASRO)

NS National Standard, to be applied in harmonised editions, only

UVV Unfall-Verhütungs-Vorschriften (Regulations of Accident Prevention)

VDE Verband Deutscher Elektrotechniker – German Association for Electrical, Electronic & Information Technologies

Copies of the used standards shall be available any time for the Engineer

## Standards, Regulations and Engineer’s Approval

The design, workmanship, materials, strength and dimensions of all parts shall be to the satisfaction of the Engineer and shall comply with one or more of the standards, as mentioned above.

Where no standards are stated in the Contract, all materials, components, equipment, workmanship and tests for which DIN, BS or their acceptable EN equivalents have been issued, shall be in accordance with such standards.

The electrical installations shall comply with and be tested in accordance with national or internationally recognised regulations or codes of practice subject to any specific requirements of the local electricity supply authority.

Material and equipment supplied and work performed shall comply with these standards and regulations as a minimum. Where manufacturers offer equipment to other standards, the standards shall be equal or superior to those specified and full details of the difference shall be supplied to the Engineer if requested.

Where the design or choice of materials or Works is affected by National (Project country) Statutory Safety Acts, then the materials and works supplied shall comply with all relevant sections of those acts even though no particular reference may be made in the Specification.

## Mixture of Standards

The Contractor should note that the Engineer will not approve of any complete system incorporating component parts and design standards to different National Standards unless the entire system has been designed to function as a whole within the standards and design codes laid down by only one of the approved authorities.

## Design and Design Life

The Contractor shall design the Works in accordance with the TR and to the satisfaction of the Engineer. The design of works shall be in accordance with good modern practice and shall be such as will facilitate operation, inspection, cleaning, lubrication and repair to ensure long life and satisfactory operation under all service conditions. The Contractor’s design calculations shall be submitted to the Engineer as required.

Works shall be designed for a long reliable operating life and shall be suitable for 24 hours per day continuous operation for prolonged periods in the climatic conditions applying and with a minimum of maintenance.

The Contractor may be called upon to demonstrate this for any component, either by the service record or evidence of similar equipment already installed elsewhere or by records of relevant type tests.

Wherever possible works shall be designed and arranged so that the degree of skill required maintaining and servicing the works shall be minimal. Except for consumable items such as carbon brushes and the like, which normally require more frequent replacement, no part subject to wear shall have a design life from new to replacement or repair of less than five years of continuous normal operation, and, where major dismantling is required to replace a part, the life of such parts shall not be less than ten years.

Electrical contactors and switches incorporated in mechanical equipment shall have a minimum life under normal full load working conditions of two million operations without replacement of any part and two hundred thousand operations without maintenance of any kind. Electrical relays and light current switching devices shall not require maintenance of any kind before completing two million operations under normal full working load.

The works shall be designed for the prevention of corrosion, entry of insects and vermin, entry of dirt and dust, and to minimise risk and damage in the event of a fire. Works shall operate without undue vibration and parts shall be designed to withstand the maximum stresses under the most severe conditions of normal service after loss due to any corrosion allowance, or the specified test condition including any corrosion allowance.

Works shall be designed so that when operating at the normal condition, the intensity of emitted noise in the working environment shall not constitute a health hazard to operators and other personnel or cause a nuisance outside the boundary of the works. The anticipated noise characteristics of all items of works and systems, which have high noise potential, shall be submitted to the Engineer early in the design stage of the Contract.

The Contractor shall ensure that all pollutants are discharged from these works in a controlled and safe manner.

## Design Safety Features

Works, as designed and installed, shall have no feature that could be a hazard to operators, maintenance staff, visitors or other persons having access thereto. Guard electrical safety devices, thermal insulation, noise suppression devices, written notices, safety covers, lifebelt and the like shall be provided where needed.

Adequate safeguards shall be provided to prevent personnel accidentally coming into contact with dangerous machinery mechanisms, hot surfaces, electrically live parts and any other hazardous components or contents.

Emergency stop devices shall be provided and positioned adjacent to all driven works which:

* Involves a risk of injury to personnel during norm and maintenance operations;
* Handles high pressure fluid or dangerous chemicals;
* Is located at a distance of more than five metres from its controller;
* Has no direct, unimpeded access between the controller and the item of controlled works, irrespective of distance.

Secure and substantial guards shall be supplied throughout the installation to cover drive mechanisms. All rotating and reciprocating parts, drive belts, etc. shall be shrouded to removable for gaining access to the works without the need to first remove or displace any major item of works; and they should also allow for adequate ventilation.

Guards shall not have to be removed during normal operation running maintenance and routine inspections, and shall be designed to prevent access of fingers to the moving parts.

Rubber mats shall be provided in front of all motor control centres, distribution boards, instrument and battery supply power cabinets.

## Materials General

Works and any component parts thereof shall be made of new materials of suitable grade, quality and strength, protected where appropriate for the operating conditions and the working and climatic environments.

Where there is slight relative motion of two materials to contact, one or both being metals, suitable precautions shall be taken, to prevent seizure by fretting.

Materials shall have a high resistance to any change in their properties due to the passage of time, exposure to corrosion, light or any other cause, which may have a detrimental effect upon the performance or life of the works.

Where dissimilar materials in contact or proximity can be bridged by an electrolyte producing a corrosive condition, the Contractor shall demonstrate to the satisfaction of Engineer that adequate precautions have been taken to prevent corrosion.

Where brass and bronze are to be used in environments where “de-zincification” or “de-aluminification” may occur, suitable inhibitors to prevent this type of attack shall be incorporated.

## Finish

All covers, flanges and joints shall be properly faced, bored, fitted, fixed, hollowed, mounted or chamfered as the case may be, according to the best approved practice and all working parts of the plant and other apparatus, shall similarly be well and accurately fitted, finished, fixed and adjusted.

## Wrought Steels

Where not otherwise specified, wrought steel parts shall be selected from appropriate grade of BS 970 or equivalent EN, DIN Grade and be free from blemishes, shot or hammer marks.

The Contractor shall submit for the approval of the Engineer, the grade number selected for the various components.

## Cast Molybdenum

Cast Molybdenum steel shall be supplied to BS 3100 or equivalent DIN EN Grade

## Cast Iron

All castings supplied shall be to the appropriate grade. No plugging, filling, welding or “burning on” will be acceptable.

The structure of the castings shall be homogenous and free from non-metallic inclusions and other injurious defects. Surfaces of castings, which are not machined, shall be smooth and shall be carefully fettled to remove all foundry irregularities.

Non-destructive tests will be required for any casting containing defects whose extent cannot otherwise be judged.

## Bronze

Where not otherwise specified, bronze shall be made of a strong and durable zinc free mixture to BS 1400 or equivalent DIN EN Grade

## Aluminium and Aluminium Alloys

Due to the corrosive atmosphere, the use of aluminium or aluminium alloys requires the approval of the Engineer in all cases.

Alloys where magnesium is the main addition shall be of types used for marine applications.

Castings shall be manufactured from LM5 to BS 1490 and bars and sections from NE 8 to BS 1474. or equivalent DIN EN Grade

Full details of the composition of each alloy shall be supplied to the Engineer for approval, before commencing manufacture.

Immersed structures or structures that are periodically immersed shall not be constructed from aluminium or aluminium alloys.

## Stainless Steel

Stainless steel parts shall be provided in following Grades:

|  |  |  |  |
| --- | --- | --- | --- |
| **BS** | **DIN EN** | **AISI** | **EURONORM** |
| 321S31 | 1.4541 | 321 | X 6 CrNiTi 18 10 |
| 320S31 | 1.4571 | 316Ti | X 6 CrNiMoTi 17 12 2 |
| 316S13 | 1.4435 | 316L | X 3 CrNiMo 17 13 3 |
| 316S11 | 1.4404 | 316L | X 3 CrNiMo 17 12 2 |
| 316S31 | 1.4401 | 316 | X 6 CrNiMo 17 12 2 |
| 304S11 | 1.4306 | 304L | X 3 CrNi 18 10 |
| 304S15 | 1.4301 | 304 | X 6 CrNi 18 10 |

In respect locations where machinery and works are exposed to high humidity, condensation and aggressive atmosphere or total, partial or intermittent submergence in corrosive liquid and/or gas if not specified otherwise it shall be as follows:

* Completion of all internal steel works (ladders, platforms, a.s.o.) in stainless steel grade EN 1.4571
* Completion of all internal pipe work shall be in stainless steel grade EN 1.4571 or polyethylene (HDPE)
* Flanges, bolts, nuts, washer, etc. where made of stainless steel; in order to prevent seizing shall be different materials used for bolt and nut, e.g. material 1.4571 and 1.4541

## Fastening, Bolts, Nuts and Washers

Bolts for fixing metal work other than works to concrete brickwork or block work shall be of the following types:

1. For fixings into drilled holes in horizontal, vertical and inclined surfaces, approved proprietary epoxy resin fixed bolts shall be used.

The epoxy resin shall be a quick setting formulation, supplied in suitable pre-measurement sachets to separate the components until punctured in the hole and mixed by rotation of the fixing bolt.

The resin and bolts shall be used in accordance with the manufacturer’s instructions. When fixed, the resin shall completely fill the space between the bolt and the hole to the surfaces of the concrete, brickwork or block work.

1. Alternative to a), approved mechanical expansive type bolts may be supplied for fixing to concrete surface inside buildings above ground level where the application proposed by the Contractor is approved by the Engineer.

Expansion bolts shall not be used inside liquid retaining structures, in chambers, basements and similar locations below ground level, in exterior locations, nor in any block work or brickwork.

1. Fixing into horizontal upward facing surfaces in concrete, by grouting using cement based grout or mortar into preformed, drilled or cut pockets, stainless steel foundation bolts may be used.
2. Screws and approved fixing plugs may be approved for use in some applications.

The Contractor shall submit details of his proposed type of resin fixed and mechanical expansion bolts for the approval.

The materials used for fixings, anchors, bolts, nuts, studs and washers and other demountable fastenings in the works shall be in accordance with the following:

Unpainted stainless steel in the following circumstances:

* Where specified;
* For all fastenings and fixing connections or holding galvanised or aluminium alloy parts; PTFE washers shall be fitted beneath stainless steel washers for both bolthead and nut.
* All bolts, nuts, studs and washers used in the construction of pumps shall be of stainless steel
* In locations liable to high humidity, or condensation or total, partial or intermittent submergence in corrosive liquid.

Otherwise, general holding-down bolts, nuts, washers, anchor plates, and self-drill anchor fittings shall be bright steel galvanised and all exposed surfaces painted after assembly and tightening.

Fastenings, except high tensile, of all ferrous parts shall be steel prepared and galvanised or sherardized, primed and painted in accordance with the Protective Coating Specification of these ER. Electro-galvanising, nickel, cadmium or any other plating process except chromium plating, will not be acceptable.

All exposed bolt-heads and nuts shall be hexagonal and the length of all bolts shall be such that when fitted with a nut and tightened down the threaded portion shall fill the nut and not protrude from the face thereof by more than half a diameter in the fully tightened condition.

PTFE (polytetrafluoroethylene) washers shall be fitted beneath bolt-head and nut when fastening parts of different materials, i.e. mild steel and stainless steel or aluminium.

Fitted bolts shall be a light driving fit in the reamed hole they occupy, shall have the screwed portion of the diameter such that it will not be damaged or cause damage in driving and shall be marked in a conspicuous position to ensure correct assembly at the Site.

Washers, locking devices and anti-vibration arrangements shall be provided where necessary to ensure that no bending stress is caused in the bolt.

Where there is a risk of corrosion, bolts and studs shall be designed so that the maximum stress in the bolt and nut not exceed half the yield stress of the material under all conditions.

Except where otherwise approved, wood screens shall be brass with round or countersunk heads.

Nails will only be permitted in specifically approved circumstances.

Should the protective coating or physical form of any fixing be damaged due to over-tightening or any other cause, the Contractor shall replace the fixing.

# Welding, Painting and Protective Coating

## Welding

### General

All welding works shall be applied under most convenient working conditions, utilising modern, effective equipment and techniques and latest welding technologies.

All welding shall be performed by welders qualified and experienced in the particular type of welding required. It shall be the responsibility of the Contractor to ensure that all welding operators are properly qualified and competent to carry out all required welding on site.

Records of the welding procedures and welder performance qualification tests for work done shall be maintained by the Contractor for review by the Engineer.

The method and procedure adopted for welding in workshops and at site shall be approved by the Engineer before production starts.

### Standards

Welded structures shall comply with the regulations set out in National (Project country) welding documentation and/or the latest edition of the welding documents of the International Institute of Welding.

Furthermore, for the welding of carbon steel piping, the and for the welding of stainless steel piping, the latest international EU harmonized DIN, BS or other Recommended Practices shall apply.

In general, the following standards shall be applied for the welding operation during the manufacturing and installation of equipment:

1. DIN 1910-3: Welding; Welding of Plastics, Processes
2. DIN 1910-11: Welding; terms dependent on materials for metal welding
3. DIN 1910-100: Welding and allied processes - Vocabulary - Part 100: Metal welding processes with additions to DIN EN 14610
4. DIN EN 14610 Welding and allied processes - Definitions of metal welding processes; Trilingual version EN 14610
5. DIN EN ISO 6520-1: Welding and allied processes - Classification of geometric imperfections in metallic materials - Part 1: Fusion welding (ISO 6520-1:2007)
6. DIN EN ISO 6520-2: Welding and allied processes - Classification of geometric imperfections in metallic materials - Part 2: Welding with pressure (ISO 6520-2:2001)
7. DIN EN 287-1: Qualification test of welders - Fusion welding - Part 1: Steels
8. DIN EN ISO 9606-2: Qualification test of welders - Fusion welding - Part 2: Aluminium and aluminium alloys (ISO 9606-2:2004)
9. DIN EN ISO 9606-3: Approval testing of welders - Fusion welding - Part 3: Copper and copper alloys (ISO 9606-3:1999)
10. DIN EN ISO 3834-1: Quality requirements for fusion welding of metallic materials - Part 1: Criteria for the selection of the appropriate level of quality requirements (ISO 3834-1:2005)
11. DIN EN ISO 3834-2: Quality requirements for fusion welding of metallic materials - Part 2: Comprehensive quality requirements (ISO 3834-2:2005)
12. DIN EN ISO 3834-3: Quality requirements for fusion welding for metallic materials - Part 3: Standard quality requirements (ISO 3834-3:2005)
13. DIN EN ISO 3834-4: Quality requirements for fusion welding of metallic materials - Part 4: Elementary quality requirements (ISO 3834-4:2005)
14. DIN EN ISO 14731: Welding coordination - Tasks and responsibilities (ISO 14731:2006)
15. DIN EN ISO 5817: Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections (ISO 5817:2003 + Cor. 1:2006)
16. DIN EN ISO 14555: Welding - Arc stud welding of metallic materials (ISO 14555:2006)
17. DIN EN ISO 13919-1: Welding - Electrons and laser beam welded joints; guidance on quality levels for imperfections - Part 1: Steel (ISO 13919-1:1996)
18. DIN EN ISO 13919-2: Welding - Electron and laser beam welded joints; Guidance on quality levels for imperfections - Part 2: Aluminium and its weldable alloys (ISO 13919-2:2001)
19. DIN EN ISO 10042: Welding - Arc-welded joints in aluminium and its alloys - Quality levels for imperfections (ISO 10042:2005)
20. DIN EN 25817 Arc-welded joints in steel; Guidance on quality levels for imperfections (ISO 5817:1992)
21. DIN EN 462-1: Non-destructive testing; image quality of radiographs; part 1: image quality indicators (wire type); determination of image quality values
22. DIN EN 462-4: Non-destructive testing - Image quality of radiographs - Part 4: Experimental evaluation of image quality values and image quality tables
23. DIN EN 462-3: Non-destructive testing - Image quality of radiogrammes - Part 3: Image quality classes for ferrous metals
24. DIN EN 1435: Non-destructive testing of welds - Radiographic testing of welded joints
25. DIN EN 12681: Founding - Radiographic examination
26. DIN EN 444: Non-destructive testing; general principles for the radiographic examination of metallic materials using X-rays and gamma-rays
27. DIN EN 1330-4: Non-destructive testing - Terminology - Part 4: Terms used in ultrasonic testing

Welding work on steel structures subjected to static and/or dynamic loads shall be carried out by welders holding a valid welding certificate according to DIN EN 287-1. On request, the certificates shall be submitted to the Engineer

The valuation for welding seam execution shall be based on DIN EN ISO 5817, Categories B and C (category B for inside analysis; category C for outside analysis, for gas lines only category B will be accepted).

Steel structure, in particular pipes, shall be shop-prefabricated as far as possible in order to minimize welding work on side.

The Engineer reserves the right to order at the Contractor’s expense the X-ray examination of up to a maximum of 10 % of all executed welding seams. In case more than 10 % of the examined welds fail the test, the Engineer will order the X-ray examination of a further 30 % of all executed welding seams at the expense of the Contractor. If, again more than 10 % of the welds fail the tests, the Engineer shall order the X-ray inspection of all welds. The Contractor shall bear all costs involved.

The X-ray examination shall be conducted according to DIN EN 444, DIN EN 462 and DIN EN 1435. Test classification according to DIN EN ISO 5817.

### Welding of Carbon Steel

Manual, shielded metal-arc, submerged arc, gas metal-arc, flux-cored arc, gas tungsten arc, and other applicable welding processes and methods may be used in the construction and fabrication of welded carbon steel equipment. Prefabrication in workshop shall be used as far as possible

### Welding of Stainless Steel

The welding method, which shall be used, shall be the tungsten inert gas method (TIG) or the metal inert gas method (MIG) for both workshop welding and site welding. For workshop welding the metal arc, plasma method is also approved. Irrespective of the method chosen, the inner surface of the welds shall be protected by clean inert gas.

Besides adherence to applicable Standards, the guidelines from the supplier of stainless steel with regards to processing must be strictly followed.

Welders employed in welding stainless steel must possess the welding certificate according to DIN EN 287-1 131/135/141.

Quality of execution of welds will be based on DIN EN ISO 5817, Categories B, and C (category B for inside analysis; category C for outside analysis, for gas lines only category B will be accepted). Correct edge preparation and cleanness of weld joints are of great importance.

Special care must be taken to avoid the occurrence of annealing colours. The root weld must be protected by inert gas against ingress of oxygen. Ignition spark spots and weld spatter will not be accepted on material surface. In case the need arises the spots must be removed from the surface by smooth grinding with approved tools or a stainless steel brush. Areas affected by scale / annealing colours must also be subjected to smooth grinding.

Pickling should be the usual post-treatment of stainless steel surfaces. In case the pickling process is employed, the subsequent flushing of surfaces with clean water is of utmost importance

In order to guarantee high quality welded joints, piping and other quality stainless steel equipment shall as far as possible be prefabricated in the workshop

### Performance

The work shall be executed in accordance with the Standards and Practices referred to in the foregoing. Furthermore, for stainless steel welding the following shall be noted:

1. Only butt weld jointing of the pipes is allowed during the erection work.
2. Where butt welds are used, the penetration shall be completed, if necessary, with root run.
3. Backing rings shall not be used.
4. No surface defects reducing the corrosion resistance or discoloration of the surface will be accepted.
5. After welding, the welds shall be carefully pickled and passivated.
6. The welds must be thoroughly washed in clean water after pickling and passivation.
7. Sand blasting will not be permitted for stainless steel.

## Chromium Plating

All chromium plating shall comply with relevant standards (BS 1224. or equivalent DIN EN Grade)

## Galvanizing

Where steel or wrought iron is to be hot–dip galvanised, it shall be carried out by the hot–dip process and shall conform in all respects with relevant standards (BS 729. or equivalent DIN EN)

Attention shall be paid when galvanizing all machinery details in accordance with BS 4479 or equivalent DIN EN. Adequate provision for filling, venting and draining shall be made for assemblies fabricated from hollow section. Vent holes shall be suitably plugged after galvanising.

All surface defects in the steel including cracks, surface laminations, laps and folds shall be removed in accordance with relevant standards (BS 4360 or equivalent DIN EN).

All drilling, cutting, welding, forming and final fabrications, unit members and assemblies shall be completed before the structures are galvanised. The surface of the steel work to be galvanised shall be free from welding slag, paint, oil, grease and similar contaminants. The articles shall be pickled in dilute sulphuric or hydrochloric acid following by rinsing in water and pickling in phosphoric acid. They shall be thoroughly washed, stoved and dipped in molten zinc and brushed, so that the whole of the metal shall be evenly covered and the additional weight thereof after dipping shall not be less than 610 grammes per square metre of surface galvanised, except in the case of tubes to BS 1387 or equivalent DIN EN when it shall be 460 grammes per square metre.

On removal from the galvanising bath, the resultant coating shall be smooth, continuous, free from gross imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross. Edges shall be clean and surfaces bright.

Bolts, nuts and washers shall be hot-dip galvanised and subsequently centrifuged in accordance with BS 729. or equivalent DIN EN . Nuts shall be tapped up to 0.4 mm oversize before galvanising and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nuts.

During off–loading and erection the use of nylon slings shall be used.Galvanised work which is to be stored in Works or on Site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining.

Small areas of the galvanised coating damaged in any way shall be restored by:

1. Cleaning the area of any weld slag and thoroughly wire brushing to give a clean surface.
2. The application of two coats of zinc–rich paint (not less than 90 % zinc, dry film), or the application of a low melting–point zinc alloy repair rod or powder to the damaged area, which is heated at 300°C.

Surfaces shall not be immersed within three months of hot dip galvanising (according to DIN 50976) and/or before an adequate protective patina has formed.

Where surfaces of galvanised steelworks are to be in contact with aggressive solutions and/or atmospheres the galvanising shall receive further protection by painting.

## Painting and Protective Coating

### General

These Specifications are to be considered for both mechanical and civil applications.

Where very detailed requirements are expressed in other parts of these ER (i.e. Section 5 - General Civil Specifications) they shall take precedence over the requirements of this part.

This section of the Specification shall apply to the general requirements and standards of workmanship for the painting and protective coatings required to be carried out by the Contractor, unless specified otherwise or unless the Contractor has submitted an alternative specification at the time of tendering to meet one of the following conditions:

* Particularly corrosive local environment;
* Possible reaction of escaping chlorine;
* Reaction of chlorine residuals on phonemic paints;
* Harmful or toxic paint in contact with process liquids.

No alternative or substitute painting standard or specification will be accepted unless it is specifically required for the above stated reason. No painter work or protective coatings will be accepted by The Engineer unless it is at least to the standard and of the quality specified herein.

### Contractor’s Responsibility

The Contractor shall be responsible for the complete cleaning, preparation, priming, painting and protection of the works carried out by him:

* At the place of manufacture;
* In preparation for packing and transit;
* For preservation during storage;
* For immediate ‘touch up’ or remedial work when received, placed in store, and/or delivered to the Site;
* For supervision of the protection of the coating during the erection, testing and commissioning of the works;
* For the supervision of final painting following testing of the works;
* For the supervision of ‘touch up’ or ‘re-protection’ as the result of any trouble-shooting activities during the commissioning of the works.

Special care shall be taken to all works carried out at site with regard on the rehabilitation works of existing metal constructions.

### Submissions

The Contractor shall deliver for approval to The Engineer triplicate copies of a comprehensive submission (in English) as Method Statement per each individual item with samples, certification and data regarding the protective coating (materials, sources, manufacturer’s instructions, methods of application etc., ) which are specified or which he proposes finally to be adopted.

The samples shall include for all paints:

* Applied paint coatings and colours on sample chips;
* Reference samples of the paint.

The certification shall include:

* The results of taste and odour tests for all coatings proposed or specified for any pipeline, or item of Works or surface which is designed to be (or could normally be) in contact with, or feed into the water being processed, stored or pumped;
* The results of tests on the effects of water and/or any other chemical fluid or gas which the coating is specifically required to protect against, and to which the protected installations may be exposed, by nature of the works arrangements,.

The data shall include:

* A complete schedule of the protective coating and paint systems;
* Colour charts for finishing coats (including the system colour notation);
* Manufacturer’s product data on the protective treatment, coatings and paint systems;
* Manufacturer’s preparation and application instructions;
* Method of application.

The schedule required with the submission shall contain the following information, in detail:

* Item;
* Environment of item;
* Type of surface;
* Surface preparation;
* Protective or paint system to be applied;
* Name of coating manufacturer;
* Brand name and reference number for each coat to be used;
* Manufacturer’s data sheet for each coat, including the technical description and formulation of paint, and the colour of each paint;
* Colour of finishing coat stating the system colour notation;
* Proposals concerning place of application and detailed;
* Method of application of each coat, including information on equipment to be used;
* Wet film minimum and target thickness for each coat;
* Dry film minimum and target thickness for each coat;
* Density of paint for each coat and coverage of paint per unit volume including volume solids.

The work detailed on the painting schedule shall meet the requirements of the Specifications of these ER and the Drawings.

Prior to the commencement of erection works, the Contractor shall submit quadruplicate copies of the final approved painting schedule to The Employer/ Beneficiary through the Engineer. During the erection, testing and commissioning periods, the Contractor shall maintain a copy of the document on site for his own use and shall provide a separate copy for exclusive use by the Employer/ Beneficiary and the Engineer.

### Appropriate Standards

Where no explicit instruction is given in the Specifications or by the manufacturers concerning any particular aspect of the workmanship, materials or procedures in connection with anti-corrosion protective systems in the works for iron and steel structures, the relevant recommendations of the local i.e National (Project country) equivalent harmonized with European norms (or DIN, BS) Standard and code of practices shall apply.

In particular, DIN EN ISO 12994 Part 1 until DIN EN ISO 12994 Part 8 shall be applied for corrosion protection of steel works and for the rest is as follows:

1. ISO 8504-2 Preparation of steel substrates before application of paints and related products - Surface preparation methods - Part 2: Abrasive blast-cleaning
2. DIN 55 928-8 Protection of steel structures from corrosion by organic and metallic coatings; part 8: protection of supporting thin-walled building components from corrosion
3. DIN EN ISO 12944-1 Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 1: General introduction (ISO 12944-1:1998)
4. DIN EN ISO 12944-2 Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 2: Classification of environments (ISO 12944-2:1998)
5. DIN EN ISO 12944-3 Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 3: Design considerations (ISO 12944-3:1998)
6. DIN EN ISO 12944-4 Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 4: Types of surface and surface preparation (ISO 12944-4:1998)
7. DIN EN ISO 12944-5 Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 5: Protective paint systems (ISO 12944-5:2007)
8. DIN EN ISO 12944-7 Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 7: Execution and supervision of paint work (ISO 12944-7:1998)
9. DIN EN ISO 12944-8 Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 8: Development of specifications for new work and maintenance (ISO 12944-8:1998)
10. DIN EN ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods (ISO 1461:1999)
11. DIN EN ISO 2063 Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys (ISO 2063:2005)
12. DIN 8577 T1 Alloys for Thermal Application
13. DIN EN ISO 14919 Thermal spraying - Wires, rods and cords for flame and arc spraying - Classification; Technical supply conditions (ISO 14919:2001)
14. DIN EN 13507 Thermal spraying - Pre-treatment of surfaces of metallic parts and components for thermal spraying

Each base surface shall be checked with regard to the suitability of the follow-up coating and – if necessary – shall be pre-treated accordingly. The paint supplier’s instructions for the application of the coatings shall be strictly adhered to.

### Trial Areas and Sample Pieces

Site procedures specified shall be such that prior to the commencement of the site paint work, designated area(s) or section(s) of the works shall be completely painted as a sample of the work and workmanship to be carried out. The area(s) or section(s) shall include complete samples of all the major painting required in the works.

The area(s) shall be prepared for review and then, upon approval, shall be preserved as a reference standard for the work.

### Color, Coding, Labels, Arrows

Pipe work, tanks and ducting shall be detailed as colour coded either by banding with the appropriate code colour over the decorative paint, or by totally painting with the appropriate code colour as specified or detailed on the drawings.

The principal code colours shall be as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| Contents/Description | **Colour** | **Munsell** | **Notation** |
| Potable water | Blue | 7.5 PB | 2.5/10 |
| Hot water | Crimson | 5 R | 2.5/12 |
| Raw water | Light green | 7.5 GY | 7/4 |
| Irrigation/Service water | Medium green | 7.5 GY | 4.5/8 |
| Waste water | Dark Green | 10Y | 3/1.5 |
| Chlorine liquid and gas | Yellow | 5Y | 9/14 |
| Compressed air | Light | 10BG | 7.5/1.5 |
| Air Scour | Silver | / | / |

Alternative colours or notations (i.e. RAL codes) can be applied after approval from the Engineer. The colour coding for other minor pipelines will be notified to the Contractor prior to the commencement of erection but after approval from the Engineer.

Where colour banding of pipe work (as distinct from total painting in the code colour) is detailed the bands shall be of the sizes shown on the approved drawings.

All pipes and tanks shall be detailed to also bear painted labels to indicate the contents.

Lettering shall be in English and project country ( local) language.

Labels on pipe work shall incorporate arrows showing the direction of flow within the pipe work. When pipes are colour coded with coloured bands, the label shall be located on the colour band.

Black lettering shall be used on orange, yellow and green and white lettering shall be used on red and blue.

Sufficient labels shall be used to ensure adequate identification throughout the length of the pipe runs. These shall be located at least adjacent to each flange or disconnecting joint, where pipe work passes through walls, floors, crosses, doorways and other access ways and at intervals in long runs of pipe work.

### Bitumen Coating

Suitable grades and bitumen coatings shall be specially selected where the coating will be in contact with potable water.

### Metal Coating General

Metal coatings required for protective purposes on any item of metalwork shall be applied after completed fabrication of the items, including all punching, welding, drilling, grinding, screw tapping and cutting, and after the removal of surface defects. Tapped holes shall be blanked off before the metal coating is applied.

Any damage to zinc coatings during installation shall be proper made good with a suitable cold galvanising compound.

### Prefabrication Primers

Unless otherwise specified, prefabrication primers for steelwork shall incorporate corrosion inhibiting pigments, shall adhere firmly to the substrate and form suitable bases for the succeeding coats in the protective paint system.

### Surface Preparation by Blasting

All surfaces to be coated shall be free of scale, rust, grease, oil, dust and other deleterious materials.

The surface finish of blast cleaned steel shall be in accordance with ISO 8501 -1 :2007 , finished to a SA 2.5 blasting quality - very thorough blast cleaning; the blast profile shall be within the limits 50 – 75 µm;

Millscale, rust paint and foreign matter shall be removed completely from the surface. Any remaining traces shall be visible only as slight stains or discoloration in the form of spots or stripes.

Only abrasive cleaning techniques shall be used. The clean abrasives shall be carefully stored in a dry atmosphere; they shall be clean and shall not be re-used unless properly recycled in equipment, which has de-dusting, screening and drying facilities. Abrasives shall be restricted to re-usable iron or steel (grit or shot) or copper slag.

The blasting shall be carried out in a dry atmosphere, as high humidity will result in agglomerates of dust and abrasive particles forming which will inhibit the cleaning process.

Clean, dry compressed air should be available in sufficient quantity at an adequate pressure. It should be free from water and oil. Separators, filters and traps shall be fitted to collect water and oil. These should preferably be of automatic operation.

After blast cleaning and immediately prior to painting, all accumulated dust; residue and debris shall be removed by means of a hand-held or equivalent vacuum cleaning method.

Laminations, blow holes, crevices and other surface defects exposed after blasting shall be overfilled with suitable weld metal and ground flush. Welding flux and spatter remaining after blasting shall be removed by grinding or other best mechanical means and edges made flush. All sharp corners, edges and burrs shall be removed by grinding. Where extensive rectification has been necessary to areas greater than 0.15 m² these shall be blasted to the original quality of surface preparation.

Within four hours of completion of surface preparation, and before surface re-resting occurs, a coating of primer shall be applied to avoid deterioration of the prepared base metal. No contamination shall be permitted to occur between blast cleaning and primer coating.

### Dehumidification Required for Special Purposes

All surfaces to be coated shall be free of scale, rust and deleterious substances.

Re-humidification equipment shall be utilised as may be necessary to preserve blast-cleaned surfaces in a pristine condition until they can be coated and/or to provide the curing conditions necessary for such coats.

### Preparation of Damaged Surfaces

Works (shop) prepared surfaces (other than galvanised surfaces), damaged during site fabrication and/or handling shall comply with at least the following:

1. All slag and spatter shall be removed from areas of welds by chipping hammer and these areas together with all other areas of priming coat damaged in the process of fabrication and/or handling shall be thoroughly mechanically wire brushed and given one priming coat of an approved polyamide cured - zinc phosphate epoxy corrosion resistant primer - two pack **or** alternative shall not apply to surfaces in location ‘B’ - Surfaces in contact with untreated or treated water for potable use)
2. Zinc chromate epoxy corrosion resistant primer - two pack applied to give a dry film thickness not less than 50 µm, special care have to be taken to cover uneven surfaces completely, particularly those of welds.

Where relevant, the first finishing paint system shall be applied within 48 hours of the above primer.

### Embedded Steel

Steel, which is to be totally embedded in concrete, shall be cleaned and shall not be primed

### Preparation and Painting Works

Lettered classification of surfaces shall be used for the purpose of identifying protective coatings specified herein:

**‘A’ -** Surfaces above process liquid level and not liable to splashing thereby, in non-aggressive atmosphere;

**‘B’ -** Surfaces in contact with untreated or treated water for potable use;

**‘C’ -** Surfaces below process liquid level or liable to splashing thereby in non-aggressive solutions and/or atmospheres;

**‘D’ -** Surfaces in contact with aggressive solutions and/or atmospheres.

### Steelwork in Locations “A”, “B” and “C”

Works (shop) preparation and initial protection of steelwork in locations ‘A’, ‘B’ and ‘C’ shall comply with at least the following:

* Works preparation shall be carried out when all machining has been completed and all traces of grease removed;
* All steel, other than stainless steel, (except that which subsequently will be totally encased in concrete or that which may be pieced sufficiently small to hot dip galvanise), shall be grit blast cleaned to the Standard SA 2.5 such that the depth of surface from valleys to peaks shall not exceed 75 µm +/- 25%;
* Initial protection shall be applied within 4 hours of grit blast cleaning in a ‘clean condition’ area of the workshop subject to the provisions of requirements for the working environment;
* All surfaces shall be completely cleaned of loose abrasive and given a priming coat of an approved polyamide cured:
* Zinc phosphate epoxy corrosion resistant primer - two pack; or
* Zinc chromate epoxy corrosion resistant primer - two pack; (alternative shall not apply to surfaces in location ‘B’)
* An approved airless spray process shall be used to apply a dry film thickness above peaks of not less than 50 µm;
* Painted identification markings shall be reproduced on the priming coat;
* Steelwork fabricated at works shall only receive the above preparation and initial protection after all machinery and fabrication has been completed and when such fabrication is by means of continuous welded runs with all exposed surfaces accessible for subsequent treatment. All slag and spatter shall be removed from the area of welds by chipping hammer prior to grit blast of cleaning;
* The inside surfaces of box members and similar non-fabricated sections where grit blast cleaning is impracticable shall be cleaned to Standards (shall not apply to surfaces in location ‘B’);
* Where relevant, the first finishing paint system shall be applied within 48 hours of the initial primer in accordance with the specification;
* Steel work shall be protected in covered storage works until fabrication is ready to commence at Site, where also the first finishing coat shall be applied after fabrication

### Steelwork in Location “D”

Works (shop) preparation and initial protection of steelwork in location ‘D’ shall comply with at least the following:

* Shop preparation shall be carried out when all machining has been completed and all traces of grease removed;
* All steel, other than stainless steel, shall be: prepared and hot dipped galvanised;
* Initial protection shall be applied at works (shop) only when exposure to aggressive solutions and atmospheres is expected within three months and/or before an adequate protective patina has formed;
* Initial protection when required to hot dip galvanised surfaces shall comprise thoroughly cleaning and degreasing of all surfaces followed by etching with T wash as described in DIN 50976. If any surface failing to turn black - the cleaning, degreasing and etching process shall be repeated;
* All surfaces shall then be thoroughly washed with clean water, completely dried and given a priming coat of an approved polyamide cured zinc phosphate epoxy corrosion resistant primer - two pack;
* An approved airless spray process shall be used to apply a dry film thickness of not less than 50 µm.

### First Finish Steelwork in Location “A”

The first finishing paint system for surfaces in location ‘A’ (other than galvanised surfaces), shall comply with the least the following:

* To surfaces in location ‘A’ one coat of an approved: Polyamide cured epoxy miscellaneous iron oxide - two pack shall be applied at the place of manufacture to give a dry film thickness not less than 125 µm.
* application being brush or airless spray; Interval after application of priming coat shall not exceed 48 hours;
* Painted identification markings shall be reproduced on the first finishing painting system.

### Final Finish in Locations “A”, “B” and “C”

The final finish paint system for surfaces in locations ‘A’, ‘B’ and ‘C’ ( other than galvanised surfaces) shall comply with at least the following:

* All surfaces of the fabricated steelwork (except those areas which are inaccessible and to which the final coat was applied at works) shall be given a final coat of colour to be approved. This final coat shall be applied at site when all associated engineering work has been completed;
* Bolted site connections other than fraying surfaces of grip bolt connections shall be brought together ‘wet’;
* All areas where the first finishing coat has been damaged in transit and/or erection shall be repainted as specified;
* Special attention shall be given to severe damage exposing bare metal in which instance the damaged areas shall be thoroughly sand blasted to a bright finish, primed and repainted as specified;
* To surfaces in location ‘A’ sufficient coats of approved : silicone alkyd enamel shall be supplied to give a dry film thickness of not less than 50 µm;
* On site, to surfaces in location ‘B’ two coats of approved: - amine adduct - cured pure epoxy resin - two pack shall be applied to give a dry film thickness not less than 125 µm per coat;
* On site, to surfaces in location ‘C’ two coats of approved: - polyamide cured epoxy coal tar - two pack shall be applied to give a dry film thickness not less than 125 µm per coat.

### Final Finish in Location “D”

Priming and first finishing paint system surfaces in location ‘D’ shall comply with at least the following:

* All surfaces of galvanised fabricated steelwork (except those on which an adequate protective patina has not formed and/or those surfaces which have received initial protection under the provision of the Specification) shall receive a priming coat immediately following erection at site and prior to immersion in or exposure to aggressive solutions or atmospheres;
* All surfaces shall lightly wire brushed and all traces of grease and other contaminants removed;
* All loose particles shall be removed and immediately thereafter all surfaces including those of fastenings shall be given a priming coat of an approved: polyamide cured zinc phosphate epoxy corrosion resistant primer - two pack to give a dry film thickness not less than 50 µm, (to ensure that no uncovered spots remained) ;
* All surfaces of galvanised fabricated steelwork on which an adequate protective patina has not formed shall be treated and given a priming coat immediately following erection at Site and prior to immersion in or exposure to aggressive solutions or atmospheres followed by a first finishing coat as described below;
* All surfaces which have received initial protection at works or a priming coat at site shall be thoroughly cleaned and given a first finishing coat of an approved: - polyamide cured epoxy coal tar – two pack applied to give a dry film thickness not less than 125 µm;
* No uncovered spots shall exist in the finished work;

The final finishing paint system shall be applied within 48 hours of the above

### Painting of Welds

After the completion and grinding of exposed welds, weld spatter, weld residues and all alkaline deposits and contamination shall be removed from the surface of the steelwork, and welds and any other areas affected or damaged by the welding process shall be blast-cleaned. Filings shall be removed, preferably by vacuum or compressed air.

Welds shall be primed immediately with the nominated primer before contamination can reoccur. Ensure that the primer overlaps the sound adjacent coating by not less than 25mm or greater than 50mm.

Apply intermediate and topcoats over the primed welds to match the surrounding coating system, overlapping the sound adjacent coating by not less than 25mm or greater than 50mm.

The important thing to note from this specification is that the coating system over the welded area is to be identical to that of the steel generally, to ensure continuous corrosion protection over the entire steelwork. Overlapping ensures that there are no gaps or weak points in the coating system.

If in doubt, a stripe coat can be applied to the welded area. A stripe coat is defined as “an additional coat“ applied to edges, holes, welds and corners to ensure complete coverage, before spray application of the main coat.

### Uncoated Surfaces

The only surfaces of iron or steelwork not of corrosion-resistant material, which are to be left unprotected by paint or metal coating, are:

* The internal surfaces of boxes or hollow sections which are of dimensions too small to permit access for painting either at the fabrication stage or for maintenance during the operational life of the steelwork and which are to be hermetically sealed by welding;
* Those surfaces of built-in iron or steel members, which are to have concrete cast against them;
* Machine bright parts and bearing surfaces which shall be thoroughly cleaned, polished and protected from corrosion by painting with one coat of a mixture of white lead and tallow or other similar approved material before despatch. The Contractor shall provide solvent for removing the treatment;
* Parts which are specified to include corrosion allowances instead of protective coatings.

Surfaces of iron or steel components, which are to have concrete cast against them, shall be clean and free of deleterious matter and loose rust at the time of concreting. The paint protection system to be applied to the permanently exposed faces of these components before they are built in, shall be continued for 50 mm as marginal stripes along the contact surface. No paint containing aluminium in metallic form shall be allowed to come into direct contact with the concrete.

