SECTION 5A - Subsection 8: Mechanical Works

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8 Mechanical Works

8.1 General Requirements

In the following are outlined the general and particular minimum requirements for mechanical installations.

It shall be the responsibility of the Contractor to provide all detailed design of the installations, to ensure full coherence of all the equipment installed and to comply with the present minimum quality requirements. If equipment, not mentioned in this section, is offered, the Contractor shall with his Tender demonstrate through submission of documentation and specification that the proposed equipment is of equal or better quality than the requirements to quality specified in this section.

8.1.1 Suitability of design and equipment

During the selection and/or design of equipment and installations, particular attention shall be paid to the following:

- Safety of operation and easy maintenance
- Well-proven and reliable components
- Ability to withstand the service conditions
- Inaccessibility for vermin, dust and humidity
- Precautions to minimize corrosion
- Spare parts available in Turkey
- Service available in Turkey
- Minimization of noise

Alterations of design and make of the offered equipment after the contract has been signed can only take place with the consent of the Engineer.

Data sheets for all mechanical equipment shall be provided in order to define minimum criteria of the equipment

8.1.2 Environment

All equipment shall be rated for the ambient temperatures relative humidity and altitude at the Site. Necessary frost protection by means of insulation and, if so required, also electric heat tracing shall be considered in the design.

The Contractor shall in his design and selection of equipment take into consideration under which conditions each item shall be in operation. Equipment placed in the open shall be designed for solar radiation induced temperatures or in some way protected from direct sunlight.

Equipment placed where the risk of condensation prevails shall be provided with drainage holes placed in the lower part of the equipment.

Equipment shall moreover be designed for preventing intrusion of insects and smaller reptiles.

8.1.3 Programme of works for machinery

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

Part I Manufacturing period:

Design and manufacture of all equipment to be supplied under the contract including inspection and works testing.

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.

Part III Erection period:

Removal of the materials and equipment from off or on-site storage, delivery to erection site and installation.

Part IV Site testing:

All mechanical equipment and machinery shall be tested in the presence of the Engineer before being put into operation.

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 as specified in the Employer's Requirements, Subsection 4: General Requirements for the Execution and Completion of the Works 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 will, at the time for Tests on Completion, have been in operation for some time.

8.1.4 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.

8.1.5 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.

8.1.6 On-site storage and safekeeping

The Engineer shall be informed by the Contractor about machinery delivery dates 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 is 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.

8.1.7 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.

8.1.8 Standards

For standards in general, see the Employer's Requirements, Subsection 2: Design Basis. Standards for particular equipment are included where applicable in the following. For specific technical requirements, see Subsection 5 : MBT Technical Specifications.

American standards will be valid in case of inadequate of standards which are specified in document

8.1.9 Equipment and manufacture

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.

Mechanical equipment manufacturers, will be proposed as wonders, shall have ISO 9000:2000 quality system certificate.

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 equipment 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. Engineer may not accept any equipment or material which is not as per specification.

Warranty period of all offered mechanical equipment shall be 2 (two) years after delivery date of the plant to the Employer, following installation and proper operation. The Contractor shall be responsible for draw-up of warranty certificates of these equipment in the name of The Employer and hand over the original copies to the Employer. 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 equipment and paying costs due to the lateness in and evasion of his obligations stipulated in the Contract.

8.1.10 Machinery 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.

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 Turkish language.

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. Self-tapping screws shall not be used.

8.1.11 Lubrication

Equipment 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 for collection of waste oil into containers without removing the equipment from its normal position.

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.

Furthermore, a list of recommended lubricants and their equivalents shall be included in the operation and maintenance instructions. The lubricants recommended shall be available in Turkey. 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.

A list of recommended lubricants and their equivalents shall be included in the operation and maintenance instructions.

8.2 Corrosion Protection

8.2.1 General

Mechanical equipment shall be protected against corrosion by painting or other convenient treatment to a degree sufficient for the intended function and placement of the actual works.

All bright metal parts shall furthermore be covered before shipment with an approved protective compound and adequately protected during shipment to site. After erection these parts are to be cleaned.

Where the Contractor has a possibility to select different coatings that comply with technical requirements then the coating that has the smallest possible impact on workers health and safety has to be used. Documentation of the choice should be made available to the Engineer.

Dry surfaces, e.g. outer sides of valves, shall be categorised to C3 in ISO 12944 and shall be protected against corrosion accordingly. Wetted or submerged surfaces, e.g. inner sides of valves, shall be categorised to IM2 in ISO 12944 and shall be protected against corrosion accordingly.

8.2.2 Galvanizing

Where steel or wrought iron is to be hot-dip galvanized, it shall be carried out by the hot-dip process and shall conform in all respects with EN ISO 1461.

Attention shall be paid to the detail of members in accordance with EN ISO 14713. Adequate provisions for filling, venting and drainage shall be made for assemblies manufactured from hollow sections. Vent holes shall be suitably plugged after galvanizing.

All surface defects in the steel including cracks, surface laminations, laps and folds shall be removed in accordance with EN 10113. All drilling, cutting, welding, forming, unit members and assemblies shall be completed before the items are galvanized. The surface of the steel to be galvanized shall be free from welding slag, paint, oil, grease and similar contaminants.

The additional weight of the items after being galvanized shall be not less than 610 gram (80 micron) per square meter of galvanized surface.

During off-loading and erection utmost care must be taken in order to avoid any damages to the galvanized surfaces. Galvanized items in stock shall be stacked so as to provide adequate ventilation to avoid wet storage staining.

Small areas of damaged galvanized coating may according to agreement with the Engineer in every case, be restored by:

- Cleaning of the area of any weld slag and thoroughly brushing to provide a clean surface
- Application of two coats of zinc-rich paint or application of a low melting point zinc alloy repair rod or powder to the damaged area, which is heated at 300°C.

Where galvanized steel will be in contact with aggressive solutions and/or atmospheres, the galvanized surfaces shall receive further protection by painting in accordance with the paint specifications given below.

The geometry of galvanized steel parts shall be thoroughly checked after galvanising. Any deformations shall be corrected without damaging the zinc layer.

Inspection and Documentation of Hot Dip Galvanising

The inspection and quality assurance of the hot dip galvanising carried out by the Contractor shall be in conformity with EN ISO 1461. Documentation for this inspection and quality assurance shall be issued and become part of the Quality Assurance documentation. After components have become hot dip galvanised, machining is not allowed.

8.2.3 Painting

Paint applicable to metal surfaces shall not be applied in high wind and/or dusty conditions that will cause dust to settle on the surface of the paint before it has dried, nor when the steel surface temperature is less than 3°C above dewpoint, nor higher than the maximum advised by the paint manufacturer, nor when humidity is greater than 85%*, nor when the ambient temperature is less than the minimum or greater than the maximum specified by the manufacturer of the coating material.

Application shall be by brush, roller, spray, airless spray or other suitable equipment as appropriate for the surfaces to be coated and in accordance with the recommendations of the manufacturer. Application equipment shall be maintained in clean condition and in good working order. The use of equipment not maintained in good clean condition may lead to rejection of the coating.

Over coating times shall be not less than the minimum nor greater than the maximum specified by the manufacturer, relevant to the ambient temperature. Where over coating times in the data sheet relates to 25°C, the contractors must acquaint themselves with the correct over coating times for lower and higher temperatures. Strict adherence to over coating times is particularly important for two pack coatings that are subsequently immersed. The Contractor will be held responsible for delamination or blistering of paint coatings on immersion. All surfaces to be coated shall be clean and free from dust, oil, moisture and perspiration before over-coating.

8.3 Steel Constructions

Steel constructions shall be designed as to resist the static and dynamic forces they are exposed to. The Contractor must specify in his offer the most important materials used.

Where risk of galvanic corrosion persists, galvanic separation is required.

