HYDRAULIC ENGINEERING

REHABILITATION OF THE SAUDI MATERNITY HOSPITAL

KASSALA HEALTH CITADEL, SUDAN

DETAILED DESIGN

TECHNICAL SPECIFICATIONS

ampc International Health Consultants

jfa engenharia

INDEX

1. GENERAL

The standard specifications included define the standard of equipment and materials as well as the quality of the services required for the various sections of the installation. Not all the clauses in this section of the standard specification shall necessarily be applicable on the contract. Refer to the detailed or material specification for materials and equipment to be used.

The contractor shall at all times adhere to this specification unless otherwise specified on the drawings and/or in the detailed specifications.

The engineers' drawings show broad principles of design, general layouts, schematic arrangements and when read together with the specifications and the drawings of other disciplines and other contractors, they carry sufficient information to enable the contractor to determine how the installation is to be installed, operated, services and maintained.

Pipe sizes and possible positions are shown on the engineers' drawings. Fittings, valves, strainers etc must adapt to these pipe sizes.

The contractor shall submit workshop drawings, samples, catalogues, performance characteristics etc., on all equipment, except when specifically included by the engineer.

The contractor shall take in situ measurements for installation of the equipment of the system and produce complete workshop drawings for fabrication and installation. These drawings shall be co-ordinated by the contractor with all other relevant equipment and services. Dimensions given on the engineers' drawings are only a guide and should be adapted to suit the relevant measurements of the specific fittings and/or equipment.

1.1. WORK INCLUDED

A. Design Conditions

B. Water Supply Plumbing

C. Water Treatment System

D. Water Heating System

E. Irrigation Network

F. Testing, Adjusting & Balancing

G. Commissioning of Water Supply Network (Cold, Hot, Recirculation and Irrigation Systems)

2. DEFINITIONS AND ABBREVIATIONS

2.1. DEFINITIONS OF TERMS USED HEREIN:

"Provide" : to supply, install and connect up, complete and ready for safe and regular operation particular work referred to unless specifically indicated or specified otherwise.

"Install" : to erect, mount and connect complete with all related accessories.

"Supply" : to purchase, procure, acquire and deliver complete with all related accessories.

"Work" : all labour, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.

"Concealed" : embedded in masonry or other construction, installed in furred spaces within double partitions or hung ceiling, in trenches, in crawl spaces or in enclosures.

"Exposed" : not installed underground or "concealed" as defined above.

"Indicated", "Shown" or "Noted" : as indicated, shown or noted on drawings and/or specifications.

"Similar" or "Equal" : of approved manufacture, equal in materials, weight, size, design and efficiency of specified product.

"Approved", "Satisfactory", "Accepted" or "Directed" : as approved, satisfactory, accepted or directed by the Engineer

2.2. ABBREVIATIONS:

"EN" : European Norm

"BSS" : British Standard Specifications

"DN" : Nominal Diameter

"WWP" : Water Working Pressure

"WOG" : Water, Oil, Gas

"PB" : Polished Brass

"CP" : Chromium Plated

“AASHTO” : American Association of State Highway and Transportation Officials.

“AISI” : American Institute of Steel Industries

"CSIR" : Council for Scientific and Industrial Research

"GFRP" : Glass Fiber Reinforced Polyester

2.3. DIAMETERS OF PIPES

All diameters of pipes given are the nominal diameter or external diameters in accordance with the normal conventions of the materials being used.

3. CODES OF PRACTICE, LAWS AND STANDARDS

All workmanship and materials used in the execution of the works shall be of the highest class and, where not fully covered by the Specification, shall be carried out in conformity with best modern practice, as determined by the Engineer.

It shall be the contractor's responsibility to ensure that the entire installation fully complying with all relevant requirements of governmental and Local Authorities whose jurisdiction embraces the location of the Site of the Works.

All materials and equipment supplied and installed shall carry the BS mark of approval unless otherwise specified or agreed to in writing by the engineer. Where alternatives are offered, the submission is to include full details of the item together with tests and compliances with any other standards.

Wherever relevant, this Specification shall be understood to be amplified to embrace Codes of Practice and Standards promulgated by recognised authorities in the field of Plumbing and Drainage Technology and all other branches of engineering science applicable to this project.