### Reparation Painting of Damaged Works

Unless specified elsewhere, areas of paint on steelwork that have been damaged shall be cleaned to sound material and the edges of the undamaged paint smoothed with sandpaper to a gentle level.

The specified paint system shall then be applied to bring the damaged area up to the same state of protection as the surrounding paintwork, with each coat of new paint overlapping the corresponding existing coat of paint by at least 50 mm.

Areas of paint on which weld spatter, concrete or their adherent matter has fallen shall be cleaned or washed free of the adherent material immediately and any repair or making good of the affected surface to its original standard shall be carried out before the area is over-coated with paint.

Where the steel is exposed, it shall be cleaned to remove all corrosion, by blast cleaning if necessary.

Where epoxy coatings are damaged, suitable repair material supplied by the manufacturer of the original coating shall be applied in accordance with the manufacturer’s instructions.

### Preparation and Painting of Pipes

Steel pipes below 80 mm in bore, for use at temperatures up to 40°C shall be made of stainless steel ( detailed material requirements in relevant chapter for Stainless Steel Pipework) or hot dip galvanized and security wrapped with plastic sheeting where laid in ground. For use at temperatures above 40°C galvanized steel pipes shall not be laid in ground.

In locations ‘A’, ‘C’ and ‘D’ cast iron and steel pipes 80 mm in bore and greater, for use at temperatures up to 40°C shall be cleaned in accordance with the pipe manufacturer’s accepted trade practice and shall be hot dipped internally and externally in an approved bitumen solution.

Ductile iron and steel pipes shall be securely wrapped with polythene sheeting where laid in ground. For use at temperatures above 40°C and up to 80°C approved bitumen shall be applied to the external surface only of ductile iron and steel pipes, prior to lagging and they shall not be laid in ground.

External surfaces of exposed pipes shall be given two coats of approved Silicone alkyd enamel to give a dry film thickness of not less than 50 μm after all civil the Engineering work has been completed.

In location ‘B’ cast iron, ductile iron and steel pipes 80 mm in bore and greater shall be treated strictly in accordance with the requirements for equipment in location ‘B’.

### Preparation and Painting of Metal Parts

Mild steel items (including steelwork sections, small pieces and machinery castings) shall be hot dip galvanized when all machining and fabricating has been completed by means of continuous or intermittent welding of all exposed surfaces accessible for galvanizing. Alternatively, mild steel items shall be prepared in accordance with the provisions herein regarding preparation and painting works.

All other parts and attachments, whether of cast-iron or cast steel, shall be thoroughly cleaned by grit blasting to the Standard Sa 2.5. All surface imperfections shall be knife stopped. Priming and painting shall then be carried out in accordance with location.

### Preparation and Painting of Non-Ferous Parts

Non-ferrous metal parts except structural metal aluminium (in locations ‘A’ only) shall not be painted unless specifically requested by the Engineer. Exceptions are the bolt holes and faces which shall be given one coat of zinc chromate epoxy - two packs

### Preparation and Painting of Mild Steel Stairways

Mild steel stairways including stringers, treads, pillars and supports in locations ‘A’, ‘B’ and ‘C’ shall be prepared and hot dip galvanised when all machining and fabrication has been completed and they shall remain unpainted

### Preparation and Painting of Fastenings

Bolts, nuts and washers and other demountable fastenings of all galvanised parts (and also aluminium alloy parts) shall be in stainless steel and shall remain unpainted. PTFE washers shall be fitted beneath bolthead and washers, when fastening galvanised parts and also aluminium alloy.

Fastenings, except high tensile, of all ferrous parts shall be steel prepared and galvanised or sherardized, primed and painted in accordance with location.

Unless specifically approved and required for superior protection, electro-galvanising, nickel, cadmium or any other plating process, except chromium plating, will not be acceptable, and shall not be offered.

### Painting and Protection of Bolted Connections

Joint areas of bolted connections shall be masked to maintain the surfaces free from any paint applied prior to making the connections. Masking shall be removed before erection.

After installation and all bolts have been tightened the area of the connection shall be cleaned to remove all dirt, dust, oil or other contaminant. Particular care shall be taken to ensure that all traces of oil and grease are removed from bolts, nuts and washers.

Any surrounding areas of paintwork that have been damaged shall be prepared as specified in repair of damaged work.

Bolts, nuts and washers and any exposed surfaces at bolted connections shall also be primed as specified, particular care being taken to ensure that any crevices are fully sealed.

The remaining coats of the paint system shall then be applied.

Following painting and where the bolted connections are in an area to be backfilled (pipe trench flanges etc.) the bolt, nuts and washers and the entire joint assembly shall be carefully packed with an approved purpose made water proof protective paste (non solvent) and finally wrapped with an approved protective impregnated tape to completely encase the assembly. Pipe joints protection shall continue along the length of the barrel for a distance of 200 mm.

### Overcoating of Bituminous Coatings

Where items with factory applied bituminous coatings are to be over coated with a decorative finish, the surface shall be sealed with a suitable alkyd aluminium primer compatible with both the bituminous coating and the decorative system.

## Waterworks Finish

The following general requirements shall define the standard of finish required on various items of the works. This is referred to as “Waterworks Finish”.

1. Welding and flame cutting; a smooth neat finish, by careful grinding if necessary, is required on all exterior welding and flame cutting. All plates and bars used in fabrications shall have good smooth surfaces with no pitting or deep inclusions;
2. Castings; surfaces shall be smooth and free from surface blowholes. Stock castings shall be specially selected. All castings shall be shot blasted before machining;
3. Covers; shall be firmly fixed. Weld mesh shall sit square in its frame;
4. Flanges and beadings; all bolt holes shall be spot face parallel with the mating face for good seating of nut and bolt heads. Mating faces and peripheries shall be machined true.
5. Small exposed screw and bolt heads, nuts and washers; shall be chromium on copper plated or made in stainless steel or otherwise as specified or approved in advance.
6. Gauges; all indicating gauges fitted to any one piece of machinery shall be of similar appearance and grouped together.

# Pipework

## General

This Section sets out the general specification and standards required for the external pipework and pipework within structures.

These Specifications are to be considered for both civil and mechanical applications.

Where very detailed requirements are expressed in other parts of these ER (i.e. Section 5 of these Employer’s Requirements) they shall take precedence over the requirements of this part.

All pipework, valves and fittings shall be of a class in excess of 1.5 times the maximum pressure they will attain in service including any surge pressure, and shall be supplied by a manufacturer approved by the Employer/Beneficiary.

The pipework installation shall be arranged for easy dismantling and removal of pumps or other major items of equipment.

Flange adaptor or detachable couplings shall be included in the connecting pipework of all items to facilitate dismantling. Provision shall be made for flexible joint arrangements adjacent to all structures. Adaptors on pump delivery branches shall be upstream of their respective reflux valves.

The ends of pipes for use with flange adaptors and couplings shall be faced squared and sized to the tolerances required by the manufacturer of the coupling.

All pipework shall be adequately supported in trenches or with purpose-made fixings in structures and when passing through a wall, shall incorporate a puddle flange or other suitable purpose-made sealing device.

All loose flanges shall be secured to fixed flanges by suitable tie-bolts.

Flange adaptors shall be supplied and fitted in the pipework wherever is necessary to perform simple disconnection of flanges, valves and equipment

Flexibility shall be provided in the pipework at joints in the main structures to allow differential settlement and thermal stresses which shall not be transferred to the anchor blocks. Flexible joints or collars and cut pipes shall also be allowed on all pipework because of some error in the construction work.

The pipework system shall be designed to enable the necessary anchorage at blank ends, bends, tees and valves ; it may be kept to a minimum. The Contractor shall indicate on his detailed drawings the blocks required to anchor pipework supplied by him.

Each force and moment that may occur in the works may be compensated by an appropriate location of solid fixations, expansion joints and sliding supports. For liquids, the incorporation of rubber compensator is not permissible. All new air ducts should be made of stainless steel.

Buried pipes of stainless steel should be protected against cathodic corrosion.

Pipelines in the open air delivering sludge or water should be insulated with mineral wool or rigid foam and accompanying heating should be provided for. Protect the insulation with weatherproof aluminium shell.

Pipeline for pump mains should be made of material resisting to chemicals. Removable pipe sections are recommendable at places where assembling and dismantling of the pipeline - due to pipe layout - is not possible in any other way. Pipe manifolds around pumps are required to be in welded steel. Any other pipeline may be stainless steel, galvanised steel, ductile iron or HDPE.

Threaded surfaces (nuts) should receive a coat of corrosion preventing grease and closed with plastic cap, sealing strip and ring clamp. The same holds true for screw joints of stainless steel.

At necessary measuring positions detailed for electric equipment, pipe end welded in of ND 50 with flange joint should be built in. Places that are anticipated to be developed into future measuring position should be equipped with gate valve of flange joint ND 50

In each pipeline (in case of full-section medium flow), following maximum velocities of flow should be considered:

|  |  |  |
| --- | --- | --- |
| **Streaming medium** | **Type of pipeline** | **Flow velocity (m/s)** |
| Cold water | Suction pipe  Delivery pipe | 0 - 1.0  1 - 2.5 |
| Mix of sand-water | Suction pipe  Delivery pipe | 2 - 5.0 |
| Compressed air | Control air pipe  Delivery pipe | 10 - 16 |
| Hot air | Suction pipe  Delivery pipe | 0.8 - 1.0   * 1. - 10 |

If “water hammer” is possible, the necessary precautions shall be applied. In such cases the preventive measures shall be described. Waterhammer calculations shall be included when long discharge lines exist. The reverse speed shall be calculated assuming power failure and discharge valves fail to close

### Quality Certificate

Before starting with construction, certificates as follows should be submitted to The Engineer:

* Pipe layout drawings and isometric drawings with item list;
* Wall thickness calculations with static calculations of fixing;
* Welding drawing;
* Descriptions on material ( listing basic and auxiliary materials);
* Certificates of welders;
* Technological examination, if necessary;
* Staff requirement naming the manager, indicating among others the name and qualification of person supervising welding;
* Manufacturer’s certificate;
* Certificate attesting the durability (sustained loading) of the given material (for materials in contact with the medium such as pipelines, pipe shapes, sealings, fittings, etc.) in case of given medium, given temperature and given operational pressure;
* Instructions for gluing.

Quality certificates are required for all used materials.

On the assembly drawings pipelines of ≤ ND 80 should be indicated by one single line, those of > ND 80 by triple line. Isometric drawing should be made of pipelines ≥ ND 50. Any deviation from the foregoing should be fixed in the contract.

Only welders having appropriate certificate should be engaged. Before starting to work, a copy of the welder’s certificate should be submitted to the The Engineer. Welder repeatedly failing in producing the agreed quality of welded joint should be replaced if so required by the The Engineer

### Wall Passing

Where pipes pass through a concrete wall or structure they shall project from the external face(s) of the structure by 300 mm for pipes with nominal bores of 500 mm or less, and 500 mm for pipes with nominal bores in excess of 500 mm. The surface of such pipes shall be prepared to the approval of the Engineer to ensure a satisfactory bond between pipes and concrete.

Wall sleeves for water retaining structures shall be completed watertight. Puddle flanges, wall pieces with flange and/or standard wall sleeves form internationally accepted manufactures would be approved, only.

The first pipe in open ground leaving a structure shall be short length of either spigot and socket or double socket to suit the flow direction. The length of this pipes shall be one and half times the nominal bore or 600 mm whichever is the greater.

### Adapters

Adapting pieces shall be provided to all valves, in suction and pressure pipes of pumps and blowers and where necessary to ensure simple dismantling of the pipework. They shall be lockable in position.

Adapting pieces shall be flanged according to DIN 2501 and shall comply with the requirements of the DIN 2631, 2632, 2633 or equivalent harmonized European Standards.

The flexible/flange adapters used for jointing the plain ended pipe and bends shall be gasket, sleeve type with diameter to properly fit onto a pipe/flange forming permanently tight joints under all reasonable conditions of expansion, contraction, shifting and settlement in buried or above ground condition.

Flexible couplings shall connect pipes without flanges of the same or different materials.

Flange adapters shall be used for connection of pipes, one with flange and one without flange of the same or different materials.

The couplings and flange adapters shall be of galvanised mild steel or galvanised rolled steel. The sealing shall be of artificial rubber resistant against sewage

### Rubber Compensators

Rubber compensators shall be provided to all pipework at the access to machines like blowers, etc. Rubber compensators shall be capable of balancing thermal expansions, discrepancies of assembling, vibrations of machinery and settlements.

|  |  |  |
| --- | --- | --- |
| Direction | **Diameter** | **Excursion/value** |
| Axial | up to ND 50 mm | ≥ + 10 mm |
|  | from ND 65 mm | ≥ + 20 mm |
| Lateral | Displacement | ≥ ± 15 mm |
| Angular |  | ≥ 7.5 ° |
| Compression |  | ≤ 30 mm |

Rubber compensators shall be flanged according to DIN 2501 and DIN 2630 or equivalent harmonized European Standards. Screws shall not protrude in the direction of the rubber. Rubber parts shall not be painted.

### Support of Pipeworks and Valves

All necessary supports including structural steelworks, foundations, hangers, saddles, sliding shoes, slings, expansion pieces, fixing bolts, foundation bolts, fixing and anchor points and all other attachments shall be supplied to support the pipework and its associated equipment in an approved manner. Valves, meters, strainers and other devices mounted in the pipework shall be supported independently of the pipes to which they connect.

Wherever possible flexible joints shall be provided with tie-bolts or other means to transfer longitudinal thrusts along the pipework as a whole so that the external anchorages at blank ends, tees and valves may be kept to a minimum. The Contractor shall indicate on his working drawing what thrust blocks are required to anchor pipework supplied by him.

All brackets or other forms of support which can conveniently be so designed, shall be rigidly built up of steel sections by riveting or welding, in preference to the use of castings.

No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Engineer.

All brackets and fixings shall be hot-dip galvanized.

### Bolts, Nuts and Washers

All bolts, nuts and washers used in the jointing at flanged valves shall be of stainless steel in accordance with already stated general material SST requirements of these ER

### Ductile Iron Pipes and Fittings

Iron pipes and fittings shall be ductile iron and comply with the relevant Standards. Non-standard specials shall be avoided. Unless otherwise specified, puddle flange thickness and diameter shall be similar to the flange of the corresponding diameter.

Spigot and socket joints shall be flexible and of an approved “push-in” or bolted gland type unless otherwise specified.

## Steel Pipework

### General

All pipes and assembling parts must be of first quality, truly circular, and of uniform thickness, free from scale, lamination, honeycombs and other defects, and shall be designed and suitable for the stated pressures and temperatures.

The Contractor shall include for the supply, delivery and erection of all pipework and fittings within the buildings.

The pipework installation shall be so arranged, as to ease the dismantling and removal of pumps or other major items of equipment.

Expansion and dismantling joints shall be of the sleeve type and be double flanged. Dismantling joints shall be able to withstand the total tension loads from the maximum pressure occurring in the pipes. The material shall be carbon steel as specified in DIN 2632 and the coatings shall inside and outside be epoxy as specified in these ER.

A flange adapter shall be included in the suction and delivery pipework of all pumps for easy dismantling and provision shall be made for flexible joint arrangement to structures. The adapter on the pump delivery shall be upstream of its respective check valve. Where the pump delivery pipework joins the pumping station manifold the entry shall be horizontal.

The ends of pipes for use with flange adapters and couplings shall be faced, squared and sized to the tolerances required by the manufacturer of the coupling.

All loose flanges shall be secured to fixed flanges by suitable tie–bolts.

All pipework shall be adequately supported with purpose made fixings. When passing through walls, pipework shall incorporate a puddle flange.

Where the coating of the pipes is damaged, the surface shall be cleaned and dried and the Contractor shall paint the damaged area with a minimum of three coats of paint to the full thickness and specification as the original coating.

Flange adapters and unions shall be supplied and fitted in the pipework runs wherever necessary to permit the simple disconnection of flanges, valves and equipment without the need to disturb long runs to remove valves, equipment, etc.

The final outlet connection of the pipework shall match the connecting point of the external rising main.

Flanged joints shall be made with 3 mm thick, full face, rubber gaskets, pierced to take the bolts, and the face of all flanges shall be machined to give a true angle of 90° to the centre line of the pipe or fitting.

The whole of the jointing and materials necessary to fix and connect the pipe including adequate and efficient pipe supports shall be included in the Contract.

The hydraulic test pressure applied at the manufacturer's works shall be twice the working head, or one and a half times, the maximum working head, whichever is the greater, unless otherwise specified.

After completion of any fabrication, all pipes shall be hydraulically tested. If any alterations involving additional fabrication are made after dispatch, a further hydraulic test will be required on the pipe or piping assembly concerned.

The Contractor shall be responsible for ensuring that the internal surface of all pipework is thoroughly clean before and during erection and before commissioning. Cleaning shall include removal of all dirt, rust, scale and welding slag due to site welding. Before despatch from the Contractor's works the ends of the pipes, branch pipes, etc. shall be suitably capped and covered to prevent any accumulation of dirt or damage. This protection shall not be removed until immediately prior to connecting adjacent pipes or valves.

All small bore pipes shall be blown through with compressed air before connection is made to instruments and other equipment.

The Contractor shall note the necessity for providing flexibility in the pipework at joints in the main structures to allow for differential settlement and thermal stresses which will not be transferred to the anchor blocks. Flexible joints, collars and cut pipes shall be provided on all pipework where necessary to allow for some margin of error in the building work. The pipework system shall be so designed to ensure that anchorages at blank ends, bends, tees and valves are kept to a minimum. The Contractor shall indicate on his working drawings any thrust blocks that are required to anchor pipework supplied by him.

Steel pipework shall comply with the relevant Standards and all assembling from piping shall be made to this Specification. Steel pipework shall comply with the requirements given in the General Specification for Civil and Building Works.

The type of pipe shall be hot finished seamless steel.

Steel pipework above 80 mm bore shall be either coated externally and security wrapped where laid underground and shall be painted externally when laid above ground or in ducts.

In both cases they shall be internally lined at the manufacturer’s works with either an approved epoxy based or similar lining of not less than 250 microns in thickness or with concrete lining. The internal lining shall be continuous across joints as far as this is practicable according to the size of pipe.

Steel pipework below 80 mm bore, excepting that for conveying oil, shall be galvanised.

Individual sectioning of pipework shall be cut to the correct length and joined with loose flanges. The flange connections shall have welded collars with loose flanges according to DIN 2642 PN 10 (or equivalent harmonized European Standards) and shall have SST material quality (detailed requirements in relevant chapter for Stainless Steel Pipework) Flexible joints shall be bolted gland or detachable flexible coupling as necessary.

The following main standards shall be exemplarily considered, but shall not be limited to:

* ***Steel Pipes***

DIN 2460 Steel water pipes and fittings

EN 805 Water supply - Requirements for systems and components outside buildings

EN 10216 Seamless steel tubes for pressure purposes; technical delivery conditions

EN 10217 Welded steel tubes for pressure purposes; technical delivery conditions

EN 10220 Seamless and welded steel tubes - Dimensions and masses per unit length

EN 10224 Non-alloy steel tubes and fittings for the conveyance of water and other aqueous liquids

EN 10226 Pipe threads where pressure tight joints are made on the threads

EN 10255 Non-Alloy steel tubes suitable for welding and threading

EN 10296 Welded circular steel tubes for mechanical and general engineering purposes

EN 10297 Seamless circular steel tubes for mechanical and general engineering purposes

* ***Fittings***

EN 10253 Welding pipe fittings

DIN EN 12041 Threaded steel pipe fittings

* ***Steel Names and QC standards***

DIN EN 10027 Steel names and numbers

DIN EN 10204 Inspection documents supplied to the purchaser for the delivery of iron and steel products

* ***Material Tests***

DIN EN 10002 Metallic materials; Tensile test

DIN EN 10003 Metallic materials; Brinell hardness test

DIN EN 10004/10109 Metallic materials; Rockwell hardness test

DIN EN 10232-10237 Metallic materials; tube test

* ***Corrosion Protection***

DIN EN-ISO 12944-1 Part 8 Corrosion Protection of Steel

DIN 2880 Cement mortar inside lining for ductile cast iron and steel pipes and fittings, application

DIN 30670 Wrapping of steel pipes, PE

DIN 30675 Outer corrosion protections of buried pipes, steel pipes

DIN EN 10286 Steel tubes and fittings for on and offshore pipelines - External three layer extruded polypropylene based coatings

EN 10287 Steel tubes and fittings for on and offshore pipelines - External fused polyethylene based coatings

EN 10288 Steel tubes and fittings for on and offshore pipelines - External two layer extruded polyethylene based coatings

EN 10928 Cement mortar inside lining for ductile cast iron and steel pipes and fittings, requirements

DIN EN 22063 Metallic and other inorganic coatings: thermal spraying: zinc, aluminium and their alloys

* ***Welding General***

DIN 1910 Welding

DIN EN 287 Approval testing of welders

DIN EN 288 Specification/and Qualification of Welding Procedures for Metallic Materials.

DIN EN 729 Quality Requirements for welding of metallic materials

DIN EN 1011-1 Welding - Recommendations for welding of metallic materials - Part 1: General guidance for arc welding

DIN EN 25817 Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections

DIN EN 29692 Specification for metal-arc welding with covered electrode, gas shielded metal arc-welding and gas welding. Joint preparation for steel

* ***Welding Consumables***

DIN 1913 Welding electrodes

DIN EN 440 welding consumables: wire electrodes and deposits for gas shielded metal arc welding of non-alloy and fine grain steels : classification

DIN EN 499 Welding consumables - covered electrodes for manual metal arc welding of non alloy and fine grain steels - Classification

DIN EN 756-760 Welding consumables

DIN EN 1668 Welding consumables - Rods, wires and deposits for tungsten inert gas welding of non alloy and fine grain steels - Classification

DIN EN 12074 Welding consumables - Quality requirements for manufacture, supply and distribution of consumables for welding and allied processes

DIN EN 12536 Welding consumables - Rods for gas welding of non alloy and creep-resisting steels - Classification

EN 20544 Welding consumables - Technical delivery conditions for welding filler metals - Type of products, dimensions, tolerances and markings

* ***Welding Tests***

DIN EN 895 Destructive tests on welds in metallic materials - Transverse tensile test

DIN EN 910 Destructive tests on welds in metallic materials - Bend tests

DIN EN 970 Non destructive examination of fusion welds: Visual examination

DIN EN 1289 Non destructive examination of welds: Penetrant testing of welds: Acceptance criteria

DIN EN 1290 Non destructive examination of welds: Magnetic particle testing of welds: Method

DIN EN 1291 Non destructive examination of welds: Magnetic particle testing of welds: Acceptance criteria

DIN EN 1435 Non destructive examination of welds: Radiographic examination of welded joints

DIN EN 1711 Non destructive examination of welds: Eddy current examination by complex plane analysis

DIN EN 1712 Non destructive examination of welds: Acceptance criteria for ultrasonic examination of welded joints

DIN EN 1713 Non destructive examination of welds: Characterization of imperfections in welds

DIN EN 1714 Non destructive examination of welds: Ultrasonic examination of welded joints

DIN EN 10246 Non-destructive testing of steel tubes

DIN EN 12517 Non destructive examination of welds: Acceptance criteria for radiographic examination of welds

DIN EN 29302 Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes; electromagnetic testing for verification of hydraulic leak-tightness

DIN EN 29303 Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes; full peripheral ultrasonic testing for the detection of longitudinal imperfections

### Stainless Steel Pipes and Fittings

Stainless steel (SST) pipes shall be of higher anticorosive and weldable quality according to DIN EN and equivalent harmonized European BS standards

All stainless steel pipes and fittings shall be in accordance with already stated general material SST requirements of these ER, unless otherwise stated.

Terms of Delivery in line with DIN EN 10312 and test certificate DIN EN 10204/3.1B.

Edge preparation for welding according to DIN EN ISO 9692-1. Pipe ends to be sealed by PVC caps during transportation. Pipes to have permanent marking, stating EN DIN-Standard and material identification number. Tools and appliances for processing and installation of pipes must be of approved type.

* Pipe Bends

Welded stainless steel pipes to be used for the fabrication of bends. Wall thickness of bends must correspond to those of adjoining pipes. Bends in accordance with DIN EN 10253.

Bending radius R = 1.5\* D. DN 250 and above may have R=D + 100 mm.

* Branch Pipes

Wherever possible, sockets should be used. Tees DN 65 and smaller according to DIN EN 10253.

* Reducer

Reducer to be of concentric type, similar to DIN EN 10253.

* Flange Connections

Generally, flange dimensions have to be as specified for normal steel flange. Flanges, bolts, nuts, washer, etc. must be made of stainless steel in accordance with already stated general material SST requirements of these ER

* Welding Works

Besides adherence to applicable EN DIN-Standards, the guidelines from the supplier of stainless steel with regards to processing must be strictly followed.

Welders employed in welding stainless steel must possess the welding certificate according to DIN EN 287-1 131/135/141.

Quality of execution of welds will be based on DIN EN ISO 5817, Categories B, and C (category B for inside analysis; category C for outside analysis, for gas lines only category B will be accepted). Correct edge preparation and cleanness of weld joints are of great importance.

Great care must be taken to avoid the occurrence of annealing colours. The root weld must be protected by inert gas against ingress of oxygen. Ignition spark spots and weld spatter will not be accepted on material surface. In case the need arises the spots must be removed from the surface by smooth grinding with approved tools or a stainless steel brush.

Areas affected by scale / annealing colours must also be subjected to smooth grinding.

Pickling should be the usual post-treatment of stainless steel surfaces. In case the pickling process is employed, the subsequent flushing of surfaces with clean water is of utmost importance.

* The minimum wall thickness of SST-Pipes:

|  |  |
| --- | --- |
| **Nominal Diameter** | **Wall Thickness** |
| ND 25 - 32 | 2.0 mm |
| ND 40 - 200 | 2.0 mm |
| ND 250 - 350 | 2.5 mm |
| ND 400 - 600 | 3.0 mm |

For all kind of stainless steel pipe works the following standards shall be applied:

DIN EN 439 Shielding gases for welding of stainless steel components

DIN EN 1127 Stainless steel pipes: dimensions and masses per unit length

DIN EN 1600 Electrodes from stainless wire suitable for submerged arc welding stainless steels

BS EN 3506 Mechanical characteristics of jointing elements: screws, nuts, setscrews

DIN EN 10027 Steel names and numbers

DIN 2462/2391 Seamless stainless steel pipes

DIN 2463 Welded stainless steel pipes

DIN 8556 Electrodes from stainless wire suitable for submerged arc welding stainless steels

DIN 17455 Welded stainless steel pipes technical conditions

DIN 17456 Seamless stainless steel pipes Technical conditions

The tolerances on thickness and on masses shall not exceed the tolerances given in DIN EN 1127.

### Mild Steel Pipework

Steel (ST) pipework below and equal 200 mm shall be of the hot finished seamless steel type according to DIN 2448/DIN 1629 sheet 3 or equivalent harmonized European Standards.

All pipe assemblies shall be from piping to these requirements

The overall dimensions and minimum wall thickness of ST-Pipes:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Nominal Diameter** | **Outside Diameter** | | Wall Thickness | |
| ND 25 | 33.7 mm | x | | 2.6 mm |
| ND 32 | 42.4 mm | x | | 2.6 mm |
| ND 40 | 48.3 mm | x | | 2.6 mm |
| ND 50 | 60.3 mm | x | | 2.9 mm |
| ND 65 | 76.1 mm | x | | 2.9 mm |
| ND 80 | 88.9 mm | x | | 3.2 mm |
| ND 100 | 114.3 mm | x | | 3.6 mm |
| ND 150 | 168.3 mm | x | | 4.0 mm |
| ND 200 | 219.1 mm | x | | 6.3 mm |

Steel pipework above or equal 250 mm shall be of the welded steel tubing type and shall be according to DIN 2458/DIN 1626 sheet 3 or equivalent harmonized European Standards.

All pipe assemblies shall be made up from piping to these requirements.

The overall dimensions and minimum wall thickness of ST-Pipes:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Nominal Diameter** | **Outside Diameter** | | Wall Thickness | |
| ND 250 | 273.0 mm | x | | 5.0 mm |
| ND 300 | 323.9 mm | x | | 5.6 mm |
| ND 400 | 406.4 mm | x | | 6.3 mm |
| ND 500 | 508.0 mm | x | | 6.3 mm |
| ND 600 | 609.6 mm | x | | 7.1 mm |
| ND 700 | 711.2 mm | x | | 7.1 mm |
| ND 800 | 812.8 mm | x | | 8.0 mm |
| ND 900 | 914.4 mm | x | | 10.0 mm |
| ND 1000 | 1016.0 mm | x | | 10.0 mm |

The individual sections of pipework shall be pre-fabricated in required lengths.

Connections shall be pre-welded according to DIN 2632/2633 min. NP 10-16 or equivalent harmonized European Standards, unless required with special connections.

Connections to be jointed at site shall be made by pre-welded flanges, unless otherwise required.

### Galvanized Steel Pipes

Galvanised steel pipes shall be hot galvanised according to the relevant EN-ISO Standards, i.e. DIN EN 10240 (Galvanizing of steel pipes) and in accordance to these TR.

Galvanized steel pipes and fittings shall be supplied with either flanged ends or with threaded ends.

### Cooper Pipes and Fittings

Copper tubing and fittings for domestic water services shall be light gauge copper tubing and shall conform to the relevant EN-ISO or DIN Standards.

The fittings shall be compression type fittings approved by The Engineer.

Pipes shall be fixed clear of walls or soffits with cast brass brackets at no more than 1.5 metre centres.

## Plastic Pipework

### uPVC Pipes

Unplasticised PVC pipe (uPVC) shall only be used for water and drainage purposes with the express approval of The Engineer and shall comply with the relevant EN-ISO or DIN Standards and test methods, i.e. DIN 1187, AS 24391, or ASTM D 2729-86.

PVC pipes shall have mechanical joints of a type suitable for the liquid to be carried by the pipework. Small-bore pipework shall be jointed with PVC “hand tight” screwed fittings of standard manufacture.

Adhesives for cold solvent welding of pipes and their elements for pipes shall comply with DIN 16970 or equivalent. PVC pipes shall be capable of withstanding ultraviolet degradation.

A rodent inhibitor shall be incorporated in the material of the pipe.

The Contractor shall advise the manufacturer of the climatic and transporting conditions at the site of the Works and shall seek his advice on the storage of PVC materials on site. Subject to The Engineer’s approval this advice shall be followed at all times.

Except in the case of flanged joints and where otherwise specified or approved by The Engineer pipe joints shall be flexible and sealed with a rubber ring or gasket to the approval of The Engineer and shall withstand the various tests specified in the applicable standards.

For pipes with a nominal bore of 600 mm or less the joints shall be capable of withstanding a deflection of not less than 1.5 degrees in any direction and for pipes with a nominal bore of more than 600 mm 0.5 degrees in any direction.

All pipes shall be capable of withstanding a ”draw” of 13 mm over and above the initial jointing allowance. The initial jointing allowance is the gap measured parallel to the centre line of the pipeline and shall not be less than 6 mm or more than 13 mm or as otherwise recommended by the pipe manufacturer and approved by The Engineer.

Pipes and fittings shall be indelibly marked prior to laying to indicate the correct initial jointing allowance.

### ABS Pipes

ABS (Acrylonitrile butadiene styrene) is an extremely robust thermoplastic pipework system resistant to impact with good resistance to chemicals. As non-toxic it is used by many industries in systems for food and beverage production, drain-waste-vent pipe systems and sewer systems, water treatment etc. It is also used as [electrical](http://www.diffen.com/difference/Category:Electrical) insulation.

ABS is approved by the International Water Research Advisory Scheme for use with potable water. Conforming to the toxicological requirements in Code of Practice for Food Usage, and EEC requiremtns for plastic materials in contact with foodstuffs. These systems are light, strong and simple to fit using a solvent cement.

ABS piping has a higher impact strength than PVC, especially at lower temperatures. However, ABS can deform under sun exposure. Both plastics are resistant to chemical and water degradation also used in pipes because they are non-toxic and resistant to abrasion. PVC and ABS pipes are resistant to most acids, alkalis and salts. However, they are not resistant to aromatic and chlorinated hydrocarbons . ABS has good resistance to a wide range of diluted inorganic acids, organic acids, salts, animal fats and oils.  ABS is not resistant to organic solvents, alcohol, petrol, acetic acid or vegetable oils.

ABS pipes are easier to install compared to PVC pipes ( PVC pipes need a purple primer before each joint is glued together, and the joints must then be held together for 5 to 10 seconds for the glue to take hold)

Both types of piping can be used above or below the ground, but ABS is more likely to deform when exposed to the sun. Because of this, some local regulations require ABS pipes to contain pigments to protect it from UV radiation or to be painted with [latex paint](http://www.diffen.com/difference/Latex_Paint_vs_Oil_Based_Paint).

Pressure ratings for plastic pipework systems are always quoted at 20°C, it is a fundamental principle of such systems that if the temperature is increased then the pressure rating must be reduced. ABS systems should never be used for temperatures in excess of 70°C. The following chart gives a rough guide as to the temperature/pressure relationship of ABS pipework systems.

In above ground installations it is essential to provide support to ensure that the weight of the pipe and its contents are adequately supported. Pipes operating at higher temperatures up to 70°C must be continuously supported.The following recommended maximum spacings are for ABS pipes operating under the following conditions:

* Fluid density of not more than 1g/cm cubed
* PN15 pipe
* Horizontal pipe runs (For vertical pipe runs spacing should be increased by 50%.)

ABS pipework shall only be used upon the written instructions of The Engineer.

Where permission has been granted, ABS pipes, fittings and valves (which shall be of the diaphragm type) shall be in accordance with BS, DIN or harmonized European norms and shall be supported in accordance with at least the minimum requirements of the manufacturer.

ABS pipework shall in all instances be left in natural light grey colour.

### HDPE Pipes

High Density Polyethylene (HDPE) Pipes and fittings pipes shall comply with listed standards or equivalent harmonized European Standards.

DIN 8074 PE HD pressure pipes, dimensions

DIN 8075 PE HD pressure pipes, dimensions

DIN 19533 PE HD/LD pressure pipes for water supply, requirements

DIN 19537 PE HD/LD non-pressure pipes and fittings

DIN 16963 PE HD fittings

DVGW W 330 German Association for Gas and Water: Guideline “Approval testing of welders”

EN 1519 PE HD/LD plastics piping systems for soil and waste discharge (low and high temperature) within the building structure

EN 1555 PE HD/LD Gas pipe systems

EN 12201 PE HD/LD non-pressure pipes for water supply

EN 12318 PE-X plastics piping systems for hot and cold water

EN 12666 PE HD/LD non-pressure pipes for wastewater

EN 13244 PE HD/LD pressure pipes

The pipes shall be manufactured from high-density polyethylene containing only those antioxidants, UV stabilisers and pigments necessary for the manufacture of potable water black pipes. The Contractor shall provide an approved third party certi­fi­cate to verify the above.

The pipes shall be designed for a nominal working pressure class PN 16, have a hydrostatic design stress of 50 kg/cm² at 20 °C and be jointed with push fit couplings. The couplings and fittings shall be designed for a nominal working pressure of 16 bars and a temperature of 40°C and shall fit the HDPE pipes

The minimum diameter of the rollers for coiled pipe should be such that kinking of the pipe is prevented. The mini­mum internal diameter of the rollers shall not be less than 24 times the nominal out­side diameter of the pipe. The ends of the pipe shall be plugged or covered.

Mechanical couplings and fittings shall be used. The mechanical joints shall be push-on types. They shall be produced in acetal-homo-polymer or be combined with gun­metal adapters. The joints have to provide the system with strength in tension and water tightness. Push fit jointing type shall consist of a PVC grip ring and nitrite elastomers or equivalent O- ring.

### GRP Pipes

Pipes and fittings made of glass fibre reinforced polyester resin, centrifugally cast, aggregate filled shall comply with listed standards or equivalent harmonized European Standards.

DIN 19565 - 1 GRP-Pipes; Dimensions, Technical Delivery Conditions

DIN 19565 - 2 GRP-Pipes; Dimensions, Quality Standards

DIN 16868 Glass Fiber-Reinforced Polyester Resin Pipes

BS 5480 Pipes and Fittings for Water and Sewage

GRP pipes shall have stiffness of 10,000, .

GRP pipes and fittings shall be applied after formal approval from the Engineer and the Beneficiary, only.

### Cable Conduits

The pipe material for Cable conduits shall be PVC, suitable for retraction of control cables. The work Cable conduits includes supply of pipe material diameter not less than 63 mm, pipe laying and laying of plastic ropes 5 mm in the cable conduits, end caps and all additional work for connecting to cable shafts.

The quantity of pipes in place shall be measured as linear meters run along the centreline of the cable conduits between neighbouring cable manholes without deduction for fittings. Every type of fittings shall be deemed to be included in the unit rates of the pipe laid.

Cable shaft shall be made of precast concrete elements with entries for PVC pipes. Covers shall be suitable for single load of 10 tons.

## Flange Connections and Joints

### Flanges

Wherever pipes and fittings are connected by flanges, the following standards or equal European Standards, shall apply:

DIN 2527 Blind flanges, nominal pressures 6 to 100

DIN EN 2561 Oval screwed flanges, nominal pressures 10 and 16

DIN 2566 Screwed flanges, nominal pressures 10 and 16

DIN 2627-2638 Welding neck flanges

DIN 2641/42 Lapped flanges

DIN 2655/56 Lapped flanges, plain collars

DIN 2690-92 Sealing for flanges with plain contact surfaces

DIN 2693 Sealing rings for flanges with groove, nominal pressure 10 to 40

EN 1514 Flat packing, dimensions

EN 1591 Flat packing, specific values

The dimensions of bolts, nuts, and washers shall be in accordance with the flange dimensions.

Bolts, nuts and washers and other demountable fastenings of all galvanized parts and also aluminium alloy parts shall be in stainless steel to the appropriate standard. PTFE washers shall be fitted beneath bolt-head and washer when fastening galvanized and aluminium alloy parts.

Fastenings, except high tensile, of all ferrous parts shall be steel prepared and galvanized to or sherardized to the relevant standards, primed and painted in accordance with location.

All bolts, nuts and washers used in the jointing at flanged valves shall be of stainless steel in accordance with already stated general material SST requirements of these TR, chapter 5.14

Unless specifically approved and required for superior protection, electro-galvanizing, nickel, cadmium or any other plating process, except chromium plating, will not be acceptable, and shall not be offered.

### Joints

Pipe joints shall be completed in accordance to the pipe manufacturers recommendations after submittal of adequate Method Statements and approval of The Engineer, only.

All joints shall be accurately made and shall be capable of passing tests for individual joints and for the completed pipeline as may be specified hereafter.

### Bolted Gland Joints

Jointing of spun (asbestos cement) and cast iron spigot and socket pipe with bolted gland flexible joints shall be completed in accordance to the pipe manufacturers recommendations. In particular the Contractor shall ensure that after spigot has been centred in the socket the lead-tipped rubber ring is pressed into its seating between the socket and spigot and evenly tapped with a wide faced caulking before the gland is drawn up into position. All nuts shall first be tightened by hand and nuts on opposite sides of the joint circumference shall then be alternately and progressively tightened with a spanner so as to ensure even pressure all round the joint.

### “Push-in-Type” Joints

Jointing of cast iron spigot and socket pipes with “push-in-type” flexible joints shall be completed in accordance to the pipe manufacturers’ recommendations. In particular, the Contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, that the rubber ring is correctly positioned in the socket and that the two pipes are accurately in line, before the joint is made. After the joint has been made the Contractor shall ensure by the use of a suitable feeler gauge that the rubber ring is evenly seated in its correct final position. The rubber rings and any recommended lubricant should be obtained only through the pipe suppliers.

### Flanged Joints

Jointing of spun and cast iron pipes and specials, for steel pipes, and for valves by flanges shall be completed with rubber joint rings and steel bolts and nuts, which include two washers per bolt, unless, specified otherwise.

Joint rings shall be made from 3 mm thick rubber reinforced with fabric and of such width as to cover the machined face of the joint inside the boltholes. They shall be of such physical properties as to be capable of forming permanent watertight joints against pressures up to the maximum test pressure. The use of jointing paste or grease will not be permitted. The ring may be fastened to the bolts with cotton thread. The bores of abutting pipes or fittings shall be concentric and no jointing material is to be left protruding into the bore.

All nuts shall first be tightened by hand and nuts on opposite sides of the joint circumference shall then be alternately and progressively tightened with a spanner so as to ensure even pressure all round the joint.

### Welded Joints

Welded joints in steel pipes shall be butt-welded, carried out manually by the metal-arc process.

Only welders approved by The Engineer shall carry out welding. All bends, tees and other specials shall be prefabricated by the pipe supplier.