8.3.1 Structural steel

Structural steel shall be selected from EN 10025: part 2: 2004 of an appropriate grade and be accompanied by a materials certificate in accordance with EN 10204-3.1B.

Where risk of galvanic corrosion persists, galvanic separation is required.

8.3.2 Wrought steel

Where not otherwise specified, wrought steel parts shall be selected from appropriate grade of EN 10083 and be free from blemishes, shot or hammer marks.

The steel must be suitable for hot dip galvanizing. Serious rust must not be found.

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

8.3.3 Cast iron

All grey iron castings supplied shall be to the appropriate grade in EN 1561. All castings are to be free from blowholes, flaws and cracks.

No plugging, filling, welding or "burning-on" will be accepted.

8.3.4 Stainless steel

Stainless steel used throughout the MBT Facility shall be provided in accordance with EN 10088-1 grade 1.4404 or be of better quality, if stainless steel parts such as pipes, clamps, supports, mechanical equipment etc. permanent contacts with wastewater, leachate, sewage, sludge or biogas. All other parts in the plant specified as stainless steel shall be min quality EN 1.4306. However, the Contractor shall determine if the stated minimum requirements are sufficient for the particular application and if necessary select a higher grade.

Material thickness in constructions of stainless steel shall be at least 3 mm when not otherwise stated. Welded tubes shall have a wall thickness of at least 2 mm.

Material certificates are required for all stainless steel to be incorporated in the works. Certificates shall comply with EN 10204-3.1B. Certificates shall be part of the QA-documentation

All stainless steel material, pipes, flanges etc., shall be stamped according to their type, grade and pressure class. In addition, all stainless steel shall be accompanied by an authentic manufacturer's certificate to enable verification of origin and date of manufacture.

8.3.5 Aluminium and aluminium alloys

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

Immersed installations or installations which are periodically immersed must not be constructed from aluminium or aluminium alloys.

If used alloys shall be of a type used for marine applications with magnesium as the main additive.

8.4 Welding

8.4.1 Welding in general

All welders shall be qualified and have a valid certificate according to EN 287-1 from a recognised testing institute. The certificate shall prove that the welder has passed the tests satisfactorily.

All welds in pipe joints shall be carried out in accordance with Welding Procedure Specifications (WPS) issued for each particular type of weld and material according to EN 288. The Welding Procedure Specifications shall be filled in or approved by an independent body, approved by the Engineer, before welding.

All welding works shall be performed under the most convenient working conditions; hence all welding work shall be carried out at the manufacturer's workshop. Field welding will be allowed only after prior approval by the Engineer. Modern, effective equipment and techniques and latest welding technologies are to be utilised. 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 field welding.

Welding of Pipelines can be constructed according to standard API 1104 Welding of Pipelines and Related Facilities.
The performance of the NDT shall be documented for each girth weld, repair weld, fillet weld and recorded on a pipe book so that each weld can be identified.
The Client or his Client Representative reserves the right to request the removal of line joints, in special cases, to perform destructive tests. This should be done in terrain areas deemed difficult or where the Client feels a need to assess the condition of a particular weld or once at each change of wall thickness
Records of 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.

Welding Procedure Qualification

The Contractor shall submit detailed welding procedure specifications complying with EN 287-1. All dimensions, all combinations of materials to be joined and all repair welding shall be covered by the procedure specifications. The procedure specifications are subject to the approval by the Engineer.

The Engineer may at sole discretion approve the use of already established, sufficiently tested and documented procedures not more than two years old. Transfer of welding procedure qualification records from one contractor to another is not permitted.

For each procedure specification and prior to start of production welding the Contractor shall carry out welding of test joints under site conditions following all of the details of the approved procedure specifications.

The qualification test shall be carried out on steel with the highest specified minimum yield strength/maximum carbon equivalent which is expected to be covered by the Welding Procedure Specification. All the results from the procedure qualification records shall be submitted to the Engineer for approval of welding procedures.

Qualification of Welders and Welding Operations

Only skilled welders and welding operators who can document qualifications relevant for pipeline welding will be accepted by the Engineer. Prior to the performance of any production welding operators shall qualify for the relevant welding procedures according to EN 287-1.

The qualification tests are acceptable if they meet the requirements for visual examination, destructive testing and for radiographic examination as specified in EN 287-1. The testing shall be carried out by an approved laboratory at the Contractor's expense. Welder and welding operator performance test certificates shall be issued and kept on site during the whole working period.

Welder and welding operator qualification tests may be performed together with welding procedure qualification tests. These certificates are only valid for six months after the last welding.

Welding of Pipelines

The Contractor shall supervise the site, the welders and their work during the entire working period. For this purpose, the Contractor shall use a qualified welding engineer or alternatively, if accepted by the Engineer, an engineer with documented thorough theoretical knowledge and practical experience in the performance and evaluation of the welding work.

The welding shall be inspected by an independent inspection company engaged by the Contractor. It is the sole responsibility of the Contractor to document that welding and welding inspection fulfils all specified requirements.

Welding Preparation

Items material grades, wall thicknesses and pressure ratings shall conform to the requirements laid down in the applicable drawings and specifications.

Each pipe or component shall be visually inspected to ensure that it has not sustained any visually determinable damage. Disposition of damaged items shall be resolved in consultation with the Engineer.

All requirements for welding preparation contained in the qualified welding procedure specification shall be strictly adhered to.

Welding

All welding shall be performed by qualified welders and strictly in accordance with qualified welding procedures.

Welding shall be suspended by the Contractor when prevailing weather conditions will impair the quality of the work, e.g. airborne moisture, blowing sand, high winds or thunderstorms.

Stray arching outside the weld groove is not permitted. Should stray arching outside this area occur, this shall be brought to the attention of the Engineer who may require any such damaged section to be repaired or cut out at the Contractor's expense.

Each pass shall be completed around the whole circumference before the next pass is started.

The position of start/stop on subsequent passes shall not be identical.

No welded joints shall have less strength than the joined parts.

Upon completion of the weld and the pipe surface shall be cleaned of weld spatter and other deposits, and shall then be wrapped with a dry waterproof insulating mat to ensure a slow cooling of the weld zone and to give protection against rain.

Materials

The weld filler metal selected shall give a weld metal matching the base metal properties as closely as possible. The yield strength of consumables shall neither overmatch the base material yield strength by more than one level in EN 499, nor shall under matching be allowed.

Cleaning of Carbon Steel Items after Welding

The surface shall be dry and free of oil, grease, soil and concrete residues. All loose rust and mill scale shall be removed by wire brushing immediately before welding inspection. On straight pipes brushing shall be done mechanically using sharp brushes to avoid polishing of the steel surface. Therefore, a stock of readily accessible new brushes is required.

Welds fabricated with basic filler metals shall be washed with fresh water.

Cleaning by sandblasting to grade Sa2 is allowed as an alternative.

Identification of Weld Seams

Every girth weld shall be numbered by the Contractor in accordance with a system to be specified by the Engineer. This number shall be painted on the pipe coating on one side of the joint between 0.5 m and 1.0 m from the seam together with the pipe number and pipe length to facilitate completion of the pipe book.

For each pipeline and each pressure test section, the Contractor shall fill in pre-printed forms and enter these in a pipe log. As the work progresses, the Contractor shall present the pipe log forms to the Engineer. Before the start of a pressure test, the completed pipe log for the section in question shall be handed over to the Engineer.

General Requirements, Welding Inspection

Examination shall be performed according to this specification and the following codes and standards:

Radiographic examination according to ISO 1106, Part 3, Recommended Practice for Radiographic Examination of Fusion Welded Joints. Fusion Welded Circumferential Joints in Steel Pipes of up to 50 mm Wall Thickness.

