

## **WST-06-PIPING SYSTEMS AND MATERIALS FOR PROCESSES**

Ver.1            Date: October 2014

### **1. SCOPE**

This Specification details the technical requirements for the design, materials and equipment, testing and commissioning for the complete installation of all process pipework to suit the process(es).

### **2. GENERAL**

The Works shall be complete with all minor and incidental items necessary for the proper functioning of the whole system, even though not specifically detailed or mentioned.

All pipework shall be installed and tested in accordance with this Specification, the Pipeline Data Sheets and all relevant instructions supplied by The Engineer or the pipe manufacturers and suppliers

### **3. STATUTORY REQUIREMENTS AND STANDARDS**

The design, manufacture, supply, storage, installation, testing and commissioning of all pipework shall comply with all New Zealand Standards, (or in the absence of New Zealand Standards, the appropriate Australian, British or International Standards) Acts and Regulations in their latest amendment, including:

- Occupational Health and Safety Act and its associated legislation
- Dangerous Goods Regulations
- Construction Safety Regulations
- Factories, Shops and Industries Regulations
- Local Authority Service Rules

The Standards referenced shall form part of this Specification. Other Standards, Codes of Practice and Regulations not referred to, but which would be applicable to the design, manufacture, installation, testing or commissioning of the pipework under this contract shall be deemed to be part of this Specification.

### **4. PIPEWORK DESIGN**

#### **4.1 GENERAL**

The Drawings indicate the size of pipes and their general routes. The Drawings shall be taken as diagrammatic and approximate only, to meet architectural, structural and site requirements.

The Contractor shall be responsible for the detailed design of the service and process pipework systems to comply with the general requirements described on the Drawings, Specification and Pipeline Data Sheets.

The pipework installation shall be designed and arranged to provide for ease of erection and future dismantling. All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipework and its associated equipment in an approved manner.

All pipe supports shall be seismically rated to suit the site conditions (Design principles for Seismic Design of Equipment and Equipment Supports (DP-01) ).

Pipes may only be supported from existing structural steel works where approval has been obtained from The Engineer. Pipes shall not be supported from roof girts or other structures not specifically designed for pipe loadings.

Pipes laid horizontally shall have a gradual fall towards drain or scour points as appropriate.

Sufficient dismantling joints, flange adaptors or flexible couplings shall be provided to enable removal for replacement, cleaning and maintenance. Clean out ports shall be provided on all piping carrying solids including sludge, grit and screenings.

Where valves, flow meters, strainers and other devices mounted in the pipework are large enough to put undue strain on the pipework, these shall be supported independently of the pipes to which they connect. Particular care shall be taken to ensure that pipework thrusts are not transmitted to pumps, tank nozzles, machinery or associated apparatus.

The high points of all pipe routes shall have provision for venting any entrapped air.

Detailed design shall include:

- detailed layout and co-ordination, including all necessary bends and offsets.
- support
- anchorage, guides
- flexibility
- expansion and contraction
- prevention of water hammer

Design details shall be such as to minimise head loss in the pipework. To this end, long radius bends shall be used wherever possible, particularly on sludge lines. Long radius bends shall be used on all pipes carrying solids unless approved otherwise by The Engineer.

Pipe runs shall be laid out to minimise crossovers and unsightly offsets and shall be co-ordinated with other services. All pipes, valves and fittings shall be so arranged that they are conveniently accessible and readily replaceable.

Care shall be taken in laying out piping to ensure neat and workmanlike appearance, true alignment and grade. Pipes shall be installed in one plane wherever possible. Pipes running in the same direction shall be parallel.

Offsets shall use 45° bends wherever possible. Bends shall be used in preference to elbows.

Plant and pipework shall be supported independently, unless written agreement is provided by the plant manufacturer confirming acceptability of imposed loads.

Wherever possible pipework shall be fixed so that a clear space of not less than 100 mm is left between the pipe or pipe flange and adjacent structural surfaces, pipes, equipment etc.

High standards of cleanliness must be maintained during the erection of piping systems to ensure that no foreign matter is introduced that could adversely affect the use or performance of the plant.

Where pipework is exposed or subject to temperature variations, the installation shall include expansion loops or other approved device to take account of thermal expansion.

