CHAPTER TWELVE

Specification of Pipelines

THERE IS a certain amount of common ground between this chapter and the preceding one dealing with sewers and drains. The present chapter is primarily concerned with the drafting of specification clauses covering the provision and laying of water mains and ancillary work, but most of the clauses will be equally applicable to gas mains and oil pipelines.

Once again the order of presenting the component items of the specification should follow a logical sequence and that given below has much in its favour. It must, however, be emphasised that specifications are peculiar to each job and that while the clauses that follow will form a useful guide in the drafting of pipeline specifications, they cannot possibly cover each and every item that could arise in practice. Most jobs possess some unusual items which need special mention. A schedule of the principal items in a pipeline specification follows.

(1) MATERIALS

Pipes and fittings in a variety of materials; valves for various purposes (sluice valves, air valves, washout valves and hydrants); surface boxes, etc.

(2) PIPELAYING

Excavation, unloading pipes, laying and jointing pipes, watercourse and other crossings, backfilling trenches, surface reinstatement and cutting pipes.

(3) Testing

Followed by chlorination of mains.

(4) Valve Chambers

For various purposes, possibly followed by nameplates.

Typical specification clauses covering water mains follow, but in some cases such as excavation of pipe trenches, where similar work has already been covered in Chapter Eleven, readers will be referred to this chapter for detailed specification clauses.

TYPICAL SPECIFICATION CLAUSES	EXPLANATORY NOTES

Materials

Spun iron pipes

Pipes for water mains shall be spun iron pipes complying with B.S. 1211: Centrifugally Cast (Spun) Iron Pressure Pipes for Water, Gas and Sewage, for class B pipes, tested to 120 m (400 ft) head of water and coated both inside and outside with Dr Angus Smith's solution in 3·6 m (12 ft) lengths. Joints shall be bolted gland or similar and approved flexible joints.

Spun iron pipes are made in three classes – B, C and D – tested to 120, 180 and 240 m (400, 600 and 800 ft) head of water respectively. Varying classes of pipe may be required on different parts of a job. Four pipe lengths are available – 3·6 m, 4 m, 4·9 m and 5·5 m (12 ft, 13 ft 1½ in., 16 ft and 18 ft). Flexible joints are now very popular.

Special pipes and castings

Special pipes and castings, including bends, T's and branches, shall comply with B.S. 78: Cast Iron Spigot and Socket Pipes (Vertically Cast) and Spigot and Socket Fittings, class B, tested to 120 m (400 ft) head of water and coated inside and outside with Dr

The specials will need to be of the same class as the adjoining pipes. Flanged spigots and sockets are used for connecting spigot and socket pipes to flanged valves.

A protective coating of Dr

Angus Smith's solution. Joints shall be approved flexible joints unless otherwise specified.

T-pieces for air valves shall be spigot and socket with a 150 mm (6 in.) diameter flanged branch drilled to suit the air valve. T-pieces for washouts shall be double socketed with a 100 mm (4 in.) diameter flanged branch, level with the invert and drilled for a sluice valve.

Angus Smith's solution or other approved application is needed to both internal and external surfaces of all pipes and specials to prevent rusting.

Protective coatings on iron pipes, etc.

Any places on coated iron pipes and special castings, either on internal or external surfaces, where the coating is chipped or rusted off, shall be wire-brushed and be given a substantial coating of approved rust-inhibiting composition applied hot.

Provision should be made for re-coating iron pipes and specials where the original coating has become defective.

PVC pipes

PVC pipes shall be unplasticised PVC pipes complying with B.S. 3505, type 1420 and class B with shouldered victaulic joints.

PVC pipes are being used to an increasing extent, particularly in corrosive soils. Readers are referred to Chapter XI for concrete pipes and to B.S. 486 for asbestos-cement pipes.

Steel pipes

Steel pipes shall be lap-welded coated steel pipes complying with B.S. 534, with approved flexible type joints.

Test pressures for steel pipes differ considerably between welded and seamless pipes. Pipes can be covered externally with hessian wrapping or asphalt and may be lined internally with asphalt or concrete.

Sluice valves

Sluice valves shall comply in all respects with B.S. 1218 as far as applicable and shall be class 1. The direction of closing shall be clockwise.