Ultrasonic examination according to ASME Boiler and Pressure Vessel Code, Section V, Non-destructive Examination, Article 5, Ultrasonic Examination Methods for Materials and Fabrication.

Magnetic particle examination according to ASME Boiler and Pressure Vessel Code, Section V, Non-destructive Examination, Article 7, Magnetic Particle Examination.

Liquid penetrate examination according to ISO 3452, Non-destructive Testing, Penetrate Inspection, General Principles.

Visual examination according to ASME Boiler and Pressure Vessel Code, Section V, Non-destructive Examination, Article 9, Visual Examination.

Hardness measurement according to ASTM E 110, Standard Test Method for Indentation Hardness of Metallic Materials by Portable Hardness Testers.

ISO 9606-1 - Qualification testing of welders” should be used due to “EN 287-1 - Qualification testing of welders” is cancelled.

ISO 15614-1 - Protective clothing for firefighters” should be used due to “EN 288 - Specification and approval of welding procedures for metallic materials” is canceled.

ISO 17636-1:2013 - Non-destructive testing of welds - Radiographic testing” should be used in stead of ISO 1106-3 - radiographic examination of fusion welded joints”.

ISO 3834-3 - Quality requirements for fusion welding of metallic materials" should be used due to "EN 729-3 - Quality Requirements For Welding-Fusion welding of metallic materials" is canceled

The Contractor shall engage a qualified independent inspection company which shall perform, evaluate and document all welding inspection. The inspection company shall be approved by the Engineer.

All non-destructive examination shall be performed according to a written procedure. The procedure shall conform to the requirement of the adequate method standard and this specification. Procedures shall be submitted to the Engineer for approval and shall be qualified to the satisfaction of the Engineer.

Extent of Examination, Welding Inspection

All welds shall be 100% visually examined.

Thirty percent of the welds shall be tested. The following methods may be applied as approved by the Engineer:

- Radio-graphic
- Ultra-sonic
- Penetration

The Radio-graphic method shall be used. However, if this method cannot be applied one of the other methods may be used, as approved by the Engineer.

Ultrasonic examination may substitute radiography where radiographic examination is impractical and may be used as general back-up for radiography in case of interpretation/verification problems.

Guarantee welds (welds which will not be pressure tested) and tie-in welds shall be 100% examined by radiography as well as by ultra-sound.

Welds to be tested shall mainly be selected from those of which the backside of the weld cannot be visually inspected. Such welds shall be tested by the Radiographic or the Ultrasonic method. Selection of welds shall be carried out by an accredited independent agency, approved by the Engineer.

All welds which have been repaired or replaced shall be 100% re-examined by the same methods and with the same acceptance criteria as required for the original work.

Socket welds and branch connection welds which are not radio graphed shall be examined by magnetic particle or penetrate methods to the extent stated for butt welds.

Where spot examination is required in subsequent sections, the welds shall be selected to ensure that the work of each welder and each welding procedure is included.

When required spot examination reveals defects, two additional welds, the preceding and the subsequent welds made by the same welder, shall be examined.

If one of these welds shows defects, three preceding and three subsequent welds shall be examined at the Contractor's expense.

If five or more subsequent welds of one welder show defects, all welds of this particular welder shall be additionally examined at the Contractor's expense.

10% of all butt welds shall be examined by radiography along their entire circumference as described above. The Engineer may specify greater extent of examination.

Acceptance Criteria

The accept criterion shall be class C in accordance with ISO 5817. The test shall be carried out by an accredited independent agency, approved by the Engineer. A report on the tests shall be provided.

Production Testing

The Engineer shall be entitled to select a number of seams for destructive testing.

The Contractor shall be responsible for cutting out the seams, bevelling the pipe ends and rewelding the joint. The destructive tests shall, unless otherwise agreed, be made in accordance with the requirements in the respective general welding specification covering qualification tests for welding procedures.

The Employer will bear the cost of these tests, if the welds are proved to be acceptable. However, if it turns out that the seam does not comply with all the requirements, the Contractor himself shall bear the costs. In this case, the Engineer may insist on an additional seam being tested, and the costs of the testing and renewal of this seam shall be paid by the Contractor, irrespective of the results. If this seam does not comply with the requirements, the control may be further extended at the Contractor's expense.

The extent of any such supplementary inspection work shall be decided by the Engineer with the aim of establishing in a satisfactory manner whether the welding work complies with the requirements or not.

If any change of personnel takes place during the course of the welding work, this could influence the quality of weld seams and the Engineer may require a new seam to be destructively tested at the Contractor's expense.

Document Requirements

The following documents are required before examination:

- Certificates for NDE personnel
- NDE procedures
- Report forms
- Request for deviations, if any, from specified requirements

During examination:

- Field reports

After examination:

- Authorised examination reports with enclosed field reports and films.

Coating of Weld Seams

Upon successful completion of all inspection procedures, the weld seams on carbon steel items and their surroundings shall be carefully cleaned and protected with an internal and external coating as specified herein.

8.4.2 Welding of carbon steel

Acceptable welding processes are:

- Shielded Metal Arc Welding (Stick) SMAW
- Gas Tungsten Arc Welding (TIG) GTAW
- Gas Metal Arc Welding (MIG/MAG) GMAW
- Flux Cored Arc Welding FCAW

The use of welding processes other than those listed above is permitted only with the prior approval of the Engineer. Processes may be used in combination if the same combination and sequence of processes have been qualified by the welding procedure qualification test.

Prefabrication in workshops shall be used to the maximum extent possible.

For the welding of carbon steel pipes, the AISI code B 31.1 and API Std. 5L recommended practices shall apply. Welded structures shall comply with EN 729-3

8.4.3 Welding of stainless steel

For welding of stainless steel pipe the AWS D10.4-79 shall apply.

The welding method shall be the tungsten inert gas method (TIG) or the metal inert gas method (MIG) for workshop as well as on-site welding. Irrespective of the method chosen the inner surface of the weld shall be protected by clean inert gas. When welding the oxygen content of the mixture oxygen/inert gas must not exceed 20 ppm.

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

For stainless steel welding the following shall be observed:

- Only butt weld jointing of pipes is allowed during erection work,
- Where butt welds are used, the penetration shall be completed, if necessary with root run,
- Backing rings shall not be used,
- No surface defects reducing the corrosion resistance or discoloration of the surface will be accepted,
- After welding the weld shall be carefully pickled and passivated, and
- The welds shall be thoroughly washed in clean water after pickling and passivation.

8.5 Bolts

Steel-bolts shall be provided according to ISO 8.8 according to EN 20898-1 and EN 20898-2. Stainless steel bolts shall be provided according to ISO 3506-1 and 3506-2 in grade A4, Class 70 or 80.

Bolts shall have an over-length of minimum 3 mm and maximum 12 mm for bored in or embedded bolts as well as flanged joints.

All necessary bolts, nuts, washers and anchor plates shall be supplied together with the joints. The bolts and nuts shall be high tensile steel with metric treads, and with hexagon heads.

All bolts, screws, nuts and mounts shall correspond to the material secured by bolts. This also applies to chemical anchors.

Bolts, washers and nuts for galvanised steel items and for coated steel items shall be hot dip galvanised. Washers shall always be used for bolts fastening coated steel in order to prevent destroying the coating.

Bolts, washers and nuts for stainless steel items like flanges shall be of stainless steel of similar grade or higher.

To prevent galling, strain hardening, crack and contact corrosion, it is necessary to apply molybdenum-sulphide or similar to thread and washers.

8.5.1 Chemical anchors and anchor bolts

Holding down bolts of sufficient length shall be provided and fixed for securing the whole of the machinery to the foundation.

Chemical anchors shall be supplied in quality suitable for conditions under which they are permanently exposed to the action of water.

Alternatively, an injection technique can be applied.