It shall be assumed that the contractor is conversant with the abovementioned requirements. Should any requirement, bye-law, or regulation, which contradicts the requirements of this document, apply or become applicable during the erection of the installation, such requirement, bye-law, or regulation shall overrule this document and the contractor shall immediately inform the Engineer of such a contradiction. Under no circumstances shall the contractor carry out any variations to the installation in terms of such contradictions without obtaining written permission to do so from the Engineer.

It shall be the responsibility of the contractor to make the necessary arrangements with the local supply authority and to supply the labour, equipment and means to inspect, test, commission and to hand over the installation.

The Subcontractor shall supply and install all Notices and Warning signs that are required by the appropriate laws, regulations and/or by this document.

4. ORGANISATION AND STAFF CONTRACT

In addition to the site supervisor and/or foreman, the contractor shall employ as many competent and experienced persons as may be necessary for the purpose of the contract and shall be bound to remove from the contract works any person to whom the employer or his agent or the principal contractor may reasonably object by reason of any failure, neglect, incompetence or substandard work execution by or under the supervision of such person.

The duties and responsibilities of the contractor's management staff shall include but not be limited to the following:

A. Selection of equipment and components into working assemblies in conformance with the design concept in the subcontract specification.

B. Submission of equipment and installation drawings for approval in accordance with the required procedure.

C. Programming and planning of the work to fit in with the overall principal contractor's programme.

D. Attendance at routine site progress meetings and programme monitoring meetings organised by the principal contractor.

E. Conducting of all tests required.

F. Expediting of the work.

G. Directing his employees to ensure efficient, timely and safe execution of the work, and co-operation with the principal contractor and other trades to ensure such execution.

H. Attendance at meetings from time to time with the engineer in order to discuss any technical matters that need clarification.

5. CO-ORDINATION WITH OTHER TRADES

The contractor shall acquaint himself with the general arrangement of all other services and ensure that in fixing the work it will not obstruct the fixing or future maintenance of the contract works or other services.

The contractor shall also fully co-operate with other trades and take all reasonable precautions to ensure that he does not impede the progress of, or damage their work.

6. TEST AND INSPECTION PRIOR TO COMPLETION

Except where otherwise provided in the contract, the contractor shall provide all labour, materials, power, fuel, accessories and properly calibrated and certified instruments necessary to carry out such tests.

Arrangements for such tests shall be made by the contractor and he shall give at least 72 hours notice to the Engineer, in writing, of the test prior to commencement.

Whenever any installation or equipment is operated for testing or adjusting as provided for above, the contractor shall operate the entire system for as long a period as may be required to prove satisfactory performance at all times in the occupied space served by that system for up to twenty-four hours a day continuously until the system is handed over.

The contractor shall provide all labour and supervision required for such operation and the employer may assign operating personnel as observers but such observation time shall not be counted as instruction time.

After complete installation of the system all equipment shall be tested, adjusted and readjusted until it operates to the satisfaction and approval of the engineer and the client.

The contractor shall submit certificates of tests carried out to prove all equipment and also certificates to be obtained from all relevant authorities and statutory bodies etc.

7. SHOP DRAWINGS

The subcontractor shall prepare and submit copies of shop drawings for all fabricated work, working or setting out drawings, shop details and schedules to the Owner's representative for approval as stated below, and related work shall not be performed by the subcontractor until such approval has been given.

As soon as approval has been given, the subcontractor shall furnish the Owner's representative two prints of the approved shop drawings, setting out drawings and schedules. The subcontractor shall also furnish to the Works as many prints of the approved shop drawings and schedules as are required. No work shall be performed from shop drawings and/or catalogues not stamped with the Owner's representative's approval, and such stamped drawings and/or catalogues shall be kept available at the job site as evidence of such approval.

The subcontractor shall be responsible for dimensions, design of adequate connections, details for the satisfactory construction of all work and the furnishing of materials for work required by the subcontract even if not indicated on the submissions that have been approved by the Owner's representative.

The Owner's representative will check drawings for design only and approval of the drawings, schedules and catalogues by the Owner's representative shall not be construed as a complete check and shall not relieve the subcontractor of his responsibility as above stated. If the submissions differ from the requirements of the subcontract, the subcontractor shall make specific mention of each difference in his letter of transmission, with a request for substitution, together with his reasons for same, in order that, if acceptable, suitable action may be taken by the Owner's representative. Otherwise, the subcontractor will not be relieved of the responsibility for executing the work in accordance with the requirements of this subcontract.