Main sluice valves shall be 450 mm (18 in.) diameter and shall, where directed, be complete with spur gearing and by-pass with a by-pass valve. Valves shall be double flanged and shall have flanged sockets bolted on: 450 mm (18 in.) diameter sluice valves shall be connected to pipes of larger diameter with cast iron spigot and socket taper pipes, type 1 A.

Sluice valves for pipes smaller than 450 mm (18 in.) diameter shall be double flanged with flanged spigots and sockets bolted on.

Sluice valves for washouts shall be double flanged with a flanged socket bolted to one side only.

All steel parts shall be sherardised after machining or fabrication and all cast iron parts shall be primed with one coat of red lead primer before despatch.

B.S. 1218 covers two classes of sluice valve for 180 and 240 m (600 and 800 ft) head test pressures respectively up to 300 mm (12 in.) diameter. Double socketed valves are sometimes used with spigot and socket pipes; otherwise it is necessary to use adaptors with the double flanged valves. The British Standard details the quality of cast iron, bronze and gunmetal, and the jointing and packing to be used. It also gives the dimensions of spindles, nuts, caps and handwheels. Washouts are sometimes referred to as scours.

Air valves

Double air valves shall be of 150 mm (6 in.) diameter, with screwdown valve combined, rubber balls and brass air vent orifice, supplied by an approved manufacturer.

A common practice is to give a manufacturer's catalogue reference number which provides definite standards of quality, etc.

Hydrants

Hydrants shall be of screwdown pattern to B.S. 750, type 2, with a minimum flow of 2050 lpm (450 gpm) at the hydrant outlet with an inlet pressure of

The requirements for hydrants are usually laid down by the Fire Service, using B.S. 750 as a basis.

0·18 MN/m² (25 lbf/in.²). Each hydrant or outlet bend shall be fitted with a suitable boss at the base of the outlet with a self-operating frost valve or drilled plug. The hydrants shall have 60 mm (2½ in.) diameter round thread outlets.

Surface boxes

Sluice valve boxes shall be of cast iron, with a 225 mm (9 in.) square clear opening, 150 mm (6 in.) deep, with a hinged lid, as Messrs *X* S. 86 or equivalent, with the letters S.V. legibly cast on the top of the cover.

Air valve boxes shall be of cast iron with a 375 m × 325 mm (15 in. × 13 in.) clear opening, 100 mm (4 in.) deep, perforated to facilitate air release and provide ventilation, as Messrs *X* 14 B or equivalent, with the letters A.V. legibly cast on the top of the hinged cover.

Washout valve boxes shall be as specified for sluice valves, but with the letters W.O. legibly cast on the top of the cover.

Hydrant boxes shall be of cast iron with a 375 mm × 225 mm (15 in. × 9 in.) clear opening, 150 mm (6 in.) deep, and with a hinged cover with the letters F.H. legibly cast on the top of the cover not less than 75 mm (3 in.) high.

Valve boxes and covers vary considerably in their form and dimensions. They may be manufactured from cast iron or semi-steel. Sluice-valve covers may be chained or hinged to the box.

Once again the task of the engineer is simplified by giving a manufacturer's catalogue reference. It is essential that the appropriate letters be cast on the tops of covers for ease of identification.

An alternative with sluice valve boxes is to refer to B.S. 3461, type D (225 mm × 225 mm) (9 in. × 9 in. opening) or type E (300 mm × 300 mm) (12 in. × 12 in. opening).

Valve keys, etc.

The Contractor shall supply and deliver to the Engineer's representative, three keys for 100–150 mm (4–6 in.) sluice valves, three keys for 375–450 mm (15–18 in.) valves and three pairs of lifting keys for surface boxes.

It is usual to require the Contractor to supply a number of valve keys and lifting keys for surface boxes.

PIPELAYING

Workmanship

The whole of the workmanship necessary for the execution of the works described in the specification shall be of good quality and be undertaken by workmen who are careful, capable and skilled in their various trades or callings according to the class of work upon which they are engaged.

This is a general clause covering all the pipelaying work. The main aim is to ensure that the work is satisfactorily performed by skilled and experienced workmen.