Fixation of mechanical equipment to concrete structures can be done by anchor bolts, which can be placed during casting, or by drilling. No anchor bolts may get in contact with reinforcement bars in the concrete structure. Anchor bolts used for installation of stainless steel equipment shall be made of stainless steel of equivalent quality.

For all other purposes hot dip galvanised anchors shall be applied.

8.6 Steel Pipework

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

Pipeworks shall be arranged, as to ease the dismantling and removal of pumps or major items of equipment i.e. by the installation of dismantling joints where appropriate.

Expansion and dismantling joints shall be double flanged. Dismantling joints shall be able to withstand the total tension loads from the maximum pressure occurring in the pipes.

A dismantling joint shall be included in the suction and delivery pipework of all pumps for easy dismantling.

All pipework shall be fixed adequately with supports. When passing through walls, pipework shall include puddle flange.

In addition all stainless steel shall be accompanied by an authentic manufacturer’s certificate to enable verification of grade, origin and date of manufacture. All pipes shall comply with EN 10217-7 accompanied with a test certificate according to EN 10204 / 3.1B. The certificates shall be part of the QA-documentation.

All piping inside buildings up to 1m outside the buildings shall be made of stainless steel, see section 8.3.4. Other materials can only be accepted after prior acceptance from the Engineer.

All piping inside shall have permanent marking, stating standards and material identification numbers.

Pipe ends shall be sealed with PVC cabs during transportation.

Welded stainless steel pipes shall have a wall thickness of at least:

Internal diameter (mm)	Wall thickness (mm)
200 or less	2.0
250	2.5
300	3.0
400	3.0
500	4.0
600	4.0
>600	Subject to the Engineer's approval

8.6.1 Pipes from stainless steel

Pipe work for aquatic-, biogas- and air media shall be stainless steel (EN 1.4404) pipes if not otherwise stated. Material shall be according to requirements for stainless steel specified in section 8.3.4.

Pipes shall be according to EN 10217-7. Pumping mains and pressure pipes shall minimum be rated for PN 10.

8.6.2 Pressure test of pipes

The Contractor shall perform pressure tests according to the following instructions for all pressure piping.

The Contractor shall advise the Engineer in due and shall provide and mount all for the pressure tests necessary equipment.

If pressure tests are made against closed valves the guidelines from the manufacturer of the valves regarding the highest single side pressure against closed valve shall be complied with.

Hydraulic pressure tests shall be carried out by the use of potable water.

During pressure tests a minimum of 1.5 times maximum allowed operating pressure shall be maintained. Water shall be forced into the pipes by means of a force pump fitted with a pressure gauge to indicate the pressure at the lowest point in the section under test. Pipelines will not be accepted until they have withstood the required pressure for 30 minutes without leaking and without the pressure dropping.

Pressure tests shall be according to API 5L, TS 10217 and DIN 1626.

The Contractor shall prior to pressure testing verify on the spot that the piping is fully evacuated from air.

After successful and approved pressure test the piping shall be emptied and the pressure test fluid shall be disposed of.

If it is not possible to perform visual inspection of leaks of all welded joints, the piping shall be tested according to the following guidelines:

- Piping is tested with a test pressure of minimum 1.5 times maximum allowed operating pressure. The pressure shall be held for at least four hours.
- During the pressure hold period no water shall be allowed to be added, and
- All visible welding joints, flange joints and glands on valves and pumps shall be inspected.

The acceptance criterion demands no detected leaks.

After the pressure tests have been finalised the Contractor shall elaborate a report, a copy of which shall be submitted to the Engineer. The report shall as a minimum include:

- Pressure Test Procedure,
- Unambiguous references to piping or part of piping and shut-off,
- Specification of test pressure,
- The period of the pressure tests,
- Results and signature of acceptance, and
- A description of atypical testing results, their causes and corrective action.

8.6.3 Flanges

Flanges for stainless steel pipes shall be executed as loose flanges of similar quality as the piping.

All flanges must be rated for PN 10 and drilled according to DIN 2501. In the case the operating pressure requires PN25 components welded neck flanges according to DIN 2634 shall be installed.

8.6.4 Pipe bends

Bends shall have minimum the same wall thickness and be of same material grade as the joining pipes. Execution according to DIN 2605. Radius 1.5 x D.

8.6.5 Tapers

The tapers shall be made of stainless steel see section 8.3.4. In general, all tapers shall be of the concentric type, similar to DIN 2616.

Suction intake taper for pumps, however, shall be of the eccentric type. The installation of the taper for dry installed pumps shall be with the straight side at the top. The length of the taper shall not be less than 0.5*(D+d).

8.6.6 Flush appliances

The flush appliances shall be made out of stainless steel see section 8.3.4.

Each section, which can be separated from the overall piping system, by valves, must have a sufficient number of connections for drainage and cleaning. The exact number and location of connections shall be decided jointly with the Engineer.

A flush connection comprises:

- pipe socket DN 50 with outer thread 2“, approx. 100 mm long
- socket globe valve DN 50
- C-coupling with outer thread 2” according to DIN 14 307, material: brass
- C-blind coupling according to DIN 14 311 complete with chain, material: brass.

8.6.7 Branch pipes

Wherever possible, sockets according to DIN 2618 shall be used. Tees DN 65 and smaller shall be according to EN 2615

8.6.8 Measuring instruments

Wherever from a process engineering or operational point of view the necessity to install measuring instruments arises, the required socket or flange connections shall be provided on the pipelines.

8.6.9 Vent pipes

The vent pipes shall be made of stainless steel (EN 1.4404) see section 8.3.4. Depending on the pipe arrangements, vent pipes including valves may become necessary. Generally, vent pipes must terminate in “safe“ areas, e.g. above roofs. The arrangement of the pipes shall guarantee unobstructed ventilation.

8.6.10 Pipe brackets

All pipe brackets shall be of stainless steel (EN 1.4404) in accordance with section 8.3.4. Pipe bracket arrangements shall consist of sliding and fixed brackets. Design and installation of sliding brackets shall guarantee proper alignment of the pipe, even when the pipe is moving longitudinally. No stress shall be transmitted to the supports, except for the weight resulting from pipe and medium. The design of the fixed brackets shall be such that all forces and moments resulting from

operating conditions are safely transmitted onto the building structure. Required pipe supports, gussets, etc. shall be connected to the pipes by reinforced welds.

The design of the brackets with respect to axial movement, static and dynamic forces e.g. from water hammer etc. shall be based on the prevailing operating and ambient temperatures of the pipe system in question.

All brackets and pipe components being inaccessible after installation shall be sufficiently protected against corrosion prior to assembly.

8.6.11 Installation of piping

Pipelines shall be level, plumb and properly aligned, respectively installed to the required slope. Utmost attention shall be given to all pipes connected to machinery and appliances for not transmitting forces and moments to the equipment. Forces and moments due to misalignment of pipe work shall under no circumstances be transmitted to duct walls.

8.7 Stairs, Walkways, Platforms and Handrails

All stairs, walkways, platforms and handrails shall be made compliant to the current local requirements.

All open sides of stairs, landings, walkways and platforms shall be guarded with handrails. Handrails shall include top handrail, intermediate rail, handrail, balusters and toe kick plates. Two hanging chains shall guard access openings to stairs and ladders, which shall be secured at one end and detachable at the other.

The height of the handrails shall be 1,100 mm with an intermediate rail at a height of 550 mm. Handrail height shall be measured vertically from finish floor level to the handrail centreline. The height of toe plates shall be 150 mm. Toe plates shall be fixed securely to the stanchions.

Sloping handrails shall be as specified for horizontal handrails, but with top rail 900 mm vertically above the line of pitch and stanchions vertical and spaced at not more than 1,500 mm measured parallel to the line of pitch.