Corrections of shop drawings by the Owner's representative are not intended to change the scope of work. Should any such corrections constitute a change of scope of work, the subcontractor shall notify the Owner's representative in writing within not more than seven calendar days of such change and shall not proceed with the fabrication until so authorised by the Owner's representative. Claims for change of scope, made after performance of the work constituting the claimed change of scope, will not be considered.

8. "AS-BUILT'" DRAWINGS AND MANUFACTURERS INFORMATION

The Subcontractor shall provide the Engineer with a complete signed transparent set of "as-built" drawings; and the Engineer shall hand the set over to the Owner after having established their correctness. The "as-built" set shall include all mechanical and electrical work.

Where possible, a transparent copy of Architects or Engineers drawings shall be used and the Subcontractor may purchase copies of the necessary transparencies from the relevant party. If "as-built" variations cannot be clearly shown thereon, then the Subcontractor shall prepare supplementary transparent drawings that will properly impart the necessary information. Manufacturer's and Subcontractor's shop drawings shall be corrected to correspond with the "as-built" drawings and copies of each shall also be furnished to the Engineer.

"As-built" drawings shall be maintained on a current basis as work progresses, and all deviations in work as actually installed accurately entered, at least once a week, on paper prints of design drawings affected, with such prints kept available at the site for the inspection of the Engineer. At the end of each month, the record for the month, properly identified by notes, shall be transferred to the original drawings by competent draughtsmen.

The contractor shall submit 3 (three) sets of comprehensive operating and maintenance manuals, to the engineer, after first obtaining his approval thereof.

The operating and maintenance manuals shall at least contain the following:

A. A description of the system together with details and specifications of all equipment and items used in the works.

B. Detailed instruction in the operation of the system.

C. Details and schedules of how and when to maintain the plant and equipment.

D. List of spares to be carried, complete with part numbers and supplier(s) of equipment.

E. Names and addresses of staff of the contractor or supplier(s) or subcontractor(s) to be contacted in case of an emergency etc.

F. Guarantees for all equipment and fittings etc.

9. QUALITY ASSURANCE SYSTEM

The contractor shall institute an approved Quality Assurance system (QA) which shall be submitted to the engineer for his approval. The records of this QA system shall be kept throughout the duration of the contract and shall be submitted to the engineer at regular intervals as required by the engineer.

10. OPERATING AND COMMISSIONING OF PLANT AND INSTALLATION

The completed system shall be put into operation after all tests and adjustments have been carried out to the satisfaction of the engineer. The contractor shall run and operate the system for a period of time as specified by the engineer and train the staff of the client to operate and maintain the system for a period as required by the engineer, which will not exceed one month.

Logging of the operation of the installations shall commence immediately upon start-up.

The contractor shall submit a full commissioning report.

11. GUARANTEE OF INSTALLATION AND EQUIPMENT

The contractor shall obtain guarantees from the manufacturer(s) and/or supplier(s) to the effect that each piece of equipment shall comply with the required performance and also that it will function as part of the complete system.

12. MAINTENANCE OF THE INSTALLATION

During the performance guarantee period, the contractor shall furnish all maintenance on the entire equipment supplied by him for the guarantee period. Maintenance shall include systematic examination and adjustment of all this equipment at least every 3 months. The contractor shall, in the course of such maintenance or on call during the maintenance period, repair or replace defective parts as required and shall use only genuine standard parts produced by the manufacturer of the original part, Renewals or repairs resulting from misuse of air wear and tear where certified as such by the engineer. Specified spares shall not be used during this period. If any spaces are used due to operational necessity and with the engineer's permission, such spares shall be replaced by the contractor.

The maintenance period shall only begin with completion of the Main Contract and when the engineer has certified the contract works as completed, unless otherwise specified.

13. COMPLETION OF CONTRACT WORKS

Completion of the contract works will only occur after the following procedure has been certified by the engineer as having been carried out in accordance with the specification.