All parts to be welded shall have loose scale; paint and other foreign matter removed by means of a wire brush and shall be left clean and dry. All scale and slag shall be removed from each weld run when it is completed. Pipes manufactured with longitudinal or spiral welds shall be lined up before jointing so that these welds are at least 15° apart around the joint circumference.

## Fittings, Valves and Accessories

### General

The nominal working pressure of valves, fittings and accessories shall be 1.0 or 1.6 bar (Mpa). All valves, dismantling pieces, flexible couplings connections to pipes shall be flanged supplied with bolts, gaskets, etc.

Surface boxes, covers and other accessories shall be supplied for all valves and fittings for which manholes with access opening are not foreseen. Access openings shall be positioned directly above the valves, fittings or accessories to allow dismantling with lifting facilities.

### Tees and Wyes

Tees, crosses, couplings, Y-bends or other fittings that provide means of dividing or uniting flow in pipelines shall be factory made and shall comply with the respective standards. These fittings may be connected to pipes by welding.

For connection of all kind of valves welding neck flanges shall be applied if the nominal diameter of the pipe is greater or equal 150 mm.

Tees and wyes shall be reinforced by wrappers or collars. The design shall in all cases be submitted to The Engineer for approval.

### Bends

The pipeline shall be laid in such a way that it follows the outline of the terrain as closely as possible except where otherwise indicated on the drawings.

Changes of direction or gradient shall be made with bends, produced by the Contractor in accordance with the drawings, plans and the longitudinal sections.

Bends shall be made with R= 1.5 - 3 x D.

### Dismantling Joints

All valves, fittings and accessories etc. shall be easily accessible for disassembly and reassembly. Valves, fittings and accessories etc. shall be mounted with dismantling joints or adjustable and removable joints (dismantling pieces) of an approved manufacture to permit the dismantling of the valve, fittings and accessories

### Fllexible Couplings

Jointing of plain-ended cast iron or steel pipes with flexible detachable couplings shall be completed in accordance to the coupling manufacturers recommendations. In particular the Contractor shall render the end of each pipe smooth so as to allow the joint sleeve to slide freely and where necessary shall re-coat the pipe ends with two coats of quick drying bituminous solution

### Anchoring Sleeves

Anchoring sleeves shall be used whenever a ductile cast iron; steel or plastic pipe shall pass through a concrete wall of water or sludge retaining tanks.

Sleeves shall be of stainless steel grade in accordance with already stated general material SST requirements of these TR, unless othervise required

Sleeves shall be sealed on one or two sides with permanently elastic EPDM gasket elements. Seals between pipes and conduits shall be made of seal belts expanded when wrenched tightened to fill the gap and create the seal. The seal belt shall consist of EPDM reinforced with stainless steel bolts to be tightened with stainless steel nuts all in accordance with already stated general material SST requirements of these TR

# Valves, Penstocks and Actuators

## Standards

This section of the specification sets out the general requirements for standard valves, penstocks, handstops, headstocks, actuators etc., required for the works.

Specifications are to be considered for both civil and mechanical applications.

All valves and penstocks shall be the best water works quality and suitable for use in water or wastewater works (as appropriate) at all temperatures up to 45°C.

All valves shall be flanged and in accordance with the required standard test pressure. The face-to-face dimensions of all flanged valves shall comply with standards and shall satisfy the requirements stated in these standards as follows :

* Certification with EN ISO 9001/2000 TÜV approval, conformity to EN 1074-1.
* Flanged butterly valves and gate valves according to EN 1074-2 ( or DIN 2501)
* Air valves according to EN 1074-4.
* Check valves according to EN 1074-3
* Control valves according to EN 1074-5
* Every valve is pressure tested in factory according to EN 12266 ( or DIN 2630 )
* The flanges of the above mentioned products conform to EN 1092-2 standard for cast ductile iron
* ductile iron characteristics conform to EN 1563
* Face-to-face length according to EN 558 ( or DIN 3202 part 1)
* Rubber gaskets used in valves production-assembling parts for leakage tightness can be used for potable water, where required
* Epoxy coatings are certified to be used in contact with potable water, where required

All materials shall comply with the appropriate EN-ISO Standards and shall be subject to The Engineers approval.

All castings shall be free of blowholes and other defects. Extended spindles and headstocks shall be provided where necessary and shall be provided in stainless steel ( SST) in accordance with already stated general material SST requirements of these TR, unless otherwise specified.

Each valve or penstock gate or its operating equipment shall bear an approved nameplate stating its function in English and the local (project country) language..

## Valves

### General

Unless stated otherwise in this Specification, the valves shall satisfy the following minimum requirements:

1. The number of different types and makes of valves used shall be kept toa minimum. All valves of the same size, duty and type supplied under the Contract shall be identical.
2. Valves shall be designed and manufactured in accordance with the suitable ISO, EN or other international standards and latest editions of relevant Water Industry Standards, Codes and Water Product Specifications, subject to ( Engineer) acceptance.
3. All parts of valves shall be suitable for the design and maximum (emergency) flows, pressures and temperatures and other duty conditions.
4. The Contractor shall select valve materials best suited for the service conditions and resistant to corrosion.
5. The Contractor shall select materials to ensure that the galvanic potential between adjacent parts does not exceed 0.3 Volts. Where necessary parts shall be electrically insulated from each other to achieve this requirement. Stainless steel of grade 303, 416, or other “free machining”grades shall not be used.
6. Unless specified otherwise, all valve flanges shall be circular and conformin dimension and drilling to standard. Where flange sizes and pressure class exceed standard, valve flanges shall conform to other relevant standard codes. Flanges shall be either raised or flat face type and faced parallel and square by machining. The backs of all flanges shall bemachined or spot faced to provide a satisfactory bearing for bolt headsand nuts.
7. All valves shall have proven record of reliable operation in intended environment. Spare parts shall be readily available.
8. Valves shall be of standard and proven design to give optimum performance in meeting the specified operating conditions.
9. Unless specified otherwise, all actuated valves shall be fitted with suitable manual operating elements, such as hand wheels or handles. Loss of power or failure of the actuator shall not prevent manual operation of the valve.
10. All valves shall be supplied with spindle caps. Spindle caps and keys for valve operation shall be designed in accordance with the relevant Standards.
11. The manual operating elements, such as hand wheels or handles on all isolating and control valves DN80 and larger shall close the valve in an anti-clockwise direction. The direction to turn the valve open and close shall be indicated on the valve manual operating elements or stainless steel plates fitted on or adjacent to the valve.
12. The hand wheel diameter shall not exceed 600mm.
13. All isolating valves shall be capable of opening and closing against full unbalanced head and maximum flow and shall open and close smoothly without damage to any components.
14. Unless specified otherwise, all isolating and control valves shall be fitted with non-rising spindles.
15. All manually operated valves shall open and close with a maximum torque of no more than 100Nm and a maximum force of no more than160N applied on the operating element to overcome their normal running torque, based on the maximum differential pressure, maximum flow and orientation of the valve.
16. The “cracking” torques and forces of manually operated valves required to be applied for approximately ½ to 1 turn to off-seat or on-seat the valve under maximum differential head conditions shall not be higher than as stated by the Contractor and agreed to by the ( Engineer)
17. All isolating valves shall be bi-directional, ie capable of operation with flow in both directions and pressure on either side of valve.
18. The size, shape, strength and rating of all valve parts shall be sufficient to provide an ample factor of safety under all working conditions, taking into account corrosion and wear.
19. Valve castings shall be sound and clean. Structural defects in ductile or cast iron valve components shall not be repaired and used in valvea ssembly. No welding is permitted on cast components.
20. Drainage holes shall be drilled or formed in any external pockets on the valve body or associated equipment, when necessary, to prevent moisture ponding.
21. Valves DN80 and larger shall be supplied with support feet or include lugs to allow for the mounting of feet and attachment of anchor bolts.
22. All internal and external fasteners shall be made of stainlesssteel and shall have standard ISO thread. This includes flange fasteners on integral bypasses etc. All stainless steel bolt threads shall be coated with anti-seize lubricant.
23. All valve parts requiring grease lubricating (eg gearboxes) shall be fitted with grease nipples.
24. The valve leakage rates shall not exceed that specified in the relevant standard and this Specification.
25. Valve assemblies exceeding 25kg shall be provided with adequate lifting attachments. The lifting attachments shall be designed to withstand the total assembled mass of the valve, including the gearbox and actuator, if supplied. Where eyebolts are provided they shall comply with standard
26. The valve internal surfaces shall be devoid of sharp protrusions which may initiate secondary cavitation at high velocities.
27. All valve materials, coatings, lubricants etc for drinking water application shall comply with standard
28. Isolating and control valves may be electrically, hydraulically or pneumatically actuated or operated by portable actuators, as specified.
29. Where specified valves and penstocks shall be power operated by electric or pneumatic actuators, each actuator shall have local manual ‘override’ device. No alternative systems shall be subsequently offered.
30. Penstock gates and valves of 50 mm nominal bore and over shall be fitted with mechanical position indicators to show the amount that the valve or penstock gate is open or closed in relation to its full travel.
31. All valves fitted with electric actuators shall include position transmitters and torque and limit switches. All pneumatically actuated valves shall have limit switches and manual override. Where specified, manually operated valves shall also be fitted with limit switches and torque limiting devices. The position transmitters and limit switches shall comply with this Specification and the Specification for Electrical Works.
32. For valves fitted with pneumatic, electric or hydraulic actuators the gearbox and all valve components shall be designed to withstand the maximum rated torque capacity of the actuator plus 20%.
33. Unless stated otherwise, all isolating valves DN400 or larger up to PN16 and DN300 or larger for PN21 and above shall be fitted with bypass arrangements, which may be integral with the valve or external. The bypass arrangements and sizes shall comply with the requirements in relevant standard and be of Subject to ( Engineer) acceptance; reduced size integral bypasses may be used on smaller valves where the specified size fittings cannot be accommodated on valve body castings.
34. Manually operated gate, butterfly and knife gate valves larger than DN300 or valves which require more than 100 turns from fully closed to fully open position shall have an adapter on the valve spindle for use of a portable electric actuator. This spindle needs to be in the vertical position.
35. Unless specified otherwise; all standard valves shall have flanged joints of pressure rating PN16 and shall be to a class in excess of the maximum pressure they will attain in service including any surge pressures, but all valves shall be tested to stand a working pressure of 1.5 working pressure of pipeline or 6 bars, which is greater.
36. Valves shall be capable of withstanding the same test pressures as the pipe on which they operate. All nuts and studs subject to vibration shall be fitted with spring washers of locking taps.
37. Gate valves shall be provided with renewable seats and it shall be possible to remove the gates without removing the valve body from the pipework. Penstock gates shall be provided with renewable sealing faces. Sluice valves and butterfly valves shall be suitable for flow in either direction. Gate face rings shall be screwed into the gate or alternatively securely pegged over the full circumference.
38. Butterfly valves shall be installed in the pipework in such a manner that they can easily be removed from the line for dismantling and replacement of the seats, designed to give minimum leakage, unless otherwise specified.
39. Non-return valves on the main pump delivery branches shall possess high speed closing characteristics, with minimum shock on closing.
40. Packed glands shall be arranged for easy replacement of the packing, which shall be accessible without removal of the valve from the pipe. Precautions shall be taken to prevent corrosion of the valve spindles in contact with the gland packing.
41. Valves, cocks and operating spindles that are applied for submerged operation, shall be independent of external lubrication.

Notes:

1. The term ‘isolation valve’ defines a valve (such as gate, butterfly, knife edged gate, plug, globe, ball, diaphragm etc) that is in the normally fully open or fully closed position. Isolation valves are not used to control flow or pressure. They may occasionally be opened or closed under full unbalanced head or flow conditions.
2. The term ‘control valve’ defines a valve (such as butterfly, needle, plug,globe, ball, diaphragm etc) that may operate in a partially open or closed position to control flow or pressure.

**Marking**

Unless specified otherwise in the relevant standards, as a minimum the following lettering shall be cast on the body of each valve equal to or greater than DN80:

* Manufacturer's name or mark
* Nominal size (DN)
* Year of manufacture
* Pressure class (PN)
* Body material designation
* Standard to which manufactured
* Serial number
* Gear ratio (if applicable)
* An arrow denoting the preferred flow direction (if applicable)
* Arrows on the face of each operating element with the words OPEN and CLOSE (if applicable)
* Valve mass

All lettering shall be in legible block type letters projecting not less than 3mm. The lettering shall be as large as practicable but not less than 6mm high for sizes DN 80 to DN 150, 10mm high for DN 200 to DN 300, 20mm high for DN 350 to DN 600 and 25mm high for DN 700 and above.

### Spindle Operation

Unless otherwise specified, all valves shall be located and orientated in readily accessible positions with handwheels conveniently arranged for ease of operation.

Manual operation of valves shall be clockwise. The operating gear of valves and penstock gates shall consider a maximum torque of 13 Nm and a maximum force of 25 N.

Where this requirement is impracticable or would lead to under complications, operating spindles shall be taken vertically to headstocks for manual operation.

Chain operated wheels shall not be incorporated in the arrangements. Knuckling of spindle extensions and remote operation through mitre-geared linkages shall be avoided.

Tee-key operation of valves and penstocks shall only be adopted in unavoidable situations or for secondary and only occasionally used purposes such as underground main valve bypasses, air valve isolation, and minor drainage valves. Where so provided, the spindles shall be fitted with a cast iron detachable cap manufactured to and of identical shape to the valve spindle caps.

Operating and extension spindles shall be provided with suitable bearings that are rigidly held on brackets or stays. Bearings and spindles shall be suitably protected against corrosion, spindles shall be provided in stainless steel.

Headstocks shall be designed over at least:

1. All external main low isolating and flow control valves;
2. All external sludge and waste water valves;
3. All weir and sluice penstocks;
4. Other works valves and penstocks such as main tank feeds sludge draw off valves, tank bypasses, reservoirs, scours etc. within the scope of design.

Headstocks shall be purpose made pedestal units. Extension spindle operation by direct handwheel attachment shall not be adopted unless so specified.

### Handwheels

Operating handwheels for gate valves and penstocks shall be cast iron to EN, ISO Standards pattern, materials specification and finishes set out.

All handwheels on valves over 50 mm diameter shall be fitted with a circular inscribed brass disc with an arrow indicating English and local ( Project country) language.. Plates on handwheels for valves over 150 mm diameter shall in addition, have a simple bilingual inscription denoting the function e.g., “Inlet”.

External handwheels shall be fitted with proprietary integral locking device to prevent operation by unauthorised persons. A padlock and chain will not be acceptable

## Sluice Gates

Should be of compact design, easy and quick for installation with only few anchors, iInstantly ready for operation, self-sustaining frame design, no recess work required. Completely rubber coated gaskets for sealing of circular orifices; gaskets should be replaceable without dismantling of frame nor gate. Minimised opening and closing forces due to PTFE sliding surfaces

All sluice gates shall be leak-proof on both sides up to 6 m (19.6 ft) WC following DIN 3230, Part 3, table 5, BN, leakage rate 2, German standard for drinking or following EN 12266-2, Tab.A5

All sluice gates shall be of stainless steel of higher corrosion resistance in accordance to DIN 17007 or equivalent harmonized European Standards. The frame of the support of the drive mechanism shall be provided also in stainless steel :

* All parts of stainless steel in accordance with already stated general material SST requirements of these ER
* Driving parts of stainless steel / bronze, waste water resistant ( Spindles, spindle extensions and handwheels shall be the same as for penstocks)
* All parts of stainless steel bath pickled and passivated
* Stainless steel sluice gates shall be provided with rubber sealing faces of high synthetic rubber ( Gasket of EPDM, waste water resistant,optional of NBR)
* All anchor bolts, assembly bolts and nuts shall be of ample section to safely withstand the forces created by operation of the gate. Quantity and size of the anchor bolts shall be of stainless steel type 1.4571 to DIN 267 or equivalent harmonized European Standards.

## Sluice Valves

Sluice gate valves shall be of the double-flanged ductile iron wedge-gate type unless otherwise specified.

Valve spindles shall be generally of the internal non-rising type. Valve stems shall be of forged aluminium bronze, machined all over with a machine cut robust trapezoidal or square form thread, operating in a gunmetal nut.

They shall have renewable non-ferrous faces on body and wedge and a bolt-on bonnet to facilitate gate removal. Stem seals shall be of the stuffing box and gland form arranged for easy replacement of packing and shall be accessible for maintenance without removal of the valve from service.

Extension spindles, headstocks and foot brackets shall be provided where necessary. Extended spindle installations shall include all necessary brackets, intermediate supports etc. Headstocks for non-rising spindle installations shall incorporate a valve position indicator.

All handwheels, headstocks, foot brackets and guide brackets shall be of cast iron. Fixing nuts and bolts supplied by the manufacturer shall comply with the appropriate specifications and standards. Those subject to vibration shall be fitted with spring washers or locking tabs.

All valves shall be works tested hydraulically to pressures of 25 bar, and be suitable for working at pressures of 16 bar. All valves shall be prepared and painted in accordance with the General Specification, Painting and Protective Coatings.

All sluice valves shall be subjected to works test and the manufacturer shall issue test certificates to this effect.

## Gate Valves

Gate valves shall be of the flat-bodied type, double flanged, with cast iron bodies, and shall comply with the requirements of DIN 3352 or equivalent harmonized European Standards. They shall be of the inside screw non-rising stem type. The direction of closing shall be clockwise.

All Gate valves over 500 mm bore (300 mm if power actuated) shall be provided with jacking, and valves over 350 mm bore shall be provided with feet when mounted with spindle in the vertical plane.

Valve stems shall be forged aluminium bronze machined all over and have a strong trapezoidal or square formed thread, operating in a gunmetal nut. Stems in chromium steel (material no.1.4021) will also be permitted.

Stems shall be sealed with two O-rings, arranged for easy replacement of the packing and shall be accessible for maintenance without removal of the valve from the pipeline.

All valves shall be supplied with either hand wheels or extension spindle sockets. Extension spindle sockets shall be drilled and each provided with a nut and bolt for sealing of the stem, which shall also be drilled.

Extended spindle installation shall include all necessary brackets; intermediate supports etc. and provisions shall be made for adequate lubrication.

Handwheels shall have smooth rims and have a diameter to enable two men to operate the valve. The direction of opening and closing shall be clearly marked on the hand wheel.

## Slide Valves

Slide valves shall be of the lightweight pattern type with cast iron body, with stainless steel slide, or a slide of meehanite-grey-cast iron-25 fully covered with rubber, chromium steel outside rising screw spindle and non-rising handle. Length shall be according to DIN 3202, Part 3, boreholes shall be according to DIN 2501, or equivalent harmonized European Standards.

The valve body shall incorporate a transverse slide seal so arranged for easy replacement of the packing, which shall be accessible without removal of the valve from the pipeline.

Handwheels shall have smooth rims and have a diameter to enable two men to operate the valve. The direction of opening and closing shall be cast on the hand wheel. The direction of closing shall be clockwise

## Quick Opening Valves

Quick opening valves shall be of the lightweight pattern type with cast iron body, stainless steel slide, and chromium steel outside rising smooth spindle. Length shall be according to DIN 3202 and the boreholes according to DIN 2501, or equivalent harmonized European Standards.

Where extension spindles are necessary all installation materials including all necessary brackets, intermediate supports etc. shall be provided.

Opening and closing devices for manual control shall be designed so that one man can operate the valve

## Reflux Valves

Reflux valves shall be double flanged cast iron unless otherwise specified. They shall be of the quick acting non-slam single or multi door type designed to minimise slam on closure by means of heavy gunmetal faced doors weighted as necessary and with stainless steel hinge pins. The valves shall be fitted with renewable door sealing faces that shall be positively fixed.

The flaps and external weight shall be positively and securely fixed (grub screws, pins or clamps are not acceptable). All internal fixing devices shall be of stainless steel.

All reflux valves shall be suitable for operating in the horizontal plane unless otherwise specified.

The design of the valve body shall be such that there is adequate clearance around and at the back of the door the minimise jamming by rags etc. Stops shall be provided to limit the back lift of the door and in such a position to prevent fouling by rags.

Covers shall be provided to allow ample access for cleaning and service and shall be supplied complete with tapped bosses fitted with Air release cocks.

Valves shall carry identification marks and/or plates in accordance with the relevant EN-ISO Standards.and as specified in these TR

All nuts and studs subject to vibration shall be fitted with spring washers or locking tabs.

All valves shall be prepared and painted in accordance with the general Specification, Painting and Protective Coating.

## Butterfly Valves

Butterfly valves up to and including 2,000 mm nominal diameter shall conform to BS or equivalent EN, ISO Standards for NP 16 (i.e.16 bar) pressure rating. If butterfly valves are required for pressure ratings above 16 bar or for sizes above 2000 mm nominal diameter, they shall also comply with the all materials and other relevant provisions of the standards.

Except where otherwise specified, all butterfly valves shall be resilient seated and shall give tight closure against unbalanced water pressure in either direction. The unbalanced water pressure shall be the design pressure rating of the valve.

The valve seat shall be replaceable and be formed of rubber or other approved resilient and durable material. The valve seat shall be securely clamped into a machined groove in the valve body or to the edge of the disc by seat retention members, or other equivalent retention device, in such a manner as to prevent leakage of water under the seats and to hold the seat securely in position during opening and closing of the valve disc.

The seat retention members shall be of stainless steel shall be securely fastened to the body or disc with stainless steel fasteners.

Disc edges shall be machined with rounded corners and shall be polished to a smooth finish. The valve disc shall rotate through an angle of 90 degrees from the fully opened to the fully closed position and the seat shall be of such design as to allow the valve disc to seat at an angle normal to the axis of the pipe when the disc is in the fully closed position.

Adjustable mechanical stop shall be provided in the valve body to present over-travel of the valve disc in both the open and closed positions. These stops shall be capable of absorbing full operating torque with a minimum design safety factor of five.

Butterfly valve spindles shall be horizontal when mounted.

The valve shaft shall be fabricated of stainless steel and may be in one piece or attached as two stub ends on opposite sides of the disc. The means of the attachment of the shaft to the disc shall be using fixings in a homogenous corrosion-resistant material of a pattern which precludes the assembly becoming loose in operational service. Grub screws, pins (parallel or taper) or clamps will not be acceptable. The shaft and disc fixing shall be capable of absorbing the full operating torque with a minimum design safety factor of five. Shaft seals, when used, shall be rubber 0-ring type. Packing shall be either rubber 0-ring or self adjusting chevron type.

When all the seat retention members are in place, the finished edges shall fit closely and the surface shall be smooth with all fastenings set flush in the water passage so as to offer the least resistance possible to the flow of water through the valve.

Valve seats which extend over the face of the flanges to secure the seat in place, or which require surface grinding and/or hand fitting of the disc; or designs which require the adjoining pipe flange to retain the seat in place and resist line pressure, will not be acceptable.

Operating gear for butterfly valves shall be of the fully enclosed type. Valves shall be suitable for operation by one man at all pressure conditions that can apply. A valve position indicator shall be provided. Where a handwheel is used for operating the valve, the indicator shall be clearly visible from the handwheel operating position.

All butterfly valves shall be tested at the manufacturer’s works under ‘open end’ conditions. The seat test shall be for tight closure under maximum unbalanced water test pressure in either direction. The maximum permissible leakage for each valve shall be 0.5 per litre per hour per 100 mm nominal diameter of the valve.

The Contractor shall provide details of the materials of manufacture and design of butterfly valves, and shall provide evidence to show that the proposed seating materials and seating designs have given satisfactory performance in similar conditions to those applying under the Contract.

Valves shall carry identification marks and/or plates and those for use on process works shall carry an additional brass plate carrying valve identification and a brief description of its function.

Valves shall have 16 bar flanges and be drilled to BS or equivalent EN, ISO or BS Standards and shall be capable of withstanding the same pressure as the pipeline on which they operate. All nuts and studs subject to vibration shall be fitted with spring washers or locking tabs.

All product features and materials or corrosion protection used in manufacture of butterfly valves shall be waste water resistant and conform to the following minimum standards:

* Centric bearing of disk
* Wafer type, for installation between pipe flanges acc. to EN 1092 PN 10/16 and ANSI B 16.5 class 150
* Soft sealing due to elastomer-lining vulcanised into the body
* Standard design with free shaft extension
* Operation options: by mounted hand-lever, worm gear unit, electric or pneumatic drive
* Face-to-face length acc. to EN 558-1, basic series 20 (DIN 3202, K1)
* Body of ductile iron EN-JS 1030 (GGG-40)
* Disk of austenitic stainless steel (1.4306)
* Shaft extension of stainless steel (1.4006)
* Sealing-lining, vulcanised into the body, of EPDM

All valves and operating linkages shall be prepared and painted in accordance with the General Specification for Painting and Protective Coating in these ER

## Ball Valves

The ball valves shall be of the two-way type and be provided with a handle for easy opening.

All flanges must be rated and drilled for PN 10 according to DIN 2576 B or DIN 2632.

The ball valve shall have a smooth, unobstructed passage for installation in pipelines and shall be suitable for flowrate control and for installation between flanges

All product features and materials or corrosion protection used in manufacture of valves shall be waste water resistant and conform to the following minimum standards:

#### Ball Valves (< DN 100)

Materials:

Body: ductile cast iron

Ball: stainless steel

Shaft: stainless steel, shaft sealed by O-rings EPDM

Peripheral seal: EPDM, exchangeable

#### Ball Valves (≥ DN 100)

Stop globe double-eccentric sealing

Materials:

Body: ductile cast iron

Body seal face with built-up weld of stainless steel corrosion resistant and smooth finished surface

Ball: stainless steel

Shaft: stainless steel, shaft sealed by O-rings EPDM

Peripheral seal: EPDM, exchangeable

Bearing assembly:

Bearing brush:

Sealing part: thrust ring: special ductile cast iron

Bearing flange: cover: special ductile cast iron

Bolts: stainless steel

Gearing:

Corrosion resistant worm gear in cast iron housing, protection class IP 67 / 54 / explosion proof type (if applicable)

Limit stop in open and closed positions

Mechanical position indicator “open – shut”

Fluid grease filling, maintenance free

## Flap Valves

Flap valves shall be round or rectangular, single door bitumen coated, cast iron double hung tidal type flap valves, with the clear opening dimensions designed to pass the required discharge.

Flap valves shall be fitted with phosphate or bronze or stainless steel or similar approved corrosion resistant metal faces and hinge pins and shall have a galvanised mild steel lifting eye.

Flap valves shall be designed to withstand a working pressure equivalent to 8.0 m of water and shall be tested after installation with a feeler gauge to a non-acceptance of 0.05 m/mm between sealing faces when closed.

## Hand Operated Rising Spindle Headstock

Hand operated rising spindle headstocks shall be purpose made spindle enclosing pedestal pillars manufactured is close grained cast iron, either of the handwheel or the single or double gear crank operated type.

Lift nuts shall be in cast bronze threaded to fit the rising stem. Spindle thrusts shall be taken on ball or roller bearings provided above and below the flange on the lift nut and designed to take five times the maximum thrust developed in opening and closing the gate.

Gears shall be of cast bronze, accurately machined with cut teeth, and smooth running with similar shafts in bronze sleeve bearings or roller bearings of ample size. A removable flanged cast iron cover dome shall cover the gearbox.

All gears and bearings shall be enclosed in the cast-iron housing. Fittings shall be provided so that all gears and bearings can be periodically lubricated.

The removable cast iron crank shall be fitted with a brass rotating handle, set with its axis nominally 1.0m above ground or floor level. The maximum crank radius shall be 350 mm, the effort require shall be less than 25 kg and the direction of rotation for closing is clockwise. The direction of opening shall be marked and annotated on the headstock casting.

The rising stem unit shall be provided with a galvanised steel spindle cover of sufficient diameter and length to permit full travel of the threaded stem without obstruction. The top of the stem shall be capped and the bottom flanged to suit the housing or adaptor plate. Each penstock shall be provided with a brass position indicator to show the position of the gate at all times. Indication shall be in the support stem through a brass faced and calibrated slot.

Headstocks shall be prepared and painted in accordance with the General Painting and Protective Coatings Specifications in these TR

Headstocks shall be vertical. All mountings shall be through a rigid rectangular plate with a least 4 fixing holes. Base fixings shall be designed for the peak thrust with a factor of safety of 5. The design thrust shall be stated on the Contractor’s drawings.

## Hand Operated Non-Rising Spindle Headstock

Non-rising spindle headstocks for valves shall be proprietary vertical spindle enclosing pedestal pillars, fitted with a valve position indicator mechanism, cast iron handwheel and suitably fitted with robust bearings and bushes, and designed for prolonged external exposure.

All mountings shall be through a rigid rectangular base plate with at least 4 fixing holes. Handwheels shall be horizontal, nominally 1.0 m above ground or floor level.

The headstocks shall be prepared and painted in accordance with the General Painting and Protective Coating Specification in these TR

## Pressure Control Valves

Pressure and flow control valves for pipe bores 80 mm diameter and above used for pressure reduction, pressure sustaining or pressure relief shall be of the double flanged type and of grey or ductile cast iron and shall operate by use of an integral auxiliary actuating mechanism suitable for the application. For bores less than 80 mm diameter a direct spring controlled valve may be used.

The valves shall be adequately sized to control the flow and pressure differential required for the application with an accuracy of +/- 2.5% of the set valve. They shall be capable of operating at a sustained pressure 20% in excess of the nominal declared working pressure.

Valves shall be sized to ensure that their full capacity will be more than adequate to accept the desired maximum flow at the minimum required differential pressure. Flanges shall be of 16 bar design.

The main valve disc, ported guide and pressure differential piston shall be in high-grade cast iron or gunmetal as appropriate. For cast iron discs the seating face shall be in non-ferrous, synthetic or other approved material to suit the application. The piston cylinder shall be fitted with bronze liner.

The piston shall be fitted with rings suitable for maintaining a pressure seal with the cylinder to suit the maximum pressure differential for which the valve has been designed.

Where specified, an externally projecting indicator rod shall be fitted to the top of the piston to indicate the position of the main valve disc.

The main pressure control valve operation shall be actuated by a hydraulic differential pressure system in balance with a spring loaded bellows type diaphragm, the reference pressures being bled from the inlet and outlet of the main valve application.

The control circuit bleeds shall be controlled by isolating cocks to enable the system connections to be removed without disturbing the main valve.

The detail connections and application of reference pressure shall be arranged to suit the requirement, whether for pressure reduction, pressure relief to sustain a constant pressure, or regulate flows.

Monitoring orifices shall be protected by suitably fine mesh strainers on the pipeline side, the elements, strainers, pipework and fittings being in suitable corrosion-resistant materials.

A pressure gauge shall be fitted to indicate the regulated pressure. Where required a needle valve shall be incorporated in the connection from the relay valve to the main valve piston cylinder to adjust the rate of pressure.

When the main and relay valves are closed, the main valve seating shall be “drop tight” under the inherent hydraulic pressure. Where specified an electric or hydraulic servo device shall be incorporated to turn the spring screw for remote pressure adjustment.

Fixing nuts and bolts supplied by the manufacturer shall be as specified in the appropriate clauses herein. Before the application of paint or other similar treatment, the valve body and diaphragm shall be works tested hydrostatically to 25 bar.

All valves and operating gear shall be prepared and painted in accordance with the General Specification for Painting and Protective Coating in these TR

All materials used in the manufacture of the valves shall conform with standards but not be limited to ::

* Body, Cover and disc Cast Iron or Spheroidal graphite iron.
* Valve guide, rings, etc. Gunmetal
* Liner Bronze
* Seating Face Gunmetal, synthetic or other approved material as appropriate
* Indicator rod Stainless steel
* Actuating valve body etc. Bronze
* Spindle Stainless steel
* Valve face Nylon
* Diaphragm and bellows Reinforced synthetic rubber or approved equivalent
* Orifice body and plate Bronze
* Strainer Copper wire cloth
* Spring Spring steel

All detain parts shall be in homogeneous corrosion-resistant material.

## Surge Anticipating Control Valves, Air Relief and Vacuum Protection Valves

Surge anticipating control valve, air relief and vacuum protection valve shall be new, have no material defect and, nominal diameter, nominal pressure and manufacturer's name shall be inscribed on.

### Surge anticipating control valve

Surge anticipating control valve shall automatically protect the system against water hammers arising from power cut, power fluctuation and pump start-stops.

Surge anticipating control valve shall be installed in pump pressure side header and open to atmosphere.

The bodies shall have Y-form so that pressure loss would be small.

Pilot-Actuator pressure signal for surge anticipating control valves to be used in waste water treatment plant and pump stations shall be provided from clean water resource equivalent to minimum operating pressure. A tank and a package pump unit shall be provided to enable surge anticipating control valve to operate properly.

Valve actuator part shall be double-chambered type of materials shall conform with standards but not be limited to :

* Body type: Y-form
* Actuator type: Double-chambered diaphragm actuator
* Control pilot: Pressure-reducing pilot, pressure-fixing pilot
* Connection type: Flange connection
* Maximum operation pressure: 16 bars
* Body material: GG40 ductile iron
* Spring material: stainless steel
* Diaphragm material: Neoprene rubber
* Sealing parts: stainless steel
* Flap disk ring: stainless steel
* Seat: Replaceable Buna-N material
* Valve stem material: stainless steel
* Valve signal circuit: stainless steel

All detain parts shall be in homogeneous corrosion-resistant material.

### Pressure Relief Valve

Pressure relief and air relief valves of suitable size shall be installed in top point of pressure line and header together with surge anticipating control valve. These valves shall be able to remove cavitation problems appearing when filling-discharging pipeline. This prevents contraction and flow reduction in pipeline.

Pressure relief valve having a wide orifice shall be able to provide necessary air while discharging the line (vacuum principle). Moreover it shall have a mechanism preventing contact between wastewater and sealing elements of valve. The valve shall have the ability to evacuate compressed air and other gases while the pipe line is under pressure (air evacuation principle).

Materials shall conform with standards but not be limited to :

* Body type: Double orifice
* Connection type: Flange connection
* Minimum operation pressure: 0.2 atm
* Maximum operation pressure: 16 atm
* Valve body-bonnet material: GG 25 cast iron
* Body material: St-37, St-37-2 carbon steel
* Sphere material: Polycarbonate copolymer
* Sphere cage: Polycarbonate copolymer
* Seat: Rubber
* O-ring: Buna-N material
* Fittings: Galvanized steel
* Big floating ball: stainless steel
* Arm between floating ball and sphere: stainless steel

All detain parts shall be in homogeneous corrosion-resistant material.

## Air and Gas Relief Valves

Air and gas relief valves shall be of the double orifice pattern with grey or ductile cast iron bodies. The inlet Flange shall be faced and drilled.

The valves shall be adequately sized for the release of gas from the pipeline (or other container) without restriction of rate of filling or flow due to backpressure and also to allow admission of air during pipeline emptying at a rate sufficient to prevent excessive depression of pressure in the pipe.

Valves shall be designed to prevent the operating elements being in contact with the pipeline liquid by approved means such as the provision of an auxiliary float and chamber sufficiently large to isolate the orifice valves and seats throughout the rated operational range.

Air valves shall be fitted with an isolating sluice valve and gearing shall be provided where necessary to facilitate operation.

In applications where the pipeline characteristics may lead to liquid column separation with consequent possibility of surge, a vented non-return valve shall be provided which allows air to enter freely on separation but controls expulsion of air/gas as the liquid column rejoins.

All air and gas relief valves and associated isolating valves shall be works tested hydraulically and capable of withstanding test pressure of 25 bar and working pressures of 16 bars.

All valves and operating linkages shall be prepared and painted in accordance with the General Specification for Painting and Protective Coating.

All materials used in the manufacture of the valves shall conform to the following minimum standards:

* Float Chamber : Grey Cast Iron
* Flange and Cover : Grade 220 or Spheroidal Graphic Iron
* Liquid Float : Copper, Polycarbonate or approved equivalent
* Air Valve Float and Guide : Polycarbonate or approved equivalent
* Orifices, Guides and Mechanisms : Stainless Steel
* Sealing Rings : Moulded Rubber or suitably approved equivalent.

All detain parts shall be in homogeneous corrosion-resistant material.

## Penstocks

### General

Penstocks shall be manufactured in accordance with recognizable international standards such as BS 7775 (or EN DIN normes) and a leakage rate as per allowable standard from AWWA.

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 general material requirements in these TR , unless specified otherwise.

Following requirements

Penstocks can be classified as:

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.
2. *Channel Mounted Type*: The penstock frame shall be embedded and anchored in grooves provided in the side walls of the channel.

### Installation

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

### Quality Control Records

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

Shop drawing for equipment shall consist of the following:

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

Quality Control Records:

* Manufacturer’s Certification of Compliance.
* Material certificates.
* Performance test records and certificates.
* Calibration certificates.
* Other relevant test records and certificates.

### Testing at Site

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

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. *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.

### Storage

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

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

Penstock shall be stored in clean and dry environment to prevent distortion.

Penstock and its components i.e. stem, headstock etc. shall be stored in sleeping position and shall not be stacked together. Penstock of rubber seating faces and motor shall be stored inside the room. and shall be covered to protect its machined surface

### 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).

### 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

## Manualy Operated Penstock

Water treatment works penstocks shall be of the rising spindle type, manufactured in close grained cast iron, unless otherwise secified The frame and guide in one piece cast construction or with the guides doweled and bolted to the frame.

Frames shall incorporate a rectangular or circular opening with integral spigot on the back.

The gate shall be of one piece cast construction with vertical and horizontal ribs, a reinforced pocket to receive a gunmetal thrust nut, pads to receive wedges and reinforced periphery around the backside machined for non-ferrous seating faces.

Guide rails shall be of such length as to retain at least one half of the vertical heights of the slide when in the fully open position. Grooves running the full length of the guide rail shall be accurately matched to receive non-ferrous slide tongues.

The manufacture and assembly shall be such as to ensure accuracy in mating the frame and door faces and tight closure while maintaining freedom of gate movement during operation and minimising sliding wear of the sealing faces. They shall incorporate adjustable wedges or swivelling cams and actuating pegs manufactured from a non-corrodible materiel.

Metal sealing faces shall be formed from accurately machined gunmetal or bronze strips bedded and fixed to the machined recesses in the frame and gate. The faces of the strips shall then be brought together in the operating position and hand scraped to a watertight finish.

Penstocks shall be site tested with a feeler gauge to a non-acceptance of 0.5 mm between sealing faces when closed.

Unless otherwise stated each penstock shall be provided with a suitable handwheel of adequate diameter for the duty required, or gearing shall be supplied where necessary to ensure that the required operating force applied by hand to the rim of the wheel or geared handle does not exceed 25 kg.

Gearboxes of handwheels shall have cast on them the direction of closing which shall be clockwise and vandal and weatherproof clear polycarbonate tube covers shall be securely fitted to protect the threads of rising spindles. Each tube shall be clearly and permanently engraved to indicate the position of the penstock to which it is fitted.

Spindles shall have machine cut robust trapezoidal or square form threads. They shall be of bronze, running in gunmetal nuts. Extension spindle coupling shall be of the muff type and they shall be drilled and provided with a nut and bolt for securing the spindle to the penstock spindle-head, which shall likewise be drilled to receive the bolt.

Where penstocks are specifically required to be operated by tee-keys, spindle caps of the specified type shall be fitted. The caps shall be drilled and each provided with nut and bolt for securing to the spindle, which shall also be drilled.

All handwheels, headstocks, foot brackets and guide brackets shall be of cast iron. Guide brackets shall be adjustable. Fixing nuts and bolts shall be specified in the appropriate clauses herein.

Penstocks shall be prepared and painted in accordance with the Specification for Painting and Protective Coating in these TR

Penstocks shall be structurally designed for on-seating or off-seating pressures of 5 times the maximum possible hydraulic loading, which they could be subjected to on site. Those with on-seat pressures may have side wedges only. Those with on-seat pressures may have side wedges only. Those with off-seat pressures shall incorporate top, side and bottom wedges.

All penstocks shall be delivered with a temporarily attached template in order to facilitate accurate installation of the frame and fittings.

Weir penstocks, where specifically required, shall be designed for on-seat pressure application and shall incorporate a removable bronze sharp edges overflow cill.

Pipe entrance penstocks, where specifically required shall be faced and studded on the back spigot to suit the NP 16 pipe flange.

## Motorized Penstock

Motorised penstocks shall be opened and closed using electric actuators.

The actuator shall be of double-acting or reversing motor type with totally enclosed micro-limit switches to ensure complete protection of the actuator under all circumstances. All motorised penstocks supplied and installed shall be complete with all necessary wiring and electrical control panel.

Each actuator shall be fully weatherproof to IP 55 and fitted with upper and lower limit switches and torque switches. All local controls shall be protected by a lockable cover and comply with the relevant Electrical Clauses.

The electricity supply available is 400/230 V, 3 phases 4 wire 50 Hz. The windings shall be provided with thermostatic switches.

The gearbox shall be oil or grease filled, and capable of being installed in any position. All operating spindles, gears and headstocks shall be provided with adequate points for lubrication.

Alternative hand operation shall be possible, and the handwheel together with a suitable reduction gearbox if necessary shall be of adequate dimensions for easy operation by one man. The motor drive shall be automatically disengaged under manual operation.