Labelling to be based on the "De Neefe" system and in accordance with NZS5807. Labels to be in the fluid colour code as specified in CG-10-Painting of Piping and Equipment, and to show the fluid name and direction of flow. Adhesive labels are to be placed so as to ensure that the pipeline is identified as soon as possible after a person passes through a doorway or around a corner or any other obstruction that breaks the continuous line of sight,

## 5. PIPE MATERIALS

### 5.1 GENERAL

Pipe materials shall be as per the P&ID's (Piping & Instrumentation Diagrams) and Pipeline Data Sheets and as listed below. Alternative materials may only be used following approval by The Engineer.

### 5.2 MILD STEEL

1. MLMS: Mortar lined mild steel pipe shall comply with NZS 4442 as supplied by Steelpipe Ltd or equal. Pipe coating shall comply with the requirements of CG-10–Painting of Piping and Equipment to suit the installation conditions, environment and required design life.

Where jointing is by flexible coupling or flange, pipe ends shall be rounded to not less than 1.5 mm radius to remove sharp corners and present a rounded smooth surface for paint application.

2. MS:
  - a) Mild steel pipe shall comply with NZS 4442 and be as supplied by Steelpipe Ltd or equal.
  - b) Steel tube or tubulars shall comply with BS EN 10255:2004 medium weight, or heavier if service conditions require.
3. GI: Galvanised iron pipework shall be steel tube or tubulars and shall comply with BS 1387 medium weight, or heavier if service conditions require. GI pipe shall not be used for pipework with a diameter greater than 100 mm.

### 5.3 STAINLESS STEEL

Unless otherwise specified, all stainless steel pipework shall be manufactured from Grade 316L or Grade 316 stainless steel tube and fittings. All spiral wound stainless steel tube used shall be manufactured in accordance with the requirements set out in AS 4041 for class 3 piping with straub, vanstone or equal couplings.

All instrumentation piping shall be manufactured from Grade 316 stainless steel seamless tube and fittings of a thickness suitable for threading.

All welding shall be carried out using approved welding techniques. Welds shall be performed using low hydrogen filler material and shall be fully passivated following completion of all welding and fabrication works. All heat tint, tape, markings and all other surface contamination shall be removed.

Grade 316L stainless steel shall be used where either or both of the following circumstances occur:

1. The stainless steel is subject to welding.
2. The stainless steel is in contact with raw sewage or screenings. This includes items not fully submerged but wetted due to splashing, etc.

Grade 316 stainless steel may be used where neither of the circumstances listed above is applicable.

### 5.4 CAST IRON

CI: Cast iron pipework shall comply with BS 2035 and BS EN 598, BS EN 545 and BS EN 969 as supplied by Gillies Foundry & Engineering Co Ltd or equal.

### 5.5 DUCTILE IRON

DI: Ductile iron pipework shall comply with AS/NZS 2280 (Pressure pipe), BS EN 598, BS EN 545 and BS EN. Pipework shall be light cement mortar lined. Unless specified otherwise, all pipework shall be Class K9 except for flanged pipework which shall be Class K12. Unless specified

otherwise, all pipework shall be externally coated with bituminous paint and have external polyethylene sleeving.

#### **5.6 POLYVINYL CHLORIDE**

Where covered and not exposed to direct sunlight and fit for purpose, unplasticised polyvinyl chloride (uPVC) pipe and fittings may be used.

All uPVC systems shall be installed strictly in accordance with the requirements of AS 2032 and AS/NZS 2566.

Account shall be taken of thermal expansion by the use of expansion loops or other proprietary device as required.

uPVC pipe shall be manufactured to AS/NZS 1477 (Pressure pipe), AS/NZS 1260 or AS/NZS 1254 (Drain pipe) as appropriate for the service and duty.

#### **5.7 ACRYLONITRILE BUTADIENE STYRENE**

ABS: Acrylonitrile Butadiene Styrene pipework shall comply with AS/NZS 3518:2004

ABS pipework shall be suitably rated for the design service, but as a minimum Class 9 shall be used. The pipework shall be installed in accordance with AS 3690.

Account shall be taken of thermal expansion by the use of expansion loops or other proprietary device as required.

#### **5.8 POLYETHYLENE**

PE: Polyethylene pipe shall comply with AS/NZS 4130. All polyethylene pipe shall be PE 80B or 100, PN 12.5 unless specified otherwise.

PE pipe shall not be subjected to bending to a radius tighter than 25 times the pipe outside diameter.

Hot bending shall not be permitted.

All fusion bonding processes shall be strictly in accordance with the pipe manufacturer's recommendations and procedures. Operators shall be qualified to NZWWA standards as a minimum.