All mounting flanges shall be of substantial construction, with horizontal flanges drilled for not less than three bolts with two bolts on a line parallel to and on the walkway side of the line of handrails. Vertical flanges shall be drilled for not less than two bolts, the lines through the bolts being vertical. Fittings shall be screwed or secured by means of grub screws.

Handrails shall be able to withstand a vertical force of minimum 0.8 kN/m on the top rail. The deflection of the rails shall not exceed 0.8% of the span between stanchions, and the deflection of stanchions shall not exceed 0.8% of their height.

Handrail and balusters shall be manufactured from either aluminium, hot dip galvanised steel or stainless steel tube with bore not less than 32 mm. Toe plates shall be of 5 mm thick aluminium, hot dip galvanised steel or stainless steel plate. Distance between balusters shall not exceed 1,500 mm.

Handrails, balusters and toe plates shall include all necessary joints to facilitate easy installation and to provide a smooth and neat appearance. The Contractor shall ensure that unless specified to the contrary all handrails shall be prefabricated and of uniform appearance and manufacture.

The Contractor shall submit working drawings of the handrails to the Engineer for approval.

8.7.1 Staircases and galleries

Stairs shall have handrail on both sides. The height of the handrail on stairs shall not be less than 900 mm. If handrail is attached to a wall, it shall have at least 75 mm clearance from the wall.

Staircases shall preferable be within 38-45° with riser/go dimensions in accordance with the formula: Twice the riser plus the go should not be less than 572 mm nor more than 635 mm. Overlap shall be minimum 16 mm.

Staircases shall be designed to carry a uniform load of 3.5 kN/m2 in addition to dead weight and loads during operation calculated on the plan area of the stair. The Contractor shall design the staircases for the actual point-load adequate for the equipment to be unloaded, however, no less than 3.0 kN in the middle.

Treads shall be with non-slip pattern surface.

Material: Hot dip galvanised steel.

8.7.2 Access ladders

Ladders shall be fabricated of mild steel and hot dip galvanised after fabrication. The stringers shall be flat section not less than 65 mm x 13 mm spaced 380 mm apart and shall be flanged and drilled for wall fixing at both ends. The distance between stringers shall be widened over the top where they shall be not less than 600 mm apart. Ladders over 3,000 mm long shall have additional intermediate stays at not more than 2,500 mm centres.

Rungs shall be 25 mm diameter solids at 300 mm centres riveted or welded to the stringers. Rungs shall be not less than 225 mm from the wall.

All ladders shall have safety cages, which shall be constructed of three flat vertical strips supported by flat hoops, with a diameter of 750 mm. The hoops shall be approximately 700 mm centres and the first hoop shall be 2,400 mm above ground or platform level.

Where the rise exceeds 6,000 mm an intermediate landing shall be provided.

8.7.3 Open mesh and chequer plate flooring

Open mesh flooring and gratings shall generally comply with EN ISO 14122 except where otherwise specified hereinafter. Such flooring and gratings shall be of rectangular mesh and non-slip and shall be mild steel and hot dip galvanised after manufacture. Alternatively open mesh and chequer plate flooring may be of stainless steel (EN 1.4306) or glass fibre reinforced polyester.

Flooring shall be adequately supported by means of substantial members.

Flooring shall be designed to carry a uniform load of 3.5 kN/m^2 in addition to dead weight and operational loads. The Contractor shall design the flooring for the actual point-load adequate for the equipment to be unloaded, however, no less than 3.0 kN in the middle.

The deflection shall not exceed 0.2 percent of the span. Flooring shall be provided with curbing at the edge of walkway. Each floor panel shall be separately secured to the supporting members by means of fixing brackets. However, each floor panel shall be secured in a way that when not fixed by brackets it shall be fixed in all horizontal directions.

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

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

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

Flooring shall be provided in sizes suitable for lifting and removal by one man and with the appropriate cut-outs to permit its removal without disturbing or dismantling spindles, supporting brackets, cables or pipe-work.

8.7.4 Hatches

Hatches shall consist of a frame with a hinged cover. The frame shall be designed for mounting in recesses in the concrete slab. Hatches on dry wells shall be watertight. Detailed design for sealing shall be subject to the approval of Engineer.

A handle for opening of the hinged cover shall be integrated in the cover. The cover shall be provided with a safety mechanism, which locks the cover in open position whenever opened. The mechanism shall be manually released before the hatch can be closed again.

The hatches shall be designed to withstand a load of minimum 15 kN depending on the location.

Hatches shall be prefabricated and shall be from a recognised manufacturer specialised in the manufacturing of hatches for similar purposes.

Heavy hatches shall be provided with spring-loaded mechanisms or similar facilities which reduce the force required for safe opening and closing of the hatch.

The hatches shall be made of hot dip galvanised steel. Alternatively, hatches may be made of stainless steel (EN 1.4306).

8.8 General Mechanical Equipment

8.8.1 Lifting equipment - cranes

Hoists and cranes shall be provided everywhere necessary for the maintenance of the plant to avoid heavy lifts for the operation staff on the MBT Facility, for example, equipment such as pumps, mixers, blowers, screens, mechanical thickeners, dewatering equipment, in workshop etc. shall be serviced by cranes or hoists.

The cranes or hoist shall enable to bring the equipment to a point were further transport is possible e.g. by a forklift.

Hoists shall be of the hand operated or electrical operated type with lifting chain and designed to run on the lower flange of the lifting beam.

The hoist shall be rated for the heaviest single lift under erection or maintenance operations.

Chains shall be hot dip galvanised, and be able to reach the floor/ground.

Hoist shall be electrical operated for service lifting equipment with a mass exceeding 150 kg.

The maximum load shall be clearly marked with large easy reading figures/letters on the crane.

Construction and assembling shall be according to local laws and regulations or if not available according to EN respective ISO standards.

Crane runway consisting of one or two beams (due to static requirement), incl. all rails, mounting plates and fixing material, attachments for cabling etc. and stop blocks for limitation of movement.

Crane bridge shall be distortion free and wheels of crane travel have to operate synchronously to avoid twisting.

Crane bridges constructed as maintenance free box beam.

Tackles designed according EN or DIN.

Gearboxes, wheels and motors to be maintenance free.

Priming and painted according to section 8.2.

Cranes and lifting equipment with electric actuator:

Electric cranes shall be equipped with precision hoisting gear to allow accurate and sensitive lifting and lowering. Breaks to secure load in case of power failure.

Supply has to include all electric cabling necessary for operation.

All connections have to be equipped with vibration proof terminals.

All motors to be protected by means of thermostat protection.

Limit switches for all final positions.

Local switch cabinet for each crane equipped with pilot lamp, switches and an emergency cut-out for all actuators. Limit of delivery is terminal block in the switch cabinet.

Power supply for movable bridges and lifting devices via trailing cable or trolley wire.

Travelling cranes

Longitudinaly and transversaly moveable, one or two beams due to static requirements, incl. electric cable hoisting gear.

Rail manufactured as I-profile, corrosion protected according general specification. Two speed drive for crane and trolley.

Lifting with brake device with precision hoisting. Electric equipment integrated in trolley.

Control: If not mentioned otherwise by movable suspension switch.

8.8.2 Ventilation

Forced mechanical ventilation shall be provided everywhere either safety, heat and/or odour problems are expected. Ventilation rate shall comply with national standards for health and safety.

Dry pumping stations, pump sumps, buildings for screens, blowers, sludge dewatering etc. shall be provided with mechanical ventilation systems.

In order to avoid odour emissions to the surroundings the inlet structures shall be covered and mechanically ventilated. The exhausted air from these structures as well as from the sludge dewatering facilities shall be exhausted in free air or treated in a bio filter if stated so in order to remove any odorous compounds which could cause nuisance complaints.

Whenever forced ventilation is required the noise level shall be minimised and not exceed the levels described in the Employer's Requirements, Section 2: Design Basis.