A. Physical completion of all systems has been reported to the principal contractor by the contractor, and all defects made good. The principal contractor to satisfy himself that all work has been completed satisfactorily before reporting to the engineer.

B. Acceptance tests have successfully taken place as specified and test results have been witnessed (where required), recorded and approved by the engineer.

C. “As-built” drawings, commissioning reports and maintenance and operations manuals have been submitted to and approved by the engineer.

D. The employer’s nominated operator(s) has received instruction in the operation of the contract works by the contractor.

E. The installation or part of the installation shall only be deemed handed over when completed, tested and fully commissioned and then signed off by the Engineer.

14. WORKMANSHIP AND INSTALLATION

14.1. PIPING GENERAL

Materials and workmanship shall be the best of their respective kinds. Only new and undamaged materials shall be used in the Works. Materials to be permanently installed into the works shall not be used for any temporary purposes on site. Work shall be to the approval of the engineer and shall be executed in accordance with the relevant manufacturer’s written recommendations and instructions.

Drawings are generally diagrammatic and indicative of work to be installed. Run and arrangements of piping shall be approximately as indicated, subject to modifications as required to suit conditions at building, to avoid interference with work of other trades, or for proper, convenience and accessible location of all parts of piping systems. Due to small scale of drawings all required offsets, fittings, valves, traps, drains etc., may not be indicated. Refer to and carefully check architectural, structural, electrical and mechanical drawings and details, noting locations where walls, partitions, ceilings, beams, columns and other surfaces are furred, location of beam cuts, location of pipe shafts and conflicts with work of other trades and arrange work accordingly, providing all offsets, fittings, valves, traps, drains etc., required to meet such conditions.

Run piping in wall chases, recesses, pipe shafts and hung ceilings where same are provided. No piping shall run in floor fill unless indicated or specifically approved. Exterior utilities are diagrammatic and exact location and invert elevations shall be as indicated or required to meet existing conditions. Install piping under buildings as high as possible. Do not permanently close up, fur in or cover piping before examination and test.

Run piping as straight and direct as possible, in general forming right angles with or parallel to walls or other piping and neatly spaced with risers erected plumb and true. Install piping so that there is clearance

of at least 25mm between finished coverings (fitting hubs on uncovered piping) of piping and also between finished coverings or fitting hubs and adjoining work. Hang piping at or in ceiling from construction above, as close as possible to bottom of slabs, beams etc., maintaining maximum headroom at all times. Obtain from Engineer approved ceiling heights and install work above this height.

No piping shall be run in elevator machine rooms (except where special ducts are provided), telephone rooms containing telephone equipment, relays and terminal strips, and electric rooms and closets containing exclusively equipment such as transformers, switchgear, motor control centres, panelboards, or similar items of equipment, and in emergency generator room. Elsewhere, no piping shall be run within 1,75m laterally of such electrical apparatus as motor control panels, switchboards and electric motors, except for branch piping connecting to equipment.

All pipes are to be carefully examined for defects and flaws before installation and to be neatly fitted. They shall be run in such manner as to prevent the formation of air-locks. Automatic air vents shall be installed on all high points of the installation.

The ends of all pipes are to be cleaned, free from burrs, and rough edges, and joined together tightly. An approved pipe joint compound may be sparingly used with best quality hemp. All surplus or exposed hemp is to be thoroughly cleaned off joints before the painting of pipes.

Use reducing fittings for changes in pipe sizes. Use no bushings except with special permission.

Provide unions or flanges in connections to risers, by-passes and equipment.

All vertical pipes must be securely fixed with brackets and supports of an approved type securely fixed into the wall, not more than 40mm from the wall. These fixings must be strictly adhered to.

Pipes installed in service ducts and ceiling voids are to be perfectly plumbed and to be secured by approved brackets securely fixed at distances not exceeding the specified distances and to be not more than 40mm away from the face of the walls or soffits. Pipes inside buildings and where specified shall be chased into walls, wrapped with approved materials and properly secured and covered. Pipes must be free to move in the brackets.

During construction all pipe ends shall be kept plugged to prevent any ingress of dirt, rubble etc.