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

Handwheels shall be rotated clockwise to close the valve or penstocks and shall be clearly marked "OPEN" and "CLOSE" with arrows in the appropriate directions. The rims of handwheels shall be machined to a smooth finish.

Each actuator shall be adequately sized to suit the application with a time rating of 15 minutes or twice to penstock operating whichever is longer. Where actuators are required for modulating purposes, continuously rated motors shall be provided.

The actuator shall be equipped with an indicator showing whether the penstocks are fully opened or closed.

## Handstops

Handstops shall have cast iron frames with galvanized mild steel doors or alternatively made of stainless steel. Handstops on some part of wastewater treatment process shall be of proprietary manufacture in appropriate non-ferrous materials resistant to H2S attack.

Handstops shall be suitable for channel or wall mounting according to the installation requirements.

Handstop doors shall be provided with hand-slots to facilitate operation and a peg or chain shall be provided to hold the door in the open position. Pegs or chains shall be of stainless steel or galvanized mild steel.

On deep channels or where specified, handstop doors shall be provided with lifting handles. Lifting handles shall be of identical material to the doors and guide/retaining brackets shall be provided.

All handstops shall be prepared and painted in accordance with Specifications for Protective coating Stainless steel shall not be painted.

All materials used in the manufacture of handstops shall conform to the requirements for penstocks specified herein.

# Metalworks

## General

This Section sets out the general requirements for the metalwork's required both externally and internally in the structures.

These Specifications are to be considered for both civil and mechanical applications!

## Structural Work

The Contractor shall fabricate, supply, deliver and erect all steelworks, fixing materials and associated parts according to the specifications and drawings and shall comply with the specifications of the relevant Standards, unless otherwise specified or instructed by The Engineer.

The steelworks shall comprise of the following main items:

* Columns and beams;
* Open mesh flooring and gratings including framework and supports;
* Hatches, including frameworks;
* Covers for water supply chambers;
* Sheet piling;
* Flanges and bolted connections;
* Anchors;
* Angles for protection of edges in several lengths, including anchors;
* Step irons, ladders and pipes where shown on the approved Contractor's Drawings or instructed by The Engineer;
* Staircases, landings and platforms;
* Other structural steelwork associated with the specified mechanical and electrical works..

### Standard (Steel)

Rolled structural steel sections shall be mild steel conforming to BS or equivalent EN, ISO or BSS Standards. The dimensions, tolerances and properties of the structural sections shall conform to BS or equivalent EN, ISO or BSS Standards. Where the use of prefabricated proprietary design is proposed, the standards to which they are manufactured shall be no less rigorous than specified herein.

For structural steel work assemblies, steel bolts and nuts shall be high strength friction grip bolts or black bolts. Bolts & washers shall conform to BS or equivalent EN, ISO or BSS Standards. High strength friction grip bolts shall be used in conduction with approved proprietary load indicating washers.

All welding consumables (electrodes, wire, filler rods, flux, shielding gas and the like) shall comply with the requirements of BS or equivalent EN, ISO or BSS Standards. Electrodes for metal-arc welding shall conform to BS or equivalent EN, ISO or BSS Standards, and with the requirements of the appropriate weld procedure.

### Submissons by the Contractor

Except where specified on the drawings the Contractor shall design, detail and fabricate the metalwork in accordance with the specified standards and shall minimise the need for site welding, brazing or other special skilled assembly work.

Structures and components, such as required for the clarifier bridges, cranes and laddering, hoppers etc., shall be shop fabricated so as to form sub-assemblies of the largest practical size suitable for transportation, handling and erection. Connections between members at the erection stage shall generally be bolted.

Structural steelwork shall be detailed and fabricated so as to minimise the formation of pockets to hold condensation, water or dirt. Where such pockets are unavoidable, suitable drainage shall be provided.

Prior to any steel fabrication work the Contractor shall submit full details of his proposed procedure, qualification and methods of fabrication and all other fabrication details ( Drawings and calculations) to The Engineer for approval.

This information shall include (but not be limited to) the details concerning the method of plate forming; joint design; proposed welding procedure and proof of competence of welders; methods of straightening, sizing and hydrostatic testing; quality control and inspection procedures.

### Drawings

The Contractor shall prepare detail shop and erection drawings and welding procedure sheets for all structural steelwork and shall submit these to The Engineer for approval before fabrication commences. The sequence of submittals shall match the order of fabrication and erection.

Shop drawings for fabrication shall show full details of the type of steel, member sizes and dimensions, weld details, welding sequences and any requirements for weld stress relieving.

Welding procedure sheets shall show all details of the welds including:

* Welding method;
* Current type, voltage and amperage;
* Welding positions;
* Preparation angles and methods;
* Number of runs and their welding positions;
* Type, size and class of electrode;
* Shielding gas type and flow rate (where applicable);
* Non-destructive testing methods and extent of coverage;
* Pre-heat, post-heat and stress relief methods, temperatures and the like.

Erection drawings shall detail all connections, bolt types and sizes, and all site weld details if applicable.

Shop and erection drawings shall show all marks necessary to facilitate erection and the marks shown on the drawings shall be identical with those shown on the fabrications.

### Calculations

The Contractor shall submit to the Engineer for his approval calculations of the following items:

* Structural calculations where applicable or required by the Engineer;
* Mounting plates;
* Stiffening parts;
* Welded seams;
* Anchors and bolts, even when these items are shown on the Drawings.

In the event of unavailability of certain materials and steel sections, deviations from the original design can be made after approval from The Engineer. In such cases the Contractor shall submit to the Engineer his calculation for the proposed design. Such calculations shall be submitted to the Engineer for approval in three copies together with three copies of corresponding workshop drawings.

The Contractor shall submit to the Engineer for his approval calculations of weights of all relevant steel structural components. The basis for the calculations shall be the measurements of items as indicated on the approved workshop drawings multiplied by their number and the specific weights.

These calculations shall be submitted in three copies together with three copies of corresponding workshop drawings.

### Welding

All welding carried out during fabrication in the factory and erection on the Site shall be carried out in accordance with the requirements as shown on the approval detail drawings. Details of the proposed weld procedures shall be submitted to the Engineer for approval at the same time as the detail drawings. All connections shall be welded in such as manner as to make the finished connections neat and smooth in appearance, and suitable for painting. All slag shall be removed, and any sharp projections shall be ground smooth. Before welding is commenced either in the fabrication shop or on Site, weld procedure tests shall be carried out in accordance with BS or equivalent EN, ISO or BSS Standards.

All welders employed either in the fabrication shop or on Site shall pass qualification tests relevant to the weld procedures in use in accordance with DIN or equivalent EN, ISO or BSS Standards. Welders shall have least 9 months skilled experience in the preceding 12 month period. If the work of any welders employed on the Contract is unsatisfactory, the Contractor shall carry out such further welder qualification tests as are necessary to demonstrate that the welders are proficient.

Where directed and/or specified, welds shall be subject to non-destructive testing by processes which may include but not necessarily be limited to radiographic, ultrasonic, magnetic particle, or dye penetrate methods, depending on the type of weld and its position in the structure.

If any work shows defects or fails to comply with the requirements of the approved drawings or the specification for any reason, it shall be repaired or rejected, even though it may have been carried out by qualified welders using approved procedures.

The welding procedure for cupro-nickel linings shall avoid porosity in the weld and any uncontrolled dilution of the weld by iron picked up from the steel.

Special precautions shall be taken to avoid lamellar tearing when welding thick plates and low hydrogen content electrodes shall be used. Class 1 welds shall be fully radiographed except where otherwise specified.

In bad weather, additional measures are requested in the course of welding consequently, in case of rainy weather, provision shall be made to keep the places of welding dry. In weather with temperatures below 5 C°, a strip of 100 mm should be preheated to 50 C°, on both sides of the welded joint in case of both seams and tack welds.

Splash, burning-in, uneven arc, oversized root edges at corner joints, unsatisfactory seam or any crack are impermissible in the course of welding. Surfaces should be free from any marks of impact, indentation and deformation.

### Galvanising

Where steel or wrought iron is to be hot–dip galvanised, it shall be carried out by the hot–dip process and shall conform in all respects with BS 729 or equivalent DIN EN norms.

Attention shall be paid to the detail of members in accordance with BS 4479 or equivalent DIN EN norms. Adequate provision for filling, venting and draining shall be made for assemblies fabricated from hollow section. Vent holes shall be suitably plugged after galvanising.

All surface defects in the steel including cracks, surface laminations, laps and folds shall be removed in accordance with BS 4360. or equivalent DIN EN norms

All drilling, cutting, welding, forming and final fabrications, unit members and assemblies shall be completed before the structures are galvanised. The surface of the steel work to be galvanised shall be free from welding slag, paint, oil, grease and similar contaminants. The articles shall be pickled in dilute sulphuric or hydrochloric acid following by rinsing in water and pickling in phosphoric acid. They shall be thoroughly washed, stoved and dipped in molten Zinc and brushed, so that the whole of the metal shall be evenly covered and the additional weight thereof after dipping shall not be less than 610 grammes per square metre of surface galvanised, except in the case of tubes when it shall be 460 grammes per square metre. to BS 1387 or equivalent DIN EN norms

On removal from the galvanising bath, the resultant coating shall be smooth, continuous, free from gross imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross. Edges shall be clean and surfaces bright.

Bolts, nuts and washers shall be hot-dip galvanised and subsequently centrifuged in accordance with BS 729.or equivalent DIN EN norms Nuts shall be tapped up to 0.4 mm oversize before galvanising and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nuts.

During off–loading and erection the use of nylon slings shall be planned.

Galvanised work which is to be stored in Works or on Site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining.

Small areas of the galvanised coating damaged in any way shall be restored by:

1. Cleaning the area of any weld slag and thoroughly wire brushing to give a clean surface.
2. The application of two coats of zinc–rich paint (not less than 90 per cent zinc, dry film), or the application of a low melting–point zinc alloy repair rod or powder to the damaged area, which is heated at 300°C.

Where surfaces of galvanised steelworks are to be in contact with aggressive solutions and/or atmospheres the galvanising shall receive further protection by painting.

### Tolerances

Metal work shall be constructed and installed within the following tolerances:

* The general tolerance on all dimensions shall be ± 2 mm;
* A structural member shall not deviate from straightness (or from the specified shape) by more than 1/500 of the overall lengths (maximum 25 m);
* A structural member shall not deviate from its length by more than + 0 to - 4 mm;
* Lengths of components shall be such that cumulative variations do not prejudice the accurate alignment of the completed structure;
* Where two steel surfaces are required to be in contact to effect a bearing or frictional contact, the surfaces shall be prepared so that at least 90 % of the area is touching before any clamping force is applied;
* Metalwork at floor level (e.g. joints between flooring sections and between steel flooring and adjacent concrete); difference in level at joints 3 mm and joint gap 3 mm;
* Dimensions shown on drawings ± 5 mm;
* Levels shown on drawings ± 5 mm.

### Fabrication Tolerances

The general tolerance on all dimensions shall be ± 2mm. Holes shall be aligned such way that fasteners can be freely inserted through the members at right angles to the contact face. Holes, which cannot be aligned other than by damaging the structure, shall cause rejection, except where reaming is allowed by The Engineer.

A structural member shall not deviate from straightness (or the specified shape) by more than:

* 1/1000 of the length between lateral restraints for compression members and beams; or
* 1/500 of the overall lengths of other members but not more than 25mm
* A structural member shall not deviate from its intended length by more than:
* ± 1mm for compression members faced at both ends for bearings; or
* 0 mm to –4 mm for other members.

Lengths of components shall be such that cumulative variations do not prejudice the accurate alignment of the completed structure.

Where two steel surfaces are required to be in contact to effect a bearing or frictional contact, the surfaces shall be prepared so that at least 90 % of the area is touching before any clamping force is applied.

### Identification of Members

All members of assemblies shall be marked at the factory with distinguishing numbers, letters or marks corresponding to those of approved drawings or parts lists. Such markers if impressed before painting shall be clearly readable afterwards. Care shall be taken that any temporary bolts for field erection are readily distinguishable from any high strength bolts for permanent connections

### Storage and Erection on Site

All structural elements and other materials shall be stored (whether at the place of fabrication or on site) clear of the ground and shall be protected against deterioration from any cause.

The Contractor shall supervise all site erection processes, which, as far as is possible, shall be supervised with the following standards as the objective. The works used for handling and erection shall be suitable and safe. Temporary protection shall be required for workmen and materials below any structural steel under erection of any part of the completed structure may be safely carried out.

Anchor bolts shall be properly located by the use of templates or other approved method and after building in the anchor bolts, a sufficient time shall be allowed for concrete strength to develop before finally pulling down to shims and grouting.

Every part of the structural steelworks shall be positioned accurately in accordance with the dimensions on the approved drawings with a maximum tolerance of ± 5 mm except where the steelwork supports metal flooring, when the finished tolerances shall be such that differences in level between adjacent flooring sections or between flooring sections and adjacent building floors shall not exceed 3 mm and the gaps between flooring sections shall not exceed 3 mm.

Where structural steelwork is to be grouted on or against concrete or other similar surfaces and where it is considered essential to effect a uniform contact area under the base plate or where necessary, the erection team shall remove all steel shims or wedges and replace these with grout of the same constituents and consistency as the main grout. Such steel shims shall be initially positioned so as to aid removal. In the case of baseplates with large overhangs or with heavy bearing loads, the Contractor shall specify the shim position before the structure is erected on them.

During erection, the work shall be securely bolted or otherwise fastened, and if necessary temporarily braced, so as to make adequate provision for all erection stresses and conditions including those due to erection works and its operation. No permanent bolting shall be done until proper alignment has been obtained.

The Contractor shall report immediately to the Engineer any errors in shop fabrication or deformations resulting from handling and transportation that prevent proper assembly and fitting of parts. Agreement as to methods to be used to correct such errors or deformations shall be reached with The Engineer prior to beginning of any corrections.

The Contractor may recommend the use of drift pins to bring together several parts but to be not used so as to distort or damage the metal.

In the course of erection, provision shall be made to hinder any foreign body from entering the pipes and to avoid the inside surface of the pipe from getting contaminated. Open pipe ends should be closed and welding residuals like droplets of welding, slag, electrode residuals should completely be removed.

In processing stainless steel components, rigorous measures should be taken to avoid any direct contact between stainless steel components and standard steel.

In the course of processing, stainless steel components should undergo careful and professional treatment, pipes and shapes should be stored on timber and only non-metallic grinder should be used for grinding. Welding with protective atmosphere is permissible. Welded joints should be etched at the topcoat by immersion in full and should undergo passivization.

In case of no stainless steel fixings, supports, flanges, screw joints, etc., metals should consistently be separated. Coupling of galvanised steel parts with stainless steel parts components is not permissible. Preparations preceding welding should permit inside pipe diameter to fit, gap sealing to be within tolerances and root to be the same in size.

### Bolted Connections in Steel Structures

The Contractor shall make bolted connections in accordance with the details shown on the shop or erection drawings. Where necessary, washers shall be tapered or otherwise suitably shaped to give the nuts and heads of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut not less than one thread and not more than five threads when fully tightened. The length of bolt shall be such that there shall be at least two threads under the nut after tightening.

Facing surfaces (i.e. those surfaces required to transmit friction in connections with high strength friction grip bolts) shall be kept free of contamination by grease, rust, moisture, dust and the like. If the surfaces are primed after fabrication, the primer shall be suitable for use in such connections and shall be protected from damage during transit or erection.

If contamination should occur, it shall be removed by appropriate means, e.g.:

* On coated surfaces, with a degreasing agent followed by washing and drying;
* On uncoated surfaces, as above, or by blast cleaning or wire brushing to clean steel.

These remedial measures shall be applied immediately before bolting the surfaces together.

High strength friction grip bolts shall be used in accordance with DIN or equivalent EN, ISO or BSS Standards using approved load-indicating washers to check bolt tension. They shall be tightened in accordance with the manufacturer’s recommendations and the tension shall be re-checked not less than three hours after the first tightening. The bolts shall then be re-tightened to the initial load.

### Crane Beams and Rails

Crane beams shall be aligned so as to ensure satisfactory performance of the crane under all reasonable circumstances and shall be generally in accordance with the crane manufacturer’s requirements.

Crane beam fixings shall be so designed as to allow adjustment to be readily carried out to accommodate misalignment of the structure. Crane rails shall be fixed to beams with adjustable clips (spring if used in conjunction with a resilient pad) with an adjustment range of ± 10 mm in a direction at right angles to the rails longitudinal axis.

End stops shall be provided faced with hardwood blocks or similar approved buffer materials and shall be designed to withstand a fully loaded crane running into such that they will arrest the crane in the event of overrun under full load.

### Quality and Testing of Materials

The Engineer may require to inspect any metalwork during fabrication and to witness testing at the fabrication shop, in addition to all inspections and tests undertaken on the Site.

The Contractor shall give The Engineer 21 working day’s notice of any operations, which The Engineer has notified to the Contractor in order that The Engineer may arrange to undertake such inspections.

The Contractor shall select the appropriate material for the application and provide full details with the tender submission.Should the Contractor propose to use materials, complying with Standards other than those specified above, he shall have submitted details of such Standards with his ER. At least two weeks before ordering materials, the Contractor shall send a written notice to the Engineer giving the details regarding type, quality and quantities to be ordered.

Test certificates from the steel manufacturers shall be required to be submitted to the Engineer for the materials ordered. Material obtained from stocks shall be checked by the Engineer for the exterior defects either in the workshop or at the site.

## Supporting Accessories

### Handrailing General

Handrail shall consist of galvanised steel with handrails and standards 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.

Standards and handrails shall be not less than 32 mm in diameter. Horizontal handrails shall be 1.100 mm high with an intermediate rail, knee-bar and kick-plate. Handrail height shall be measured vertically from finished floor level to the handrail centreline.

Sloping handrails shall be as specified for horizontal handrails but with the top rail 900 mm vertically above the line of pitch and stanchions vertical and spaced at not more than 1.5 m measured parallel to the line of pitch.

Horizontal mounting flanges shall be drilled for not less than three bolts with two bolts on a line parallel to and on the walkway side of the line of the handrail. Vertical mounting flanges shall be drilled for not less than two bolts the line through the bolts being vertical. Fittings shall be screwed or secured with grub screws. The standards shall be set at not more than 1.5 m centres. When provided in sections handrails shall be gained together with purpose made fittings secured by screws or grub screws.

Ladders and other openings shall be closed with two galvanised mild steel hanging chains, which shall be secured at one end and detachable at the other.

Bolts, nuts and washers shall be made of stainless steel.

The Contractor shall ensure that, unless specified to the contrary, all handrails shall be of uniform appearance and manufacture.

Detailed drawings of handrailings to be provided shall be prepared prior to fabrication for approval by The Engineer.

### Galvanized Steel Handrailing

The galvanised 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 or DIN EU harmonized.standards including National ( Project country) NS standards

Handrailing shall include galvanised 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 shal be applied onto the welding parts prior to application of galvanized paint, where welding is done at site all in accordance with Specifications in these TR.

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 galvanised hanging chains which shall be secured at one end and detachable at the other. Access to openings shall be closed with lockable hinged gates.

### 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 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.

### Flooring General

Flooring shall be fabricated from chequer plate or open mesh panels.

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.

Flooring and its support shall be designed and manufactured to carry a loading of 7.5 kN/m² and the deflection shall not exceed 0.2% of the span.

Flooring panels shall generally be removable by one man and the maximum weight of each panel shall not exceed 25 kg. Removable sections of flooring shall be provided with holes for lifting keys, keys to suit for each location, and be arranged to permit its removal without disturbance to support brackets, spindles, cables pipework, etc. 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.

Flooring shall be detailed and fabricated so that no cutting is required on site. Bolt holes in brackets and mountings shall be slotted to allow for adjustment of line and level. Mild steel continuous kerbing shall be provided for seating the flooring in concrete. Kerbing and other supporting structures for building into concrete shall have lugs welded on at maximum spacing of 600 mm. Flooring shall be secured to the kerbing or supports by stainless steel flush screws.

The clear width of any access walkway shall be not less than 1,000 mm.

All members of assemblies shall be marked at the factory with distinguishing numbers, letters or marks corresponding to those of approved drawings or parts lists.

### Steel Walkway

Walkway shall be constructed from structural steelwork conforming to the relevant standards and at least with the requirements of clauses for Structural Steelwork in these TR.

The width of walkway shall be at least 1000 mm. Walkway shall be made up by open mesh or chequer plate flooring.

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

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.

Supporting steelwork shall comply with the requirements of clauses for Structural Steelwork in these TR.

### Floor Plating

Floor plating shall have a raised pattern and be complete with cut-outs and in sizes suitable for removal by hand; steel flooring shall be not less than 6 millimetres thick (as measured excluding the raised pattern).

Floor plating over openings in concrete or brickwork shall be set flush in mild steel framed kerbing provided with adequate integral lugs for building in. External floor plating and frames shall be mild steel, heavily galvanised

### Open Mesh Flooring

Open mesh flooring and gratings shall generally comply with BS 4592 or similar DIN EU except where otherwise specified. Such flooring and gratings shall be of non-slip, hot deep 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.

Open mesh flooring panels shall be fabricated from hot dip galvanized mild steel with load bearing bars of flat section braced with round, square, or twisted bars perpendicular to and welded to each load bearing bar.

Panels shall be trimmed across the ends of load bearing bars by flats of the same cross section welded to each load bearing bar. Box-outs for works items shall be trimmed with curved or straight edge trimming as appropriate.

Panels shall be fixed to the kerbing or supporting steelwork with adequate flush stainless steel screws or clips so that movement is prevented.

### FRP Gratings

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 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.

### Access Covers

Internal and external access covers shall generally be designed and fabricated as specified for flooring.

In situations, which warrant special measures to prevent pollution of filtered water, the covers shall be air tight, or cast.

External access cover such as sludge channels or chambers shall be steel open mesh, hot dip galvanized.

### Cast Iron Covers and Frames

Access covers and frames for use with manholes, chambers, drawpits and other structures shall be cast grey iron or ductile iron and shall comply with the relevant quality requirements of DIN or equivalent EN, ISO or BS Standards. Lockable covers shall be provided for the locations specified or otherwise vulnerable.

Access covers and frames shall have minimum openings of diameter 625 mm or of 600 x 600 mm or 750 x 750 mm and shall be capable of taking a load of 40 tonne (400 kN) as per Class D of DIN 1229 and EN 124 whichever loading is greater.

Covers and frames detailed as sealed shall incorporated suitable neoprene or other synthetic rubber sealing rings, or other approved sealing methods.

Where covers are ventilated, the total area of ventilation and the size of individual slots shall be designed.

Where covers and frames are supplied from manufacturers to standards other than those specified, the alternatives shall be designed and tested for loading equal to or greater than the covers specified, and the clear openings of the frames of the alternatives shall be equal to or greater than the covers specified.

### Surface Boxes

Cast iron surface boxes shall comply with the relevant specifications of DIN 405 or equivalent Standards. The lid shall be chained to the frame.

### Step Irons

Step irons shall comply with DIN 1211, Part: 2 or other international equivalent Standards and be of the general purpose or pre-cast concrete chamber as appropriate.

Step irons of both purpose pattern shall have 80 mm tails.

## Ladders

### General

With exception of internal access ladders to water tanks, reservoirs and wet sumps, laddering shall be in steel (fully hot-dip galvanised). Ladders for internal access shall be in stainless steel.

Generally all ladders shall be in accordance with DIN 3620 or equivalent EN, ISO or BS Standards icluding relevant project country ( local), required for WWTP application

### Steel Ladders

Mild steel ladders shall generally be in accordance with DIN or equivalent EN, ISO or BS Standards and shall have the following dimensions:

* Minimum thickness of stringer 12 mm
* Diameter of rungs 25 mm
* Rung spacing (uniform) between 230 mm and 260 mm
* Rung length 400 mm
* Minimum clearance to wall or other obstruction 200 mm

The stringers shall be sized to suit the height of the ladders and the interval of the stringer supports. Stringers shall be radiused over the top and drilled to receive the rungs that shall be welded to the stringers on each side of each stringer. The bottom ends of the stringers shall not be designed for floor fixing, but shall terminate at wall fixing supports at least 150 mm above the floor. All edges of stringers shall be ground smooth to remove burrs and sharp edges.

Ladders exceeding 3 m high shall be provided with safety hoops at intervals not exceeding 900 mm, with the lowest hoop 2.5 m above the ladder foot. Landings of open mesh flooring and handrails as specified shall be provided at intervals not greater than 9 m. Anchorage points may be provided for attaching safety harnesses instead of the above safety hoops where hoops would be inappropriate.

Ladders over three metres long shall have pairs of intermediate stringer stays at not more than 2.5 m centres. Stays shall be fabricated to be continuous with the stringer section. At least one fixing hole shall be provided at each palm type stay.

The Contractor shall provide detailed drawings prior to fabrication for approval by The Engineer.

### Aluminium Ladder

Aluminium ladder shall be designed for heavy duty application and should comply with general material requirements for usage in WWTP as stated in these TR.

It 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.

### Other Non-ferrous Ladders

Ladders for internal access to reservoirs, tanks and submerged sumps shall be either made of stainless steel or GRP, and shall be otherwise provided to the same specification for steel ladders. Safety hoops shall be avoided in these locations

## Stairways

### Steel Stairways

Stairways shall be designed for a loading of 7.5 kN/m² of plan area of the stairway. Steel stairways shall be provided with tubular handrailings, stringers of cross section suitable for the span and loading, and treads of open mesh flooring or chequer plating.

Except where specified otherwise, the rise between treads shall be uniform and between 150 mm and 175 mm. Stairways in the same area of the works and in similar locations shall have the same angle and height of rise between treads.

The width of the treads shall be between 250 mm and 300 mm. The width of the stairways shall not be less than 1,100 mm.

The stringer shall be mounted by means of angle brackets with slotted holes for adjustment of line and level.

## Miscellaneous

### Dissimilar Metals

Where metals dissimilar to those specified above used in close proximity to structural steel members or their connections, contact between such metals and the steel shall be avoided unless the Contractor can demonstrate to the satisfaction of The Engineer that contact between the dissimilar metals will not lead to galvanic corrosion.

Contact between aluminium and aluminium alloy or galvanised mild steel will be permitted. For fixing aluminium to steel structures, bolts, nuts, washers and screws shall be unpainted stainless steel.

Where galvanised parts might otherwise become sacrificial anodes to the main structure, or where the electrolytic potential difference exceeds 250 mV, the parts shall be separated by an insulating medium of adequate strength.

### Aluminium Fittings

The materials for fittings made of aluminium shall be in accordance with the relevant parts of DIN or equivalent EN, ISO or BSS Standards.

### Opening Tools

Lifting keys and devices for unfastening screws shall be galvanised mild steel and supplied at the rate of one set for each five similar covers supplied, with a minimum of two sets of each particular type.

### Protection

Galvanised metal work shall be protected in accordance with the General painting and Protective coating Specification.described in these TR

### Installation

Where metalwork is to be founded on and fastened to concrete, the Contractor shall specify the use one of the following methods as subsequently detailed:

1. Bolting or screwing the metalwork to plates or angle sections with anchors set into the concrete structures or set into pockets left in the concrete structure.
2. Setting the metalwork into pockets or recesses formed in the concrete structure.
3. Bolting the metalwork to bolts set into the concrete structure or set in pockets or holes in the concrete structure.
4. Bolting the metalwork to self-anchoring epoxy resin fixed bolts placed in drilled holes.
5. Bedding the metalwork on cement-mortar placed on the concrete surface.

Cement-mortar of 1 part of cement to 3 parts of sand shall be used for bedding access covers and the like and for filling around metalwork or bolts set into pockets or holes smaller than 100 mm square. For larger holes, concrete of the same grade as the structure shall be used instead of mortar.

The installation methods permitted for each type of metalwork are specified in the table below:

| Metalwork items | Permissible methods of installation |
| --- | --- |
| Stairs, ladders, flooring | 1, 3 and 4 |
| Step irons | 2 |
| Handrailings | 2,3,and 4 |
| Access covers, | 2 and 5 |
| surface boxes and gully grating | / |

During installation, each item of metalwork shall be temporarily braced as necessary to resist all forces that are likely to be applied to it during installation, fixing and building in.

Any bolted connections required as part of the installation operation shall be fitted and tightened before fixing bolts are tightened or pockets are grouted. The nuts of grouted or resin fixed bolts shall not be tightened until the grout has fully cured.

Small or lightly loaded items ( as per standard) may be fixed using screws and approved plugs set in drilled holes.

# Machinery – General

The Contractor shall guarantee all mechanical equipment against faulty or inadequate design, improper assembly or erection, defective materials or workmanship, as well as leakage, breakage or other failure. Materials used shall be suitable for operation conditions.

All equipment shall be designed, manufactured and assembled in accordance with recognized and acceptable engineering and shop practice and selected for long life and minimum maintenance.

Individual parts shall be manufactured to standard sizes to the extent possible, so that repair parts furnished at any time can be installed on site.

Mechanical equipment shall be new and shall not have been in operation at any time prior to delivery, except as required by tests.

It is the Contractor's responsibility to ensure that the components of the systems are compatible as to dimensions, ratings and operational characteristics and integrated to form a fully efficient system complying with the specifications.

All equipments and materials, which will be provided to be used in pertinent works, shall be submitted to the Engineer's approval together with operating capacity, certified test reports and other necessary information. The Engineer may not accept any equipment or material which is not as per specification.

Warranty period of all offered mechanical equipments shall be 2 (two) years after delivery date of the plant to the Beneficiary, following installation and proper operation. The Contractor shall be responsible for draw-up of warranty certificates of these equipments in the name of The Employer and hand over the original copies to the Employer through Engineer

Any defects or failure within warranty scope and period shall be fixed up in the liability of the Contractor. In such cases; the Contractor shall be involved in not later than 10 days after written communication from the Employer considering the urgency of the case. The Contractor shall be responsible for fix-up of damages in the equipments and paying costs due to the lateness in and evasion of his obligations stipulated in the Contract.

## Programme of works for Machinery

The programme of works for machinery to be supplied and installed shall be divided into the following parts:

1. Part I Manufacturing period: Design and manufacture of all equipment to be supplied under the contract including inspection and works testing
2. Part II Shipping period: Delivery of all equipment from factory to the Contractor's on site storage including all freight loading, off loading, customs duties and clearance.
3. Part III Erection period: Removal of the materials and equipment from off or on-site storage, delivery to erection site and installation
4. Part IV Site testing: All mechanical equipment and machinery shall be tested in the presence of the Engineer before being put into operation.
5. Part V Running-in and Tests on Completion: All installed mechanical equipment and machinery shall be adjusted so as to comply with the operation requirements and actual conditions.

Manuals and other documentation shall be provided by the Contractor.

Tests on Completion (Taking Over) shall not take place before the Contractor has finalized all the works including testing and running in, despite the fact that some machinery, at the time for Tests on Completion, have been in operation for some time.

## Inspection and Works Testing, Guarantee Period

### Inspection and Factory Acceptance Tests of the Equipment

All mechanical and relevant electrical equipment shall be tested (Factory Acceptance Test (FAT) and Site Acceptance Test (SAT)). The Contractor shall list all the mechanical and electrical equipment and propose for each component an inspection and testing procedure, to be approved by the Engineer.

The Engineer shall be given notice in writing to attend works tests. The Engineer may, at his discretion, forego the witnessing of any tests. In such instances, the Contractor shall have the required tests carried out, and shall supply test certificates to the Engineer. The Engineer’s approval is required before shipment to site. Formal test certificates are required in triplicate in all cases.

All large mechanical components, including corespondent switchboards and MCC’s shall be inspected before transport to the site i.e a FAT shall be executed

All costs related to visits outside the Project country (transport, lodging, visa’s, etc.) shall be born by the Contractor. The Contractor shall minimise the time needed for inspection visits.

### Test during Manufacturing

The entire scope of supply may only consist of new manufactured materials.

The Engineer shall be entitled, at all reasonable times during manufacture, to inspect, examine and test on the Contractor's premises the materials, workmanship and performance of all pipes and equipment to be supplied under the Contract. If the plant or any part is being manufactured at a plant other than the Contractor's, he shall obtain, for the Engineer, permission to inspect, examine and test such component as is required. Any such examination, inspection or testing does not relieve the Contractor of his obligations under the Contract. The results of any testing shall not prejudice the Engineer’s rights to reject the Work if it fails to comply with the Specification when installed, or to give complete satisfaction in service.

The Contractor shall provide free of charge all assistance, labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably required to carry out the tests.

Where the Contract provides for on‑site tests, the Contractor shall provide at his own expense all labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be required and reasonably demanded for the carrying out of the tests.

The Contractor shall submit to the Engineer fully detailed documentation of his inspection and test procedures for approval by him. Testing shall not commence until the Engineer has formally approved the procedures.

If after inspecting, examining or testing any material, the Engineer should decide that such material or any part thereof is defective or not in accordance with the Contract, he may reject the said material or part thereof by giving the Contractor, within a reasonable time, written notice of such rejection, stating therein the reason for rejection.

Full witness testing by the Engineer at the manufacturer’s works of the following may be required:

* Pipes;
* Valves;
* Pumps;
* Flow meters;
* Electrical switchgear and motor control panels;
* Water level control system equipment;
* Other items as may be required from time to time.

Also full witness testing by the Waterworks Company personal at the manufacturer’s works of leakage detection equipment may be required.

All major items of materials and equipment shall be offered for inspection prior to their being despatched from the Manufacturer's or his Sub‑Contractor's works. Inspection may also be required during preparation and manufacture.

#### ****Pipes****

Before incorporation into the pipeline each pipe shall be brushed out and carefully examined for soundness. Damaged pipes, which in the opinion of the Engineer cannot be satisfactorily repaired, shall be rejected and removed from the Site.

If the Engineer considers that an unacceptable proportion of the pipes within a test length has failed, the Contractor may be required to test hydraulically, to the site test pressure, each pipe and joint before pipe laying. In this event, test results shall be submitted to and approved by the Engineer before any further pipes are laid. The cost of individual pipe testing shall be borne by the Contractor.

The details of the pipes testing are in the Pipelines Technical Specification of these TR

#### ****Pumps****

The Pumps shall be tested with their own motors. The Contractor shall obtain guarantees of pump delivery, head, kW input, overall efficiency and other figures.

He shall satisfy the Engineer as to the mechanical reliability of the plant and its capability of fulfilling the whole of the conditions. The Contractor shall detail the type of apparatus available for testing, and the method for measuring pump discharge. He shall satisfy the Engineer as to the accuracy of the instruments used in the tests and shall, if required, carry out calibration tests.

#### ****Flow meters****

Before installation to ensure that all this equipment is functional correctly, a test of part of equipment is necessary. This test will be done in an authorised institution.

The number of pieces to be tested will be determined by the Engineer.

#### ****Sewerage flow meters****

Before installation to ensure that all this equipment is functional correctly, a test of part of equipment is necessary. This test will be done in an authorised institution..

The number of pieces to be tested will be determined by the Engineer.

#### ****Electrical Switchgear and M.C.C.’s.****

Works tests on electrical switchgear and motor control panels shall include complete functional testing of all components, insulation, phasing and high voltage testing according to international standards. Complete checking of mechanical and electrical interlocks and sequential operation of motor control equipment using simulated signals shall also be carried out.

Primary and secondary injection current tests shall be carried out to prove the operation of circuit breakers, current transformers, relays and instrumentation.

#### ****Screens, Scrapers, Valves, Blowers, Compressors, Mixers****

The Contractor shall satisfy the Engineer as to the mechanical reliability of the plant and its capability of fulfilling the whole of the conditions. Contractor shall, at the time of tender, indicate the full extent of the Test Procedures proposed.

### Inspection on Delivery and During Installation

All materials and equipment shall be visually inspected before installation to ensure that no damage has occurred during transit or storage. Labelling, warranty certificates, statements of conformity, etc. shall also be checked.

During installation, the Engineer will visually inspect all materials and equipment to ensure:

* That it complies with the requirements of the Specification;
* That installation workmanship is acceptable, and in compliance with the Manu­facturer’s requirements.
* Warranty certificate;
* Statement of conformity.

### Tests on Completion

All mechanical and relevant electrical and control components and functions that are finished ( including civil works necessary for installation of the equipment) shall be tested dry and wet and if found in compliance with the contract conditions shall be accepted by the Engineer for start of the Start-up Period. Remedy of defects, if any, shall be done according to the decision of the Engineer before or under the Start-up Period.

All mechanical equipment shall be inspected and tested dry, all electrical equipment shall be tested on site (SAT) to the satisfaction of the Engineer. Only after these tests are completed the components can be tested wet. The main components/functional units (i.e. inlet works, primary sedimentation tanks, lifting pumping station, aerobic tank, aeration tanks, final sedimentation tanks, digestion tanks, gas holder, gas engine sludge dewatering equipment) shall be started-up after approval of the Engineer.

During or after the start-up, the performance tests shall be executed, as agreed by the Engineer.

After the technical completion of a main component / functional unit the performance of the functional unit/main component is monitored. If the functional unit/main component is working to the satisfaction of the Engineer **a technical completion certificate** will be issued. Normal operation should be proved based on the daily running journal and other automatically recorded operation parameters. If the component is not working properly, the Contractor shall repair, adapt, etc. the (control of the) component, until the component is working to the satisfaction of the Engineer.

After the completion of Works, a testing period is foreseen. In this period all equipment not tested during the construction phase shall be tested. All performance tests, not executed during the Construction Phase, shall be executed.

During this period the Contractor shall optimise the wastewater treatment process in co-operation with the staff of the plant and a Process Engineer of the Engineer and/or Employer. A minimum of 3 days input at the WWTP shall be provided of the Process Engineer of the Contractor at the end of the Testing Period.

The following tests generally shall be carried out:

* Hydraulic pressure test of the pipes, valves, fittings, in sense that the pressure tested to a head of not less than 1.5 times the designed working pressure;
* Non pressure pipelines will be tested with water (1.2 m head of water above pipe soffit or ground level) or air pumped in by suitable means until a pressure of 100 mm head of water is reached;
* All equipment shall be tested mechanically and electrically to prove that each item or equipment functions as designed;
* All electrical installations shall be tested and the rotation direction and insulation resistance of all motors shall be checked;
* Calibration tests shall be carried out on all instrumentation;
* Water-tightness of reservoirs;
* All pumping station shall be tested mechanically and electrically to prove that each item of plant or equipment functions as designed. Greasing and lubrication systems shall be tested for all plant;
* The capacity and electrical performance of all pumping installations shall be fully tested. In addition, all pipework, valves, penstocks etc. shall be pressure tested, to a head of not less than 1.5 times the designed working pressure;
* The pumps and water network control systems shall be fully tested to demonstrate that the sequence of operation of the plant is correct, and that the plant generally performs in the manner and to the parameters specified. This shall encompass the SCADA system;
* The sewerage flow meters shall be fully tested to demonstrate that perform in the manner and to the parameters specified.

### Maintenance Plan

The Contractor shall :

* prepare and implement a maintenance plan for the WWTP. This plan shall indicate the activities which are required for the proper organisation of the maintenance activities and shall cover, but not be limited to:
* Programs for all maintenance activities indicating frequencies, Plant usage and equipment defects,
* Workshop practices and stores management,
* Plant replacement policy, and
* Check lists for the evaluation of maintenance activities.
* Prepare and maintain a detailed inventory of all items of plant and spares provided for the works.
* A detailed O&M Manual must be provided containing all individual sub manuals for the equipment provided. In addition all required operation and maintenance procedures will be described including routine and ad hoc O&M activities frequency of sampling and analysis of required parameter.
* A list of spare parts, including a breakdown of prices, shall be provided for operation and maintenance of the plant.

### Spare Parts

Spare parts shall be handed over by the Contractor immediately before Taking-Over. The Contractor shall, based on the manufactures recommendation, determine the required spare parts for all equipment and prepare a list of spare parts. The list shall be included in the tender. The Contractors and manufactures selected spare parts shall serve as supplement to the spare parts listed hereunder which only comprise the minimum required mandatory spare parts:

If any of the spare parts are used for the purpose of remedying defects arising during the period of liability, then such spare parts shall be immediately replaced by the Contractor at his cost.

All spare parts shall be strictly interchangeable with the corresponding parts of the Plant. The quality of spare parts shall not be inferior to that of the original Plant. Spare parts shall be adequately protected and packed in suitable containers to withstand storage under site conditions and shall be handed over with four copies of a detailed itemised list of the spare parts.

### Mandatory spare parts

General: The following mandatory spare parts shall be exemplarily considered, but shall not be limited to:

1. Touch up paint for all equipment.
2. Screens:
   * 5% extra bars if appropriate
3. Pumps:
   * 1 set of gaskets for each pump
   * 1 set of mechanical seal for each type of pump
4. Blowers, for each item:
   * 1 set of inlet filters for each blower
   * 1 set of oil filters for each blower
   * 1 set of hydraulic cylinders, if applicable, controlling pre rotation and diffuser position
5. Sand classifier, for each item:
   * 1 set liner
   * 1 screw complete
6. Submerged mixers:
   * 1 set of gaskets for each mixer
   * 1 set of mechanical seal for each type of mixer
7. Aeration grids:
   * 5 % spare diffusers
8. Screw conveyors:
   * Complete set of liners for all screw conveyors
9. Front loader:
   * 4 new tires
10. 1 complete set of lubricants and hydraulic oil.