All intakes and exhausts shall be covered for all weathers.

8.8.3 Drive units

Drive units for the equipment shall be designed for 24 hours continuous operation. The nominal rating of the gear shall be at least equal to the nominal kilowatt output of the attached motor. Each gear shall be a totally enclosed unit with oil or grease lubricated antifriction rolling bearings throughout.

All drives, couplings and other moving parts shall be efficiently covered on all sides with safety guards.

Long-life seals on the input and output shafts shall be fitted up to prevent the escape of lubricant and the ingress of dust, sand and moisture.

Lubrication of bearings etc. shall be by either splash or forced feed system.

The Contractor shall ensure that the lubricants used for initial filling and specified in the maintenance manual is adequate for prolonged operation in ambient temperatures of up to 55°C. without overheating.

The gearboxes shall be marked with manufacturer's identification together with the rated shaft speeds, output power and maximum ambient temperature.

8.8.4 Bearings

All bearings shall be generously rated and sized to secure satisfactory and stable running without vibration under all conditions of operation for a minimum life of 50,000 hours running, which shall be certified or otherwise documented.

All bearing shall be to ISO standard and SI metric unit dimensions where practicable.

The intervals between lubrication shall be maximized (not less than 2 weeks) and shall be defined for each individual item and included in the operation and maintenance manual.

8.8.5 Motors

General

Motors shall comply with the following general standards and norms:

- IEC 60034-1, 60034-5, 60034-6 and 60034-8, 60034-9.
- Relevant EN standards.

Motors shall be designed for the temperatures and humidity occurring on Site and the installation in which they operate.

- The motors shall be designed and marked for operating conditions according to IEC 60034-1.
- Motors with rated nominal power larger than 15 kW shall be delivered for soft starter or frequency converter.
- Motors for pumps shall be squirrel-cage asynchronous motors unless otherwise stated.

Mechanical Requirements

The degree of protection provided by enclosure for motors shall be minimum IP 55 to IEC 60034-5.

Protection grade for outdoor motors shall be minimum IP 55 and equipped with a drainage hole in the lowest point

The degree of protection for submerged motors shall be minimum IP 68.

The motors shall be cooled in order that the permissible operation temperature is not exceeded.

Motors shall be balanced according to ISO 2373 vibration class N.

Noise level shall minimum fulfil IEC 60034-9.

All motor covers shall be delivered efficiently protected against corrosion according to specifications in section 8.2.

Motors shall be insulated to class F in accordance with the IEC 60085. The limit of temperature raise during operation shall not exceed that for class B insulation.

Electrical Specifications

Motor performance and data shall be in accordance with IEC 60034-1 and shall legible be marked with:

- manufacture,
- serial number,
- rated power,
- full load current,
- voltage,
- cos φ
- frequency,
- number of phases,
- start current,
- rpm.

Each motor shall be provided with thermo protection.

Motors larger than 5.5 kW shall have star-delta windings.

Motors larger than 10 kW shall be provided with thermistors in the windings for each phase.

Smaller motors shall be provided with bi-metal thermo switches in case thermistors cannot be provided.

Submerged gearboxes shall be provided with moisture sensor.

The motors shall be designed for the following parameters:

- Voltage fluctuations +/- 10%. The voltage variations must not result in a temperature increase in excess of what is stated in IEC 60034-1,

- Frequency: 50 Hz. Frequency variations +/- 2.5 Hz.

Motors shall be equipped with connection boxes with separate terminals for each winding end, and connection for protective conductor. The terminals shall be designed for twice the nominal current, however, minimum 2.5 mm^2.

Thermo switches shall be connected to separate terminals inside the connection box.

Marking of connections and rotation direction shall be in accordance with IEC 60034-8.

All motors shall be equipped with suitable number and dimension of cable glands.

All submerged pumps (and other motors) that can be taken out of operation and lifted to ground level by a hoist (or in an equal way) shall have power supply and signal cables connected by CEE sockets enabling electrical disconnecting without use of tools. The sockets (the male as well as the female part) shall be mounted in a location where flooding is impossible. The sockets shall be protected against rain and other weather conditions as described for outdoor instruments in general. If these demands cannot be met the degree of protection shall be IP 68 to IEC 60529.

8.8.6 Balancing

Revolving parts shall be balanced both statically and dynamically, so that for any combination of speed and load up to the maximum, there shall be no vibration caused by out-of-balance forces.

8.8.7 Suppression of noise

All plant offered should be quiet in operation. The noise level within the buildings shall not be more than 80 dB(A) if not otherwise stated. The Contractor shall ensure that all sections of equipment are designed such that when installed the noise emitted is no more than stated in the specific requirements and as stated above. The equipment shall also comply with the requirements of the Employer's Requirements, Section 2: Design Basis.

8.8.8 Penstocks

Penstocks shall be of the following types:

- Stainless steel in accordance with EN 10088-1 grade 1.4404(EN 1.4404), with rubber sealing faces.

Each manually operated penstock shall be provided with a suitable handle of adequate size for the duty required and the gearing shall be supplied where necessary to ensure that the required operating force applied by hand to the handle shall not exceed 250 N. The height of the operating handle shall be approximately 1 meter above operating level unless otherwise stated.

The handles shall have cast on them the direction of closing, which shall preferably be clockwise.

Electrically operated penstocks shall be provided with an adequately rated electrical drive (section 8.8.17).

Spindles shall have machine cut robust trapezoidal or square form threads. They shall be of stainless steel (ref 7.3.4), manganese steel or manganese bronze.

All penstocks shall be of the non-rising spindle type.

All penstocks shall be provided with one or more separate stainless steel emergency lifting wires for use in case of spindle brakeage. The wires shall be properly attached to the penstock door and led to operating level where the end of the wire(s) shall be provided with lifting eye(s) which shall be attached to a bracket.

Penstocks shall be watertight under the conditions of head and flow direction they are designed for and exposed to.

Non-ferrous metal sealing faces shall be formed from accurately machined gunmetal or bronze strips, bedded and fixed to machine recesses by corrosion resistant countersunk screws. The faces of the strips shall be brought together in the operating position and hand scraped to a watertight finish.

The penstocks shall be designed so as to secure tight closure while maintaining freedom of plate movement during operation and minimizing sliding wear of the sealing.

Rubber sealing faces shall be formed from high quality synthetic rubber suitably shaped to interlock into groves in the frame or plate and shall be securely bonded thereto.

Channel mounted penstocks shall be installed in recesses in the channel sides and grouted.

In case that penstock width is greater than 2 m, penstocks shall be of double spindle type.

The materials used for the manufacture of the penstocks shall conform to the following minimum standards:

Cast Iron

EN 1561 Grade 180

Gunmetal

BS 1400 Grade LG2 (EN 1982)

Stainless Steel

BS 970, pt 4 Grade 316 S31 (EN 10083)

Manganese Steel

BS 970, pt 4 Grade 150 M19 (EN 10083)

Phosphor Bronze

BS 2874 Grade PB 102 (EN 12167).

Any standard, which fulfils the same functionality and describing the same quality level or better, can replace any non-EN standards.
Cast iron penstocks shall be painted in accordance with the specifications in Preparation and Painting of Steel Work above.

8.8.9 Gate valves

Gate valves shall be of the double-flanged cast iron resilient seated full bore type with vulcanised EPDM rubber on ductile iron wedge.

Gate valves from DN 50 mm to DN 300 mm shall be in accordance with DIN 3352 Part 4. The face to face dimension shall be to DIN 3202 Part 1, F4.

Gate valves DN 350 mm to DN 600 mm shall be in accordance with DIN 3352 Part 4. The face to face dimension shall be to DIN 3202 Part 1, F5.