14.2. **EXPANSION JOINTS**

Make adequate provision for proper expansion and contraction of piping and for piping passing through building expansion joints. At connections of branches to water mains and risers and at connections to heaters, tanks, pumps, coolers and other equipment, provide sufficient number of elbow swings to allow for proper expansion and contraction of piping. Provide adequate elbow swings, or expansion loops, or approved type expansion joints, wherever indicated or required to allow for proper expansion and contraction of mains and risers.

Where flanged "Bellows" type expansion compensators are specified they are to be installed as detailed and in accordance with the manufacturer's recommendations.

Should these compensators be specified for installation in wood truss roof structures the Contractor is to report to the engineer, who will provide details of the location and installation requirements.

14.3. SLEEVES

Provide sleeves large enough to accommodate pipe and its covering passing entirely through floors, ceiling, walls, or partitions.

Provide PVC sleeves for pipes passing through exterior walls and footings or through floors (interior) and here extending 50mm above finished floor.

Sleeves shall extend 10mm beyond finished surface.

14.4. OFFSETS

Pipes passing through the ceilings or floors shall be offset from the wall to the front of the cornice with sufficient clearance to allow for the clear fixing of a ceiling plate. Pipes installed directly through the cornice will not be allowed. In multi-storey buildings where wall thicknesses vary, the same shall apply.

15. MATERIALS

15.1. GENERAL

All materials, etc. specified herein under a trade name, catalogue number or reference shall be either exactly as described or, in the opinion of the Engineer, of equal quality, specification and mass in all respects to those described. Written approval shall be obtained for the use of any alternative to the specification before the submission of tenders, otherwise it will be assumed that the specified materials, etc. have been allowed for in the tender.

Materials shall be new, unused, best of their respective kinds and free from defects.

16. WATER SUPPLY NETWORK

16.1. PIPINGS

16.1.1. PIPEWORK IN POLYETHYLENE HDPE PE80 PN10

16.1.1.1. GENERAL CHARACTERISTICS

A. APPEARANCE

When viewed without magnification the internal and external surfaces of pipes shall be smooth and clean and shall have no scoring, cavities, and other surface defects to an extent that would prevent conformity to this standard. The ends of the pipe shall be cut cleanly and square to the axis of the pipe.

B. COLOUR

Pipes intended for the conveyance of water for human consumption shall be black or blue. In addition, black pipes may be identified by blue stripes, according to national preference. Blue pipes or black pipes with blue stripes are intended for the conveyance of water for human consumption only. Pipes intended for other purposes, drainage and sewerage shall be black or black with brown stripes or according to national preference.

For others coextruded layer of coextruded pipes or the outer peelable layer of peelable layer pipes made conform to EN 12201-1.

NOTE 1: In some countries, pipes made from non-pigmented compound in conjunction with an external peelable layer are permitted, providing the compound conforms to the requirements of this standard. If this is allowed in a country, this should be clearly stated in the national foreword.

NOTE 2: For above ground installations, all components other than black should be protected from direct UV light.

NOTE 3: The national preference for colour should be stated in the National Foreword.

C. EFFECT ON WATER QUALITY

For compounds intended to be used for components in contact with water for human consumption, attention is drawn to the requirements of national regulations.

16.1.1.2. GEOMETRICAL CHARACTERISTICS

A. MEASUREMENTS

The dimensions of the pipe shall be measured in accordance with EN ISO 3126 and rounded to the next 0.1 mm. In the case of dispute the measurements of dimensions shall be made not less than 24 h after manufacture after being conditioned for at least 4 h at (23 ± 2) °C.

NOTE 1: Indirect measurement during the stage of production is allowed at shorter time periods providing evidence is shown of correlation.

NOTE 2: The national preference for pipe size and PN rating may be given in the National Foreword.

B. MEAN OUTSIDE DIAMETER, OUT-OF-ROUNDNESS (OVALITY) AND TOLERANCES

The mean outside diameters, dem, and the out-of-roundness (ovality) shall be in accordance with Table 1. For coiled pipes, the maximum out-of roundness shall be specified by agreement between the manufacturer and the end-user. Pipe extruded from PE 40 materials shall be limited to diameters up to and including 63 mm.

NOTE 1: In some countries pipe in PE 40 materials may be used in diameters up to and including 90 mm. If this is the case this should be stated in the National Foreword.