The Contractor shall take special care with all PE pipes and fittings which are prone to surface damage if incorrectly handled or stored as well as being subject to degradation when exposed to sunlight. All handling and storage shall be strictly in accordance with the manufacturer's recommendations and procedures. No metal chains or slings shall be used.

All pipe laying shall be in accordance with both the manufacturer's recommendations and installation procedures and AS/NZS 2566.

PE has a relatively high coefficient of linear expansion (Approximately 0.18 mm/m/°C). When laying the pipe, sufficient allowance must be made for expansion and contraction.

#### **5.9 COPPER**

Cu: Half hard copper tube shall comply with NZS 3501 Table 1 for water supply and Table 2 for sanitation. Hard drawn copper pipe to a current approved standard may be used for water reticulation above ground. Copper tube shall be solid drawn.

Wherever a copper pipe is connected to a steel or cast iron pipe, insulating dielectric unions of an acceptable type shall be installed. Wherever copper pipe is supported from hangers, it shall be suitably insulated from the hangers.

#### **5.10 FIBRE REINFORCED PLASTIC**

FRP: Fibre reinforced plastic pipes shall comply with AWWA C950, AWWA M45 and ISO TR10465-1 as appropriate.

#### **5.11 CONCRETE**

RRJRC or FJRC: Rubber ring jointed or flush jointed reinforced concrete pipe shall comply with NZS 4058.

#### **5.12 VITRIFIED CLAY**

VC: Vitrified clay spigot and socket pipe with polyester fairings and elastomeric "O" ring seals, shall comply with BS EN 295-1.

#### **5.13 HOSE**

1. Hose for process pipework shall be textile reinforced rubber, Dunlop D214 as supplied by Paykel Engineering Supplies Ltd or equal.
2. Hose for wash down purposes shall be GEM type as supplied by Wormald NZ Ltd or equal. Reels for hose storage shall be fabricated from stainless steel and be supplied with 10 metres of 32 mm diameter hose (PVC). Flow shall be controlled at the downstream end by use of a proprietary nozzle allowing adjustment from jet through spray to stop.

#### **5.14 SUBSOIL DRAINAGE**

Subsoil drainage pipes shall be class D uPVC to New Zealand Transport Agency F2 or heavy wall (SDR 17) polyethylene.

### **6 FITTINGS**

#### **6.1 GENERAL**

Fittings (bends, tees and the like) used in pipelines shall be of the following types, the actual type being as indicated on the Drawings. Unless shown otherwise, fitting material shall be the same as the adjacent pipe material.

#### **6.2 MILD STEEL**

3. MLMS fittings shall be manufactured from MLMS pipe and shall comply with NZS 4442 unless dimensioned otherwise. Coating and end protection shall be as specified for the MLMS pipe.
4. Wrought pipe fittings for steel tube or tubulars shall comply with BS EN 10241 heavy weight.
5. GI pipe fittings for steel tube or tubulars shall comply with BS EN 10241 heavy weight.

#### **6.3 STAINLESS STEEL**

SS fittings shall be fabricated where possible, of a grade to match adjacent pipework.

All welding shall be carried out using approved welding techniques. Welds shall be performed using low hydrogen filler material and shall be fully passivated following completion of all welding and fabrication works. All heat tint, tape, markings and all other surface contamination shall be removed.

#### **6.4 CAST IRON**

CI fittings shall comply with BS 2035, BS EN 598, BS EN 545 and BS EN 969 as supplied by Gillies Foundry & Engineering Co Ltd or equal.

#### **6.5 DUCTILE IRON**

DI fittings shall comply with AS/NZS 2280 (Pressure pipe), BS EN 598, BS EN 545 and BS EN 969. Fittings shall be light cement mortar lined. External protection shall be as specified for D1 pipe.

#### **6.6 POLYVINYL CHLORIDE**

Moulded uPVC fittings shall be as supplied by the manufacturer of the adjacent pipe. Fittings shall have a pressure rating not less than the adjacent pipe. Factory fabricated fittings shall be manufactured by a fabricator approved by the pipe manufacturer and regularly engaged in this type of work.

Fittings shall be double socket with solvent welded joints.

All pipes, fittings & glue shall be of the ONE manufacture and dissimilar piping and fittings will not be acceptable.

Pipes and fittings shall be suitably rated for their design service but shall be Class 9 minimum. All isolating valves 50 mm and smaller shall be double union ball valves with PVC body and ball and with PTFE ball seats and seals, or as appropriate for the fluid and duty. Check valves shall be of a similar specification.