## Coordination

It is the responsibility of the Contractor to ensure full coherence between the equipment delivered according to the present mechanical specifications and the specifications for electrical and civil works.

The Contractor shall also be responsible for all sub-contractors and suppliers of equipment and materials.

No direct formal communication between the Employer and the sub-contractors will be permitted.

It is the responsibility of the Contractor to secure that sub-contractor and suppliers get all the relevant information of the present specifications.

The Contractor shall appoint and provide an experienced mechanical and electrical Engineer to monitor and co-ordinate all aspects of the mechanical and electrical work.

## On-Site Manufacturing

It is the obligation of the Contractor to provide all installations within the working area as he considers necessary for on-site manufacturing and shaping of materials and equipment. The working site may be used as intermediate storage for equipment at the Contractor's own risk and at his own cost.

It shall be noted, that the Contractor's obligations on taking the necessary safety precautions shall apply for the working camp area as well.

## On-Site Storage and Safekeeping

The Engineer shall be informed by the Contractor about machinery delivery dates as well in advance of the anticipated time of arrival of the items.

In general all equipment shall be stored according to the manufacturer's requirements.

If equipment and/or machinery are to be stored on site the Contractor shall either:

* Adequately package all items to enable the equipment and materials to be stored in the open without any deterioration whatsoever, or
* Provide an approved store, complying with the following minimum requirements:
* Rotating mechanical equipment: Covered, ventilated, dust and vermin proof area.
* Pipes, valves, steelwork etc.: Sheeted on open hard standing area.

The storage site as defined above shall be arranged by the Contractor at his own expense within the contract price.

The Contractor shall be responsible for the operation, safe keeping and maintenance of all equipment on site during storage and after erection up to the issue of the taking-over certificate.

Operation and maintenance of the equipment after the taking-over period and during the Contractor's operation and maintenance period shall be the responsibility of the Contractor.

## Erection

The Contractor shall make his own arrangements for unloading of equipment and materials supplied and shall be responsible for any damage occurred. The Contractor shall at his own expense provide all tools, meters, gauges, temporary provisions as well as skilled and unskilled labour for the erection of the mechanical installations so that it can be installed complete and in good working order.

If required by The Engineer, for the proper installation of all mechanical equipment under this Contract an authorised representative of the manufacturer and its service organisation shall approve the installation and sign together with the contractor a statement with such approval. A form of such statement will be provided by the Engineer.

## Setting of Machinery

The machinery shall be mounted on flat steel packing of thickness selected to take up variations in level of the concrete foundations.

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.

The machinery shall be aligned, levelled and pulled down by the nuts of the holding down bolts with a spanner of normal length. Only grouting of holding down bolts to the approval of The Engineer shall be carried out before the machinery has been run and checked by The Engineer for stability and lack of vibration. Final grouting of shims etc. shall be carried out only after the aforementioned run and check by The Engineer has been completed, approval given, and the grouting area clean and suitable in every way.

## Machinery Finish

All covers, flanges and joints shall be clean, properly faced, bored, fitted, hollowed, moulded or chamfered as the case may be according to the best approved practice and all working works and other apparatus shall in like manner be well and accurately fitted, finished, fixed and adjusted

## Machnery Guards and Labelling

Machinery shall be guarded to prevent injury to persons, and meet international and local safety regulations. Adequate guards shall be supplied and installed throughout the installation to cover all drive mechanisms.

All rotating and reciprocating parts, drive belts etc. shall be securely covered to the satisfaction of the Engineer to ensure the complete safety for both maintenance and operating personnel. However, whilst all such guards shall be of adequate and substantial construction, they shall also be readily removable for gaining access to the equipment.

Guards for machinery shall be constructed of stainless steel mesh or other corrosion resistant material.

Means of set bolts or studs in tapped holes shall attach guards for parts that need to be examined. Selftapping screws shall not be used.

The Contractor shall supply and fit engraved labels and each item of works throughout all installations.

The labels shall be permanently attached in a conspicuous position and shall detail the design performance, function manufacturer’s identification and system identification. In general the function and system identification shall be separately labelled.

All indicating and operating devices shall have securely attached to them or marked upon them designations in English and the project country language as to their function and proper manner of use. Items such as valves shall have indicated direction of rotation for closing and opening.

Only non-flame-propagating materials may be used for place and labels.

Inscriptions shall be permanently engraved and, in general, a dark inscription on a light background shall be provided.

The proposed style, label material, inscription, location and means of fixing shall be submitted to The Engineer for approval. Embossed materials and techniques will not be accepted.

Where withdraw able or detachable equipment is provided, both the fixed and moving or detachable portions shall be similarly labelled.

The Contractor shall arrange for the supply and fitting of warning labels for all machinery operated under automatic control. All identification information and warning labels shall be in English and the project country language.

Labels shall be provided to warn of dangerous or potentially dangerous circumstances or substances.

Inscriptions on danger labels shall start with the word “DANGER” and be white on a red background in the project country language.

Inscriptions on caution labels shall start with the word “CAUTION” in the project country language.

Instruction labels shall be provided where safety procedures are essential to protect operating and maintenance personnel from hazardous or potentially hazardous conditions, e.g. advising the isolation or earthling of electrical circuits or the wearing of protective clothing.

In addition to the above works identification labels the Contractor shall ensure each item of machinery shall have a manufacturer’s identification/rating plate detailing the following:

1. Manufacturer’s name and address
2. Model/type identification
3. Serial number
4. Year of manufacture
5. Appropriate rating details
6. Other relevant details, limitations, etc.

For electrical panels, switchgear, etc., labelling shall be as follows:

1. All external labels shall be clear perspex back-engraved in the project country language, filled black and back-painted the same colour as the panel. Edges shall be chambered. The labels shall be affixed with chromium-plated nuts and bolts;
2. All internal labels shall be engraved multi-layered plastic affixed with chromium-plated nuts and bolts;
3. Each compartment door shall have a title and each door-mounted component or control shall have a function label;
4. Every internal component shall be identified and fuse shall be labelled with identification of fuse type or fuse current capacity;
5. Compartments with doors or covers not interlocked to the isolator shall have an external label affixed thereto as follow: “DANGER LIVE TERMINALS” with flash and voltage in which letters on red background in the project country language.

All labels shall be removable to facilitate replacement by an equivalent sized label should the need arise.

## Suppression of Noise

All equipment offered shall be quiet in operation unless otherwise specified.

In addition, the noise level at a distance of 1 m from each sound-producing piece of mechanical equipment shall not exceed 85 dB (A) unless otherwise specified in local i.e. National ( Project country) standard (NS)

The noise level within any building shall not be more than 70 decibels “A” scale when measured along a contour 3 m from any single item of equipment during starting, running and stopping, subject to a tolerance of +/-5% on this over the audible frequency spectrum measured at mid band.

The noise level outside each building shall not be more than 55 decibels “A” scale when measured along a contour 3m from the external wall subject to a tolerance of +/-5% on this over the audible frequency spectrum measured at mid band.

Noise test measurements shall be made on completion of the installation of the equipment at Site to verify that it complies with this Specification. Equipment, which fails to comply with the noise level limits when tested, will render it liable for rejection unless it is satisfactorily modified at the Contractor’s expense by the programmed commissioning date.

## Lubrication

Equipments shall be adequately lubricated by systems, which require attention not more frequently than weekly during continuous operation. Lubrication systems shall not require attention during start-up or shutdown and shall not waste lubricants.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easy accessible from the normal operating area or platform. Drains shall be located so as to allow collection of waste oil into containers without removing the equipment from its normal position ( except some pumps which have to be pulled out from working media).

Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, start-up and operation prior to acceptance of the equipment by The Engineer.

Sufficient lubricants shall be supplied for operation of the plant during the entire defects liability period. The quantities shall be based on operating hours of 24 hours per day.

All bushes and ball or roller bearings shall be arranged for grease gun lubrication. Grease nipples shall be standardised.

Provision shall be made in the design to prevent the over lubrication of any part. It is preferable that routine lubrication of the works shall be kept to a minimum.

Grease lubrication systems shall preferably be of the pressure type designed so that adjustment or recharging is not required more than once per thirty days under normal operating conditions. Grease application points shall be easily accessible and where needed, extension piping shall be provided. When a number of such points can be grouped, they shall be brought to a rigidly constructed battery plate and each point shall be clearly labelled. A permanently labelled grease gun shall be supplied for each type of grease required and each standard type of nipple fitted.

Oil lubrication shall preferably be of the re-circulating reservoir type, which automatically maintains the correct oil, level and shall be designed for continuous normal operation for long periods. Sight glass level indicators shall be fitted on all oil reservoirs, and the levels shall be easily read over the maximum operating range. Re-circulating oil lubrication systems shall be provided with an external replaceable filter element.

The level indicators shall be simple to dismantle for cleaning, clearly marked, with the minimum, normal and maximum oil levels at normal running temperatures, and shall show the normal filling level at design ambient temperature. The sight glass shall be positively protected against mechanical damage.

Particular care shall be taken in arranging lubrication points to protect the works and the process water from accidental contamination. Catch trays, drip trays, screens and the like shall be provided throughout the works.

The type of lubricants and intervals of lubrication for each individual item of works shall be entered on a working schedule, which shall form part of the operating and maintenance instructions.

A complete draft of this schedule of recommended lubricants, with their trade names, their purpose, viscosity, etc., container size and life, and the name of the manufacturer (preferable one only) and his local supplier shall be submitted to The Engineer for approval before the schedule is incorporated in the draft operation and maintenance instructions.

The number of different lubricants shall be kept as small as possible.

## Location and Alignment

Where separate items of interconnected works, such as motors, couplings gearboxes and similar items depend upon correct alignment for satisfactory operation then each and every item shall be positively located in its correct operational position by means of dowels, locating pins, fitted bolts or other approved means to ensure that correct realignment can be easily achieved when reassembling the items after removal for overhaul

## Flexible Couplings

Couplings, where supplied, shall be rated to cover the full range of duty and shall be of the flexible multi-pin and bush type having not less than six bushes and each bush shall have an inner sleeve to allow rotation on the pin (bushes shall not be in direct contact with the pin). All pins shall have shoulders to allow positive location and securing to the coupling flanges, bosses shall be a tight fit on the shafts and secured with hand fitted keys.

Couplings shall be supplied in matching balanced sets and shall be dynamically balanced and marked before leaving manufacturers works.

## Standard Gearboxes

Standard enclosed gearboxes for machines shall be obtained from an approved manufacturer where necessary. The gearbox shall be designed to operate with the output shaft oriented at the required angle of inclination without lubricant leakage. The input shaft shall be horizontal where possible and appropriate.

All gearboxes shall be suitable for outdoor installation and shall be derated considering continuous operation and heavy shock loads. Service factor shall not be less than 2. The thermal power rating of the gear reducer shall exceed the motor power after derating for 40°C ambient temperature. The gearbox selection shall be checked for momentary overloads, and overhung radial and thrust loads.

Gearbox housing shall be of rigid high-strength close-grained cast iron with provisions for:

* Proper closing inspection cover;
* Ventilation opening;
* Oil level gauge;
* Gauge window protection.

The ingress of moisture into the gearbox shall be prevented and splash and leakage water etc. must be able to drain off easily.

The transmission of power shall be achieved by means of precision gears. Helical gears shall be used. Cylindrical gears having helical or herringbone teeth shall be precision ground for close tolerance operation. All gears shall be amply designed, both regarding surface durability and strength, guaranteeing a life span of at least 100,000 hours running.

The gearbox shafts shall be solid forgings of the parallel type; precision ground and made from heat-treated hardened and tempered chrome-molybdenum alloy steel.

Gear-box shafts shall be mounted on tapered roller bearings or double row self-aligning spherical roller bearings (or as recommended by the gear-box manufacturer) capable of handling radial and thrust loads simultaneously and guaranteeing a life of at least 60,000 hours running.

Lubrication of the gear teeth surfaces shall be achieved by being immersed in the oil contained in the gearbox housing. For this purpose the gearbox shall be oil-tight and shall be such as to prevent the total loss of oil from the gearbox in the event of the failure of the oil seals. The whirling oil and the oil dripping from the surfaces shall lubricate the bearings.

Where immersion or splash lubrication is not effective, gears and bearings shall be lubricated automatically by a forced lubrication system. Lubricants shall be as or the equal to that recommended by the manufacturer of the gearbox.

Provision shall be made in the design of the gearbox for oil filling and drainage. If the drain is not easily accessible, the gearbox shall be equipped with an outlet hose and small hand pump.

The gearbox shall be provided with a flexible overload coupling (including safety guards) between the motor and the input shaft of the gearbox. Parts subject to wear must be easily replaceable without disassembling the motor.

Particular care shall be taken in designing gear-box arrangements to protect the works or water under treatment from contamination arising from accidental overflow, any future leakage due to excessive wear, seal failure, or poor filling or drainage practices. Drip and catch trays and the like shall be generously provided throughout the works.

## Bearings

All bearings shall be rated and sized to ensure satisfactory and stable running without vibration under all conditions of operation for a minimum running life of 60,000 hours. They shall be sufficiently lubricated and adequately protected from ingress of moisture and sand and the particular climatic conditions prevalent at the Site. All bearings shall be to ISO standard SI unit dimensions where practicable

# Pumping Equipment

## Pumps Design

### General

The whole of the pumping works, machinery and apparatus shall be new and of first class manufacture.

The pumping unit design and performance shall have been demonstrated by previous successful operation of pumps of the required type and of equal design complexity by the manufacturer.

Contractor should liaise with the supplier of the pumps during the design stage and agree the detailed pump requirements and specifications to ensure that the optimum pump, representing the lowest total cost of ownership is specified for the duty.

The design of sumps shall be in accordance with the suppliers recommended dimensions to obtain a high efficiency of each pump.

Pumps shall be delivered with all protection as recommended by the manufacturer for safe and long term functioning.

For the purpose of the Contract, the following definitions shall apply:

1. “Design point of performance” - means the total head developed between the pump unit inlet and outlet connections.
2. “Static head” - means the difference between the free water surface level on the suction side of the pump and the delivery level.
3. “External works friction head” - means the head required to overcome friction external to the pumping station and velocity head at the outlet of the pumping main.
4. “External works losses” - means the friction and turbulence losses in all pipework and valves included in the pumping station beyond the pump delivery flange.
5. “Internal works turbulence losses” - means the friction and losses in the pump and suction pipework up to the pump delivery flange.
6. “Total head” - means the sum of (b), (c), (d), and (e).
7. “Net effective lift” - means the sum of (b) and (c).

The pump shall have a continuously rising head characteristic with decreasing capacity over the required range of operation specified. The pump shall not have an unstable operating characteristic over the required range of operation

Characteristic and system curves for the pump against the various static heads to a reasonably large scale, shall be supplied with the tender and when tested through their complete range of workable heads at the manufacturer’s works, the pumps shall give results which conform to the said curves. The curves shall also show pump efficiency and kW loading. Pump testing to be carried out according to regulations as set out by the German Hydraulic Institute (or equal EN norms).

The Contractor shall order pump manufacturer to establish and state in the operating manual the procedures for starting and stopping the pumps, including setting of valves or any sequential operations.

Where pumps are working in parallel curves for solo operation and all the various possible parallel combinations shall be submitted. It should be noted that under solo operation the pump output will increase owing to the pump and system characteristics and the pump shall operate satisfactorily for long periods under these conditions without motor overloading.

The system design and pump curves shall illustrate the design conditions with operational efficiencies and power demands illustrated on the systems curve or envelopes and shall take account of at least the following conditions:

1. When the pipework is new and in good condition;
2. When the pipework is older;
3. The full range of static heads occurring in the works;
4. The various possible combinations of parallel pump operation.

Where possible 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 submitted which shall be compatible with that available to enable the pump to operate, without cavitations over the full range of flows at all liquid levels.

The design speed of any pump shall not exceed 1,500 rpm. Pump unit assembly design and the method of supporting rotating assemblies shall ensure that no unit or shaft operates at a speed within 25 % of any critical speed.

The rotating parts of each pump shall be supported by substantial bearings. The design shall be such that no thrust is transferred from the pump to the motor shaft where these do not form an integral unit. The combined thrust and journal bearings shall be capable of reverse rotation at 150 % of full forward speed.

Dry installed pumps shall be equipped with double acting mechanical seals with sealing water /sealing liquid connection and shaft sleeve. Submersible pumps shall be equipped with double acting mechanical seals with leak detection sensor in the oil chamber between the two seals. All mechanical seals shall be of material SiC/SiC. Where shafts are susceptible to wear at bearings and glands, renewable sleeves shall be fitted. Wear rings and bushes shall be fitted to the casing and impeller at the points of running clearance. Where sealing and lubricating water is supplied to bearings and glands, it shall be free from suspended solids and the associated pipework shall be fitted with air release cocks and flow indicators.

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, cooling water discharge pipework, gland leakage pipework, air release pipework, pressure gauges, gauge pipework, holding down bolts, access platforms and other items as appropriate. Where practicable, pressure gauges shall be wall mounted.

Apertures in pump head stools shall be guarded and, if outdoors, the guards shall be of solid polycarbonate or acrylic plastic to offer protection from wind and airborne particles.

All studs, bolts and nuts used in the construction of the pumps shall be of stainless steel.

All intermediate shafting between pumps and motors shall be provided complete with adequate guards.

All pumps, where possible, shall be of the same manufacture and design to simplify spares requirements and maintenance.

### Pump Motor

The Contractor must ensure that the pump motors provided shall be of sufficient power, without overloading, to drive the pumps when operating at the worst static head conditions and when operating against worst pressure condition on Site at an ambient temperature of 40°C.

The motors shall comply with the requirements of the Electrical Specifications in these TR

The Contractor shall in his offer give details of motor power requirements; pump configuration and pump-motor set assembly dimensions.All pump motors shall be equipped with thermal switches in the motor windings as a safeguard against overheating.

All motors shall be prepared for variable speed operation, capable of fully utilizing the available power.

### Pump Bearings and Seals

The rotating element shall be carried on ball and/or roller bearings generously rated to ensure satisfactory and stable running without vibration under all conditions of operation. Bearings shall be suitable for an ISO B10 minimum service life life of 60,000 hours at the pump speed.

1. All bearings shall be according to DIN standard and/or other internationally acceptable standards. ; SI unit dimensions where practicable.
2. Pump bearings shall be external to the pump casing and be removable with the rotating element.
3. Pump bearings shall be adequately rated ball or roller type and shall be arranged to take all radial and axial loads during start-up and running conditions.
4. Pump bearings shall be mounted in dust-proof housing and provided with accessible lubricating points for grease gun greasing.

Seals shall be provided to protect the bearings from ingress of moisture, dust, sand and the particular climatic conditions prevalent at the Site.

### Connecting Flange

Connecting flanges of horizontal and vertical split casing pumps, single end suction pumps and centrifugal sludge pumps shall be pressure rated to PN10 to DIN 2462 (or internationally acceptable standards).and shall incorporate two adjacent tapping plugged unless otherwise specified. Flanges shall be machined on face and edge and spot faced at the back.

### Pressure Gauge

The gauge mechanism shall be of the bourbon tube type on 100 mm diameter having stainless steel movements and shall comply and be tested in accordance to DIN 16064 (or internationally acceptable standards).

1. Gauge graduations shall be such that the gauge is never used continuously beyond 60 % the max. graduations. Pressure gauges shall be graduated in bars or milli-bars.
2. The face of the dial shall have a warning label marked in red attached thereto, reading “IMPORTANT : TURN OFF WHEN NOT IN USE”.
3. All gauges shall be provided with glycerine filling to dampen pressure pulsation.

As far as possible, all pressure gauges shall be mounted either on walls, pump supports or brackets that do not have any vibration. Direct mounting at the pressure gauges on the pump casings or pipes must be avoided. They must also be mounted at a height suitable for ease of reading.

### Anti Surge Vessels

Anti surge vessels on pumping mains shall be air/water pressure vessels, the function of which shall provide a reservoir of water to prevent ‘column split’.

The vessel shall be of the fusion welded type manufactured in accordance with BS 5276 part 4 and BS 5500 or correspondent EN DIN norm, having a vertical configuration. The ends shall be dished and the vessels shall be provided with fabricated vertical supports. The working pressure shall be in accordance with the installation requirements and the test pressure shall be 1.75 times the working pressure.

The painting of the vessels shall be in accordance with chapter Preparation and Painting Works”, surface ‘B’ inside and surface ‘C’ outside.

The following fittings and instruments for a nominal pressure of 16 bars shall be provided:

* sight-glass and guard complete with top and bottom isolating cocks and a bottom blow down cock
* spare sight glasses shall be provided)
* Inspection manhole, 500 mm in diameter and bolted with galvanized bolts
* 20 mm air inlet valve and check valve at the top of the vessel
* 20 mm air relief valve at the top of the vessel to open at 20 bars
* 20 mm air bleed valve at the top of the vessel
* Water inlet with 200 mm tee and valve for draining, at the bottom (dimension of water inlet in accordance with the application)
* Ultra sonic level transmitter at the top
* Galvanized steel ladder to the top
* 20 mm galvanized pipeworks to the air compressor.

## Pump Types and Applications

### General

Pumps are in general classified as Centrifugal Pumps (or Roto-dynamic pumps) and Positive Displacement Pumps.

As per further classification **Submersible pumps** are type of **Centrifugal Pumps** mostly used for the purpose of fluid transport in WWTPs. Other types can be: axial-flow pumps, vertical multistage pumps**,** horizontal multistage pumps**,** end suction pumps**,** in-line pumps**,** double suction pumps**,** self-priming pumps,regenerative pumps etc

**Positive Displacement Pumps** are also further classified and among them there are type of pumps which are the most used in WWTP for dosing of chemicals : **Reciprocating pumps** ( piston, plunger and diaphragm) and most used for transport of heavy fluids: **Rotary pumps** ( progressive cavity, screw, gear, lobe, vane, and peripheral ). Power pumps and Steam pumps as also positive displacement type pumps not commonly used in WWTPs.

### Centrifugal Pump

Centrifugal pumps characteristics shall be stable with the delivery pressure falling continuously from a maximum at the closed delivery valve condition. Characteristics shall be non-overloading and unless otherwise specified all pumps shall be suitable for parallel operation with other pumps delivering to the same system. Except for axial flow pumps, all pumps shall be capable of being started and run for short periods with their delivery valves closed.

Pumps shall be designed to handle sewage, sewage effluents and sludge and shall run unattended for long periods. They shall be capable of passing solids up to a maximum sphere size of 100 mm or 3 mm less than the smallest branch size; they shall pass stringy matter, rags, paper and plastics without choking.

The peripheral speed of the impeller blades shall not exceed 25 m/sec at the specified duty.

The critical speed of the pumps shall occur at not less than 150 % of maximum rated speed.

The shut off head shall be as low as possible preferably around 160 % of duty head.

Net positive suction head (NPSH) required for the pumps when pumping singly or in any combination as specified shall satisfy the NPSH available. The calculations have to be submitted to the Engineer. Any deviation in NPSH of pumps shall be corrected on Contractors responsibility and expense.

Rotating parts of pumps shall be statically balanced during manufacturing and dynamically balanced after assembly.

Casings shall be so designed that the withdrawal of the impeller and drive end cover assembly can be affected without disturbing the pump casings.

Hand holes shall be provided, close to the eye of the impeller and near the delivery branch on the volute to facilitate inspection and the clearance of blockages. The covers to the hand holes are to be bolted and shaped internally to match the internal contours of the casing and to minimise disturbances to the flow.

Renewable internal “wear plates” shall be fitted or the casing shall be arranged for replaceable suction and gland plates.

Casings shall have sufficient metal thickness in the volute where not protected by wearing plates to compensate for corrosive and abrasive action of the sewage.

Casings shall have accesses manufactured for top and bottom wearing rings shaped in a way that after fitting the rings a smooth internal profile is obtained and the casing is continuously protected by renewable parts from the inlet to the impeller vane tips.

Impellers shall be designed in order to reduce the specific power demand to a minimum on the highest efficiency, i.e. “N-Series” type impellers shall be applied.

Impellers shall be constructed of best nickel cast iron, stainless steel or similar . They shall be smooth, well finished, and free from blowholes and imperfections, statically and dynamically balanced.

The impellers must be of the self-cleaning unshakeable type and whenever possible of the non-shrouded type. Impeller shrouds shall have rudimentary vanes designed to keep grit, solids and foreign matter away from the eye and neck bush.

The impellers shall be securely fitted to pump spindles in such manner that they do not loosen or become detached when the pump is in operation, or when the impeller is rotated in the wrong direction by reversed flow or reversed motor connections.

The impellers shall be provided with means to prevent abrasive matter getting to the glands and, in fully shrouded impellers, to prevent the collecting of matter between the outer shroud and the pump casing.

Pump spindles shall be of stainless steel or high tensile steel and fitted with renewable stainless steel, nickel chrome or bronze sleeves to protect the spindles against wear over the distance it passes through the stuffing box.

Casing wearing rings shall be of best quality close-grained cast iron or nickel iron in a full circle and fully concealed and machined.

Casing wearing rings shall be deep and of adequate section to prevent sag and distortion when not in the seating and when stored.

Casing wearing rings shall be a light drive fit in the casing and be located in suitable recesses machined in the casing.

Casing wearing rings shall form a continuous and smooth surface without gaps or steps with the adjoining surfaces of the pump casing.

Intermediate shafting between vertical spindle pumps and motors shall, whenever possible be by “Hardy Spicier” transmission shafting with a splined slip joint above the pump and universal flexible couplings with needle roller bearings.

When the transmission requirement is too great for 'Hardy Spicier' shafting, solid transmission shafting may be offered with rigid flange type couplings utilising fitted bolts.

Every length of transmission shaft complete with couplings shall be dynamically balanced.

The weight of transmission shafts shall be carried by trust bearings in the motor mountings.

Where intermediate bearings are required to steady the shafting, independent bearing supports must be provided.

All intermediate bearings must be provided with facilities for greasing and those in inaccessible locations must be piped to a common greasing manifold.

A 20 mm bore drainage pipe shall be provided for vertical spindle pump from the invert of the sill on the top cover and leading down into the floor drainage channel to allow drainage of gland seepage water.

Each centrifugal pump shall be provided with air release valve and pipe.

Air / gas release pipe mounted at the top of the pump delivery branch of not less than 25 mm diameter. The pipework shall be arranged with crosses and tees and plugs at each section to permit rotating of each leg of the pipework.

An automatic air release valve shall be fitted into the air/gas release pipework at a position convenient for maintenance.

The suction arrangement leading to the eye of the impeller shall:

* Be of best quality close-grained cast iron and of adequate thickness to provide for the abrasive and corrosive action to sewage.
* Be tested to the same pressure as the pump casing.
* Be fixed to the pump casing and horizontal suction pipe with bolts and nuts.

The suction arrangements shall avoid peroration in the suction pipework and present a good flow pattern at the entrance to the impeller. The suction pipework shall not be less in diameter than the eye of the impeller.

If “water hammer” is possible, the necessary precautions shall be applied. In such cases the preventive measures shall be described. Waterhammer calculations shall be included when long discharge lines exist. The reverse speed shall be calculated assuming power failure and discharge valves fail to close

### Positive Displacement Pumps

Positive displacement pumps (eccentric pumps), whether rotary or reciprocating, shall be self-priming and of the horizontal helical rotor and fixed stator type. They shall be driven by electric motors and mounted together with their motors on a combined base plate or frame. Rotors shall be long enough to provide more than 360 degrees of helical passage.

**Progressive Cavity Pumps**

PC Pumps are positive displacement pumps and are comprised of two primary components. During operation, the rotation of the rotor combines with the precise elastometric geometry of the stator. The complex interaction of these two parts creates a series of cavities within the pump. These cavities progress up the pump during operation and carry fluid to the surface, driving production.

Pumps shall be provided with dry running protection (DSP) of the rotor by conductivity sensor or thermal stator protection. Max. relative velocity between stator and rotor to be 1 m/s.

Pumps shall be provided with pressure relief valves to prevent generation of excessive pressures and, unless specified otherwise, means to minimise pressure fluctuations. Pressure relief valves may be integral parts of the pumps or fitted externally. Liquid bled off from pressure relief valves shall be returned to the suction side of the pump or to the suction sump.

Positive displacement pumps, which are belt driven, shall incorporate means to prevent overstressing the belt drive by using a torque-limiting clutch.

Positive displacement pumps comprising, but not limited to:

1. Horizontal dry-mounted pump
2. Common base plate for pump and motor
3. Three phase motor
4. Progressive cavity type complete with hand-wheel controlled variable speed drive
5. Pressure switch for overpressure protection and temperature control element for stator protection
6. Suction switch for low pressure protection and temperature sensing element for stator protection

Pump and motor units shall be continuously rated. All components shall be capable of renovation during overhaul and all replaceable components shall be readily available.

The pump shall be from within a standard range and shall operate satisfactorily over the range of duties.

If the pumped medium contains abrasive solids, the maximum rated speed shall be de-rated and the pressure per stage of the pump set shall be limited as follows:

| **Level of Abrasive Solids** | **Maximum Pressure Per Stage (bar)** | **% of Maximum Speed** |
| --- | --- | --- |
| None | 6 | 100 |
| Light | 5 | 75 |
| Medium | 4 | 50 |
| Heavy | 3 | 25 |

The pump set shall be mounted on a single, rigid base plate. The base plate shall prevent distortion under all operating conditions and it shall include locally reinforced holes for foundation bolts. The spacing of the hole centres shall ensure that the pump set can be accurately aligned.

The base plate shall be designed to prevent the formation of trapped air pockets during grouting and in such a way that water and debris cannot collect when the unit is in service.

The pump casing material shall be suitable for the environmental conditions and the fluid being handled. It shall further be capable of withstanding all pressures that may be generated by normal operation of the pump and shock loadings caused by solids in the pumped flow.

Stators shall be of synthetic rubber moulded into a rigid outer barrel. The pump stators shall be moulded from high quality resilient synthetic rubber bonded to an external steel sleeve to ensure dimensional stability of the stator. However, for low capacity/low pressure applications, a free-moulded stator is an acceptable alternative. Where such an alternative is offered by the Contractor, details shall be provided with the tender submission. In applications where synthetic rubber is chemically incompatible with the pumped media, the Contractor shall select a suitable alternative and state his selection in his technical proposal.

The pump rotors shall be of corrosion resistant material with a hard plated coating or abrasion resistant, hardened tool steel.

The Contractor shall select the appropriate material for the application and provide full details with the tender submission.

Nevertheless, materials specification requirements shall be as minimum:

* Casing parts in contact with media grey cast iron 25
* Shaft Cr-Steel 1.4021
* Coupling rod Cr-Steel 1.4021
* Rotor hardened tool steel 1.2436
* Stator Perburan SB
* Shaft sealing gland packing or equal

Suction and delivery connections shall be flanged.

The suction and discharge connections shall be designed so that they can be re-oriented in 90º steps.

The suction casing shall be provided with access ports to allow clearance of blockages and inspection of rotor drive components.

The transmission system shall comprise either a purpose designed shaft solidly connected to the pump rotor and to the input drive shaft or a shaft jointed to the pump rotor and the input drive shaft via ‘sealed-for-life’, lubricated pin joints. Access to the drive assembly shall be afforded without the need to disassemble the pump casing.

The sealing arrangement for the pump shaft shall incorporate mechanical seals.

Lifting points shall be clearly identified on the equipment and be located to give a balanced, safe lift.

Pump sets shall be provided with mechanical and electronic over-pressure and electronic dry running protection.

The pump unit, base plate and other arrangements shall be painted in accordance with Appendix 1: “Preparation and Painting Works”, Surface ‘C’.

# General Equipment

## Conveyor

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

Construction of the conveyors shall be of a proven manufacturer design complying with the requirements specified in these TR inclluding 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.

**Submittals**

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

**Shop Drawings** for equipment shall consist of the following as minimum:

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

**Quality Control Records**

* Manufacturer’s Certification of Compliance.
* Material certificates.
* Performance test records and certificates.
* Calibration certificates.
* Other relevant test records and certificates.

**Storage of Conveyors**

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

During handling, conveyor shall be supported by full length in order to avoid structural twisting. 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 stored in clean and dry environment to prevent distortion.
* Preferably, conveyor and its components shall be installed inside the room and shall be covered to protect its machined surface.
* Conveyor and its components shall be stored in sleeping position and shall not be stacked together.
* Conveyor motor shall be stored inside the room.

### Screw Conveyor

Screw conveyors are required to transmit both coarse and fine screenings, dewatered sludge and other debris from the discharge of other conveyors and machines. They shall be of a proven non-clogging design.

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

General design features of the conveyors shall be as follows:

1. The supporting framework is to be fabricated from stainless steel profiles or stainless steel tubes and is to be of fully welded construction. Sufficient connection pieces for mechanical stiffening are to be provided;
2. The trough shall be U-shaped with bolt on cover plates of stainless steel according to DIN 17440 with plastic or rubber wear liners and incorporate a fully enclosed discharge chute;
3. The shaftless spiral shall be of special hardened steel;
4. Geared motor; EExd Il B T4, insulation class F.

Unit to be arranged under machine discharge chute, incl. chute adapter for connection of the discharge to the media chute of the screw conveyor, incl. overload protection and local terminal box and emergency stop breaker.

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.

### Belt Conveyor

Belt conveyors shall be of the modular trough belt type for conveyance of screenings, dewatered sludge or other debris. 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 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.

General design features of the conveyors shall be as follows:

1. The conveyor frame and sub-frame shall be hot dip galvanized mild steel, all fixings shall be hot dip galvanized mild steel or stainless steel;
2. Geared motor; EExd Il B T4, insulation class F;
3. The conveyor belt shall be plain 2-ply nitrile rubber 800 mm wide running at 0.8 m/s;
4. Belt idlers shall be twin roll 50mm diameter roller bearing through set at 600 mm centres bolted into slots to allow belt tracking adjustment. Belt return rollers shall be drop in disc type to give reduced belt contact;
5. Drive and idler drums shall be fully guarded;
6. The conveyors shall be fitted with side plates to ensure that the screenings are retained on the belt and suitable arrangement shall be made to drain the belt of any excess liquid on the channels;
7. There shall be fitted under the driving discharge drums a counter balanced type belt scraper with renewable rubber blade to remove all matter which remains clinging to the belt;
8. The conveyor shall be equipped with a splash-guard with drainage connection mounted underneath over the whole length.
9. The capacity of the belt conveyor shall be designed with sufficient safety factor and the characteristics of the transported material shall be considered

Unit to be arranged under machine discharge chute, incl. chute adapter for connection of the discharge to the media chute of the conveyor, incl. overload protection and local terminal box and emergency stop breaker.

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

## Container

### Container

Commercially approved waste container for screenings, sand, sludge and waste disposal, with strengthened bottom sheet and tilting bearings for service truck, drain with connection line into screen channel/pumping station.

1. Container in accordance to local i.e.National (Project country) standard, DIN 30720 or equal European Standards;
2. Material: sheet steel St 37, shotblasted SA 2,5 with 1 prime + 2 final coatings;
3. Volume: 1 m³

Containers form the type used by the municipal services shall be preferred.

### Standard Container

Commercially approved waste container for screenings and sand disposal, with heavy-duty wheels and covering, drain with connection line into screen channel/pumping station.

1. Container in accordance to locally approved standard;
2. Material: sheet steel St 37, hot dip galvanized or GRP;
3. Volume approx. 1.1 m³

Containers form the type used by the municipal services (0.4 m³) shall be preferred.

### Container vehicle

A container vehicle shall be provided for movement of the filled waste containers.

General design features shall be as follows:

1. Transportation platform and travelling gear made of profiled steel as welded and robust construction;
2. Travelling gear with pivoted bogie (front axle) with drawbar and standard trailer coupling;
3. Fixed back axle with parking brake;
4. Wheels in heavy duty design, with rubber tires with a diameter not less than 400 mm;
5. Safety work load shall be 1.25 x filled container load: > 10 to (3 m³ container)
6. Complete construction made of galvanized steel.

## Ventilator

Axial ventilator for wet-ambient application with direct coupled drive in sheet steel housing with protective guard, wall mounted.

General design features shall be as follows:

1. Capacity: in accordance to 7-10 room-volume changes per hour;
2. Differential pressure: > 40 mm;
3. Air velocity: < 3.5 m/s;
4. Ex-prove drive unit (if required) 230/400 V/50 Hz, E Ex E II T3, with overload protection;
5. Accessories: outside weather guard and inside protective guard;
6. Material: frame and connection pieces: stainless steel, SST

Unit comprising sheet steel housing with installation flanges in square of circular design for installation in a wall-box-out, with welded support for the electric drive.

Ventilator with variable position profiled vanes with manual adjustment, c/w. in- and outside protection and weather guard, terminal box and local control switches.

## Cranes

### General

Travelling cranes shall be manually or electrically operated and include travelling bridge, crab and hoist, electrical motor gears and plant where applicable, operation and maintenance instructions and all other necessary items like bolts, buffers, fixings, etc.

Cranes, if electrically operated, shall be supplied complete with flat cables on roller suspensions, controls and motor gears giving speeds in both horizontal directions of 15/5 m/min. The hoisting speed shall be approximately 2 m/min with crawling speed of 0.2 m/min.

Electrical cranes shall be controlled from the floor by a mobile pushbutton master controller movable along with the crab or the hoist to control movements in all directions and speeds.

The single or double girder crane bridges shall be the underslung type and be fabricated from universal beams or high grade steel plate box section girders which, together with end carriages of rolled steel sections, shall form a single welded fabrication adequately braced and stiffened to give a rigid structure capable of withstanding all loads imposed.

Double girder bridge beams shall be fitted with crab rails securely welded to their upper flanges.

The flat bottomed crane rails to BS 11 shall be complete with all fixing bolts, holding down bolts, fishplates, end stops, buffers, etc. The crane rails shall be supported on steel supports bolted to columns.

Allowance shall be made for expansion of the rails.

The end carriages shall be provided with derailment and wheel brake protection, preventing the carriages falling more than 10 mm.

The long and cross travel wheels shall be double flanged and be made of forged or cast steel. The rims of the wheels shall be machined accurately to same diameters and with a form fitting the rails. The wheels shall be fitted with roller bearings and be at least 250 mm in diameter.

The travelling bridge shall be fitted with four buffers as end stops in conjunction with stops at the limits of the travelling. The buffers shall absorb the kinetic energy from the dead load of the crane.

The travelling gears and the hoists for electrically operated cranes shall be driven by electric motors fitted with automatic electro-mechanical brakes for the motors and automatic limit switches for the hoists. The brakes shall be the heavy-duty type, which shall engage automatically when the power supply is cut or fails.

The motors shall be capable of working continuously at full load for one hour and shall have the enclosure protection form IP 54.

Safety devices such as fuses, relays for overloads and limit switches, alarm bells, etc. as well as the main switch for the crane shall be located in a separate cabinet. This cabinet shall also house the transformers for the control circuits and the fuses.

Electrically driven cranes shall have speeds in both horizontal directions of normal 10 m/min. and crawling 1 m/min. The hoisting or lowering speed to be normal 4 m/min. and crawling 0.4 m/min.

The rope pulley shall be as specified in relevant standard. The crane hook shall be designed for the relevant load and comply with standards, made from Grade 30 carbon steel to BS EN 1677 or equivalent, and capable of swivelling through 360 degrees. A ball swivel device shall be incorporated into the hook as specified above.

The gearings shall be totally enclosed in gear boxes and running in oil. The wheel gears may be grease lubricated.

The maximum load of the crane shall be marked on the crane with painted figures in the project country language easily readable from the floor.

The complete crane shall be painted in accordance with chapter described in these TR, specification for *Painting and Protective Coating*

Before handing over to the Client, the crane shall be tested with a load of 125% of the maximum marked load in accordance with the applicable standard.

### Monorail Crane

Monorail crane with electric hoist with geared hand travel, with four-wheel trolley and rolled steel joist to be installed above pumps, screens and others.

General design features shall be as follows:

1. Save working load: two times heaviest piece;
2. Lifting speed: > 3 m/min;
3. Crane rail: length and profile as required, with supports;
4. Crab type: monorail electro cable;
5. Standard: acc. to DIN 15020 or equal
6. Design/art: spur gearing overhead crane with chain and chain box for manual/electric operation with push-button unit;
7. Power supply: 400/230 V/ 50 Hz by as tow-cable with carrier-tappet, feeder;
8. Class of protection: IP 55;
9. Ex-protection: E Ex E II T3;
10. Material of crane: ST 37 with prime and final coating.

Unit comprising spur gearing overhead crane as common in trade, as applicable with manual or electrical drive unit.

### Lifting Davit

Movable and detachable, manually operated swivelling crane with quiver for submersible mixers and pumps lifting.