NOTE 2 Tolerance bands in accordance with ISO 11922-1:1997 [7] are calculated using the following formulae, as applicable.

a) Grade A: 0,009dn rounded to the next greater 0,1 mm with a minimum value of 0,3 mm and a maximum value of 10,0 mm;

b) Grade B: 0,006dn rounded up to the next greater 0,1 mm with a minimum value of 0,3 mm and a maximum value of 4,0 mm;

c) Grade N:

for diameters ≤ 75 mm: (0,008 d n + 1) mm;

for diameters ≥ 90 mm and ≤ 250 mm: (0,02 d n) mm;

for diameters > 250 mm: (0,035 d n) mm;

rounded to next greater 0,1 mm.

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter d_n	Mean outside diameter [a] $d_{em,min}$	Mean outside diameter [a] $d_{em,max}$	Maximum out-of-roundness (ovality) [b,d]
16	16	16,0	16,3	1,2
20	20	20,0	20,3	1,2
25	25	25,0	25,3	1,2
32	32	32,0	32,3	1,3
40	40	40,0	40,4	1,4
50	50	50,0	50,4	1,4
63	63	63,0	63,4	1,5
75	75	75,0	75,5	1,6
90	90	90,0	90,6	1,8
110	110	110,0	110,7	2,2
125	125	125,0	125,8	2,5
140	140	140,0	140,9	2,8
160	160	160,0	161,0	3,2
180	180	180,0	181,1	3,6
200	200	200,0	201,2	4,0
225	225	225,0	226,4	4,5
250	250	250,0	251,5	5,0
280	280	280,0	281,7	9,8
315	315	315,0	316,9	11,1
355	355	355,0	357,2	12,5
400	400	400,0	402,4	14,0
450	450	450,0	452,7	15,6
500	500	500,0	503,0	17,5
560	560	560,0	563,4	19,6
630	630	630,0	633,8	22,1
710	710	710,0	716,4	24,9
800	800	800,0	807,2	28,0
900	900	900,0	908,1	—
1 000	1 000	1 000,0	1 009,0	—
1 200	1 200	1 200,0	1 210,8 [c]	—
1 400	1 400	1 400,0	1 412,6 [c]	—
1 600	1 600	1 600,0	1 614,4 [c]	—
1 800	1 800	1 800,0	1 816,2 [c]	—
2 000	2 000	2 000,0	2 018,0 [c]	—
2 250	2 250	2 250,0	2270,3 [c]	—
2 500	2 500	2 500,0	2522,5 [c]	—

[a] In accordance with ISO 11922-1:1997 [7] grade B for sizes ≤ 630 and grade A for sizes > 710 except for dn 40 and 50.
[b] In accordance with ISO 11922-1:1997 [7] grade N for sizes ≤ 630 and is measured at the point of manufacture.
[c] Tolerance calculated as 0,009dn and does not conform to grade A in ISO 11922-1:1997 [7].
[d] For straight lengths of pipe with diameters ≥ 900 the maximum out-of-roundness shall be agreed between the manufacturer and the purchaser.

Table 1 – Mean outsider diameter and out-of-roundness

C. WALL THICKNESSES AND THEIR TOLERANCES

The wall thickness shall be in accordance with Table 2 & 3.