Excavation of pipe trenches

Excavate trenches to the width necessary for the size of pipe to be laid to lines shown on the Drawings or as directed by the Engineer and to the depths required to give cover to the pipes of not less than 1 m (3 ft) from finished levels. Pockets shall be formed for sockets, flanges, valves, etc., so as to give the barrel of each pipe a full bearing throughout its entire length.

Timber or otherwise support the sides of the trenches as may be necessary and keep the trenches free from water.

Detailed pipe trench excavation and trench timbering clauses are given in Chapter XI, to which the reader is referred for more detailed information. The accompanying clause is kept quite brief but embodies all the essential information.

Unloading pipes

All iron pipes and specials shall be unloaded singly from trucks and lorries. Unless hoists are used, pipes shall be unloaded by means of skids and check ropes and no pipe shall be dropped or allowed to roll unchecked. Pipes shall not be permitted to roll together and shall be wedged to prevent further movement.

In laying out pipes on the site, they shall not be allowed to impede traffic or

It is essential that proper precautions should be taken in the unloading of iron pipes and specials to prevent damage to the pipes, etc., or to their external protective coatings. Emphasis has been placed here on cast iron pipes, as many water mains are laid in this material.

The accompanying clause

to obstruct paths and accesses to private and other property. Pipes shall not be laid out in beds of ditches and every precaution shall be taken to preserve their cleanliness before laying. Should any pipe become fouled, it shall be washed out and then brushed through with an approved chlorine solution at the Contractor's expense.

also lists the basic requirements to be observed in laying out pipes on the site and the need, with water mains, to cleanse and sterilise thoroughly pipes which become fouled.

Laying and jointing pipes

The pipes shall be laid in straight lines or regular curves so as to avoid any unnecessary resistance to flow. The insides of pipes, etc., are to be cleaned thoroughly before jointing and each iron pipe shall be tested for soundness by being struck with a hammer while the pipe is suspended clear of the ground.

Each pipe shall be carefully lowered onto its prepared bed with slings and tackle. If the prepared bed is damaged or stones are dislodged into the trench, then the pipe shall be raised, and the bed made good and stones removed before the pipe is laid. Any fractured pipes shall be replaced at the Contractor's expense.

Where it is required to shorten a pipe, it shall be cut off cleanly and squarely with an approved pipe cutting machine.

When making screw gland flexible joints, the spigots shall penetrate into the sockets for the required depth, the jointing rings shall be properly fixed and the joints tightened, all in accordance with the manufacturer's instructions, to make thoroughly sound and watertight joints.

In flanged joints, the rubber jointing rings shall be properly fixed and the

Pipes are to be carefully lowered into trenches and laid to the correct lines and levels. The pipes must be kept free from mud, debris or other obstructions during laying and until completion of the Contract. It is often specified that pipes shall be laid singly and that they shall not be jointed before being lowered into the trench.

The accompanying specification clauses cover the making of screw gland flexible joints and flanged joints on iron pipes. Typical requirements for caulked lead joints are detailed in Chapter XI. The jointing of asbestos-cement pipes is also dealt with in the previous chapter. It will probably be necessary to cut pipes to accommodate some of the valves.

bolts pulled up uniformly tight, with two threads projecting beyond the nut and washer.

PVC pipes shall be laid on a 75 mm (3 in.) bed of sand and shall be jointed strictly in accordance with the manufacturer's instructions.

Sluice valves, air valves, washouts and hydrants shall be fixed in the positions shown on the Drawings or where directed by the Engineer and the joints made as specified.

Laying cable and pumping main in same trench

The Contractor shall provide and lay in the same trench as the 525 mm (21 in.) cast iron pumping main, between pumping station A and reservoir B, a rubber-insulated lead-covered single wire armoured four core cable, each conductor consisting of 3/0·7 mm (3/0·029 in.) wires.

After the pipes have been laid and tested and the trench refilled up to 150 mm (6 in.) above the pipes, the cable shall be carefully laid in one side of the trench and covered with 75 mm (3 in.) of selected fine soil and 225 mm × 115 mm × 50 mm (9 in. × 4½ in. × 2 in.) interlocking cable protection covers as manufactured by Messrs *X* or other equal and approved. Lengths of cable are to be left at each end as directed by the Engineer for future connection to the transmitting and recording apparatus and for connecting together separate lengths of cable.