Valves greater than 50 mm shall be flanged unless noted otherwise.

Sufficient additional union couplings shall be provided in the pipeline to facilitate removal for maintenance.

#### **6.7 ACRYLONITRILE BUTADIENE STYRENE**

ABS fittings shall comply with AS/NZS 3518 Fittings shall have a pressure rating not less than the adjacent pipe.

Fittings shall be double socket with solvent welded joints and of the one manufacturer.

All isolating valves 50 mm and smaller shall be double union ball valves with ABS body and ball and with PTFE ball seats and EPDM seals. Check valves shall be of a similar Specification.

All valves greater than 50 mm shall be flanged.

Sufficient additional union couplings shall be provided in the pipeline to facilitate removal for maintenance.

#### **6.8 POLYETHYLENE**

Moulded PE fittings shall be as supplied by the manufacturer of the adjacent pipe. Fittings shall have a pressure rating not less than the adjacent pipe.

Hot bending shall not be permitted.

All fusion bonding processes shall be strictly in accordance with the manufacturer's recommendations and procedures.

No fitting shall be reheated.

The Contractor shall take special care with all PE pipes and fittings which are prone to surface damage if incorrectly handled or stored as well as being subject to degradation when exposed to sunlight.

All handling and storage shall be strictly in accordance with the manufacturer's recommendations and procedures. No metal chains or slings shall be used.

#### **6.9 COPPER**

Fittings and flanges shall be silver soldered. Joints up to 50 mm may be made by couplings with pre-placed solder. Screwed fittings shall only be used on 50 mm sizes and smaller. Pipes over 50 mm in diameter shall have brass or gunmetal flanges.

#### **6.10 FIBRE REINFORCED PLASTIC**

Fabricated FRP fittings shall comply with BS EN 14364 AND BS EN 1796. Fittings shall have a pressure rating not less than the adjacent pipe.

### **6.11 CONCRETE**

Prefabricated RC pipe fittings shall be factory fabricated by the pipe manufacturer.

### **6.12 VITRIFIED CLAY**

Moulded VC fittings shall comply with BS EN 295-1 and shall be as manufactured by the manufacturer of the adjacent pipe.

## **7 JOINTING**

### **7.1 GENERAL**

Subject to the requirements of the Specification, Drawings and Pipeline Data Sheets, and good engineering, trade and maintenance practices, the method of jointing of pipes, valves and fittings shall be selected by the Contractor. All connections to equipment and contract termination points shall be flanged.

Valves, instrumentation and other fittings and equipment shall be installed such that they are readily accessible or alternatively access ladders, platforms and walkways shall be provided.

### **7.2 STEEL WELDING**

#### **1. Mild Steel / Carbon Steel**

##### **a) General**

All welding shall be carried out by welders appropriately qualified for the particular service in question with a minimum qualification of MOT Marine Division Test, using approved procedures, consumables and equipment; and as recommended by the manufacturer concerned for the particular work involved. All residual scale, weld spatter and slag shall be removed from the works.

##### **b) Oxy-acetylene Welding**

Oxy-acetylene welding shall comply with BS 2640 (withdrawn) Class II. All welding shall be carried out by qualified welders, using approved welding procedures, consumables and equipment.

##### **c) Arc Welding**

Arc welding shall comply with BS 2971 Class II. Arc welding electrodes shall be stored at a temperature of 38°C and not used until they have been stored for at least 24 hours. Welders shall be qualified to NZS 4711. All welding shall be carried out by qualified welders, using approved welding procedures, consumables and equipment.

##### **d) Testing**

Tests shall be carried out in accordance with BS 1295 (withdrawn), BS 2640 (withdrawn) Class II or BS 2971 Class II.

#### **2. Stainless Steel**

All welding shall be carried out by appropriately qualified welders suitably experienced in welding of stainless steel, using both welding materials of size and type and approved welding techniques recommended by the manufacturer concerned. Gas shielded arc welding and high molybdenum filler rod shall be used. All welds shall be chemically cleaned and passivated. Welds shall be full penetration butt welds so that crevices do not occur. All spatter shall be removed. Welding of dissimilar steel together is not permitted without specific approval from The Engineer. All work shall be in accordance with BS 4677:1984 or ASTM A312 or A778.