1. Loading capacity: according to weight of mixers and pumps (1.5 times heaviest piece);
2. Reach: as required in particular design requirements
3. Swivel-angle: 360 º;
4. Accessories: cable winch with approx. 12 m traction rope and davit socket (alternatively SST chain);
5. Material of column/swivel: SST or mild steel, hot dip galvanized, cable sheaves made of PA, connection pieces made of stainless steel.

Crane made of profile steel, with davit socket and swivelling lifting device of easy motion, incl. block and tackle.

## Blowers

### Roots Blower

Roots blower with sound protection hood for compressed air generation. The blower assembly shall incorporate a pressure relief valve; start up relief valve and non-return flap valve.

General design features shall comprise, but not limited to:

1. Roots blower manufactured in accordance with EN DIN 1945 (ISO 1217) with an admissible tolerance of ± 5 %, referred to the power consumption and the intake volume, with inlet and outlet branch positions, to be arranged suitable to the pipework configuration, inlet filter including filter maintenance indicators, connecting pipework (max. velocity of 13 m/s);
2. Delivery branch with flexible joints to be provided with an acoustic bend or silencer in the delivery branch, incl. drain at the lowest part and reflux valve;
3. Housing to be provided in cast iron, with cast-in pre-inlet channels in the discharge side cylinders part to minimise the sound by pulsation reduction;
4. Rotors made of carbon or cast steel, drop-forged in one piece and finished to an accurate contour, with an integral shaft, and statically and dynamically balanced;
5. Gears between the driver and driven rotor shall be of nickel cast steel, or other approved material, accurately ground with close clearance to prevent interference between rotors. External ball or roller bearings and external gearing to be applied in order to generate oil-free delivery;
6. Casings shall be of high grade cast iron adequately ribbed to avoid distortion;
7. Squirrel-cage motor, arranged for frequency converter control through a matched v-belt drive. Motor to be mounted vibration poor on slide rails to facilitate the tensioning of the belts and mounted on a common bed-plate bed plate of cast iron or fabricated steel. The bearing housings and gear boxes shall be separated from the blower housings by air spaces;
8. The sealing at the conveying chamber shall be by three piston ring labyrinth seals and oil slingers. The sealing at the driving shaft shall be by radial sealing;
9. Each piston blower shall be provided with the following components:
   1. Base frame with integrated absorption-silencer, incl. console and tension device for motor
   2. 1 set of anti-vibration mountings including holding down bolts
   3. 1 intake filter silence and 1 discharge filter silencer
   4. V-belt drive with guard
   5. 1 pressure relief valve
   6. Connection housing with fitted non-return valve and connecting flange for pressure relief valve
   7. Flexible connection with hose clamps
   8. Pressure gauge with connection places
   9. Vacuum indicator for filter control
   10. Pneumatic start-up unloading device
   11. Electric motor: 400 V/50 Hz/IP 54, max. 2,900 rpm, 1EC standard, design B, insulation class B

10. Each piston blower shall be covered by an acoustic hood of galvanised steel plate in segmental design with hardly inflammable internal lining.

* + 1. Noise level as per general requirements in these TR
    2. Ventilator, temperature controlled

Unit c/w. overload protection for the electric drive and local terminal box, acc. to VDE regulations; c/w. local emergency-OFF-switch, wiring and assembling accessories.

On small blowers the cover may be a drop over cover with a detachable top weighing no more than 60 kg (two man lift). On larger installations full height access doors shall be provided for routine maintenance access. The cover shall in all instances be fully demountable to allow for removal of blower casing or drive motor. The acoustic cover shall include an attenuated intake adequately sized for the blower air volume and cooling air requirements.

### Turbine Blower

Turbine blower for compressed air generation. With regard on the complexity of the system and in order to assure compatibility of all system components, a single, commercially approved manufacturer shall supply the air compressor and motor assemblies and all accessories including control panels.

The compressor equipment shall include all appurtenances described below with local control panels for each compressor and the master sequence controller, housed in a separate control panel.

General design features shall comprise, but not limited to:

**Motor**

Single-stage centrifugal, integrally geared, vertically split type compressor, complete with accessories as described hereinafter: End-suction and side discharge, with discharge adjustable radial, in 15 degree increments. Integral intake filter/silencer, modulating inlet guide vanes and/or discharge, variable diffuser vanes, integral speed-increasing gear, discharge cone/discharge silencer, direct coupled motor, coupling and guard, inlet and discharge flexible connectors; discharge check valve, motorised blow-off valve with silencer, lube oil system, instrumentation and control system.

**Compressor and integral gearbox construction:**

Compressor casings shall be made of close-grained cast iron GG20, DIN 1691, and have a minimum design temperature of 250ºC and a minimum design pressure of 6 bar. The compressor inlet shall be connected directly to the inlet filter/silencer by a flexible connection. Air inlet shall be axial through a concentric inlet. All joints of the casings shall be machined. A threaded pipe tap shall be provided at the lowest point of the casing for drainage;

The impeller shall be of the open radial flow type, with backward leaning blades (at least 6º) and machined from forged aluminium alloy, statically and dynamically balanced. Impeller design shall be able to operate at peripheral speeds of minimum 120 percent of maximum actual operating speed. All surfaces shall be finished. Impellers constructed of steel or aluminium weldments as well as cast aluminium or cast steel impellers shall not be acceptable;

An adjustable inlet guide vane assembly shall be mounted integral with each compressor. Vanes shall be multi-leaf and pivoted, mounted in a cast iron housing. Sleeve bearings shall be of the permanently lubricated type or accessible for lubrication. Inlet guide vanes shall be made in an aerodynamic, streamlined design in cross-section and located radial around the concentric inlet. Flat steel plates shall not be used for inlet guide vanes. Each guide vane assembly shall be installed complete with an electric actuator to operate from a 4-20 mA DC signal. The position of the vanes from fully open to fully closed shall be transmitted via a 4-20 mA signal and indicated by a meter mounted on the local control panel. Position shall also be indicated by an adjustable manual lever arm and calibrated dial;

Variable diffuser vanes in aerodynamically shaped brass or aluminium alloy design shall be provided for capacity control and designed to obtain high diffuser efficiency in the entire regulating range. The assembly shall be mounted integral with each compressor with the diffuser vanes multi-leaf and pivoted, in permanently lubricated sleeve bearings. Flat steel plates are not acceptable for diffuser vanes. Each variable diffuser assembly shall be installed with an electric actuator to operate from a 4-20 mA DC signal;

Inlet guide vane and variable diffuser vane system shall facilitate turndown of each compressor from 100 to 45 percent of capacity, while maximizing efficiency over this entire turndown range, especially when the compressor is operating under off-design conditions (lower temperature and/or pressure). The inlet guide vane and variable diffuser vane actuators shall be operated by open-close pushbuttons, an auto-manual selector switch and indicating lights located in the compressor control panel. In the automatic setting, the actuator shall respond to a 4-20 mA DC position control signal, and shall position the vanes in proportion to the control signal from the programmable controller located in the compressor local control panel, which shall adjust the inlet guide vanes and variable diffuser vanes;

Compressor and gear shafts shall be machined from heat-treated, forged or hot rolled steel and suitably ground. Any responsive lateral critical speed of the rotating assembly shall be at least 15 percent from the normal operating speed range. Any torsional resonance of the package shall be at least 10 percent above or 10 percent below normal operating speed. All rotating elements shall be dynamically balanced;

Speed-increasing gear shall be of the helical parallel shaft type. The pinion gear shall be integral with the rotor shaft. The gears shall be made of casehardened alloy steel forging with the gear teeth precision ground for a service factor of at least 1.8;

The gearbox shall be of ample size and rated to transmit the max. torque and horsepower input requirements to the compressor under all operating conditions and continuous duty at a service factor of at least 1.5;

The gear drive housing shall be of close-grained cast iron GG20, DIN 1691, sufficiently rigid to maintain the shaft positions under maximum loads. The gear housing shall be horizontally or vertically split in order to allow easy inspection and maintenance. The gear housing assemblies shall be machined to close tolerances for bearing fit, gear alignment and oil tightness.

Air and oil shaft seals are provided to contain the compressed air inside the compressor casings, partly to prevent oil from leaking out of the gearbox, partly to prevent air from entering the gearbox casing and to avoid contamination of the lube oil with compressed air, dirt or moisture. The shaft seals shall be of a non-contact, multi-point labyrinth type, operated dry. The high-speed air and oil seals shall be located in a vented chamber;

Hydrodynamic radial and thrust bearings are required. Drive shaft radial bearings shall be cylindrical journal bronze bearings. Drive shaft thrust bearings shall be multiple segment, tapered land bronze bearings designed for thrust in both directions. Pinion shaft radial bearings shall be multi-segment babbitted bronze bearings designed to suppress hydrodynamic instabilities and provide sufficient damping to limit rotor deflections. Pinion shaft thrust bearings shall be multiple segment, tapered land, babbitted bronze bearings designed for thrust in both directions. Radial and thrust bearings shall be pressure lubricated with sufficient oil film thickness under all operating conditions. All bearings shall be rated for a bearing life of 100.000 hours. Anti-friction bearings shall not be used for dN factors higher than 300.000 rpm.

**Oil Lubricating System:**

A complete lube oil system shall be provided with each compressor. The system shall be capable of supplying clean oil at suitable pressure and temperature to lubricate the speed increasing gears and bearings. All components of the lubricating system shall be installed integral with the compressor base plate and arranged to permit ease of accessibility for operation, maintenance, inspection and cleaning.

The lube oil system shall consist of a reservoir in the base equipped with a suitably sized vent and breather filter and have a minimum working capacity of 3 min. retention time based on normal flow, one or two positive displacement pumps with strainer, an oil-to-air or oil-to-water heat exchanger, one oil filter and miscellaneous appurtenances. A pressure gauge, thermometer, adjustable high and low temperature switches and adjustable high and low oil pressure switches shall be installed on each lube oil system.

The oil pumps shall be two electric, motor-driven oil pumps, each of adequate capacity to supply lubrication for the air compressor/gearbox when operating and during start/stop. One of the oil pumps will operate as a stand-by unit activated at low oil pressure by the control system. The gearbox shall be supplied with a high level reservoir (incorporated in the gearbox cover) or a bladder accumulator to supply a sufficient amount of oil during run-down of compressor in case of power failure.

The oil filter shall be of the full flow, replaceable cartridge type, single or duplex filter with visual gauge suitable for at least two years of undisturbed operation, capable of removing particles over 10 microns with a clean oil filter pressure drop not exceeding 0,35 bar at design temperature and flow. Strainers shall be manually cleaned and equipped with a magnetic trap. Design and installation shall permit ready access for cleaning.

Oil cooler for each compressor shall be furnished and shall be of the air-to-oil or water-to-oil type, mounted on each compressor skid. Cooler shall be capable of maintaining required cooling rate at all ambient temperatures. Air-to-oil cooler shall be furnished with an electric motor-driven fan. Water-to-oil cooler shall be furnished with a cooling-water, flow control valve and an on-off water solenoid valve.

Oil heating system shall be provided if the temperature at the compressor unit is expected to go below 10ºC. The heater and thermostat shall be mounted on the oil reservoir with the contactor located in the local control panel. The compressor shall not start unless the oil temperature is above 10ºC. A warning light of low oil temperature shall be provided on each local panel.

**Couplings:**

Flexible, forged steel spacer couplings, double disc type, or approved equal, shall be furnished for connecting the compressor and motor. Couplings shall be sufficient for power transmission between motor and blower with a service factor of min. 1.5., coupling and spacer shall be dynamically balanced to tolerance suitable for maximum continuous speed of quality class 6.3 ISO 1940*-*1:2003*;*

Couplings shall be the dry type and designed for long periods of continuous operation. The coupling design shall absorb inaccuracies of alignment and permit axial adjustment. The coupling shall ensure that the motor shaft does not exert a thrust on the compressor bearing. Coupling construction shall be such that either shaft of the unit may be removed without disturbing adjustment of the other. An approved steel guard shall be provided and installed over the coupling;

Special purpose couplings must be used for motors without internal thrust bearings,

Each compressor and motor, coupled together, shall be mounted on common steel base, properly braced to form a rigid support for the entire unit.

**Base plates and mountings:**

Each compressor unit shall be furnished with a base plate of adequate size to support the blower, speed increasing gear, motor, lubricating system and accessories. The base plate shall be constructed of fabricated steel, provided with lifting lugs;

The base plate shall be mounted on machine mounts provided by the compressor manufacturer, suitable to absorb the weight and vibration of the blower assembly without undue stress or distortion.

**Electric Motor:**

Each compressor shall be provided with a horizontal, constant speed, squirrel cage induction motor. The motor kW-power shall be equal to or in excess of maximum normal load that will be imposed at any point in the operating range of the design conditions specified;

The motors shall be manufactured according to standard ISO 2373, vibration specification “R”. This also applies to fully loaded motors. For shaft heights above 400 m, the maximum RMS-value of the vibration velocity is 2,8 mm/s. Unless otherwise specified, the motors shall be balanced according to the “HALF KEY CONVENTION”;

The motors shall be equipped with a fan for low noise level. Maximum sound pressure, according to ISO 3744, is 87 dB(A) at 1 meter distance. When using a silencer hood covering the whole compressor unit, the motor fan shall provide the necessary amount of cooling air when working against an external pressure of 60 - 80 Pa.

**Inlet filter/silencer:**

Each compressor shall be provided with an inlet filter/silencer mounted directly on the inlet of the compressor via a flexible connector. Filter/silencer housing shall consist of steel plate and acoustical sound-deadening material on the inside;

The filter elements shall be square or rectangular replaceable elements mounted on a flat, vertical mounting frame, secured by hold-down clips. Suitable gasket material shall be permanently affixed to the mounting frame to prevent bypass of air around filters. If the filter/silencer is located outside, a weatherproof cover shall protect the filter elements from rain, snow, etc. The air filter elements supplied shall filter the ambient air and have a coefficient of arrestance of 85 - 95 percent. The filters shall be sized for a max. face velocity of 3,0 m/sec with a final pressure drop of 30 mbars;

The integral inlet silencer shall consist of a lamella, mounted internally in the filter/silencer between the filter elements and the compressor inlet, suitably wrapped with sound absorbing material. The lamella internals shall serve to reduce the noise level from compressor inlet via the sound absorbing material. Maximum pressure drop of the inlet filter/silencer unit with dirty filter elements shall be 60 mbars.

**Discharge Flex Connector:**

Discharge expansion joint with alleviate stress caused by thermal expansion and contraction in the piping system and the vibration imposed on the piping by the blowers. The expansion jointsshall be capable of withstanding the pressure under all operating conditions and a temperature range of 0ºC up to 200ºC;

**Discharge Cone:**

Discharge cone to increase the discharge from the compressor outlet to the discharge pipe, thus reducing the air velocity to max. 20 m/sec. The length of the discharge cone shall be aerodynamically designed in order to recover dynamic pressure head and minimize discharge turbulence. The discharge cone shall be constructed of galvanized steel plate with flanges;

**Blow-off (By-pass) Valve:**

Blow-off valve to allow for unloaded start-up and stop. The valve shall be a wafer type butterfly valve, for air service. The valve operator shall be motorized, equipped with open/closed limit switches, and shall be suitable for air service at 200ºC operating temperature. Controls for the vale shall be mounted in each local blower control panel with indicating lights to indicate fully open or closed;

**Blow-off Silencer:**

A blow-off silencer shall be provided for each compressor and mounted on the discharge by-pass line. The blow-off silencer shall be constructed of carbon steel and contain sound absorption material encased in an outer shell. The silencer shall have one flange inlet connection for bolting onto the end of the by-pass line;

**Check Valve:**

Each compressor shall be provided with a discharge check valve. Check valves shall be dual flat plate type with centre hinge and spring closure, and shall have cast iron body and aluminium/bronze plates, stainless steel hinge pin and springs, and silicone or Viton seal. The valve shall handle the blower rated discharge flow with a head loss not to exceed 100 mbars and shall be rated for temperatures up to 200ºCL;

**Folowing requirements** are detailed described in Volume 3, Section 4 - General Electrical and SCADA Specifications.

**Instrumentation:**

Instrumentation components shall be provided by the compressor manufacturer. These components shall be mounted on the compressor skid insofar as possible with all electrical connections brought to the terminals of the local control panel or to a junction box located on the compressor skid;

Instrumentation shall include, as a minimum:

* 1. Inlet Air Filter Differential Pressure Gauge
  2. Inlet Air High Temperature Switch (recirculation)
  3. Surge Indicator Switch (surge monitor)
  4. Oil High Temperature Switch
  5. Oil Temperature Gauge
  6. Oil Low Pressure Switch
  7. Oil pressure Gauge
  8. Oil Filter Differential Pressure Indicator
  9. Self-Acting Thermostatic Water Valve for Water-cooled Oil Cooler
  10. Variable Diffuser Position Transmitter 4-20 mA
  11. Inlet Guide Vane Position Transmitter 4-20 mA

**Local Control Panels (LCP):**

Each compressor shall be furnished with a separate local control panel (LC) including all controls to start, stop, and operate the compressor, provide detection of malfunctions and shut down the blower should malfunctions occur. The LCP shall incorporate all features required for proper operation of the blowers. Control philosophy shall be fail-safe operation. I.e. all controls and instruments shall fail in an alarm situation. The control shall be designed so that the compressors cannot operate unless the control is energized, nor can they operate with any defective control. The control shall be housed in a panel to be mounted on the blower skid;

The local control panel shall comprise the following:

1. Low voltage system - with main switch and motor-overload relays for auxiliary equipment such as blow-off valve, variable diffuser, and inlet guide vanes. Further, with thermistor relay (trip to connect to the temperature sensors of the drive motor, and relay for control of the main switch of the drive motor;
2. Control System - with automatic PLC Siemens SIMATIC S7-313U (or similar) with current overload circuit to limit power consumption of the compressor, and all necessary control circuits for oil pressure, oil temperature, surge limit and recirculation.
3. Front Panel with necessary Touch panel with symbols for function indication, in solid and dirt-resistant diaphragm technique, Siemens TP 170 (or similar) with positioning indicator for variable diffuser and inlet guide vanes, with hour counter, Amp.-meter and emergency stop.
4. Low voltage and control systems mounted in a steel panel, IP54, and internally wired. Terminal strip for external wiring.
5. The transmitters for the inlet temperature and differential pressure (discharge pressure) are part of the delivery. The mA signals from here are connected with the LC-4A control. Sudden pressure changes are not allowed.
6. Power supply : 3×400 V, 50 Hz, 0-earth, 16A

**Master Control Panel (MCP):**

A programmable controller-based sequencing panel shall be provided for starting and stopping compressors automatically and to provide discharge air header pressure control or dissolved oxygen control.

The sequencing system shall provide discharge header pressure with any or all of the blowers in service. The discharge pressure set point shall be adjustable over a certain range. The remote set point input shall be a 4-20 mA DC signal corresponding to the control range.

The sequencing system shall provide dissolved oxygen control with any or all of the compressors in service.

The dissolved oxygen set point shall be adjustable from a remote analogous input provided by others. The remote set point input shall be a 4-20 mA DC signal corresponding to the dissolved oxygen control range.

The panel front shall have a priority selector switch for each compressor that shall select the start sequence of the blowers. The local set point adjustment knob and the switch for local or remote control shall also be located on the panel door.

The MCP shall have status lights as follows, for each blower:

1. Compressor in Remote
2. Compressor on
3. Common Alarm

The master sequence controller, via the internal programmable controller, shall receive the main air header pressure 4-20 mA signal, alternatively dissolved oxygen signal (provided by others), that calls for more or less air. The controller shall bring compressors on- and off-line and increase/decrease on-line compressor capacity based on the Manufacturer’s standard control logic. The result is being gradual increase/decrease of air throughout the entire range of the compressors on-line. In the event of a compressor failure, the next compressor in the pre-selected start sequence shall come on-line.

All equipment shall be skid mounted or crated and delivered to protect against damage during shipment. 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 completed, and the units and equipment are ready for operation. Factory assembled parts and components shall not be dismantled for shipment or installation, unless permission is received in writing from The Engineer.

Finished surfaces of all exposed flanges shall be protected by wooden or fibreboard blank flanges strongly built and securely bolted thereto. Finished iron and steel surfaces not painted shall be properly protected to prevent rust and corrosion. No shipment shall be made until approved by The Engineer in writing.

## Compressor

Dry running compressor for compressed air supply, comprising rotary vane compressor, electric drive with coupling, inlet filter, pressure relief- and check valve, throttle valve, brackets, baseplate for wall mounting, sound protection with silencer.

Each compressor shall be provided with the following components:

1. Inlet filter
2. Inlet silencer + 1 discharge filter silencer
3. Pressure relief valve with silencer
4. Flexible connection with hose clamp
5. Pressure gauge with connection places
6. Vacuum indicator for filter control
7. Electric motor, IEC-Standard, protection IP 54, insulation classification B.

Unit has to be c/w. overload protection for the electric drive and local terminal box, acc. to VDE regulations; c/w. local emergency-OFF-switch, wiring and assembling accessories.

## Mixers

### Submersible Mixer

For homogenising of sludge and sewage and in order to prevent sedimentation of activated sludge submersible agitators shall be applied. Agitators shall be equipped with cast iron or polyurethane blades with self-cleansing hydraulics.

General design features shall comprise, but not limited to:

1. Unit with direct starting, design according to DIN 19569 or equal;
2. Drive motor shall be submersed in the media and of protection class IP 68 with insulation class F, minimum 80% efficiency, leakage control;
3. The bearings are to be sized to guarantee a service life of 60,000 hours;
4. Low speed mixer with large diameter installed in the middle axis of the basin with its driving gear in horizontal position for maintaining complete suspension and low-shear mixing of the wastewater during low load periods (i.e. night-time);
5. Mixer with parallel shaft helical spur gear suitably dimensioned for direct start and a starting frequency of 10/h;
6. Drive with double acting mechanical seals (SiC/SiC) with seal liquid supervision in the oil chamber;
7. Mixer with non-clogging Propeller made of high-quality, fibre-glass reinforced plastic, completely coated with biologically neutral gel coat
8. Mixer units shall be lifted or lowered on sliding rails mounted in the tanks, incl. shock-absorbing guide rail, directly installed on the tank bottom
9. Technical data:
10. Motor speed 1,450 rpm
11. Maximum, periphery speed < 8 m/s
12. Explosion protection EExd Il B T4 if applied for sludge, septage and raw sewerage
13. Sealing Motor Cast-in cable entry, longitudinally water tight, cable plug-in connection in motor chamber
14. Mechanical seal propeller side mating of material silicon carbide/silicon carbide mechanical seal motor side mating of material hard carbon/silicon carbide common water seal made of paraffin oil.
15. Materials specification:
16. Casing motor-gear grey cast iron
17. Propeller grey cast iron / Polyurethane
18. Propeller shaft SST
19. Bolts and nuts SST

The mixer system shall be complete with a local terminal box with emergency stop push button; On/Off-key-switch; Manual/O/Automatic-switch.

Materials specification describes the minimum required qualities.

Each mixer shall be complete with all necessary ancillary equipment to render the unit complete and immediately ready for service.

### Vertical Mixer

Vertical mixers shall be applied for flocculation. Agitators shall be equipped with cast iron or polyurethane blades with self-cleansing hydraulics.

General design features shall comprise, but not limited to:

1. Unit with direct starting, design according to DIN 19569 or equal;
2. Drive motor shall be vertically mounted on the gearbox; protection class IP 65 with insulation class F, minimum 80 % efficiency;
3. Bearings are to be sized to guarantee a service life of 60,000 hours;
4. Low speed mixer with large diameter its driving gear in horizontal position for maintaining complete suspension and low-shear mixing;
5. Mixer with parallel shaft helical spur gear suitably dimensioned for direct start and a starting frequency of 10/h;
6. Drive with double acting mechanical seals (SiC/SiC);
7. Mixer with non-clogging Propeller made of high-quality, fibre-glass reinforced plastic, completely coated with biologically neutral gel coat;
8. Technical data:
9. Motor speed 1,450 rpm
10. Maximum, periphery speed < 8 m/s
11. Materials specification:
12. Casing motor-gear grey cast iron
13. Propeller grey cast iron / Polyurethane
14. Propeller shaft SST
15. Bolts and nuts SST

The mixer system shall be complete with a local terminal box with emergency stop push button; On/Off key-switch; Manual/O/Automatic-switch.

Materials specification describes the minimum required qualities.

Each mixer shall be complete with all necessary ancillary equipment to render the unit complete and immediately ready for service.

## Pumps

### Submersible Pump

The pumps shall be designed for handling of wastewater, activated return sludge and for surplus sludge, and shall be capable of passing solids up to a sphere size of 80 mm. They shall pass stringy matter, rags, paper and plastics without clogging.

General design features shall comprise, but not limited to:

1. The pump casings shall be of cast iron, and shall be provided with a renewable suction end, wear plate, a discharge cover and a support foot.
2. The impellers shall be designed to give non-overloading characteristics over the complete working range of the pump and shall be capable of conveying liquids, which will evolve gas.
3. Impellers shall be designed in order to reduce the specific power demand to a minimum on the highest efficiency, i.e. “N-Series” type impellers ( adaptive self-cleaning impeller that can move axially to enable easy passage of large solids through the pump) shall be applied.
4. The design of the pump units shall be such that there will be no tendency to unlock any part due to a possible reversal of rotation and shall not pass through or approach the critical speed.
5. The pumps shall be capable of working for long periods without cleaning or attention and special precautions shall be taken to avoid wear on working surfaces due to grit.
6. Slide ring sealing, sealed for life shall be provided between motor and pump.
7. The unit shall be supplied with an adequate length of suitably sheathed flexible cable and pass through a watertight gland on the entry of the motor body.
8. The pumps shall be installed as a permanent wet sump installation and each unit shall be complete in all respects with guide rails complete with upper and lower fixing brackets, lifting chain, automatic pump discharge branch connection, cable guides and holders to allow pumps to be raised or lowered without entering the sump.
9. Glands shall be fitted with mechanical seals (Material: SiC/SiC) with automatic seal supervision in the oil chamber. The mechanical shaft sealing shall be two independent seals to obtain double security.
10. The shafts of pumps shall be made wear resistant with protection sleeve where they pass through the mechanical seal.
11. The pumps shall be suitable for operation on a 400 volt, three phase, 50 Hz supply.
12. The pump motor shall be of squirrel cage induction type, with protection class IP 68, Ex-rated and be continuously rated for use in sewage at ambient temperature.
13. The motor shall allow 15 starts per hour and be protected from overheating by the use of PTC thermistors.
14. The motor shall be protected with a moisture resistant at least Class “F” insulation capable of resisting temperature of up to 155°C. For monitoring moisture intrusion into the motor cavity, the pump shall be supplied with an additional and independent moisture sensor in the motor cavity.. The sensors shall shut the pumps down in the event of liquid penetrating into the stator housing and in the event of overheating, respectively.
15. The pressure pipework shall be provided with reflux and gate valves in vertical position and shall be of stainless steel and flanged. The reflux valve shall be fitted in the delivery pipe immediately below the gate valve. Fittings and valves shall be secured to the wall by stainless steel brackets.

Each pump shall be fitted with a removable lifting handle and supplied with a connected stainless steel lifting chain to facilitate removal. The upper end of the chain shall be conveniently anchored in an approved manner and location. Chain ends shall be fitted with stainless steel shackles and pins.

### Horizontal and Vertical Propeller Pump

Submersible pump in compact, modular design suitable for handling of wastewater and activated sludge shall pass stringy matter, rags, paper and plastics without clogging.

The pumping unit shall comprise a multi-stage axial flow propeller directly connected to a horizontally or vertically arranged hollow-shaft electric motor with installation accessories and protection sleeve, including stationary double rail guide system, inlet cone and discharge assembly. The pumping unit shall be suitable for ambient temperatures of 50 °C.

General design features shall comprise, but not limited to:

1. Unit with direct starting, design according to DIN 19569 or equal;
2. Propeller: Hydraulically optimized three blade propeller with self-cleaning characteristics in high efficient design for delivery of high capacity at low differential heads;
3. Motor: Squirrel cage induction motor with 8/12/16-pole windings designed for class S1 duty, insulated acc. to class F, protection class IP 68, stator windings capable of starting up to 15 times/hour; with monitoring system comprising thermal switches in the winding; with leakage control; in ex-proof version where required; minimum 80% efficiency
4. The bearings are to be sized to guarantee a service life of 60,000 hours; shaft sealing with double acting mechanical seals (SiC/SiC) with seal liquid supervision in the oil chamber;
5. Cable junction chamber, sealed, with separate cable gland assembly incorporating strain relief clamp;
6. Technical data:

* Motor speed 1,450 rpm
* Maximum, periphery speed < 8 m/s
* Explosion protection EExd Il B T4 if applied for sludge, septage and raw sewerage

1. Materials specification:

* Casing motor-gear grey cast iron
* Propeller stainless steel / grey cast iron / Polyurethane
* Propeller shaft SST
* Bolts and nuts SST

1. Pump units shall be lifted or lowered on sliding guide rails mounted in the tanks, incl. shock-absorbing guide rail, directly installed on the tank bottom; material: SST;
2. Pump units, c/w. discharge connection comprising feed pipe.
3. The pump system shall be complete with a local terminal box with emergency stop push button; On/Off-key-switch; Manual/O/Automatic-switch.
4. Each pump shall be complete with all necessary ancillary equipment to render the unit complete and immediately ready for service.

Each pump shall be fitted with a removable lifting handle and supplied with a connected stainless steel lifting chain to facilitate removal. The upper end of the chain shall be conveniently anchored in an approved manner and location. Chain ends shall be fitted with stainless steel shackles and pins.

### Horizontal Centrifugal Pump

Horizontal single stage casing pumps in modular construction with single vane impeller not self priming. Casing shall have an interchangeable wear ring, axial inlet nozzles and radial top discharge nozzles.

Fitting and removal of the rotor shall be possible axially without having to remove the pump from the pipeline or the foundation.

Shaft bearings are sealed for life anti-friction bearings. The bearings are to be sized to guarantee a service life of 60,000 hours.

Shaft Sealing; at the drive end: mechanical seal independent of direction of rotation SiC/SiC material combination at the rubbing surfaces.

Shaft Sealing; at the pump end: mechanical seal independent of direction of rotation SiC/SiC material combination at the rubbing faces.

Common, permanent liquid quench consisting of paraffin oil.

Assembly parts: Belt drive, inclusive baseplate, belt pulleys, belts, belt guard, masonry bolts dowels.

Materials specification ( minimum requirements):

* Casing parts in contact with media grey cast iron
* Impeller grey cast iron
* Discharge Cover grey cast iron
* Wear ring grey cast iron
* Shaft SST
* Bearing Bracket grey cast iron

Each pump shall be complete with all necessary ancillary equipment and fittings to render the unit complete and immediately ready for service, as required in the pump-sections before

### Submersible Sump Pump

Each sump pump shall be installed as a fixed unit and shall be complete with all necessary pipework, level controls, motor starter and cabling.

Sump pump shall be of the submersible type with pump units suitable for operation on 400 volts three phase, 50 Hz supply. It shall be capable of handling floor drainage from the various pump chambers and floor ducts.

The sump pump shall be of heavy construction with impellers made of high-grade abrasive resistant material having non-overloading characteristics.

Discharge pipework and valves shall be provided with reflex valve and gate valve and shall discharge into an adjacent chamber channel or pipe.

Discharge pipework shall be 50 mm minimum nominal bore and the pump shall be capable of passing sphere of up to 18 mm diameter.

Each pump shall be fitted with a removable lifting handle and supplied with a connected stainless steel lifting chain to facilitate removal. The upper end of the chain shall be conveniently anchored in an approved manner and location. Chain ends shall be fitted with stainless steel shackles and pins.

### Portable Site Drainage Pump

Portable site drainage pumps shall be provided complete with all necessary hoses, cables, starter and support rope suitable for transportation to and use at any location on the works.

The pumps shall be of submersible type suitable for operation on a 400 volt, three phase, 50 Hz supply.

Each pump shall be capable of handling sludge, liquids containing grit, and solids as found in pump suction sump drainage, tanks and general site drainage duties.

The pumps shall be of heavy construction with open type impellers of high abrasive material having non-overload characteristics and shall be generously rated for prolonged operation. The pump shall be suitable for operation in liquids that have been subject to direct sun and the rating has to be continuous when operated at any point on the characteristic curve between closed valve and zero head.

The pumps delivered shall be suitable for the connection of flexible hoses utilising a quick release type coupling. Discharge hoses 15 m long of 50 mm diameter rubber with fabric or cord reinforcement shall be provided for each small pump, each length fitted with quick release type metal coupling to suit the pump.

Large pumps shall be rated to deliver 15 - 20 litres per second against heads up to 16 meters. The pump shall be capable of passing solids up to 75 mm diameter sphere.

Small pumps shall be rated to deliver 5 - 7.5 litres per second against heads up to 10 m. The pump shall be capable of passing solids up to 18 mm diameter sphere.

Manual control shall only be provided for the portable pumps. The motor-overheating protection by thermal switch in the windings shall be included in the control circuit.

### Booster Unit

Multistage centrifugal pumps shall be provided as booster pumps for the water supply system. All booster units shall be of the same construction.

The booster pumps shall be installed as a permanent wet installation for example in the chlorine contact basins or effluent pumping station. The pumps shall be mounted directly at the bottom of the basins or the intake chamber by means of support feet.

The connection to the distribution network shall be via a hydro-pneumatic pressure tank. The pressure tank shall be fitted between the booster pumps and the system. Aeration of the pressure tank requires a compressor set. The compressor shall be given automatic control according to the water level.

The wetted parts of the pumps must be made in stainless steel and materials resistant to chlorine solution.

The booster units shall be driven by a speed regulation system and peak load connections.

The pressure pipework shall be provided with reflux and gate valves and shall be of stainless steel and flanged.

Pipe fittings and valves shall be secured to the wall by stainless steel brackets.

The booster units shall be supplied with pressure switches for cut out at low intake pressure (pressure smaller than 15%) and switches for the pump control.

The booster units shall be provided with local control panel. The panel shall include all necessary connection devices, fuse, protection switches, control transformer, digital controller with analogue inputs, programmable logic controller (PLC), selector switch and push buttons. For transmission of operation and fault signals voltage-free contacts shall be provided.

### Progressive Cavity Pump

Progressive Cavity Pumps shall have compliant general technical Spesification as Positive Displacement Pump in corespondant chapter of these general TR

### Macerator

Inline macerator is used for crushing of solids at various stages of wastewater treatment systems.

Crushing elements are the rotating impeller and the stationary cutting ring. By means of two crushing stages (cutting tips / cutting teeth and slotted cutter disc (toothed rim), grain sizes of 3.5 mm or fibre sizes of 1.5 cm² should be obtained;

The crushing elements should be arranged symmetrically for the operation of the macerator in both directions of rotation, which increases the service life considerably. A higher wear-resistant mechanical seal must be provided as shaft seal;

Materials specification (minimum requirements):

* Casing parts in contact with media grey cast iron 25
* Impeller G-X 1 0 (Cr Ni 1 8 8 with stellite segments)
* Cutting Ring G-X165 (Cr Mo V 12 hardened 60 HRC)
* Discharge Cover grey cast iron 25
* Wear ring grey cast iron 25
* Shaft stainless steel 1.4021.05

The complete system for the seal water supply to allow the macerator shaft seal lubrication and cooling purposes should be delivered, including the complete pipework, instruments and accessories for the regulation and control of the seal water flow.

# Screening Plant

## Protective Screen

### Coarse Screen

Manually operated coarse screen for channel installation made of profiled steel or sheet steel as welded, robust construction, with inclined screen bars and drip launder, incl. hand-rake.

Screen bars made of rectangular section, as removable parallel steel bars mounted in a fixed frame. Drain through with perforated sheet steel spanning over the channel width.

All parts shall be made of stainless steel with high corrosive resistance

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 emersion 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.

### Cable Operated Bar Screen

The cable operated bar screen as fully automatic operated cleaning device for mechanical removal of coarse matters in order to protect subsequent units; for outdoor installation in a concrete installation chamber. The equipment provided shall be of proven, robust, proprietary design.

The screen shall comprise the bar rack welded and bolted to the steel structure with exchangeable bar sections, bars of rectangular sections suitable for wastewater applications. The bar rack shall be cleaned by the rake operated by suspension of three cables - two for lifting and lowering and one for opening and closing. In automatic operation due to water-level-difference-measurement, the cleaning sequence shall be repeated continuously until all floating solids are removed, rake opening and closing is achieved by the control cable.

The rake is of semicircular shape and travels on lateral guide rails.

Cleaner rake is in anti-wedging and heavy design with polyamide rollers and adjustable type tine plate.

The drive Unit shall be a rigid and torsion-free steel structure with three cable drums and antifriction bearings mounted on a drive frame made of a welded and bolted profiled steel construction in heavy design with guide connections and anchoring provisions. Geared drive with overload protection for the electric drive and local switchbox acc. to VDE regulations, c/w. local emergency-OFF-switch, wiring and assembling accessories.

All bearings and rotating parts are to be above water level at all times to facilitate lubrication and improve machine life. All parts of the assembly are to be above water level at the end of each cleaning cycle providing easy maintenance and inspection. No hydraulic operation shall be provided. The design must be well proven and capable of operating for long periods without routine maintenance.

The screens shall have the following features:

1. All bearings are to be located above the design maximum water level. All bearings, gears, chains and sliding surfaces are to be suitably lubricated and protected for maximum life;
2. Wiper assembly with exchangeable scraper to remove the debris from the rake,
3. Suitable shock absorbers shall be provided to limit machine vibration and impact loading;
4. A limit switch shall provide mechanical overload protection to disengage the rack from the screen. Further switches shall provide stops for rest positions and reverse operation control;
5. Explosion proof motors and installation; EExd Il B T4, insulation class F
6. Local control panel per screen mounted in a convenient position adjacent to the screen to allow the screen to be stopped and started locally;
7. The supporting frame and steel constructions of the screens to be fabricated of mild steel with corrosion protection and painting as specified hereinafter:
8. Parts below water: shotblasted SA 2,5 with 2-component PU-hot spray system ≥ 400 µm
9. Parts above water: shotblasted SA 2,5 with 1 prime coat, 70 µm and 2 epoxy-coat, 150 µm
10. Materials specification: roller/roller shaft - PA/SST
11. tine plate/bar rack - mild steel, profile
12. guides/rake - mild steel, profile
13. connection pieces - stainless steel SST
14. bolts & anchoring dowels - SST
15. Screen rake and all travelling parts below water level or in permanent contact with the media shall be from stainless steel

Materials specification describes the minimum required qualities.

1. Each screen shall be provided with a water level differential control for screen operation, comprising control cabinet, limiting value transmitter and PLC control. The system must operate on the ultrasonic level principle with two measurement sonde’s upstream and downstream of the screen with a range of 0/4 – 20 mA corresponding to 0 – 300 mm water level differential with limiting value contract the screens and an additional limiting value contact for local and remote alarm.
2. The main controls for the operation of the screens shall be located in the adjacent control building. A key operated, hand (local operation only) / Auto switch shall be provided for each screen together with indicator lamps giving the operation or fault status.

Operational procedure plans and equipment details for the erection of the screen works are to be included.

### Grab Bar and Fine Screen

Grab type coarse and fine screens are to be designed to suit the type of screenings to be removed from the channel appropriate to the location and screen size. The equipment provided shall be of proven, robust, proprietary design.

The equipment for each screen shall include a screen frame, apron plate, bar screen, fixed pin with driven roller pinion and motor/gearbox unit, rake wiper dump plate as required to suit the design of the screen.

All bearings and rotating parts are to be above water level at all times to facilitate lubrication and improve machine life. All parts of the assembly are to be above water level at the end of each cleaning cycle providing easy maintenance and inspection. No hydraulic operation shall be provided. The design must be well proven and capable of operating for long periods without routine maintenance.

The screens shall have the following features:

1. All bearings, etc., are to be located above the design maximum water level. All bearings, gears, chains and sliding surfaces are to be suitably lubricated and protected for maximum life;
2. A steel sheet apron plate shall be installed above and be coextensive with the screen bars. The plate is to be securely attached to the screen frame and adequately supported to maintain a flat surface. The upper edge is to terminate at an acceptable elevation for transferring the screenings to the dump plate to feed the conveyor system;
3. Wiper assembly with exchangeable scraper to remove the debris from the rake;
4. Suitable shock absorbers shall be provided to limit machine vibration and impact loading;
5. A limit switch shall provide mechanical overload protection to disengage the rack from the screen. Further switches shall provide stops for rest positions and reverse operation control;
6. All fixing material shall be of stainless steel;
7. Explosion proof motors and installation; EExd Il B T4, insulation class F
8. Local control panel per screen mounted in a convenient position adjacent to the screen to allow the screen to be stopped and started locally;
9. The supporting frame and steel constructions of the screens to be fabricated of hot dip galvanized mild steel according to DIN 17100 with corrosion protection and painting as specified in this tender;
10. Screen rake and all parts underneath water level or in permanent contact with the media shall be from stainless steel
11. Each screen shall be provided with a water level differential control for screen operation, comprising control cabinet, limiting value transmitter and PLC control. The system must operate on the ultrasonic level principle with two measurement sonde’s upstream and downstream of the screen with a range of 0/4 – 20 mA corresponding to 0 – 300 mm water level differential with limiting value contract the screens and an additional limiting value contact for local and remote alarm.
12. The main controls for the operation of the screens shall be located in the adjacent control building. A key operated, hand (local operation only) / Auto switch shall be provided for each screen together with indicator lamps giving the operation or fault status.