Unless otherwise specified, each valve shall be provided with a suitable hand wheel of adequate diameter for the duty required. Gearing shall be supplied where necessary, to ensure that the required operating force applied by hand to the rim of the wheel does not exceed 250 N.

Gate valves of DN 500 diameter and bigger shall be motor driven.

Hand wheels shall have smooth rims and the direction of closing, which shall be clockwise, cast on them.

Valve stems shall be of stainless steel (ref 8.3.4), machined all over with a machine cut robust trapezoidal or square form thread, operating in gunmetal nut.

Stem seals shall be the O-ring type with two such seals arranged for easy replacement of O-rings and shall be accessible for maintenance with the valve under pressure without removing the valve from service.

Fastening bolts shall be of stainless steel, countersunk and corrosion sealed.

Extended spindles for all motorized or actuator operated valves shall be provided with thrust tubes between valve and headstock in order to absorb the thrust in both directions of operation.

Valves shall carry identification plates or marks in accordance with appropriate standard.

All valves shall be painted in accordance with the specifications in Section 8.2 according to actual location.

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

- Ductile Iron DIN 1693 GGG-50
- Dezincification Resistant Brass BS 2874 Grade CZ132 (EN 12167)
- Stainless Steel DIN X 20 Cr 13
- O-rings NBR Rubber.

Any standard, which fulfils the same functionality and describing the same quality level or better, can replace any non-EN standards.

All components being part of the safety function shall be provided with certificates

8.8.10 Knife gate valves

Knife gate valves shall have face to face dimensions to EN 558-1.

Unless otherwise specified, knife gate valves shall be used for all sludge lines.

The body shall be made of cast iron. The gate and stem as well as connecting parts shall be made of stainless steel. Stem nut shall be of dezincification resistant brass.

Knife gate valves shall be painted in accordance with the requirements in section 8.2 according to actual location.

Unless otherwise specified, each valve shall be provided with a suitable hand wheel of adequate diameter for the duty required. Gearing shall be supplied where necessary, to ensure that the required operating force applied by hand to the rim of the wheel does not exceed 250 N.

Knife gate valves of DN 500 diameter and bigger shall be motor driven.

Hand wheels shall have smooth rims and the direction of closing, which shall be clockwise, cast on them.

8.8.11 Non-return valves

Non-return valves shall be normally closed, shall open under minimum flow conditions. The non-return valves shall be of the swing type with lever and counterweight and position indicator.

The non-return valves shall be manufactured from cast iron with top hinged door.

The tightness of the non-return valves shall be secured with renewable accurately machined non-ferrous facing strips or with rubber sealing, which shall be easily renewable as well.

Valves shall be painted in accordance with the requirements in section 8.2 according to actual location.

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

- Cast Iron EN 1561 Grade 220
- Gunmetal BS 1400 Grade LG2 (EN 1982)
- Stainless Steel BS 970 Grade 431 S29 (EN 10083)

Any standard, which fulfils the same functionality and describing the same quality level or better, can replace any non-EN standards.

8.8.12 Butterfly valves

Butterfly valves shall only be used at locations with no risk for rags, fibres etc.

Butterfly valves shall comply with EN 593 and be of the double flanged type with metal or resilient seating and grey or ductile cast iron body.

Valves shall be drop tight at closure and the diameter not less than that of the nominal pipe bore.

The disc shall be in grey or ductile cast iron with a resilient seating ring in moulded rubber, or other material to the approval of the Engineer, located in a landing on the disc and secured by a gunmetal retaining ring fixed with screws made from homogenous corrosion resistant material.

The shaft shall be in one piece and attached to the disc by using fixings in a corrosion resisting material of a pattern which precludes the assembly becoming loose during service. Grub screws, pins or clamps will not be accepted.

The shaft shall rotate in bearing bushes fitted with grease lubrication facilities.

Glands shall be of the O-ring type fitted on the operational shaft extension to the pressure side of the valve. The design shall be such as to facilitate O-ring replacement without removing the valve from service.

Unless otherwise specified, each valve shall be provided with a gearbox with hand wheel proportioned so that the required force applied by hand to the rim of the wheel does not exceed 250 N.

Butterfly valves of DN 500 diameter and bigger shall be motor driven.

The closing direction shall be clockwise and cast on the wheel.

Suitable stops shall be incorporated to prevent disc movements beyond the fully open and fully closed positions.

A valve position indicator to show the position of the disc shall be provided on the valve.

Valves shall carry identification marks or plate in accordance with EN standards.

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

- Cast Iron EN 1561 Grade 220
- Sph. Graphite Iron EN 1563
- Stainless Steel BS 970 Grade 431 S29 (EN 10083)
- Gunmetal BS 1400 Grade LG2 (EN 1982)
- Seals and O-rings Moulded rubber.

Any standard, which fulfils the same functionality and describing the same quality level or better, can replace any non-EN standards.

All butterfly valves and operation devices shall be painted in accordance with the requirements in section 8.2.

8.8.13 Dismantling joints

A sufficient number of dismantling joints shall be incorporated in the pipe work in order to facilitate the exchange of bigger than DN 200 mm size or wherever necessary valves and armatures in the pipe work. The dismantling joints shall be made of GGG50 sphero cast iron and shall have an axial adjustment capability of at least ± 25 mm to facilitate easy dismantling and installation of pumps, valves, non-return valves, measuring devices, etc. Threaded rods and nuts through two opposite flanges shall secure the dismantling joint in the position determined during installation, so that the system represents a rigid connection of two adjoining pipes.

8.8.14 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.

8.8.15 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.

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 constriction 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). The valve shall have the ability to evacuate compressed air and other gases while the pipe line is under pressure (air evacuation principle).

8.8.16 Telescopic valves

Open stem and yoke valve to be used to draw sludge from clarifiers, its pipes and parts shall be made up of EN 1.4404 stainless steel. It shall be used in sludge taking lines. It shall telescope up and down (two pipes, one inside other), having a proper diameter, depending on the flow rate of sludge taken. Sealing shall be provided between two pipes.

Telescopic valve may be controlled by motor or manually. For manual control, wheel shall be installed in a suitable size, the turning force of which does not exceed 250 N. Wheel is approximately 1 meter above the platform. Closing direction shall be inscribed on wheels, preferably clockwise.

Motor driven valves shall have actuators which have 4-20 mA control signal.

8.8.17 Electric actuators

Where required, penstocks and valves shall be operated by means of electrically driven actuators with integral reversing starters (EN ISO 5210). Each actuator shall be fully weatherproof to minimum IP55, and fitted with anti-condensation heater, upper and lower limit switches and torque switches, for operation through 4-20 mA signals.

Each actuator shall be adequately sized to suit the application. 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.

The gearbox shall be oil or grease filled, and capable of installation in any position.

Alternative hand operation shall be possible, and the hand wheel 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 when under manual operation. Hand wheels shall be rotated clockwise to close the valves or penstocks, and shall be clearly marked with the words "OPEN" and "CLOSE" and arrows in the appropriate directions. The rims of hand wheels shall have a smooth finish.

Control drives shall have a stall torque rating of at least 150 percent of the maximum required torque for the driven element, and shall be capable of operating at 65ºC continuously. Stroking time to be suitable for application.

All drives shall have minimum repeatability of ±0.5 percent of full-scale travel.

All drives shall have slide wires or differential transformers and end limit switches for position and/or feedback control.

Electric drives shall have proportioning control.

All control drives shall include mounting stands, drive arms, clevises, connecting linkage and suitable enclosure.

8.8.18 Pumps

Where applicable before delivery to site all pumps shall be works tested according to EN ISO 9906 witnessed by the Engineer.

General

In each pumping installation all pumps shall be equal with respect to manufacturer and type.

On the suction pipe before the pump an isolating valve shall be incorporated (only dry mounted pumps) and on the pressure pipe an isolating valve, dismantling piece and a check valve shall be incorporated (both dry and wet mounted).