### **7.3 HDPE**

The jointing of PE pipework and fittings shall be by electrofusion or mechanical jointing / fittings. Alternatively, PE pipes and fittings may be jointed using fusion welding. Welding shall be performed by welders who have successfully completed a current Natural Gas Corporation of NZ Joint Qualification Test or similar equivalent test applicable to the welding procedure employed.

### **7.4 PVC**

Unless specified otherwise, joints shall be flanged, solvent welded or union couplings.

Pipes shall be cut square and flat using a fine toothed saw. Burrs shall be removed from both inside and outside edges of the pipe and a 15 degree chamfer cut on the external surface. Joints shall be made in accordance with the pipe manufacturer's recommended method using Pressure Grade solvent cement and the associated cleaner/primer as supplied by the pipe manufacturer.

Immediately after application of the cement the socket shall be pushed over the spigot, rotating  $\frac{1}{4}$  to  $\frac{1}{2}$  turn at the same time, until the spigot "bottoms" in the socket. Joints shall not be disturbed for a minimum period of five minutes after making. Excess cement shall be removed from both internal and external surfaces.

#### **7.5 COPPER**

1. Compression fittings shall be 'Alltite', 'Starkie' or equivalent. Crox unions shall not be acceptable.
2. Brazed joints shall be socket and spigot type, using an oxy-acetylene flame with 'Silbeloy 15' (containing 15% silver) and shall be neatly made to avoid dead legs or other features which may lead to corrosion or build-up of debris.

#### **7.6 FLANGES**

1. General

Flanges shall comply with BS EN 1092-1:2007. For particular fittings, in particular where required to match to existing flanges, other flange standards may be used subject to approval by The Engineer.

Flanges shall be to a class in excess of the maximum pressure they will attain in service including any surge pressures, closed valve pressures or test pressures.

Flanges on all MS, CI, DI and FRP pipes shall be full face. Flanges on SS, PVC, ABS and PE pipes may be stub flanges with metal backing rings or full face up to 100 mm pipe diameter. On PVC, ABS and PE pipes 100 mm diameter and larger, full face flanges with metal backing rings shall be used. Backing rings shall be hot dip galvanised. Subject to the specific written approval of The Engineer, flanges on spiral welded SS tube may be stub flanges with hot dip galvanised backing ring over 100mm diameter.

All galvanised surfaces in contact with stainless steel shall be coated or painted to provide protection against galvanic corrosion.

Flange jointing sets shall include all bolts, nuts, washers and flange gaskets or insertions necessary for jointing together the flanges of the specific diameter and pressure rating.

Flanged joints shall be made with bolt sets, bolt studs with nuts on each end, or studs with nuts where the flange is tapped.

All bolts shall have hexagon heads and shall be provided with washers and hexagon nuts. Bolts, nuts and washers shall comply with AS/NZS 1111.1 and AS/NZS 1112.1-1112.4. All nuts, bolts and washers shall be hot-dip galvanised with a minimum zinc thickness of 0.1 mm.

All flanges shall be assembled square and true prior to bolting.

Bolts shall be tightened in a diametrically opposite sequence. Each bolt shall be initially torqued in sequence to 50% then the sequence repeated to give 75%. Then the sequence repeated to give 90% then 100%.

Machined flange faces are to be coated with an approved soluble lacquer.

All internal and external linings and coatings shall be made good after welding.



Unless specified or required otherwise because of pressure or other criteria, flange gaskets shall be full face of thickness to suit the test pressure and flange dimension but not less than 3 mm. The gasket material shall be neoprene where suitable, but in all cases shall be suitable for contact with the fluid being conveyed, and the specified duty, operating conditions and environment.

2. Carbon Steel Flanges

Flanges shall be to the flange table as specified, or appropriate for the maximum pressure rating of the system. For pipes up to and including 10 mm wall thickness flanges may be attached by double fillet welds. For pipes greater than 10 mm wall thickness, flanges shall be attached using full penetration butt welds.

3. Ductile Iron Flanges

Flanges for ductile iron pipes and fittings shall be integrally cast or fabricated and attached to the ductile iron pipe by screwing with mating threads filled with a suitable epoxy resin. Flange drilling shall comply with AS 2280 - 1991 to the flange Table specified or appropriate for the maximum pressure rating of the system. Flange contact surfaces shall be raised face.

**7.7 FLEXIBLE**

1. Rubber Ring

Rubber jointing rings for use in spigot and socket pipes shall be as supplied by the pipe supplier for the particular pipe. Rubber rings shall be stored in a cool shaded environment and shall not be hung over pegs or similar supports. Previously used rings shall not be reused.