Operational procedure plans and equipment details for the erection of the screen works are to be included.

### Fine/Step Screen

Automatically operated screen of the step screen type for separation of solid and floating materials from the waste water by a screen grate, for indoor installation in concrete a channel. Screen grate comprising a fixed and a moveable (travelling grate) step grate. A crankshaft drives the travelling grate which is lifting the separated screenings one step higher by circulation during each rotation of the crankshaft (effect of self-cleaning according to the counter-flow principle), auto-operated by level-differential control unit.

1. Unit comprising a frame construction made of stainless steel closed at three sides with drive assembly, fixing material shall be of stainless steel;
2. Power transmission via crank shaft assembly (no chain or cable).;
3. All metal parts in contact with sewage shall be in stainless steel, pickled in an acid bath and passivated;
4. Explosion proof motors and installation; EExd Il B T4, insulation class F
5. Unit with overload protection for the electric drive and local switchbox acc. to VDE regulations; c/w. local emergency-OFF-switch, wiring and assembling accessories;
6. Local control panel per screen mounted in a convenient position adjacent to the screen to allow the screen to be stopped and started locally.
7. Each screen shall be provided with a water level differential control for screen operation, comprising control cabinet, limiting value transmitter and PLC control. The system must operate on the ultrasonic level principle with two measurement sonde’s upstream and downstream of the screen with a range of 0/4 – 20 mA corresponding to 0 – 300 mm water level differential with limiting value contract the screens and an additional limiting value contact for local and remote alarm.
8. The main controls for the operation of the screens shall be located in the adjacent control building. A key operated, hand (local operation only) / Auto switch shall be provided for each screen together with indicator lamps giving the operation or fault status.

Operational procedure plans and equipment details for the erection of the screen works are to be included.

## Electrical Equipment

The electrical equipment to be provided for power supply and operation control, incl. measuring instruments shall comply with the requirements set out in Section 4 for Electrical Specifications of these TR

The electrical equipment shall comply with the following:

1. All PLC controls, timers, etc. necessary for the manual and automatic control of the screens, the conveyors and the screening press shall be incorporated in a sufficient number of steel control panels, as specified. For outdoor installation of individual control panels the cabinets shall be made of stainless steel;
2. Each cabinet shall include all necessary connection devices, fuse, protection switches, main switches and push buttons. For transmission of the operation and fault signals voltage-free contracts shall be provided. The cabinet shall be ventilated and heated electrically with thermostatic control to avoid condensation;
3. Automatic control shall result in the duty screens operating individually under times and differential level control as follows:
4. A differential level measuring system shall be provided to detect and indicate the difference in level between the chambers upstream and downstream of the screens. Should the screens become clogged, prior to the commencement of the automatic sequence, control contacts shall initiate the operation of the duty screens, provided that they have been selected for automatic operation. Once initiated the screens shall operate for at least the time set on the running timers.
5. Moreover each screen shall operate under time control. A 24 hour programmable controller and a 0-30 minute timer shall be provided, so that the controller will initiate the 'ON' period and the timer will control the length of the running period, a typical setting being a running period of 15 minutes per hour. At the end of the running period the 0-30 minute timer shall reset itself in readiness for the next cycle.

Each unit shall be provided with a local emergency-OFF-switch and control switch (MAN/AUTO/OFF).

The electrical systems have to be completely supplied, installed connected, tested and commissioned, including all documentation and all cabling between the switchboards and the electrical consumers.

The cable to feed main power to the plant will be supplied by the Employer/Beneficiary and has to be connected by the Contractor. All signals relevant to monitor the function of the plant have to be brought potential-free to terminal strips. All electrical components have to be of high quality.

## Rotostrainer

Self-cleaning screen with rotary screen cylinder comprising a continuously wound wedge wire of stainless steel installed in a sheet steel machine body, completely made of SST with sieve cylinder made of SST Unit comprising:

1. Stainless steel housing with supports and stand, ventilation, inlet and effluent flange connection;
2. Screen gap width: 2,5 mm;
3. Scraper mechanism made of special steel and discharge chute in order to discharge retained solids into a container, a screenings press or onto a conveyor, etc.;
4. Internal spray system with solenoid valve for screen cylinder flushing;
5. Two speed gear motor; 685/1410 min-1, EExd Il B T4, insulation class F;
6. Ultrasonic level control for works operation;
7. Electrical control equipment for automatic operation, with 2-speed drives by ultrasonic/electronic water level sensor system;
8. Local control panel, IP 65, with main switch of supply circuit, with emergency shutdown function, motor protection, main current protective device, Voltage 24 V/DC;
9. PLC control with a remanent run and monitoring program, including also the working periods for automatic operation. Manual switch for slow and fast speed, pre-selection for automatic operation, signalling lamps for operation and failure conditions, running time recording;
10. Overload protection for the electric drive and local switchbox acc. to VDE regulations, c/w. local emergency-OFF-switch, wiring and assembling accessories.

Unit comprising Rotostrainer with influent and effluent pipework, incl. measurements and local control box.

## Screening Press

Screening compaction and dewatering from the screw press type with discharge of the pressed screenings into a container. In efficient proprietary proven, non-clogging design and comply with the following minimum requirements:

1. Free standing unit comprise a rectangular inlet chute of length in excess of the width of the screenings conveyors which shall discharge directly into it;
2. Unit be provided with removable top, end, and bottom covers, together with a powered ram. The top cover shall be arranged to move longitudinally in slides, in conjunction with the ram, to provide clear access for loading the screenings deposited by the conveyors. The end cover shall also be arranged to slide preferably vertically to enable the pressed screenings to be discharged and the bottom cover shall comprise a loose perforated plate supported on load cells springs or other similar device to determine the sage loading of the press prior to pressing;
3. The operation of the press shall be entirely automatic and the pressed screenings being discharged by the ram shall travel along a chute of sufficient length to enable them to be discharged into a container;
4. The inlet chute to the screening press shall be provided with an approved reliable system of sensing equipment to alarm if the volume of screenings within the chute exceeds the maximum design throughout the press. The alarm shall be an audible type located within the inlet works control panel. Contacts shall also be provided for remote indication and for automatic reversing of the screening conveyors to discharge the screenings unpressed into the container;
5. Protection device (torque switch) against stuck (including alarm);
6. The press body, press screw and press pipe bends to be made of surface-treated steel, all other machine parts shall be of stainless steel,
7. The shaft-less spiral shall be of special steel;
8. The screening press shall be powered by a directly coupled geared motor unit; Ex-protection EExd Il B T4, insulation class F;
9. A water flushing system comprising spray system, solenoid valve and potable water connection piping shall be provided;
10. Screenings to be dewatered to residual water contents of the dewatered screenings of app. 65 %;
11. A complete electrical installation for all electrical equipment installed, taken to control panels installed on the frame of the press, incl. overload protection, local terminal box and emergency stop breaker.
12. Filtrate discharge pipework fabricated from stainless steel shall be provided.
13. The screenings shall be fed through a vertical inlet chute into the press.
14. To provide the required counter pressure, the outlet of the press should be equipped with a long, conical inclining outlet bend.

## 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.

# Grit Removal

## Grit Chamber

### Scraper Bridge

Is a travelling twin-chamber Scraper Bridge for scum and grit removal in a longitudinal, aerated grit chambers with two scum baffles and two suction pumps for grit conveyance into lateral grit channel.

Travelling bridge as robust steel construction with walkway (clear width > 1,1 m), stairs, handrailings, cable drum and local control board; with limit switches for operation control. Drive carriage of geared motor with drive shaft on both sides for traction wheels at both walls. The suction scraper shall be provided with a guiderail system with lifting device for the suction pumps, complete discharge pipework into lateral grit channel and height adjustable scum blades.

General design features shall be as follows but not limited to : :

1. The bridge beams made of profiled steel in distortion proof, weldment design with drive carriage and anti-skid open mesh grating, access ladders on both sides of the bridge;
2. The bridge shall be designed for a load of - 1.5 kN/m² and the deflection shall not exceed 1/360;
3. Two undercarriages with drive and running wheels shall be provided. Trackless are running of the wheels on the outer tank wall. The wheel axles shall run in carefully sealed antifriction bearings, surface pressure of the rubber wheels shall be below 250 N/cm²;
4. Hollow shaft spur geared motor with torque link shall be mounted on the axle of the drive wheel. Guidance by four guide rollers with vulkolan tyres running on the inner and outer side of the grit-chamber wall;
5. The motors shall be two speed motors with brakes connected directly to the driving track. (Open chains, gear wheels etc. will not be accepted);
6. The limits of scraper travel shall be secured by 4 Nos. of limit switches and rubber buffers. The main wheels shall have a diameter of not less than 400 mm and the guidance wheels shall have minimum diameter of 150 mm;
7. The service bridge shall be made of steel, hot dip galvanized. All submerged parts of the scraper mechanism shall be in stainless steel
8. Submersible pumps with abrasion resistant impellers ( grit pumps) , with 80 mm free passage shall be provided and assembled to the scraper bridge;
9. Pressure pipework SST with flexible pipe connections, discharge pipe into the grit channel, c/w. fittings and armatures shall be provided and assemble to the scraper bridge;
10. A manual hoist serving for pump lifting and service purposes shall be provided and assemble to the scraper bridge.
11. Scum blade made of folded stainless steel plate (minimum thickness 5 mm) with lateral rubber squeegees and motorized lowering mechanism comprising lifting gear with worm-geared motor, lifting mechanism with rope pulley, deflection sheaves made of polyamide and SST-rope, tube/roller guiding assembly and limit switches;
12. Motorized cable reel with 8-core cable of adequate length for power supply to the Scraper Bridge and remote transmission of operation signals;
13. Electric control with PLC, installed in a stainless steel cabinet, IP 67; provided with thermostatically controlled anti-condensation heating shall be mounted onto the bridge in an accessible and visible height. Local control panel comprising all switchgear for automatic operation, with indicator lamps and selector switch for manual operation to be installed in the front door;
14. Inductive proximity switches shall be used for control of bridge travelling and scum blade movement. The bridge shall be provided with protection device (torque switch) against stuck (including alarm).
15. The bridge shall be provided with lifting and lowering drives for the scum board and scraper mechanism. It should be possible to raise the scum boards clear over the interface of the tank and to lift the blades out of the sewage for maintenance.
16. The scraper shall be fitted with all necessary cabling and be provided with electric equipment as specified. Cabling (NYY cables) shall be carried out in corrosion-proof PVC conduits and shall be completely installed at the manufacturer's work. For transmission of a collective operation and fault signal voltage-free contacts shall be provided Suction Scraper Bridge for single channel grit chambers in analogue design.

### Suction Scraper

Travelling twin-chamber Scraper for scum and grit removal in a longitudinal, aerated grit chamber with two bottom scraper blades for grit conveyance into the grit hoppers ant the influent of the grit chambers. Two scum boards shall be provided for scum removal into peripheral scum pits.

The adjustable bottom blade shall be provided with scraping edges consisting of wearing steel plates and sliders. The section shall be formed to fit into the sand-channel. Submerged parts in SST

The scraper blade shall be suspended from the bridge by steel tubes, which shall be provided with devices to implement a secure counter pressure and prevent rising of the scraper blades even when the sand amount increases.

## Electrical Equipment

The electrical equipment to be provided for power supply and operation control, incl. measuring instruments shall comply with the requirements set out in Section 4 of these Employer’s Requirements

The local electrical equipment shall comply with the following:

1. The scraper shall be fitted with all necessary cabling and be provided with an electric driven cable drum.
2. A junction box, carrying brackets for cabling and magnetic limit switches shall be provided in robust watertight construction.
3. The cabling shall be carried out in corrosion-proof PVC conduits and completely installed at the manufacturer's work;
4. The scraper shall be provided with a stainless steel switching cabinet, mounted on the travelling bridge. The cabinet shall include all necessary connection devices, fuse, protection switches, control transformer with two separate windings for 400/230 V, 50 Hz, main switch, selector switch and push buttons.
5. All motors and operations shall be controlled by push-buttons, but the limit switches shall still operate automatically;
6. Each unit shall be provided with a local emergency-OFF-switch and control switch (MAN/AUTO/OFF);
7. For transmission of operation and fault signals voltage-free contacts shall be provided;
8. Protection device (torque switch) against stuck (including alarm).
9. The switching cabinet shall be ventilated and heated electrically with thermostatic control to avoid condensation. The switching cabinet as well as the whole bridge shall be completely wired and assembled.

## Grit Chamber Aerator

Compressed air delivery pipework comprising: connection and delivery pipework, vertical down-pipes and horizontal diffuser-pipes for coarse aeration of the grit chamber.

General design features for the aeration system shall be as follows:

1. Vertical down pipe ≥ ND 50, SST; incl. butterfly valve with hand lever, brackets and wall supports;
2. Horizontal aerator ≥ ND 50, SST bottom side with approx. with 20 boreholes ø 10 mm, with T-piece and end-caps, overall length approx. 1.0 m;
3. Capacity approx. 5 – 8 m³/h x each.

The aerators shall be installed above the grit trough along the centre middle wall of the grit chamber. The aerators shall be designed to establish medium sized aeration.

## Grit Classifier

Dewatering and classifying of the sand-water-mixture. Separation of organic material shall be supported by a rotary effect of the influent flow. After static dewatering, the separated sand shall be discharged by means of a worm-shaft and the wastewater shall be returned into the sewer system. Bearings of the drive and of the bottom edge of the trough (journal bearing) shall be maintenance-free.

General design features shall be as follows:

1. Capacity in accordance to mono-operation of at least one twin-chamber -unit;
2. The construction of the unit shall be of an uncomplicated and rugged design;
3. The grit classifier shall comprise a totally enclosed sedimentation tank and conveyor trough with screwed cover and wear rails, a shuttles conveyor spiral with bearings on the drive end.
4. Sedimentation tank, cover and supports made of stainless steel, SST
5. Wear rails made of carbon steel;
6. Spiral made of special steel, with corrosion resistant primer;
7. Geared motor: 400 V/50 Hz/IP 54, max. 1,500 rpm, EExd Il B T4, insulation class F.

Classifier comprising a tank with in- and effluent connections made of sheet steel for physical separation of sand, classifying screw with conveyance worm-screw and direct coupled drive. Unit with supporting structure, overload protection for the electric drive, terminal box and emergency stop.

## Grit Pumps

The removal of settled sand from the sand chambers to a sand washer/dewatering device (grit classifier) shall take place by automatically operated sand transport units like airlift pumps through air injection, submersible sand pumps or other devices.

If **airlift pumps** are used for the grit removal, they shall be made of cast iron or stainless steel and installed with butterfly closing valves and flushing connections. Diameter of the airlift pumps shall be a minimum of 125 mm.

The airlift pumps shall be installed with necessary air escape pipes. It shall be possible to demount and hoist the sand pumps separately for servicing without having to put the grit and grease chambers out of operation. The air extraction hoods shall be connected to the extract ventilation system and may be connected to the suction side of the blower station.

If **submersible pumps** are used for grit and grease, they shall be of vortex type, and of maximum 1000 rpm Each pump shall be suitable for operation in a wet well installation, and shall be provided complete with duck food with automatic coupling, guide rails and lifting chain.

Each grit pump shall be capable of handling wastewater containing grit settled on the bottom of grit chambers. Capacity of the grit water transport system (e.g. grit pumps) shall be sufficient for removal of the collected sand with the system not running more than 20 minutes per hour.

Each pump shall be provided with a flexible hose connected to the suction flange. The flexible hose shall be reinforced to resist vacuum conditions during operation.

Submersible sewage pump for grit and grease may be equipped with a vortex impeller and a mixing device (agitator) screwed directly onto the impeller. An agitator connected to pump shaft shall be provided after pump volutes. The impeller and agitator shall be durable against abrasive effect of the sand, coated with abrasit (material /chilled cast iron which provides excellent wear resistance and hardness of 63 HRC) or similar

Guide rails and lifting chain shall be made of stainless steel or hot dip galvanized steel. Each pump shall be provided with a control panel. The panel shall include an adjustable timer for setting the operation/pause times for the pump.

# Equilization of Wastewater Inflow

## Equilization Tank

### General

Equalization tank shall be located downstream of the grit and grease removal chambers.

Main function of the equalization tank shall be to balance variations of wastewater inflow from the upstream process unit (preliminary treatment) and transfer of wastewater to the downstream units (biological treatment).

Effective volume of the equalization tank shall be sufficient to accommodate the least favourable operational regime in terms of differential inflow and outflow, but in any case shall be ≥ 500m3.

Size and detail design of the equalization tank shall be defined at the design stage.

The equalization tank shall be designed and constructed in accordance with the WWTP capacities and requirements. The aforesaid tank shall be designed as a semi-berried water-tight reinforced concrete structure. The tank shall be hydraulically shaped (slopped slabs and walls, and similar) so as to prevent settling of suspended solids in wastewater.

The tank shall be covered with a top slab with adequate access covers and adequate ventilation and odour removal devices. The tank shall be also equipped with adequate flushing and cleaning devices (high-pressure water jetting or similar).

Wastewater from the equalization tank shall be transferred to the biological treatment by means of a SBR feed pumping station that shall be placed next to or within the tank. The tank shall have a safety overflow provision capable of evacuating maximal differential flow in case that the SBR feed pumping station is out of operation.

## Pumps

### General

SBR feeding Pumping Station shall be able to transfer the maximum design wet weather flow, including returned supernatant liquor.

Pumps shall be type submersible all in accordance to general technical specifications in these TR

In addition to operating units, one stand-by unit equal characteristics shall be provided.

Operation control of the pumps shall be by means of frequency converters (FC) in relation to hydraulic conditions at the inlet, and in relation to the WWTP requirements.

Individual pumps shall be switched “ON/OFF”, depending on operational requirements, in case of pump failure and also in order to equalize hours of operation of individual pumps an automatic changeover “Duty/Standby” shall be provided.

Water level measurement in the sump shall be established as a continuous ultrasonic measurement (or equal), with transmission to the local PLC.

In addition, each pump shall have its individual dry-run protection system. The local PLC shall be interlocked with the main operation control of the plant.

Apart from the regular power supply, in case of power cut, the lifting Pumping Station shall have provision of stand-by power supply by means of a stand-by generator set that shall provide power supply required for the pumping station full operational capacity.

Appropriate lifting device shall be considered for installation and maintenance services.

# Primary Sedimentation

## Longitudinal Scraper Bridge

Is longitudinal bottom scraper bridge assembly for scum and bottom sludge removal from rectangular sedimentation basin, which is travelling bridge as robust steel construction with walkway, stairs, handrailings and local control board; with limit switches for operation control.

General design features shall be as follows, but not limited to:

1. Folded profile bridge, live load of 1.5 kN/m and max. deflection of L/360, acc. to DIN 19569-2 and DIN EN 12255-1 (or equal);
2. The scraper mechanism shall be designed as dragged scraper blades (minimum height 500 mm, thickness 5 mm) with manual lifting gear up to 30 m tank diameter, above with electrically actuated drive unit.
3. Walkway with a minimum clear width of 800 mm with open mesh flooring acc. to anti-skid class R12. Access stairs (SST 1.4301) shall be provided at each end of the bridge;
4. Carriage with drive and running wheels; geared motor mounted on the gear reducer output shaft flanged on the wheel casing; wheels with solid rubber tyres sized not to exceed a surface pressure of 250 N/cm² and adjusted to the settlement tank running circle; minimum dimensions of wheels in accordance to DIN EN 12255-1 (not less than 400 mm diameter); travelling speed approx. 3 cm/s;
5. Two undercarriages with drive and running wheels shall be provided. Carriages with running wheel with axle running in anti-friction bearings calculated lifetime of bearings acc. to lifetime class 3 (DIN 19569-2 and DIN EN 12255-1); dive carriage connection bolted to the bridge beam; changing of wheels shall be possible after minor lifting of bridge; Trackless running of the wheels on the outer tank wall. The wheel axles shall run in carefully sealed antifriction bearings, surface pressure of the rubber wheels shall be below 250 N/cm²;
6. Hollow shaft spur geared motor with torque link shall be mounted on the axle of the drive wheel. Guidance by four guide rollers with vulkolan tyres running on the inner and outer side of the tank-wall;
7. The motors shall be two speed motors with brakes connected directly to the driving track. (Open chains, gear wheels etc. will not be accepted);
8. The limits of scraper travel shall be secured by 4 Nos. of limit switches and rubber buffers. The main wheels shall have a diameter of not less than 400 mm and the guidance wheels shall have minimum diameter of 150 mm;
9. The adjustable bottom blade shall be provided with scraping edges consisting of wearing steel plates and sliders. The section shall be formed to fit into the sedimentation basin.
10. The scraper blade shall be suspended from the bridge by steel tubes, which shall be provided with devices to guarantee a secure counter pressure and prevent a rising of the scraper even when the sand amount increases.
11. The bridge shall be provided with lifting and lowering drives, one for scraper bladder or scum board. When they are up, the bridge shall be capable of being driven clear over the interface of the tank. It must be possible to lift the blades out of the sewage for maintenance. All necessary equipment under the water shall be provided in stainless steel.
12. The adjustable scum boards shall have a minimum thickness of 5 mm, shall be fixed to the bridge by steel tubes and located so that they close tightly to the concrete edge of the grease trap when the scraper is in front position. The boards and flights shall be provided with flexible rubbers at the sides and at the bottom with a minimum size 100 x 10 mm.
13. Control cabinet shall be provided with PLC (or relay control) installed in a stainless steel cabinet, IP 67; provided with thermostatically controlled anti-condensation heating shall be mounted onto the bridge in an accessible and visible height; including all switchgear for automatic operation; with indicator lamps and selector switch for manual operation to be installed in the front door;
14. Cabling (NYY cables) shall be carried out in corrosion-proof PVC conduits; Emergency switch located at the bridge access;
15. Transmission of a collective operation and fault signal via voltage-free contacts; inductive proximity switches shall be used for control of bridge travelling and scum blade movement. The bridge shall be provided with protection device (torque switch) against stuck (including alarm);

The bridge shall be provided with lifting and lowering drives for the scum board and sludge removal mechanism. The scraper bridge shall be fitted with all necessary cabling and be provided with electric equipment as specified. For transmission of a collective operation and fault signal voltage-free contacts shall be provided.

## Chain Scraper

Chain scraper mechanism for scum and bottom sludge removal from rectangular sedimentation basin. The chain scraper scrapes the settled sludge continuously to the sludge hoppers. In addition the surface scum is collected by the flights and moved in the direction of the effluent towards the installed scum collection trough.

General design features shall comply with the following, but not limited to:

1. Chain and Flight Scraper mechanism shall be a complete 100% non-metallic system furnished by recognised experienced manufacturers only;
2. Drive station with a sufficient gear motor including mount base, pinion screw fastening, pattern chain drums and chain. The station must have a unit for re-tightening the chain e.g. with a tightening unit. The drive station must be whether protected;
3. The drive shall be installed alongside the top of the tank and drives the collector system by means of an adjustable, easily replaceable drive chain. The drive system shall be electrically and mechanically protected against overload: Geared motor: 230/400 V, 3 phase, 50 Hz, IP 55 with baseplate made of hot dip galvanised steel, adhesive anchor bolts and fastening material made of Stainless Steel
4. Protective cover for drive motor made of SST including fastening materials in SST;
5. The drive sprocket and hub assembly shall be directly attached to the motor and include a shear pin to transmit the torque between the hub and the drive sprocket. Material: Hub assembly SST; Sprocket PA6/6;
6. Drive chain made of glass reinforced Nylon 6/6 (Polyamide PA 6/6) between the geared motor drive shaft sprocket and the driven sprocket on the drive side of the main drive shaft. the chain bolts are manufactured from SST ;
7. Idler sprocket for guidance and tensioning of the drive chain, comprising: Idler sprocket, 7 tooth, pitch 66.2 mm, Material: PA and take-up bracket including fastening materials in SST to attach the chain-tensioner assembly to the tank wall.
8. Drive shaft assembly using 3-piece telescoping GRP-tubes (minimum diameter: 133mm (end tubes), 250mm (centre tubes)) mounted onto wall mounted stub-shaft spindles on both sides of the tank, with water lubricated, low friction maintenance free bearings, and fastening materials in SST. Centre tube to be filled to reduce water ingress. Maximum deflection of ½º across full span of headshaft in operating condition. Stub shaft spindle material Cast Nylon 6 (PA 6), drive shaft bearings as low-friction bearing in ultra-high molecular weight polyethylene (UHMW-PE). Non-telescoping, heavy metallic shafts shall not be permitted.
9. Bull (driven) sprocket as two part bolted construction, attached to drive shaft on the drive motor side of the tank with wedge and fixing bolts, material: PA 6; Pitch: 66.2 mm; minimum 40 teeth.
10. Drive sprockets, mounted on the drive shaft, two part bolted construction, with chain saver rims to prolong chain life, Material: PA 6, Minimum tensile strength 88 N/mm, minimum hardness Rockwell R116; minimum pitch diameter 565 mm, pitch 152.4 mm; uneven number of teeth to increase sprocket life; minimum 23 teeth.
11. Idler stations consisting of idler stub shaft (stub shaft, spindle, idler sprocket made of PA 6) with spindle, fastening ring, idler sprocket (minimum pitch diameter 422 mm; pitch 152.4 mm, uneven number of teeth to increase sprocket life; minimum 17 teeth) with integral chain saver rim, easily changeable bearings with water lubricated, low friction bearing surface (Material UHMW-PE). Fastening materials, adhesive anchors, etc. in SST. Metallic shafts spanning the tank width shall not be permitted.
12. Collector Chains, endless: The collector chains are manufactured from non-metallic materials suitable for use in sewage applications. Chain material PBT (a reinforced thermoplastic polyester resin), pitch 152.4 mm, minimum weight 1.93 kg/m, chain dimensions 110/60 mm. Chain links shall be integrally moulded with the barrel and sidebars formed in one piece to ensure squareness and strength of the links. Chain connecting pins shall include a moulded T-head to prevent pin rotation and be fitted with a retaining clip to ensure positive locking. The chain shall have a minimum breaking strength of 30 kN and a published working load of 13.8 kN based on strength, fatigue and wear considerations. The chain shall not stretch excessively with time or under load: Elongation at working load of 13.8 kN shall be less than 1.5%. The chain links shall be easily replaceable. Thanks to the easily accessible equipment, subsequent tensioning of the chain is enabled without the use of specials tools even while the tanks remain full.
13. Flights shall be non-metallic, manufactured from GRP with minimum glass fibre content 55%; maximum water absorption 0.6%. The flight profile shall be specially designed for sludge collector service, chosen so that the settled sludge is not lifted into the clear water zone at the end of the tank, and include an integral scraper lip to ensure effective cleaning of the tank floor. The flight design shall be appropriate to the width of the tank: for tanks of 8.5 – 12m wide flights shall be Box-profile, provided with cavities filled with low density material to reduce deflection and to prevent sludge build up; flights shall not be buoyant. Minimum flight dimensions 190x127x4.5 mm; minimum moment of inertia Iy 431 cm4 in horizontal plane and Ix 1721 cm4 in vertical plane; and minimum modulus of elasticity E 27’600 N/mm2. Flights shall be attached to the collector chain in such a way as to make them easily replaceable. The flights shall be bolted to the chain attachment links using SST hardware. Parallel operation of the flights shall be controlled by means of a flight monitoring system;
14. Each flight shall be fitted with two floor rail wear shoes (material PA, thickness 12.7 mm) and two return rail wear shoes with lugs for flight alignment. Wear shoes shall be reversible to provide two usable wearing surfaces. Leading edges shall be rounded for smooth transition between wear strips;
15. Floor rail wear strips (material UHMW-PE, width 66 mm, thickness 12.7 mm);
16. Wall mounted return rail wear strips shall be mounted at a minimum of 300 mm from the tank wall to ensure correct flight positioning. Support rails shall be manufactured from GRP angle, dimensions 102 x 76 x 9.5 mm. Wear strip material shall be UHMW-PE, width 66 mm, thickness 12.7 mm;
17. Wall brackets (material PA 6/6) anchored to the tank walls, as intermediate supports for the return rails, Support spacing shall be approximately 3m.
18. Control cabinet shall be provided with PLC (or relay control) installed in a stainless steel cabinet, IP 67; provided with thermostatically controlled anti-condensation heating shall be mounted onto the bridge in an accessible and visible height; including all switchgear for automatic operation; with indicator lamps and selector switch for manual operation to be installed in the front door;
19. Control cabinet shall be provided with PLC (or relay control) installed in a stainless steel cabinet, IP 67; provided with thermostatically controlled anti-condensation heating shall be mounted onto the bridge in an accessible and visible height; including all switchgear for automatic operation; with indicator lamps and selector switch for manual operation to be installed in the front door;
20. Cabling (NYY cables) shall be carried out in corrosion-proof PVC conduits;
21. Monitoring system to ensure parallel running of the flights, consisting of: 2 wall brackets, 2 bearings for switch levers, 2 switch levers, 2 proximity switches, (Ex-proof, if necessary), control system to monitor parallel running of the flights;
22. Brushes for cleaning of submerged outlet pipes, mounted on the flights;
23. Tilting scum trough made of SST for removal of floating scum.

The scraper mechanism shall be fitted with all necessary cabling and be provided with electric equipment as specified. For transmission of a collective operation and fault signal voltage-free contacts shall be provided.

## Circular Suction Scraper

Circular suction scraper bridge assembly for scum and bottom sludge removal from circular clarifier. Travelling bridge as robust steel construction with walkway, stairs, handrailings, central bearing with slip ring collector and local control board; with limit switches for operation control.

General design features shall be as follows, but not limited to:

1. Folded profile bridge, live load of 1.5 kN/m and max. deflection of L/500, acc. to DIN 19569-2 and DIN EN 12255-1 (or equal);
2. The service bridge shall be made of steel, hot dip galvanized. All submerged parts of the scraper mechanism shall be in stainless steel;
3. Walkway with a minimum clear width of 800 mm with open mesh flooring acc. to anti-skid class R12. Access stairs (SST) shall be provided at each end of the bridge, emergency ladder (SST) shall be provided at the inner circle;
4. Carriage with drive and running wheels; geared motor mounted on the gear reducer output shaft flanged on the wheel casing; wheels with solid rubber tyres sized not to exceed a surface pressure of 250 N/cm² and adjusted to the settlement tank running circle; minimum dimensions of wheels in accordance to DIN EN 12255-1 (not less than 400 mm diameter); travelling speed approx. 3 cm/s;
5. Carriage with running wheel with axle running in anti-friction bearings; calculated lifetime of bearings acc. to lifetime class 3 (DIN 19569-2 and DIN EN 12255-1); dive carriage connection bolted to the bridge beam; changing of wheels shall be possible after minor lifting of bridge;
6. Central bearing assembly comprising (large diameter) slewing ring ball bearing with grease nipple on the bridge, lifetime class 5 acc. to DIN 19569-2 and DIN EN 12255-1; with pivots to allow vertical movements of the bridge; changing of ball bearings shall be possible after minor lifting of bridge;
7. Slip ring collector, totally enclosed with at least 8 slip rings, enclosure made of SST;
8. Control cabinet shall be provided with PLC (or relay control) installed in a stainless steel cabinet, IP 67; provided with thermostatically controlled anti-condensation heating shall be mounted onto the bridge in an accessible and visible height; including all switchgear for automatic operation; with indicator lamps and selector switch for manual operation to be installed in the front door;
9. Cabling (NYY cables) shall be carried out in corrosion-proof PVC conduits; Emergency switch located at the bridge access;
10. Transmission of a collective operation and fault signal via voltage-free contacts/slip ring collector; inductive proximity switches shall be used for control of bridge travelling and scum blade movement. The bridge shall be provided with protection device (torque switch) against stuck (including alarm);
11. Bottom sludge suction system comprising height adjustable stainless steel (SST) suction pipes with lower T-shaped perforated suction tubes or V-shaped scraper blades with suction pipe; number of suction pipes (at least 4 nos.) and diameter in accordance to hydraulic calculation;
12. Suction box made of folded stainless sheet steel with telescopic valves for adjustment of the individual suction pies shall be sized in accordance to the number of suction pipes and the hydraulic calculation;
13. Draw off suction pipe from the suction box into the sludge outlet channel at the centre well; number and diameter in accordance to hydraulic calculation;
14. Central sludge collecting channel for assembling at the centre structure, incl. all fastenings, supports and discharge connection; designed as welded sheet steel made of stainless steel SST;
15. Manually operated evacuation pump, to be supplied loose;
16. Influent distribution cylinder of assembling under the scraper bridge; made of SST, diameter 1/3 of tank diameter, submerged height 1/3 of centre water depth;
17. Scum removal system comprising skimming troughs with manually operated scum discharge flaps, one of them with integrated pump sump. Floating materials and scum will be conducted to the pump sump and discharged by a submersible pump of sufficient capacity through the central bearing into the scum discharge pipe. Sum removal system to be assembled at the bridge, with manually operated lowering drive unit;
18. Secondary clarifier, only: Antifoam spray mechanism comprising distribution pipework with spray nozzles which shall be assembled under the scraper bridge, pressurized service water supply, c/w. pipework, fittings and armatures;
19. All materials in contact with water shall be constructed of stainless steel SST; steelworks above water level shall be made of mild steel with corrosion protection and coating in accordance to these requirements; handrailings and gratings shall be of galvanized steel;
20. Weir and channel cleaning system with motor driven rotating polypropylene bristle brushes comprising supporting structure with geared motor, adjustable brush-set with manually operated lowering drive unit.

The bridge shall be provided with lifting and lowering drives for the scum board and sludge removal mechanism. The scraper bridge shall be fitted with all necessary cabling and be provided with electric equipment as specified. For transmission of a collective operation and fault signal voltage-free contacts shall be provided.

## Circular Bottom Scraper

Scraper bridge with bottom scraper mechanism for scum and bottom sludge removal from circular clarifier as specified above, but:

1. Bottom sludge scraper blade assembly, which forms the shape of a logarithmic spiral, design requirement:

* Diameter of basin up to 28 m : radial bridge
* Diameter of basin up to 40 m : cantilever bridge
* Diameter of basin up to 60 m : double bridge

1. The scraper mechanism shall be designed as dragged scraper blades (minimum height 500 mm, thickness 5 mm) with manual lifting gear up to 30 m tank diameter, above with electrically actuated drive unit;

The bridge shall be provided with lifting and lowering drives for the scum board and sludge removal mechanism. The scraper bridge shall be fitted with all necessary cabling and be provided with electric equipment as specified. For transmission of a collective operation and fault signal voltage-free contacts shall be provided.

## Electrical Equipment

The electrical equipment to be provided for power supply and operation control, incl. measuring instruments shall comply with the requirements set out in Volume3, Section 4 – General Electrical Specifications of these Tender Documents.

The local electrical equipment shall comply with the following:

1. The scraper shall be fitted with all necessary cabling and be provided with a centre slip ring bearing with at least 8/12 contact rings. A sufficient number of cable tubes (1/consumer + 2/signals + 2 spare) shall be incorporated in the concrete building.
2. The cabling shall be carried out in corrosion-proof PVC conduits and completely installed at the manufacturer's work;
3. The scraper shall be provided with a stainless steel switching cabinet, mounted on the travelling bridge. The cabinet shall include all necessary connection devices, fuse, protection switches, control transformer with two separate windings for 400/230 V, 50 Hz, main switch, selector switch and push buttons.
4. All motors and operations shall be controlled by push-buttons, but the limit switches shall still operate automatically;
5. Each unit shall be provided with a local emergency-OFF-switch and control switch (MAN/AUTO/OFF);
6. For transmission of operation and fault signals voltage-free contacts shall be provided;
7. Protection device (torque switch) against stuck (including alarm).

The switching cabinet shall be ventilated and heated electrically with thermostatic control to avoid condensation. The switching cabinet as well as the whole bridge shall be completely wired and assembled.

## Effluent Weir and Peripheral Skirt

The clarified effluents shall be collected in a peripheral concrete outlet channel fitted with adjustable V-notch outlet weirs and a peripheral scum baffle).

The weirs shall be made of 3.0 mm thick stainless steel plate and shall be fitted with vertical slots to enable ample vertical adjustment of the weir and to permit the V-notch weir to be anchored to the concrete with anchor bolts.

The weir plates shall be serrated with right angle V-notches, according to DIN 19558 type B (or equal). Sealing strips shall be provided for installation between the weir plates and the effluent collection channel.

The peripheral scum baffles, according to DIN 19558 type B (or equal) shall be fixed at the peripheral concrete outlet channel. The dimension of the skirt, the mounting brackets and hardware shall be functional under the responsibility of the manufacturer.

# Activated Sludge Plant

## Compressed Air Aeration

Air distribution pipework upon the tank walls comprising stainless steel or polyethylene pipework according to tender requirements, including pipe supports, sectional valves and fittings, maximum flow velocity 13-16 m/s under operating conditions; connecting pipework to aerators inside the tanks and air distribution grids on tank bottom with fine bubble membrane aerators for intermittent operation and drains

### Membrane Aerator

Non-clogging type membrane aerators suitable for intermittent aeration shall be arranged above the concrete slap of the basin. It shall be arranged as line- or plane-aeration, therefore membrane aerators shall be assembled to a number of aeration grits comprising installation and distribution pipework with membrane aerators.

Membrane aerators shall comprise, but not limited to:

1. Supporting pipe made of water resistant PP; outside diameter shall be approx. 70 mm with connection piece to distribution pipework; PP-part of the aerator without uplift;
2. Aerators shall be in non-clogging design for intermittent operation;
3. Perforated membrane of the aerator made of EPDM or silicon rubber;
4. The max. pressure loss of the aerator shall be less than 50 mbar after 2 years operation;
5. The guaranteed service life of the aerator shall be more than 5 years under operation conditions;
6. The immersion depth may range from 2 to 7 m.
7. The distributors, on which the aerators are fixed, shall be made of stainless steel or HDPE. The minimum wall thickness of the pipework shall be 3 mm. The distributors must be vertically adjustable and be fixed on the floor of the basin.

Each distributor must have an own dewatering unit. The diameter of that unit must be not less than 50 mm and is in the same material than the distributors. The dewatering unit starts at the deepest point of the distributor and ends directly above the water level in horizontal direction with a ball valve.

Disk or plane aerators must fulfil analogous requirements and will be subject to the approval of The Engineer.

### Porous Aerator

Non-clogging type submersible aerators suitable for continuous and intermittent aeration shall be arranged above the concrete slap of the basin.

It shall be arranged as line or plane aeration, therefore aerators shall be assembled to a number of aeration grits comprising installation and distribution pipework with membrane aerators.

Aerators shall comprise, but not limited to:

1. Aerators designed as tube or disc aeration elements made of break resistant porous foamy plastic material (HDPE), high chemical resistance with a continuously smaller becoming pore size in direction of the air stream, with a high-rate air injection at low pressure loss which results in high oxygen input and oxygen yield.
2. Screw-in aerator, made of porous HDPE, with gasket made of EPDM and check valve.
3. Technical data as follows, values for clean water:

Pressure loss : approx. 12 mbar at 10 Nm³/h/m

Oxygen input : 20,5gO2/Nm³ x mdepth at 14% configuration density and 9 Nm³/h x m

Features : non breaking, easy cleaning by shock aeration

Materials : towing bar, washers and nuts made of SST, sealings and check valve in EPDM, centering piece and end-cap made of PP (polypropylene)

1. Aerators shall be in non-clogging design for intermittent and continuous operation;
2. The max. pressure loss of the aerators shall be less than 25 mbar after 2 years operation;
3. The guaranteed service life of the aerator shall be more than 5 years under operation conditions;
4. The immersion depth may range from 2 to 7 m.
5. The distributors, on which the aerators are fixed, shall be made of stainless steel or HDPE. The minimum wall thickness of the pipework shall be 3 mm. The distributors must be vertically adjustable and be fixed on the floor of the basin.

Each distributor must have an own dewatering unit. The diameter of that unit must be not less than 50 mm and is in the same material than the distributors. The dewatering unit starts at the deepest point of the distributor and ends directly above the water level in horizontal direction with a ball valve.

## Sequencing Batch Reactor – Decanting System and Scum Removal

### General

Sequencing Batch Reactors (SBR) are a flexible configuration of the activated sludge process, capable of providing low effluent nutrient levels. The SBR is fundamentally the same as any other variation of the activated sludge process, except that it operates in a batch draw and fill mode.

Activated sludge process shall take place in Sequencing Batch Reactor (SBR),in accordance with DWA M-210.