The cable shall not come into contact with the main or any other cable or pipe and the Contractor shall make all

The accompanying specification clause covers the precautions to be taken when laying a pumping main and cable in the same trench, as sometimes happens in practice.

It is important to prevent contact between the pipe and cable and to protect the cable with interlocking cable protection covers or other suitable form of covering.

arrangements for carrying the cable under any other cables, pipes, services, etc., which cross the trench above the main.

Laying mains near existing pipes

Where new mains are to be laid alongside, over or under existing sewers, drains, water or gas mains, electric cables, etc., the Contractor shall take care not to disturb the existing pipes and connections to them, and any damage caused shall be made good at the Contractor's expense.

The Contractor shall make arrangements for supporting existing services and for temporarily dealing with the flow in any pipes.

In built-up areas new water mains will often have to be laid in close proximity to other services. In these circumstances it is incumbent upon the Contractor to take all reasonable precautions to avoid damage to the existing services and to undertake any temporary work that may be necessary.

Watercourse and river crossings

Water mains laid under watercourses and rivers shall be surrounded with concrete, class C, and the remainder of the trench shall be completely refilled with clay puddle. The trench through the watercourse or river banks shall also be completely refilled with clay puddle for a length of at least 2 m (6 ft) on each side of the watercourse or river.

The whole of the necessary associated work, including any temporary staging, timbering, cofferdams, piling, pumping, etc., shall be covered in the billed rates and shall be carried out in strict accordance with the requirements of any persons or bodies having jurisdiction over the watercourse or river or its banks, and to the satisfaction of the Engineer.

The Contractor shall be held fully

It is a common requirement that pipes shall be laid under the beds of watercourses and rivers to prevent obstructions to flow in times of flood. It is also advisable to protect the pipe from scour and make the banks watertight on the line of the pipe trench.

A substantial amount of temporary work is often necessary when making watercourse and river crossings.

responsible for any direct or consequential damage which may arise from his operations and shall indemnify the Employer against any claims for damage.

Backfilling and temporary reinstatement of pipe trenches

After the pipes and specials have been inspected, tested and approved by the Engineer or his representative, they shall be properly packed underneath and at the sides up to half pipe height with fine dry material selected from the excavated material, which shall be well rammed with narrow wooden rammers. The filling shall then be carried up to 300 mm (12 in.) above the sockets of pipes with selected material and well rammed, and the remainder of the trench, to within 300 mm (12 in.) of the surface of roads and 150 mm (6 in.) from other surfaces, shall be refilled in well consolidated layers not exceeding 225 mm (9 in.) thick. Mechanical rammers shall not be used within 1 m (3 ft) of pipes.

The tops of trenches shall be filled with material originally taken from the surface and set aside for subsequent reinstatement. The surfaces over trenches shall be maintained relatively level with the adjoining surfaces, with additional material added from time to time as necessary to make up deficiencies due to settlement. The Contractor shall carry out any watering or rolling that may be ordered by the Engineer.

This is an alternative clause for backfilling of pipe trenches to that given for sewer and drain trenches in Chapter XI. The principal aim in both cases is to ensure the careful ramming of fine material round the pipes to prevent interference with pipes or their joints, and the adequate consolidation of the remainder of the backfilled material in trenches to prevent excessive settlement. Constant attention to temporary reinstatement is needed to avoid the creation of dangerous conditions.

Permanent reinstatement of trench surfaces

The permanent reinstatement of trench surfaces in public highways shall

The procedure for the permanent reinstatement of

be carried out by the Highway Authority at the expense of the Contractor. The time when the permanent reinstatement is undertaken shall be entirely at the discretion of the Highway Authority.

In the case of trenches in other locations, after the trenches have become thoroughly consolidated to the satisfaction of the Engineer, they shall be permanently reinstated by the Contractor at his own expense, and to the approval of the Engineer and the owner of the land.

The Contractor shall assume full responsibility for the safety of surfaces over all excavations and shall indemnify the Employer against all damage to persons or property by reason of the condition of these surfaces until the expiration of the period of maintenance.

trench surfaces in public highways (roads, paths and verges) varies in different localities. In some cases the Highway Authority carries out the work and in other cases the Contractor is required to do it to the satisfaction of the Highway Authority. The Contractor is usually made responsible for meeting any claims arising from badly reinstated surfaces.