2. Gibault

Gibault and similar slip over, non tension resisting type pipe couplings shall be cast iron or fabricated steel with galvanised steel bolt sets as supplied or recommended by the pipe manufacturer for use with the particular pipe.

3. Victaulic

Victaulic and similar slip over, tension resisting type pipe couplings shall be cast iron with galvanised steel bolt sets as supplied or recommended by the pipe manufacturer for use with the particular pipe.

4. Bellows

Flexible connectors shall be installed adjacent to all pumps and vibrating or vibration sensitive plant or equipment. Where necessary, flexible connectors shall incorporate tension resisting tie bolts. Connectors shall be Tift Type FSF, single sphere, or equal unless specified or required otherwise.

**8 REDUCERS / ENLARGERS**

Reducers in horizontal pipework shall be eccentric unless shown otherwise. Eccentric reducers shall be top level for liquid services and bottom level for gaseous services. Reducers in vertical pipework shall be concentric.

Enlargers shall be concentric unless shown otherwise.

**9 BENDS AND BRANCHES**

Bends shall be factory made long radius preformed fittings wherever possible.

Subject to the pipe retaining its full structural and pressure capability, hydraulic bending is permitted provided that the pipe walls are fully supported during the bending operation and that the pipe cross section distortion is less than 5% of the original diameter. Heat bending is permitted to assist in minimising distortion provided it does not affect pipe strength.

Branches shall generally be 'easy-sweep' preformed wye fittings. Alternatively branches may be cut into the main pipe providing workmanship is satisfactory. Holes cut in this manner shall be equal to the diameter of the branch pipe. Pipes shall be accurately cut so that the pipe/weld does not protrude into the main pipe.

## **10 PIPE SLEEVES**

Unless shown as being cast in, pipes passing through walls, floors or ceilings shall be sleeved. The sleeve type shall be selected by the Contractor to suit the application. Sleeves used as water stops shall ensure that no leakage can pass through the wall and shall take account of the affect of pressure surges on plastic pipes at the wall face.

## **11 PIPE HANGERS AND SUPPORTS**

Where pipe hangers and supports are not detailed on the Drawings, the Contractor shall be responsible for ensuring that the strengths and sizes of these are adequate in all respects, including compliance with the Watercare seismic requirements and the seismic requirements of NZS 4219 and the NZ Building Code. Where pipe sizes and/or materials are not listed in the Building Code, hangers and supports shall be as recommended by the pipe manufacturer. The Contractor shall ensure that piping loads are shared by the supports so that no fixing is overstressed.

The Contractor shall make provision for expansion and contraction of all pipework and for all thrust forces.

Plastic piping shall be supported in accordance with the pipe manufacturer's instructions and recommendations for the duty concerned.

Steel piping of 80 mm nominal diameter or less may be hung from steel purlins provided hanger spacing does not exceed 2.5 m for 80 mm diameter piping or 3.0 m for piping 65 mm diameter and less. Larger diameter piping shall be supported from main structural members only. When the spacing of such members exceeds the maximum spacing of hangers specified above the Contractor shall provide all necessary supporting members. The maximum spacing of pipe hangers or supports shall not exceed the design recommendations of the pipe and/or support manufacturers.

Fixing to concrete or masonry shall use chemical anchors or Rawlbolts or equivalent as directed by The Engineer. Powder fired fixings shall not be used.

Hangers shall be in accordance with BS 3974 (withdrawn)

Pipe anchors shall be provided where required. They shall be constructed from steel angle or channel welded directly to steel pipe or welded to steel pipe clamps where other materials are used. The pipe anchor shall be designed for the full range of thrust forces that need to be accommodated over all possible system operating conditions.

Pipework shall be placed and supported at the designed lines and levels and correct grades. Pipework shall be sloped to allow complete drainage.

Pipework shall be supported on appropriate racks or by anchor or wall brackets, saddles or supports.

At each change of direction of the pipeline, hangers, supports or a pipe rack shall be provided in each direction. Where not specifically designed, hangers, saddles, racks and clamps shall be standard purpose manufactured "Unistrut" components or equal. Where pipework is supported from a concrete structure "Unistrut" or equal channel sections adequately anchored into the concrete shall be provided and particular attention shall be given to the safe load capacity of such inserts.