All delivery pressure pipes from pumps shall be provided with connecting branch with ball valve and manometer.

For dry mounted pumps the connection on both suction side and pressure side of the pump shall be via flexible connections.

Pumps shall be arranged for priming by means of an adequate positive suction head in all possible operating conditions.

The operation cycle of the pumps shall include alternating also of the stand by pump. The pumps shall be dimensioned for minimum 10 starts per hour.

For centrifugal canal-wheel type pumps the maximum velocity at discharge flange is 3.5 m/sec.

Discernible noise caused by hydraulic turbulence and cavitation will not be accepted.

Water hammers in the piping system shall be eliminated by installing surge vessels, special valves or similar.

The pump impeller shall be selected for maximum efficiency. Pumps shall operate right to BEP (Best Efficiency Point) at start conditions and so to the left of BEP at stop conditions.

The pump type shall be determined by the Contractor for the maximum time between failures (clogging etc.) which shall be a minimum of 60 operation days.

Impellers of minimum or maximum diameters in relation to size of pump house shall not be used.

Pump housing shall be fabricated from cast iron and impellers shall be of wear and corrosion resistant steel.

When using frequency converters for speed control the pumps shall be equipped with external ventilation if speed control is possible below 35 Hz.

All pumps shall be equipped with thermal switches for thermal protection.

Pumps shall be easy accessible for service and provided slewing davits or cranes.

Shop tests and inspection for the complete valve assembly shall be performed in accordance with the requirements of EN 12266.

Contractor shall provide Inspection and Test Plan for approval.

Valve Testing;

Valves shall be shop tested before final coating/ painting is applied.

- Pressure testing shall be performed in accordance with EN 12266-1
- Hydrostatic shell test pressure shall be 1.5 times the pressure rating. The test duration shall not be less than 30 minutes.
- Hydrostatic seat test shall be 1.1 times the pressure rating. The test duration shall not be less than 10 minutes.
- Testing of drain, vent and sealant injection lines shall be performed in accordance with EN 12266-1
- All welds (including drain, vent and sealant lines) shall be subjected to a 100 % radiographic or ultrasonic inspection. The transition pieces shall be subjected to a 100% ultrasonic inspection over the entire circumference over a width of 50 mm in order to detect doubling or lamination.

- Welds on which radiographic or ultrasonic inspection is not possible shall be tested in another suitable way, e.g. magnetic powder inspection or dye penetrant inspection by agreement with the acceptance testing authority.

- Repair works shall be in accordance with EN 12266-1

- Minor surface defects shall be repaired by grinding provided the remaining thickness is not less than the specified minimum wall-thickness.

- Weld repairs are permissible for castings and structural welds provided they do not extend to more than 20% of the surface area of a casting or 25% of the length of a weld seam. Repairs of structural welds shall have a minimum length of 50 mm or four times the material thickness, whichever is longer.

- Repair of body castings by peening or impregnation is not allowed.

- Weld repair of forgings and to plate are not permitted.

- Castings that leak through the body of the casting during hydrotest shall be rejected and no repairs shall be allowed

8.8.19 Slewing davits for submersible pumps

Slewing davits shall be provided for all pumps up to 250 kg, however a slewing davit is only required in case the pump is not served by an overhead crane.

The slewing davit shall be capable of lifting/lowering the above specified submersible pump and shall have the following features:

- shall be mobile and easy removable by one man

- davit based on DIN 15018 H1 B2

- hoist in compliance with DIN 15020 1 Em

- davit with manually operated wire hoist

- davit complete with all necessary fastening material (fastening material stainless steel according to 8.3.4)

- slewing radius of davit to be such to permit unloading of raised pump at a place accessible by forklift

- the lifting height shall be sufficient to allow slewing the crane with pump to pass the obstacle height (e.g. handrail)

- davit including all accessories have to be in accordance with current national safety regulations

Materials

- davit: hot dip galvanized steel, stainless steel structure or aluminium
- manual wire hoist: seawater resistant aluminium, or stainless steel, with safety ratchet block
- lifting wire, thimble and shackle: stainless steel
- pulley: Polyamide

8.8.20 Submersible pumps for dry installation

The submersible pumps suitable for dry installation shall have the following features:

- Design according to DIN 19569, where applicable.
- Performance in excess of actual demand by at least 10% for flow or head.
- Casing with large-flow cross-section and replaceable wear ring where applicable.
- Impeller with large, unobstructed flow ways to ensure non-clogging and non-stringing operation
- Impeller with means to reduce end thrust
- Common motor/pump shaft supported in anti-friction bearings with grease and/or oil lubrication. Shaft not to be in contact with pumped medium.
- Intake and discharge side of pump with flanged connection
- Due to the dry installation of the pump, the motor cooling system must be highly efficient. Cooling shall be based on indirect cooling for pumps ≥7.5 kW

Materials

The materials given below are the minimum requirements. The Contractor must state in the appropriate sections the materials proposed by him.

- volute casing: min. GG-25 cast iron
- impeller: min. GG-25 cast iron or stainless steel (EN 1.4301 or higher)
- pump shaft: min. C45 carbon steel or stainless steel (EN 1.4301 or higher)
- type of seal: mechanical seal suitable for liquids with a high concentration of abrasive solids
- Fastening components: material stainless steel according to Section7.3.4

All electrical components as detailed under section “Electrical Power and Control Equipment”.

Drive

The motor shall have the following features:

- dry-running three-phase asynchronous motor in watertight casing according to IEC standard
- protection type IP 68
- insulation class H
- operating mode S3 or S8 (Frequency converter)
- internal indirect cooling for pumps ≥7.5 kW
- pump will be equipped with cooling jacket for dry running application
- moisture/water sensor device to prevent damage to motor windings and bearings
- tandem mechanical shaft seal
- thermo element in coil for motor protection
- pump completely cabled.
- motor efficiency class IE3

8.8.21 Submersible pumps for wet Installation

The submersible pump for wet installation shall have the following features:

- Design according to DIN 19569, where applicable.
- Performance in excess of actual demand by at least 10% for flow or head.
- Casing with large-flow cross-section and replaceable wear ring where applicable.
- Impeller with large, unobstructed flow ways to ensure non-clogging and non-stringing operation considering the media to be pumped.
- Impeller with means to reduce end thrust.
- Common motor/pump shaft supported in anti-friction bearings with grease and/or oil lubrication. Shaft not to be in contact with pumped medium.
- Intake and discharge side of pump with flanged connection
- The motor cooling system must be highly efficient.
- Duck foot bend for automatic coupling of pump to discharge pipe.
- Guide bar system for lowering/lifting of pump.
- Fixing components.

- The pumps shall be suitable for reversing by backflow in the pipe after pump stop.
- Cable shrouds should preferably be of steel wire mesh instead of synthetic material.

Materials

The materials given below are the minimum requirements. The Contractor must state in the appropriate sections the materials proposed by him.

volute casing : min. GG-25

impeller : min. GG-25 Cast iron or stainless steel (EN 1.4301 or higher)

pump shaft : min. C45 carbon steel or stainless steel (EN 1.4301 or higher)

type of seal : mechanical seal

suitable for liquids with a high concentration of

abrasive solids

- fastening components, material stainless steel according to 7.3.4.

Drive

The motor shall have the following features:

- dry-running three-phase asynchronous motor in watertight casing according to IEC standard
- protection type IP 68
- insulation class H
- operating mode S3 or S8 (frequency converter)
- internal cooling for pumps ≥7.5 kW
- Pump will be equipped with cooling jacket for wet running application
- moisture/water sensor device to prevent damage to motor windings and bearings
- tandem mechanical shaft seal
- thermo element in coil for motor protection
- sensor for bearing temperature
- pump completely cabled
- motor efficiency class IE3