Testing and Sterilisation

Testing of pipes

All pipes after being jointed and while uncovered shall be tested with water at a pressure of 120 m (400 ft) head (1·2 MN/m²) (173 lbf/in.²), in the presence of the Engineer or his representative. The test head shall be calculated from the lowest part of the main under test.

For testing purposes the Contractor shall provide all necessary labour, water, hydraulic pumps with gauges, clips and blank flanges with air outlets and connections for pressure pipes. Adequate support shall be provided to all blanked ends and bends by concreting or other means.

Care shall be taken to release all air

It is essential that the pipeline should be satisfactorily tested with water to the required pressure. Testing periods vary from 30 minutes to 1 hour. The accompanying specification clauses indicate the various precautions which need to be taken.

Some Engineers add a clause to the effect that this testing will not relieve the Contractor from the responsibility of delivering up the whole of the works in a sound, clean and perfect condition, free from leakage or other

by slowly filling the mains, with air valves open, before the hydraulic pressure is applied. After the full test pressure has been obtained the pump shall be closed off and the main shall withstand the pressure for one hour. All defective pipes, fittings, joints, etc., shall be made good at the Contractor's expense, after which the testing shall be repeated.

defects under the working pressure.

Chlorination of mains

After the mains have been tested and approved by the Engineer, the water used for testing shall be emptied out and the mains shall then be thoroughly flushed with clean water and again emptied. The mains shall then be slowly filled with clean water containing chlorine solution injected by means of approved portable chlorinating equipment.

After all the mains have been charged with the sterilising solution, they shall remain filled for not less than 12 hours. Thereafter they shall be emptied again and refilled with clean water.

It is essential that all water mains should be sterilised after testing and before they become operative. The accompanying specification clause describes one method of doing this.

Valve Chambers, etc.

Sluice valve chambers

Chambers for 18 in. and larger sluice valves with spur gearing and by-pass shall have clear internal dimensions of 1·4 m × 1·25 m × 1·8 m deep (4 ft 6 in. × 4 ft 1½ in. × 6 ft 0 in. deep). The base slab shall be constructed of concrete, class B, 150 mm (6 in.) thick, supporting brick chamber walls 225 mm (9 in.) thick in English bond in class B engineering

This clause covers a chamber for a large sluice valve with a by-pass which resembles a manhole in construction.

Smaller sluice valves are specified as being housed in a protecting tube of cast iron, supporting a precast concrete

bricks, flush pointed internally, with the top courses corbelled to the reinforced concrete cover slab, 150 mm (6 in.) thick. In the end walls, double brick rings shall be turned over the pipes for the full thickness of the wall. The cover slab shall be of concrete, class B, reinforced with one layer of No. 30 expanded metal, and where the chambers are located in roads, the cover slab shall be further reinforced with two 100 mm × 75 mm × 4·5 kg (4 in. × 3 in. × 10 lb) steel joists.

Holes shall be formed in the cover slab and two surface boxes, as specified, shall be set on the slab and flaunched up with cement mortar, with the top of the covers finishing level with the finished surface of the road, path or verge in which the valve is located, and surrounded with class B concrete, 150 mm (6 in.) wide and 150 mm (6 in.) deep. Sluice valves shall be supported on hardwood wedges on 600 mm × 225 mm × 150 mm thick (2 ft 0 in. × 9 in. × 6 in. thick) precast concrete pads set on the chamber base.

Sluice valves smaller than 450 mm (18 in.) without spur gearing and bypass shall have selected fill well rammed around the valve up to the top flange. An approved cast iron protecting tube shall be supported on the valve flange and a mild steel extension spindle shall be fixed as required. A precast concrete cover slab, 750 mm × 750 mm × 150 mm thick, (2 ft 6 in. × 2 ft 6 in. × 6 in.) suitably holed, shall be set over the protecting tube and shall have a surface box, as specified, set on the slab and flaunched up with cement mortar. Surface boxes shall finish to the required levels and be

cover slab. In both cases surface boxes give access to the valve spindles.

As an alternative to the concrete surround to the surface box, a small area ($\frac{2}{3}$–$1\frac{1}{2}$ m² (yd²)) of granite or whinstone blocks set on rough concrete may be used.