Additional supports shall be provided adjacent to connections to pumps, tanks, etc and on either sides of valves, measuring instruments and the like. Expansion joints and or bends, thrust blocks and anchors shall be provided where appropriate.

In assessing the design loads of pipe supports, all pipelines shall be assumed full of water. Further, the design loading of supports shall assume that every alternate support takes no load. The location and type of support to be installed shall make the appropriate allowance for thermal expansion of pipework including plastic pipelines.

All fabricated pipe supports shall be manufactured from suitable grade structural steel.

All welding shall be carried out by qualified welders using approved welding procedures, consumables and equipment.

All pipe supports shall be hot dipped galvanised after fabrication and painted where specified.

## **12 INSTALLATION OF PIPEWORK**

### **12.1 GENERAL**

The pipework installation shall be designed and arranged to provide for ease of erection and future dismantling. All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipework and its associated equipment in an approved manner.

Pipes may only be supported from existing structural steel works where approval has been obtained from The Engineer. Pipes shall not be supported from roof girts or other structures not specifically designed for pipe loadings.

Pipes laid horizontally shall have a gradual fall towards drain or scour points as appropriate.

Sufficient dismantling joints, flange adaptors or flexible couplings shall be provided to enable removal for replacement and maintenance. Removable pipe take-down fittings (gibault, straub or similar) and clean-outs shall be provided on sludge lines to facilitate cleaning and maintenance.

Where valves, flow meters, strainers and other devices mounted in the pipework are large enough to put undue strain on the pipework, these shall be supported independently of the pipes to which they connect. Particular care shall be taken to ensure that pipework thrusts are not transmitted to machinery or associated apparatus.

The high points of all pipes routes shall have provision for venting any entrapped air. The low points shall have provision for drainage, if appropriate.

All pipes shall be clean and free from dirt, mud or other foreign matter on the inside and, in the case of pipes requiring concrete surround, on the outside as well, before laying or installation. Adequate precautions shall be taken while laying or installing pipes to prevent debris entering the pipes and temporary plugs shall be provided in the open ends if work is interrupted. All pipes shall be tested for soundness prior to laying or installation and defective pipes marked and rejected.

### **12.2 SIZES**

The types and sizes to be used shall be as shown on the drawings.

### **12.3 LOCATION**

All pipes shall be carefully placed, supported and fixed at the proper lines and grades, and where possible shall be sloped to permit complete drainage. Piping runs shown on the drawings shall be followed as closely as possible, except for minor adjustments to avoid architectural and structural features.

### **12.4 UNIONS AND JOINTS**

In erecting pipelines a sufficient number of joints shall be used to allow any section or run of pipe to be dismantled without taking down adjacent runs. The provision of an adequate number of appropriate take-down fittings must be rigidly adhered to whether or not such fittings are indicated on the drawings.

### **12.5 TRENCHING**

The trench shall be cut as narrow as practicable. Additional excavation is required at each joint to provide sufficient room for the joint to be properly made and ensure that the pipe rests on the barrel and not the socket or flange.

The trench shall be excavated deeper than required (dependent on the type of ground) and then made up as required by the addition of well compacted, granular bedding material.

Where trench depths or soil conditions are such that there is a possibility of trench wall collapse then suitable means of shielding, shoring or battening of the trench walls shall be carried out.

Prior to laying pipework in a trench, a layer of sand or granular bedding material shall be placed on the subgrade and compacted to the grade of the pipe barrel to form a firm base. Sockets and flanges shall rest in hollows formed in the bedding.

Bedding and surround material shall be as shown on the drawings or described in the Pipeline Data Sheets.

## **13 TESTING OF PIPEWORK**

### **13.1 GENERAL**

All pipelines shall be tested after installation. The Contractor shall arrange to test in the presence of a representative of The Engineer. The Engineer shall be given notice of at least two clear working days of any proposed test.

The Contractor shall supply all labour, plant, equipment, instruments, materials and test water and perform any work necessary to make the tests and any work incidental thereto.

Precautions shall be taken to prevent joints from drawing during testing, and any damage resulting from the test shall be made good by and at the expense of the Contractor.

### **13.2 CLEANING**

Pipelines will not be accepted as satisfactory unless they are clean and clear of all foreign matter and objects. The Contractor shall submit details of the proposed cleaning and testing programme to The Engineer prior to any testing of the pipeline.

### **13.3 GRAVITY PIPELINES**

Gravity pipelines shall be air or water tested as specified in the relevant Pipeline Data Sheet. The section under test shall be sealed off by means of adequately supported plugs, bulkheads or flanges and pressurised. Where required, joints shall be individually tested using a joint testing device.