The SBR shall be fully automatic to maximise control of energy and to optimize sequencing of all activities between reactors taking into account variations in flow rates to the plant.

SBR tank shapes, aeration, as well as mixing systems shall be designed to:

1. maximize oxygen introduction into the wastewater at minimal energy costs,
2. avoid/minimize wastewater spraying/splashing/generation of aerosols prevent sludge sedimentation
3. allow for removal of nutrients

The decanting device shall be designed to collect and discharge clarified effluent from the SBR, properly sized to prevent vortex and withdrawal of settled sludge and shall be provided with skimming device to prevent breach of scum or other floating matter into clarified effluent.

In addition to these, an automatic turbidity measurement device shall be installed at the effluent outlet in order to control clarification.

Scum removal devices shall be located in the corner of each basin [[4]](#footnote-4) in such a way that the prevailing wind drives the scum and floating matter toward the removal device. The scum removal device may be manually operated or automatic.

SBR tanks shall be provided with service platforms (bridges) for installation and maintenance of the mixers, submersible pumps or other equipment within the tank.

Platforms shall be of sufficient space, protective rail and all necessary accessories for installation of mixers for future nutrient removal requirements.

Adequate mixing of the SBR volume shall be provided by installation of submersible mixers. Operation control of the denitrification process shall be achieved by means of a combined Redox/DO control using an automatic controller. On-line measurements are required for each individual basin.

A lifting davit of sufficient capacity to lift the equipment installed in SBR, such as submersible mixers, pumps, etc. shall be provided for maintenance services per two subsequent tanks.

### Decanting System for SBR

Clear water decanting system for the discharge of purified wastewater out of wastewater treatment reactors (SB-reactors) shall be use a moveable pipe construction, which operates simultaneously according to the lowering water level.

The requested decanting construction must be completely made of stainless steel and includes a specially developed wear-less and maintenance-free joint-construction for long-term trouble-free use

The motor drive (winch) for the moveable system shall be located at top of each SBR (tank rim), serving good access and easy maintenance.

The downwards movement of each decanter shall be controlled by use of a conductive sensor, which guarantees that a simultaneous operation with respect to the downwards moving water level is achieved.

The special design of the inlet pipe shall consider a specific barrier for floating materials so that it is prevented that any foam, floated sludge etc. enters into the inlet pipe.

During the filling- and aeration-phase inside the SB-Reactor the inlet pipe must be above water level. During the filling-phase the inlet-pipe has also the function as an emergency overflow.

The sediment sludge should not be come in turbulence and get out with the discharge pipe.

Each decanter shall end behind the twisting link with a stainless steel pipe coupling for the connection of the discharge pipe. The outgoing pipe ends in a height of 2 m above tank bottom without any backpressure (free flow is guaranteed).

Each Decanter shall include a reliable, heavy-duty and strong designed electrically driven winch, which will be installed at the rim of the tank.

A stainless steel cover for each winch (safety protection and weather resistance) shall be included in the offered scope of supply. It should be pointed out, that the basic steel plate of each winch (assembly plate) shall be made of stainless steel in order to prevent corrosion.

Each electrical winch shall be equipped with totally four (4) limit-switches (not explosion-proof), which are adapted to the gear drive of the winch. Two (2) switches are for the control of the low position and two (2) switches are designated for the control of the upper position (park-position). It is requested that two (2) of the four (4) limit switches are for emergency use, which means that the operation is 100 % backed-up (in order to guarantee a trouble-free operation).

A further mechanical limit-switch (not explosion-proof) shall be installed independent to the gear drive at the rim of the SB-reactor. This limit switch shall prevent a mechanical damage of the decanter in case, that the four switches (installed at the gear drive) have any malfunction or if the PLC is not operating properly. The fifth switch should be connected not to the PLC, but direct to a switch-relay.

The local electrical control for the tendered decanters shall be included in the offered scope of supply (not explosion-proof, but according to insulation class IP 54). It is necessary to install this control box next to the electrical winch in order to start and stop the decanter-winch by manual actuation and visual control

The control box shall be equipped with one switch for the positions “automatic” - “stop” - “hand” and a second switch for the positions “up” and “down”.

The downwards operation of the decanters shall be controlled by a conductive sensor, which transmits a signal to the central control panel. Thus, the electrical winch shall be switched off as soon as the conductive sensor is reaching the water level (a time delay will be preselected at the central control panel). The winch shall be switched on, as soon as the sensor has left the water and has reached a dry position. The necessary evaluator for the conductive sensor is part of the tendered scope of supply and shall be delivered for the installation in the central control panel.

The required decanters shall be designed under respect of the following general technical requirements:

* Voltage: 400 V / 50 Hz
* Material: SST
* Maintenance below water level: not necessary
* Type of submersed rotating link: maintenance free construction

## Overflow Weir

Height adjustable weir plate with spindle, frame and electric drive, installed at the aeration basin effluent for final regulation of the immersion depth if surface aerators are applied.

Each weir shall comply with the following specifications:

1. Height of door : 400 mm
2. Adjustable height : 0 .. 300 mm
3. Materials of door : SST
4. frame : SST
5. spindle : SST
6. bearing and nut of spindle : POM
7. sealing : PU
8. Electric drive : AUMA or equal

* Rated power : 0.18 kW at 400 V/50 Hz
* class of protection : IP 67
* class of insulation : F

1. Materials of
   * body : GG
   * shaft : stainless steel
2. corrosion protection : shotblasted SA 2,5 hot sprayed polyuretane,

UP > 400 µm

1. colour/painting : RAL 7031

Unit comprising weir plate with lateral cheek plate, sealing by flat rubber strips, plate door with canning tube for non rising worm gear-spindle with spindle-nut, supporting frame, electric geared-motor as common in trade with handwheel, c/w. local emergency-OFF-switch, terminal box, internal cabling and wiring of unit.

## Electrical Equipment

The electrical equipment to be provided for power supply and operation control, incl. measuring instruments shall comply with the requirements set out in Section 4 of these Employer’s Requirements

The local electrical equipment shall comply with the following:

1. Each aerator/drive shall be provided with a stainless steel switching cabinet, mounted close to the motor, including all necessary connection devices, fuse, protection switches, control transformer with two separate windings for 400/230 V, 50 Hz, main switch, selector switch and push buttons.
2. All motors and operations shall be controlled by push-buttons, but the limit switches shall still operate automatically;
3. Each unit shall be provided with a local emergency-OFF-switch and control switch (MAN/AUTO/OFF);
4. For transmission of operation and fault signals voltage-free contacts shall be provided. The switching cabinet shall be ventilated and heated electrically with thermostatic control to avoid condensation
5. Protection device (torque switch) against stuck (including alarm) shall be included

# Chemical Dosing Equipment

## Chemical Dosing and Transfer Installations

Pumps shall be selected taking into account the chemical being pumped, form of chemicals, wear, resistance to corrosion and, in the case of dosing pumps, the accuracy.

Each pump shall be provided with inlet and outlet isolating valves and where necessary with pressure relief and non-return valves.

Dosing pumps shall be provided with backpressure loading valves and pulsation dampeners in the delivery lines depending on the downstream conditions.

A relief valve shall be incorporated in the delivery lines under conditions where the pump discharge pipe can be shut off or where pressure may rise to an excessive point. The relief valve shall be sized to handle the system pressure and to discharge maximum pump output freely, and shall be located in the discharge line between the pump and the first downstream isolating valve or in the case of dosing pumps the back pressure loading valve. Relief valves when used on pumps handling non-hazardous chemicals shall discharge the vented liquid to waste. When used on hazardous chemicals, the valve outlet shall be piped back to the suction supply tank. The open end of the return pipe shall be located where it is visible, so that any relief valve leakage/operation can be detected.

Pumps transferring/dosing chemicals to systems under pressure shall incorporate a pressure gauge on the pump delivery. Air cocks shall be provided for release of air where necessary.

Flushing connections shall be provided at each pump inlet and direct to the delivery lines where so shown on the conceptual schematic diagram of the works; flushing water shall be at least 3.5 bar operating pressure at the connection.

## Dosing Pumps

Chemical dosing pumps shall be of the plunger or diaphragm type driven by electric motors. Hydraulically actuated diaphragm pumps will not be acceptable. Pump, motor and driving arrangement shall be mounted on a robust combined baseplate incorporating a drain connection.

The operating range of dosing pumps shall not be less than 6:1 for diaphragm pumps and 10:1 for plunger pumps, with overall accuracy within the following percentages:

|  |  |  |
| --- | --- | --- |
| Descripton | Diaphragm Pumps | Plunger Pumps |
| Accuracy of setting | 3 | 1 |
| Repeatability | 1,5 | 0,5 |
| Linearity | 3 | 1 |

Plunger pumps shall have alum-type-ceramic or stainless steel plungers.

Diaphragm pumps shall have thermoplastic diaphragms faced with polypropylene, butyl or polytetrafluoroethylene (PTFE).

Pump heads shall be either stainless steel or polypropylene. Mechanical glands shall not be used.

The output of the pump shall be adjustable by varying the effective length of the displacement stroke. Variable stroke mechanisms shall be incorporated which enable the pump is running by means of a micrometer hand wheel or similar device.

Pump motors shall incorporate an integral reduction gearbox drive, which shall be totally enclosed in a lubricated oil bath. The gearbox shall incorporate the cams for the plunger or diaphragm drive and shall be provided with oil filling and drain connections and visible oil level indication.

If integral gearboxes are not used, the drive shall be external V-belt. V-belt drives shall provide six standard stroking speeds to be selected manually by changing pulleys and which shall cover a range of pump speeds of not less than 3:1. V-belt drives shall have full guards of the type that allow the belts to be observed without the removal of the guards.

The design and location of metering pump heads shall facilitate easy dismantling for removal of any foreign matter.

Dosing pumps shall be provided with means for calibration by direct measurement upstream of the dosing pump. Manually isolated tapping shall be provided on the pump suction for connecting the calibration unit. The Contractor shall provide all necessary equipment and fittings in duplicate for the calibration of the dosing pumps.

Particular attention shall be paid to the layout of the dosing pumps and pipework. All connecting manifold systems shall be permanent and complete with drain connections. When handling chemicals with low vapour pressure, piping shall be designed to eliminate vapour pockets.

## Transfer Pumps

Where applicable pumps for the transfer of chemicals from bulk storage tanks to day tanks shall satisfy the general requirements for pumps specified elsewhere as appropriate.

These pumps and pumps for delivery of chemicals to the various points of application shall be manufactured from materials that will not be corroded by the chemicals to be handled.

The inlet and outlet valves on pumps shall be designed for easy removal or dismantling to allow any foreign matter to be removed.

Pumps shall have stable head/quantity characteristics which fall continuously from the maximum pressure at closed valve conditions and which are steep in order that variations in head shall have a minimum effect on the quantity discharge.

Pumps shall be arranged for automatic self priming.

Air cocks shall be provided where necessary for the release of air.

Gland water supplies shall be free of suspended matter and be non-corrosive.

Where necessary, glands, bushes, nuts, studs, etc. shall be of such materials or receive such protection as will prevent their corrosion by the fluid handled

## Chemical Pipework

Unless otherwise specified, each point of application shall be served by either a rigid pipe or a flexible hose and all hoses and pipes shall be connected to the pump delivery downstream of the last valve.

Unless otherwise specified, duplicate standby delivery pipes/hoses are not required,

Spare hose for each chemical point of application shall be supplied and kept in store.

At rapid mixers, threaded pipes shall be detailed in duplicate.

## Chemical Valves

Valves shall be of the diaphragm type with bodies and linings suitable for the chemicals handled.

For handling lime or carbon slurries, straight through diaphragm type or full bore valves such as globe or plug type or full bore valves such as globe or plug type shall be used.

Non-return valves on slurry lines shall be the ball type and shall be mounted on the vertical leg of the pipe.

Guard valves shall be provided for all non-return, pressure reducing, electrically actuated, loading and pressure relief valves.

## Ferric Chloride Dosing Plant

Ferric chloride dosing plant shall be stand-alone, started from a signal from the treatment works control system with the ability to accept a signal to pace the dosing pumps in response to flow through the treatment works.

The dosing plant shall comprise, but not limited to:

1. Stock Tanks; sized for at least one month usage plus one normal delivery and shall be sited in a bund sized to hold 110% of the tank capacity. The bund shall be provided with a drainage pump and alarm float switch;
2. Stock tanks shall be designed acc. to BS 4994.1987 or equal standards. Tanks shall incorporate a 150 mm weatherproof vent and a 100 mm overflow discharging into the bund. The discharge shall be arranged so as to minimise any splashing when in operation. Tank outlets shall be not less than 50 mm. Valved outlet and drain connections shall be as close to the tank as is practical to minimise leakage risk;
3. The stock tank shall be constructed in PVC with external resin impregnated fibreglass reinforcement finished with a rolled/brushed weatherproof gel coat or alternatively HDPE. Where climatic conditions dictate the tank contents shall be protected against freezing or sun radiation by locating the tank within a building;
4. Process Pipework and Valves; shall be PVC pipework with resin impregnated fibreglass reinforcement finished with a weatherproof gel coat. Flanged joints shall be made with natural rubber gaskets, screwed joints with PTFE tape. Isolating valves shall be PVC lever arm ball valves. Diaphragm valves shall not be used;
5. Safety Equipment; A safety shower complete with eye wash unit shall be installed within 4 m of the tanker unloading point but shielded from it. The unit shall be protected against freezing
6. Base Frame; made from materials unaffected by the medium, PVC or PE, steel base frames shall have a suitable surface treatment and finish to resist the corrosive effects of the medium. In either case the base frame shall be bunded to contain any leakage. The bund shall be sized to contain any spillage from the base frame mounted works and in addition any leakage from the pipework via any containment system;
7. Dosing Pumps; Duty/standby dosing pumps together with associated pipework and valves shall be installed on the base frame. The pumps shall be variable speed/stroke units constructed from stainless steel. Braided PTFE shall be used for packed glands, alternatively suitable mechanical seals may be used;
8. Instrumentation elements/components shall be suitably rated/protected against the corrosive effects of the medium. Pressure gauges shall be PTFE diaphragm type;
9. A local control panel shall be provided. The control panel shall be fabricated in corrosion free material GRP or equal and as a minimum shall comprise:

* Incoming fuse switch
* Starters and overloads inverters with fuse protection for the dosing pumps
* Control transformer
* Relays and timers as necessary for the effective operation of the works
* Door mounted indication lamps for control supply; heating; run and trip lights for all drives
* Hand/off/auto switch for all drives

1. The following volt free signals shall be provided:

* Ferric chloride available,
* Ferric chloride low level
* Bund high level
* Works fault

1. Input signals shall be provided for works start and 4/20mA for pump speed control..

## Polymer Preparation & Dosing Plant

Polymer dosing plant shall be stand alone plants started from a signal from the treatment works control system with the ability to accept a signal to pace the dosing pumps in response to flow through the treatment works.

Polymer preparation and dosing plant shall be suitable for the preparation of diluted polymer from a concentrate. The concentrate shall be supplied in man portable drums for small plants or IBC containers for large plants.

The dosing plant shall comprise, but not limited to:

1. Concentrate stock tanks; sized for at least one month usage plus one normal delivery and shall be sited in a bund sized to hold 110% of the tank capacity. The bund shall be provided with drainage pump and alarm float and low-level switch. In the case of small plants fed from drums a concentrate tank with cover shall be provided with connections to the concentrate pump. In the case of larger plants fed from an IBC the pump shall be coupled directly to the IBC outlet valve using a flexible hose and cam lock connectors, the concentrate pump shall be suction protected to prevent dry running;
2. Concentrate pump shall be a stainless steel direct driven centrifugal pump mounted onto the base frame. The pump shall be complete with all necessary pipework and valves to discharge into the suction connection of the emulsion pump;
3. Emulsion Pump shall be a gearbox driven positive displacement pump installed on the base frame. The pump shall have a manual speed adjustment facility. The pump shall be complete with all necessary valves, pipework flow switches, flow meters and regulators so as to discharge diluted polymer into the polymer storage tank;
4. Polymer storage tank to be installed on the base frame sized to provide adequate storage of polymer for at least one-week operation of draw off. The tank shall be complete with all fill, draw off and drain connections. It shall be fitted with a float switch to initiate a top up of emulsion and a float switch to indicate low level. A mechanical mixer shall be provided;
5. A base frame mounted control panel shall be provided. The control panel shall be fabricated in corrosion free material GRP or equal and as a minimum shall comprise:

* Incoming fuse switch
* Starters and overloads with fuse protection for pumps control transformer and mixers
* Relays and timers as necessary for the effective operation of the plant
* Door mounted indication lamps for: Run and trip lamps and Hand/off/auto switch for all drives

1. The following volt free signals shall be provided: Polymer available/Polymer low level/Polymer concentrate low/Polymer high level/Plant fault
2. Base Frame; made from materials unaffected by the medium, PVC or PE, steel base frames shall have a suitable surface treatment and finish to resist the corrosive effects of the medium. In either case the base frame shall be bunded to contain any leakage. The bund shall be sized to contain any spillage from the base frame mounted plant and in addition any leakage from the pipework via any containment system;
3. Dosing Pumps; Duty/standby dosing pumps together with associated pipework and valves shall be installed on the base frame. The pumps shall be variable speed/stroke units constructed from stainless steel. Braided PTFE shall be used for packed glands, alternatively suitable mechanical seals may be used;
4. Instrumentation elements/components shall be suitably rated/protected against the corrosive effects of the medium. Pressure gauges shall be PTFE diaphragm type;
5. Input signals shall be provided for plant start and 4/20mA for pump speed control.
6. Process pipework shall be PVC pipework with resin impregnated fibreglass reinforcement finished with a weatherproof gel coat. Flanged joints shall be made with natural rubber gaskets, screwed joints with PTFE tape. Process pipework shall be PVC pipework with resin impregnated fibreglass reinforcement finished with a weatherproof gel coat. Flanged joints shall be made with natural rubber gaskets, screwed joints with PTFE tape. Isolating valves shall be PVC lever arm ball valves. Diaphragm valves shall not be used.
7. A safety shower complete with eye wash unit shall be installed within 4 m of the tanker unloading point but shielded from it. The unit shall be protected against freezing.

# Sludge Thickening & Dewatering

## Gravity Belt Thickener

The gravity belt shall be designed to extract water from the excess sludge after conditioning of the sludge with a polymer. This process of thickening shall be accomplished by natural free drainage upon a moving horizontal belt to the extent that a finished sludge product meeting the performance requirements specified herein is produced.

The system shall be of the continuous belt thickener type and shall be designed to concentrate and thicken sludge by means of one belt of synthetic fibre mesh arranged to perform the conveying and thickening functions.

The major equipment items to be provided by the belt thickener equipment supplier include the belt thickener, one floor-mounted hydraulic unit, local belt thickening control panel, sludge feed inlet tank, and all other required components with complete and operable system.

The gravity belt thickener shall be complete, including frame, distribution box, filtration belt, belt drive, belt tensioning system, belt alignment system, ploughs, adjustable ramp, scraper (doctor) blades, belt washing system, drainage components, rollers, rollers bearings, control panel, motor drives, and other specified and necessary accessories.

All moving wetted parts, or all wetted parts on which moving parts ride, shall be fully corrosion resistant.

The gravity belt thickener will be exposed to waste activated sludge in an enclosed area subject to continuous 95 % relative humidity and splash conditions.

The gravity belt thickener shall continuously receive, flocculate, condition, and thicken the waste-activated sludge and neatly discharge thickened sludge into a holding tank. Units shall collect filtrate for further treatment.

The unit shall achieve the following minimum performance on waste activated sludge:

All parts of the equipment in contact with the sludge shall be made of stainless steel or shall be nylon or rubber coated. Other parts, including the frame, shall be covered with a corrosion-resistant coating as specified hereinafter. Coatings shall be suitable for the expected service conditions.

The structural main frame shall be fabricated from EN 10279, or equal structural steel members and plates and be of welded and/or bolted construction.

All main frame members shall be finished or protected by hot-dip galvanizing after fabrication with zinc.

Each gravity belt thickener shall be provided with a sludge conditioning system, designed to efficiently mix polymer with the sludge, prior to thickening. The sludge conditioning system shall be mounted upstream of the thickener and shall consist of an in-line, adjustable, non-clog static mixer with a variable orifice and a vortex polymer injection ring constructed of stainless steel.

The machine shall be equipped with a sludge feed inlet box fabricated of stainless steel, adjustable baffles or similar devices which uniformly distribute the sludge feed across the entire working width of the belt prior to the gravity drainage section. The perimeter of the box shall be provided with a skirt to prevent leakage or splashing from the box.

The belt shall be supported by a slotted grid assembly constructed of stainless steel and equipped with high density polyethylene support and wear bars spaced at 2-1/2 inch and 2-inch wider than the belt resistant containment seals. An even distribution of material across the entire width of the belt shall be ensured.

The belt shall be of the split type and manufactured of continuous weave monofilament polyester twill. Belt seam closures shall be stainless steel and shall not produce interference with scraper (doctor) blades or any other equipment.

All drums and rollers shall be supported with heavy-duty externally mounted four bolt base, split case. All bearings shall be lubricated, regreasable type having a rating of 700,000 hours. Stainless steel grease fittings on the machine shall be extended to the outside face of the frame.

All rollers, shall be of carbon steel with a 25-mil protective coating of heat setting thermoplastic nylon (Rilsan). Rollers shall be coated up to the point of insertion into the bearing block or shall have shafts and heads of 316 stainless steel. Carbon steel roller surfaces shall not be exposed to sludge or moisture. The use or rollers constructed entirely of stainless steel in lieu of rollers of carbon steel with protective coatings, shall be considered acceptable under this specification.

The manufacturer of the belt press shall warranty the rollers for three years from date of acceptance of the equipment. The warranty shall include all parts, labor and coatings for repairing or replacing any roller that fails during the warranty period, provided that the owner has not physically through external action, damaged the roller (weld splatter, fire, etc.).

The thickener shall be provided with an integral belt wash station suitable for cleaning the belt as it returns to the head of the machine. The wash station shall include a high pressure spray pipe header, flat jet spray nozzles, nozzle cleaning units, and shall be so contained to eliminate spray from the work area.

Spray headers and nozzles shall be of stainless steel. Nozzle cleaning unit shall be of built-in design suitable for cleaning nozzles without disassembly of wash station or interruption of sludge dewatering operations. Wash station enclosure shall be fabricated of fiberglass reinforced plastic withencapsulated reinforcing steel, or of stainless steel.

The thickener shall be equipped with blades to assist in the removal of adherent sludge from the belt at the discharge rolls. The discharge blade shall be mounted so that the sludge will normally discharge by gravity, only in the event of sticking to the belts.

A discharge chute fabricated of stainless steel to conduct sludge to the holding tank shall be provided.

A ramp adjacent to the output end of the thickening belt shall be provided to cause the dewatered sludge to ascend the ramp to discharge. All material related to the ramp assembly shall be corrosion resistant.

Material in direct contact with the sludge shall be stainless steel or high density polyethylene. The operating mechanism for angle adjustment shall be manufactured of brass. All other material shall be galvanized.

Hydraulic drive units shall be pre-packaged systems produced by one manufacturer including pumps, motor, oil reservoir, oil filter, pressure relief valve, pressure compensated flow control valve, and discharge isolation valve.

The pump shall be motor driven positive displacement gear type.

The pump and motor shall be mounted on a common steel or cast iron base plate which shall be mounted on the oil reservoir.

The oil reservoir shall be a horizontal tank constructed of steel plate and supported off the floor with steel legs. The tank shall have a flat top suitable for mounting the pump, motor and other equipment hereinafter specified. The tank shall be provided with integral baffles which separate the pump suction from the returned oil, sight gauge, filler assembly, and drain.

A low level indicator or pressure switch shall be provided to detect low hydraulic oil and initiate a shutdown signal. The system shall be provided with hydraulic oil, cartridge type, pressure and return filters suitable for removing any particles 10 microns and above in size.

## Belt Filter Press

Beltfilter press (BFP) system for dewatering of stabilized sludge under consumption of organic flocculant (polyelectrolyte).

1. General design features shall be as follows, but not limited to:
2. The BFP comprises a supporting steel framework, which incorporates the pre-dewatering drum with filtrate collecting trough, the belt assembly comprising sieve belt and pressure belt and the vertical arrangement of the pressure rollers (tower press).
3. The filtrate-collecting tank with automatically operated filter-cleaning system consisting of jet nozzle pipes and spray water pump using its own recycled filtrate, which is largely free of solids, and drain connection.
4. Electric drives with variable speed control, pneumatic belt tracking, control and monitoring devices.
5. Each BFP shall comply with the following specifications:

Mesh size of filter fabric: 500µm

Materials

* frame : folded and sheet steel made of SST
* medium touched parts: SST
* filter fabric : Polyester
* rollers : "Rilsan" coating, drive roller with rubber coating
* flocculation tank : PE-HD
* internal piping : PVC/PE-HD

1. Electric motors shall be 400 V AC + 10 % , 3 phase, 50 HZ, IP 55 enclosure
2. The thickening drum sieve is provided with a polyester sieve fabric of approximately 0.5 mm mesh size. It achieves maximum pre-dewatering due to free drainage of free water from the sludge up to a concentration of approx. 8 % and more. The capacity of the integrated drum sieve concentrator shall be adjusted to the sludge characteristics by manual adjustment of the individual drives (i.e. stirrer mixer and drum sieve). It shall be designed for automatic and maintenance-low operation in accordance with international standards (IEC/EEC).
3. The BFP shall be provided with a preceding flocculation reactor with integrated manually adjustable stirring mixer in order to improve the sludge flocculation process. Flocculent will be added to the thin sludge flow via an inline mixer installed within the feed pipe.
4. Raw sludge shall be feed into the BFP system unit by a connecting feed pipe from the flocculation reactor into the head of the dewatering drums. Thickening of sludge takes place by the continuous tumbling conveyance process of the sludge inside of the drum sieve to the lower discharge end onto the sieve belt.
5. The sludge dewatering belt system shall comprise of the wedge zone, the high pressure/shear zone and the cake discharge zone. The wedge zone consists of two horizontal endless sieve fabric belts with perforated rollers that gently apply and gradually increase the pressure to the thickened sludge. Equal dispersion of the pre-dewatered sludge is effected by a system of baffle and mixing plates. The high-pressure zone consists of a number of rollers with decreasing diameter in order to ensure an increasing contact pressure onto the sludge belts. The rollers are solid faced and arranged in a vertical configuration provided with drain trough for filtrate collection, roller shafts shall be a high strength chromium alloy steel selected for strength and corrosion resistance.
6. The sludge cake shall be removed from the discharge roller by polyethylene doctor blades into a stainless steel discharge chute. The scrapers shall be adjustable in order to provide gentle pressure on the belts without injuring the sieve fabric.
7. Filter belts shall be made of polyester monofilament wovenware with optimum mesh size. Edges have to be chamfered and belt seals shall be from the stainless steel clipper type.
8. The filter belt shall be washed by a low volume spray nozzles device in non-clogging design, made of stainless steel. Header shall be of stainless steel. A filter/strainer shall be installed in the pressure line to the nozzle headed.
9. Drainage pans shall be located under all gravity and pressure sections of the press, collecting, both filtrate and belt wash water. Pans shall be of SST. The Arrangement of filtrate collection system shall be such that no filtrate or sludge spillage shall be discharged into the dewatering, room floor at any time. The filtrate collection system shall be arranged in a manner permitting reuse of the filtrate from the gravity section for belt washing.
10. The Wash water pump shall be from the horizontal centrifugal type, of cast iron construction, rated according to belts wash capacity and head requirements. The pump shall be supplied with a 400 V AC ± 10 % , 3 phase, 50 Hz, IP 55 enclosure, electric motor. Pump and motor shall be connected by a flexible coupling, mounted on a common base frame and include a coupling guard.
11. The BFP shall be provided with a pneumatic (or hydraulic) belt tracking system for belt tensioning and belt tracking permitting the pressure of the belt filter fabric to be infinitely adjustable to the respective sludge properties by means of simple valve adjustment.
12. Belt tensioning shall be maintained of non-corrosive pneumatic cylinders attached to a rigid tensioning assembly actuating the respective adjustment roller in the event of lateral displacement, thus returning the belt to its correct position.
13. The capacity of the BFP shall be adjusted to the sludge characteristics by auto-/manual adjustment of the individual drives (i.e. drum sieve/belt drive). It shall be designed for automatic and maintenance-low operation in accordance with German (DIN/VDE) and international standards (IEC/EEC).
14. Control panel with PLC and touch screen visualization for control and monitoring of all drives and machine operation, installed in a control cabinet made of stainless sheet steel. Control cabinet with power switch, main switch ON/OFF, operation and failure indication and FI-protection switches, selector switch for man./auto control. Indication lights for running and failure. Potential-free contacts for man./auto operation and collective fault signal.
15. All steel construction parts shall be made of SST, all medium touched parts shall be made of SST or other corrosion-free materials (i.e. HDPE/PVC). Motors, gears, bearings and switch devices shall be conventional make and protected against spray water.

## Polymer Preparation and Dosing System

The polymer preparation system shall be in accordance to the requirements in chapter Chemical Dosing of these ER

In addition the dosing plant shall include, but not limited to:

1. All necessary flow control valves, suction strainer on polymer pumps, level switch on polymer tank, and pressure switch on dosing pumps outlet (linked to automatic control system). Interconnecting pipework for the equipment listed in this clause shall be included.
2. The dosing pumps must be regulated eccentric worm pumps : 1 Dosing pump for 1 unit.
3. Modules for dosing and in-line dilution of polymer to the sludge feed to the centrifuge press, comprising the in-line dilution unit for post dilution of polymer, with rotameter flowmeter on dilution water line.
4. Flowmeters on polymer dosing lines. 1 flow meter for 1 line.
5. Variable speed eccentric screw dosing pumps. Pump rating shall be per maximum system requirements plus 25 %. One pump shall serve as a stand-by unit.
6. All other components required for a complete polymer preparation system.

## Sludge Pumps

The pumping units shall include horizontal, positive displacement, progressive cavity type pumps with variable speed control in accordance but not limited to general requirements in chapter Pumping Equipment of these Tender Dossier

# Auxiliary Plant Parts

## Emergency Generator Set

An emergency stand-by generator will be provided at the pumping station to supply the full power load (power supply required for the full operational capacity) of the Inlet Coarse Screens, Lifting Pumping Station and Site and Building Lighting and Low Power Utilities.

The generator set will be complete with fuel storage tanks. The set will be configured to automatically start in the event of a “mains” power supply failure and automatically shut down when the “mains” power supply is on.

The generator set shall comply with the requirements as stipulated in Section 4 o these Employer’s Requirements.

## Potable Water Supply System

Potable water shall be supplied to the buildings and locations of potential demand. Water from municipal supply shall be taken into a storage tank sufficient for demands for 5 days or minimum 10 m3 whichever is larger and then fed to the points of demand by an automatic booster set.

The capacity and pressure rating of the set shall be calculated by the Contractor but the number of pumps in the set shall not be less than 2.

## Treated Wastewater (Efluent) for Service Water Supply System

The treated wastewater water shall be used for service water to treatment units for flushing and cleaning purposes and also for irrigation of landscaped areas of the plant as well as fighting system hydrants.

The use of treated wastewater for reuse shall comply with current National ( Project country) standards (NS) and regulations.

### Washwater Pumping Station

The water for re-use shall be taken from the outlet, with due consideration given to location of the by-pass pipe.

A complete pumping station including two (one stand-by) centrifugal pumps, valves, pressure control tank, necessary filter and piping system for supply of treated wastewater for, but not limited to:

* Sludge Dewatering Station to be used for the sludge dewatering units
* Fine Screenings Station for washing/flushing of the fine screens and the screenings press
* Grit and Grease Chamber for washing the grit
* flushing system (if any) in the Digesters
* flushing system in Sludge Thickening

The station shall include the necessary intake fine screen, pumps, filter, manometers before and after the filter, pipes and valves according to the requirements of the flow, pressure and content of suspended matters in the water. Material requirements shall be as for wastewater.

A booster set shall be installed to feed water for service and irrigation. Another jockey pumpset shall also be installed for fire fighting.

The calculations for the demand of service, irrigation and fire fighting water demand shall be made by the Contractor and submitted to the Engineer for approval

Capacity shall correspond to the consumption plus 25%. A storage tank shall be provided for treated water having a capacity sufficient for service water, irrigation and fire fighting demand.

The pressure at any tapping point shall be calculated by the Contractor but not less than 4,0 bar.

Operating costs of the system of re-used wastewater shall be stated in the offer by the Contractor and considered in the evaluation only for the parts pertaining to the process, i.e. necessary for operation of the process equipment, unless otherwise stated.

## Heating and Ventilation

### Scope of Work

Ventilation.

The ventilation systems required for process buildings are specified under the relevant main components of Pumping Stations, Screening Stations, Grit Chamber, Sludge Thickening and Dewatering Stations.

Heating.

At least 80% of all yearly heating requirements, ( excluding process heating of digesters) shall be provided from the plant’s hot water central heating system.

### Execution of Works and Quality Requirements

Ventilation ducts shall be made of corrosion proof materials like GRP or other plastics, aluminium sheets, stainless steel. Ducts shall be well supported by galvanised supports. The extract fan shall likewise be made of a non-corrosive material. The extract shall be round ducts above the roofs fitted with jet covers.

## Hydrant System

### Scope of Work

A complete hydrant system supplied from the town water supply system for jet cleaning of structures and mechanical components with a maximum distance of 100 m between each hydrant shall be installed. 25 mm hose taps with 10 m long hoses shall be installed in all pumping stations for rinsing of pumps.

Three 60 m long tubes, 50 mm in diameter, with connectors for the hydrants and with nozzles shall be supplied.

This specification of the hydrant system does not prejudice any special flushing requirements set forth elsewhere in the contract for the specific plant parts or any other special flushing requirements deemed necessary by the Contractor.

The Contractor should be aware that the testing procedure for consumption of potable water may benefit from installation of metering systems in order to measure its consumption for different plant parts. It may therefore be necessary to provide such metering in the hydrant system as well as other plant parts consuming potable water.

### Capacity

The capacity of the system shall be sufficient for two of the above tubes being used simultaneously giving a minimum pressure of 4 bars at the nozzle.

Due consideration shall be given to the fact that the town water supply system guarantees pressure of 2,0 bar only.

Operating costs of the system of municipal water shall be stated in the Tender by the Contractor and considered in the evaluation only for those parts pertaining to the process, i.e. necessary for operation of the process equipment, unless otherwise stated.

## Fire Protection Equipment

The plant Fire Protection Equipment shall be equipped and furnished to enable the service fully in accordance with National (Project country) standards (NS) and legalislations.

The following requirements shall be at least satisfied for the equipment to be provided:

Carbon dioxide fire extinguishers of the pressurized type having a trigger release and to comply with the requirements of local i.e. National (Project country) standards and shall be installed on wall mounted brackets. The capacity shall be 7 litres of carbon dioxide.

Dry powder, pressurized with carbon dioxide, fire extinguishers being plunger operated and also to comply with the requirements of local i.e. National (Project country) standards and shall be installed on wall mounted brackets with protection covers. The capacity shall be 5 kg of dry powder.

The extinguishers shall be provided with a prefitted flexible non conductive discharge hose having a flared end.

Fire blankets shall be 1.5 meter square asbestos type supplied in a wall mounted container.

The equipment shall be mounted, with operation instructions printed on a metal plate in the project country language, at positions where directed by the Engineer.

Fire extinguishers shall be painted “fire red” in accordance with Protective Coating requirements, surface ‘A’. as specified in these TR

## Workshop

### Plant Workshop

The plant workshop shall be equipped and furnished to enable the service for maintenance and repairing:

The following equipment shall be provided:

1. 1 pcs. - Turret lathe of min. 7.5 kW.
2. 1 pcs. - Universal milling machine of min. 5 kW (stationary).
3. 1 pcs. - Universal drilling machine of min 2 kW (stationary).
4. 1 pcs. - Drilling machine of min 1.5 kW (portable).
5. 1 pcs. - Double grinding machine of min 3 kW.
6. 1 pcs. - Arc welding equipment complete with tools.
7. 1pcs. - Oxyacetylene welding equipment with tools.
8. 2 pcs. - Locksmith's bench (approx. 1500x700 mm).
9. 2 pcs. - Screw vices. one of the two pieces should be rotary of size at least 9 inches.
10. 2 pcs. - Wall mounted tool cabinet (approx. 700x700 mm).
11. 1 pcs. - Floor standing tool cabinet (approx. 700x1800 mm).
12. 1 pcs. - Complete electrician tool-set with tool box.
13. 1 pcs. - Complete set of hand tools for mechanical works including necessary sizes of screw drivers, adjustable wrenches, hexagon keys, socket wrenches, nippers, hammers, etc.
14. 1 pcs. - Complete set of tools for plumber workers.
15. 2 pcs. - Complete set of tools for locksmith workers.
16. 1 pcs - Spinning lathe
17. 1 pcs - air compressor, direct drive, min. 1,5 kW with basic set of equipment; this assuming use for air jet cleaning and small jobs.

### Mechanical Workshop

A mechanical workshop shall be included in the project minimum furnished with the following equipment:

1. 1 pcs. Monorail crane (capacity 2 t).
2. 1 pcs. Universal drilling machine of minimum 2 kW (stationary).
3. 1 pcs. Drilling machine of minimum 1.5 kW (portable).
4. 1 pcs. Double grinding machine of minimum 3 kW.
5. 1 pcs. Arc welding equipment complete with tools.
6. 1 pcs. Oxyacetylene welding equipment with tools.
7. 2 pcs. Locksmith's bench (approximately 1500 x 700 mm).
8. 2 pcs. Screw vices.
9. 2 pcs. Wall mounted tool cabinet (approximately 700 x 700 mm).
10. 3 pcs. Floor standing tool cabinet (approximately 700 x 1800 mm).
11. 3 pcs. Complete electrician tool-set with tool box.
12. 3 pcs. Complete set of hand tools for mechanical works including necessary sizes of screw drivers, adjustable wrenches, hexagon keys, socket wrenches, nippers, hammers, etc.
13. 3 pcs. Complete set of tools for plumber workers.
14. 3 pcs. Tools for site maintenance including, shovels, brushes, rakes, spades, wheelbarrow, etc.
15. Set of any special tool, including grease guns or other lubricating devices which may be necessary for the adjustment, operation, maintenance and disassembly of the any part of the plant.

The Contractor shall in his Tender specify make, type, etc. of all provided equipment. All equipment shall be of new and of professional quality

### Tools

A complete set of tools including spanners and special tools, necessary for the servicing, maintenance and dismantling of most critical parts of the plant shall be handed over by the Contractor immediately before Taking-Over.

The tools shall be contained in a suitably painted steel box marked with the contents and fitted with a good quality lock and keys.

The Contractor shall, based on the manufactures recommendation, determine the required tools for all equipment and prepare a list of tools. The list shall be included in the offer.

## Vehicles for Maintenance

For maintenance purposes the following vehicles necessary for transportation, supply or stuff controls /visits on site shall be provided:

1. **1 pcs. of Pickup car** with the following specifications:

The engine shall have a power take off of no less that 50 kW.

4 wheel drive.

The cabin shall be with heating unit and minimum 5 seats.

The car shall have a truck body for transport of tools, etc.

The load capacity shall be minimum 850 kg.

The vehicle shall be adapted for operation by the extreme temperatures occurring in Romania (approx. from minus 30°C up to plus 40°C).

The brand shall be represented in local ( Project) country.

1. **1 pcs. of Combined mini tractor** with the following specifications:

The diesel engine shall have a power take off of no less that 25 kW.

4 wheel drive.

Closed cabin with heating and ventilation.

Adjustable lawn cutter unit minimum 2,5 metre wide.

Rotating snowbrush minimum 1,5 metre wide.

Snowplough minimum 1,5 metre wide.

Hydraulic front loader minimum 1,5 metre wide.

Trailer for transport of tools, excavated soil, etc.

The brand shall be represented in local ( Project) country.

1. MEICA = Mechanical-, Electrical-, Instrumentation-, Control & Automatisation [↑](#footnote-ref-1)
2. For main equipment, such as pumps, blowers, mixers, etc. [↑](#footnote-ref-2)
3. For main equipment, such as pumps, blowers, mixers, etc., on request of Supervisor (Engineer) [↑](#footnote-ref-3)
4. Some SBR design solutions offers *combined clear water decanter - floating sludge skimmer* (such as for example: HydroClear®-COMBI ) which incorporates clear water decanting with the removal of scum in SBR basins. No additional installations are necessary.

   A tilting skim channel is attached to the frame of the clear water decanter and directed against the basin current. The floating sludge is retained in front of the skimmer and enters the skim channel over a 1-2 cm deep immerged inlet baffle. The immersion depth of the skim channel is stagelesly adjustable. The immersion depth and break-run times are programable when adding the control module RBS-HKK. The float system is designed to ensure a constant position towards the water surface. This ensures a low amount of water in the removed sludge. Sludge removal takes place preferrably during the Bio-P- and Denitrification phase. [↑](#footnote-ref-4)