With the smaller sluice valves, a common alternative adopted in practice is to build brick chambers 340 mm × 340 mm (1 ft $1\frac{1}{2}$ in. × 1 ft $1\frac{1}{2}$ in.) in the clear with 115 mm ($4\frac{1}{2}$ in.) brick walls set on a 75 mm (3 in.) concrete base. The top courses of the brickwork will be corbelled to receive the surface box, thus eliminating the need for a precast concrete cover slab. Yet another alternative is to use precast chamber rings.

Note: class B concrete would probably be a mix of 1:2:4.

surrounded with concrete as before described.

Air valve chambers

Chambers for double air valves shall have clear internal dimensions of 1·2 m ×900 mm×1·25 m deep (3 ft 9 in.× 3 ft×4 ft deep). The base slab shall be constructed in concrete, class B, 150 mm (6 in.) thick, supporting brick chamber walls 225 mm (9 in.) thick in class B engineering bricks in English bond, mainly flush pointed internally but with the bottom four courses laid dry. Double brick rings shall be turned over pipes.

The cover slab shall be of reinforced concrete, class B, 150 mm (6 in.) thick reinforced with one layer of No. 30 expanded metal. An opening shall be formed in the cover slab and a surface box, as specified, set on it, flaunched up with cement mortar and surrounded with concrete as before described.

Air valve chambers are normally constructed in a similar manner to those for sluice valves, except that it is common practice to leave a few of the bottom courses unjointed to facilitate drainage.

The size of the chamber will vary with the size of the air valve. Precast concrete chamber rings offer a suitable alternative form of construction.

Washouts

Washouts shall be constructed at the low points on the main in the approximate positions shown on the Drawings and where finally determined on the site by the Engineer. 100 mm (4 in.) double flanged sluice valves shall be fixed to double socketed T's having a '100 mm (4 in.) flanged branch level with the invert of the main. 100 mm (4 in.) cast iron pipes shall be laid from the sluice valve to discharge into a watercourse or to some other agreed point.

A chamber shall be constructed around the sluice valve in the manner previously specified.

Washouts or scours are provided at the low points on a water main to permit sediment to be flushed out of the pipes periodically. In some cases hydrants are installed for this purpose. Scour pipes must not be connected to foul sewers.

Hydrant chambers

Hydrant chambers shall be 340 mm × 340 mm (1 ft 1½ in. × 1 ft 1½ in.) internally, built on a concrete base, class B, 75 mm (3 in.) thick. The walls shall be of brick, 115 mm (4½ in.) thick, built of class B engineering bricks, flush pointed internally except for the four bottom courses which shall be laid dry. The top courses of the brickwork shall be corbelled to receive the surface box, as specified, which shall finish level with the adjoining surfaces and be surrounded with concrete as before described.

Hydrant chambers may have to be constructed to the requirements of the Fire Service. The accompanying specification clause is a typical requirement, although it is sometimes specified that weep holes, 25 mm (1 in.) in diameter, are to be provided in each wall as an additional measure to facilitate drainage.

Name plates

Cast iron name plates of approved pattern shall be fixed near all valves. The distance from the plate to the valve shall be accurately measured and shown on the plate to the nearest metre (foot), together with the type of valve. The plates shall be secured to walls of buildings, etc., with strong round-headed spikes driven into wooden plugs, or shall be bolted to suitable reinforced concrete posts 1·25 m (4 ft) long and driven 450 mm (18 in.) into the ground.

All valve name plates shall be painted with one coat of red lead primer before fixing, and after fixing with two coats of good quality lead paint with letters and figures picked out in white on a blue background. Hydrant plates will be supplied to the Contractor by the Fire Service.

All valves need to be clearly identifiable by the provision of prominent name plates or markers on the highway boundary opposite the valve. It is customary to use letters to represent the different types of valve, such as S.V. for sluice valve, A.V. for air valve, W.O. for washout and H for hydrant. Hydrant plates are normally yellow in colour, and water fittings are sometimes indicated by white letters and figures on a black background or black letters, etc., on a white background.

A common practice nowadays is to use loose figures for valve sizes and distances which fit into slots in the plates, all enamelled to avoid the need for painting.