### **13.4 INVERTED SIPHONS**

All inverted siphon shall be water tested, unless directed otherwise by The Engineer. All inverted siphons shall be hydrostatically tested to 120% of the maximum operating pressure. The test procedure shall be as specified for pressure pipelines.

Pipelines constructed using mortar lined, reinforced concrete or vitrified clay pipes shall be filled with water and allowed to stand under pressure for a sufficient length of time to allow for absorption and the passage of air from any air pocket. During this absorption period the plugs or bulkheads and pipe joints shall be examined and any points of leakage made good before the actual testing period commences. The required head shall be regularly checked and if any drop in level has occurred it shall be made good.

### **13.5 PRESSURE PIPELINES**

Unless directed otherwise by The Engineer, all pressure pipelines shall be hydrostatically tested to the test pressure shown on the Pipeline Data Sheets. If a test pressure is not shown, then the line shall be tested to 1.5 times the maximum working pressure of the pipeline. The section under test shall be sealed off by means of adequately supported watertight plugs, bulkheads, valves or flanges and pressure in the pipeline measured using a pressure gauge located at a point remote from the sealed end of the pipe under test.

Unless required otherwise by The Engineer, uPVC and PE pipes shall be tested in accordance with the procedures specifically approved by the pipe manufacturer for the particular pipeline. Such procedures shall be submitted to The Engineer for review prior to testing.

The Contractor shall select the lengths of pipe to be individually tested taking into account the ability of valves to withstand the test pressure and the various classes of pipe. Valves shall only be used if they are specifically suited for seat closed testing at the specified test pressure.

The pressure gauge for measuring test pressures shall be a Class 1 industrial gauge, calibrated and certified, capable of being read to 10 kPa. A separate valved connection shall be available for connection of a second pressure gauge. Gauge tappings shall be on the sealing plug and independent of the make-up water line.

The pipeline to be tested shall be slowly filled with water, allowing all air to escape, and allowed to stand at the test pressure for a sufficient length of time to allow for absorption and the passage of air from any air pocket. During this absorption period the plugs or bulkheads and pipe joints shall be examined and any points of leakage made good before the actual testing period commences.

The hydraulic pressure in the pipeline shall be raised by a suitable approved pump supplied by the Contractor. The pump rate shall be throttled if necessary to ensure the pipeline is not subjected to adverse pressure surges. The pump reservoir tank shall incorporate a gauge for measuring the quantities of water added to maintain the specified test pressure in the pipeline. The gauge shall have an accuracy of  $\pm 0.10$  litres.

Alternative means of pressurising the pipeline and measuring make-up water may only be used after submission to and approval by The Engineer.

The pressure shall be maintained within five percent of the test pressure for not less than 2 hours. The pipeline test will be considered satisfactory if the leakage does not exceed 120 millilitres per hour per millimetre of diameter per 1000 metres of pipe per 100 metres head of water.

Any leaks shall be recorded, corrected and a full retest carried out by the Contractor.

On completion of the successful test, the Contractor shall submit to The Engineer, completed and signed test documentation for each section of pipe.

### **13.6 DISINFECTION AND BACTERIOLOGICAL TESTING**

All potable water pipelines and facilities shall be cleaned and disinfected in accordance with the general procedures outlined in "Guidelines for Cleaning and Disinfecting Water Mains and Reservoirs", Ministry of Works, CDP 910/A:1985.

The Contractor shall submit at least two weeks prior to disinfection, a procedure, plan and schedule for disinfection and bacteriological testing.

The Contractor shall furnish all labour, chemicals, and equipment necessary for completing the disinfection process. The use of chlorine solution is anticipated as the active disinfecting agent. An alternative disinfection agent shall only be used with the prior approval of The Engineer.

Prior to application of disinfectants, the pipelines shall be thoroughly cleansed of loose and suspended material. Pipelines shall be flushed until clear of suspended solids and colour.

Items of plant that are not tolerant to chlorine or other strong oxidants shall not be exposed to the disinfecting solutions specified herein. To the extent possible, non chlorine tolerant items shall be disinfected before installation. Non chlorine tolerant items shall be removed from service during disinfection and substitute piping installed in their place.

The Disinfecting Solutions shall be chlorine solution having a free chlorine concentration of not less than 50 ppm for a minimum of 24 hours