Dimensions in millimetres

	Pipe series											
	SDR 6 S 2,5		SDR 7,4 S 3,2		SDR 9 S 4		SDR 11 S 5		SDR 13,6 S 6,3		SDR 17 S 8	
	Nominal pressure, PN [a] in bar											
PE 40	—		PN 10		—		PN 6		—		PN 4	
PE 80	PN 25		PN 20		PN 16		PN 12,5		PN 10		PN 8	
PE 100	—		PN 25		PN 20		PN 16		PN 12,5		PN 10	
Nom. size DN/OD	Wall thicknesses [b]											
	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
16	3,0 [c]	3,4	2,3 [c]	2,7	2,0 [c]	2,3	-	-	-	-	-	-
20	3,4	3,9	3,0 [c]	3,4	2,3	2,7	2,0 [c]	2,3	-	-	-	-
25	4,2	4,8	3,5	4,0	3,0 [c]	3,4	2,3	2,7	2,0 [c]	2,3	-	-
32	5,4	6,1	4,4	5,0	3,6	4,1	3,0 [c]	3,4	2,4	2,8	2,0 [c]	2,3
40	6,7	7,5	5,5	6,2	4,5	5,1	3,7	4,2	3,0	3,5	2,4	2,8
50	8,3	9,3	6,9	7,7	5,6	6,3	4,6	5,2	3,7	4,2	3,0	3,4
63	10,5	11,7	8,6	9,6	7,1	8,0	5,8	6,5	4,7	5,3	3,8	4,3
75	12,5	13,9	10,3	11,5	8,4	9,4	6,8	7,6	5,6	6,3	4,5	5,1
90	15,0	16,7	12,3	13,7	10,1	11,3	8,2	9,2	6,7	7,5	5,4	6,1
110	18,3	20,3	15,1	16,8	12,3	13,7	10,0	11,1	8,1	9,1	6,6	7,4
125	20,8	23,0	17,1	19,0	14,0	15,6	11,4	12,7	9,2	10,3	7,4	8,3
140	23,3	25,8	19,2	21,3	15,7	17,4	12,7	14,1	10,3	11,5	8,3	9,3
160	26,6	29,4	21,9	24,2	17,9	19,8	14,6	16,2	11,8	13,1	9,5	10,6
180	29,9	33,0	24,6	27,2	20,1	22,3	16,4	18,2	13,3	14,8	10,7	11,9
200	33,2	36,7	27,4	30,3	22,4	24,8	18,2	20,2	14,7	16,3	11,9	13,2
225	37,4	41,3	30,8	34,0	25,2	27,9	20,5	22,7	16,6	18,4	13,4	14,9
250	41,5	45,8	34,2	37,8	27,9	30,8	22,7	25,1	18,4	20,4	14,8	16,4
280	46,5	51,3	38,3	42,3	31,3	34,6	25,4	28,1	20,6	22,8	16,6	18,4
315	52,3	57,7	43,1	47,6	35,2	38,9	28,6	31,6	23,2	25,7	18,7	20,7
355	59,0	65,0	48,5	53,5	39,7	43,8	32,2	35,6	26,1	28,9	21,1	23,4
400	-	-	54,7	60,3	44,7	49,3	36,3	40,1	29,4	32,5	23,7	26,2
450	-	-	61,5	67,8	50,3	55,5	40,9	45,1	33,1	36,6	26,7	29,5
500	-	-	-	-	55,8	61,5	45,4	50,1	36,8	40,6	29,7	32,8
560	-	-	-	-	62,5	68,9	50,8	56,0	41,2	45,5	33,2	36,7
630	-	-	-	-	70,3	77,5	57,2	63,1	46,3	51,1	37,4	41,3
710	-	-	-	-	79,3	87,4	64,5	71,1	52,2	57,6	42,1	46,5
800	-	-	-	-	89,3	98,4	72,6	80,0	58,8	64,8	47,4	52,3
900	-	-	-	-	-	-	81,7	90,0	66,1	72,9	53,3	58,8
1000	-	-	-	-	-	-	90,8	100,0	73,4	80,9	59,3	65,4
1200	-	-	-	-	-	-	-	-	88,2	97,2	71,1	78,4
1400	-	-	-	-	-	-	-	-	102,9	113,3	83,0	91,5
1600	-	-	-	-	-	-	-	-	117,5	129,4	94,84	104,4
1800	-	-	-	-	-	-	-	-	-	-	106,6	117,4
2000	-	-	-	-	-	-	-	-	-	-	118,4	130,4

[a] PN values are based on $C = 1,25$.

[b] Tolerances in accordance with grade V of ISO 11922-1:1997 [7].

[c] The calculated value of e_{min} (ISO 4065:1996 [5]) is rounded up to the nearest value of either 2,0, 2,3 or 3,0. This is to satisfy certain national requirements.

Table 2 - Wall thickness (PART 1)

Table 2 — Wall thicknesses *(continued)*

Dimensions in millimetres

	Pipe series							
	SDR 21 S 10		SDR26 S 12,5		SDR 33 S 16		SDR 41 S 20	
Nominal pressure, PN [a] in bar								
PE 40	—		—		—		—	
PE 80	PN 6		PN 5		PN 4		PN 3,2	
PE 100	PN 8		PN 6		PN 5		PN 4	
Nom. size DN/OD	**Wall thicknesses [b]**							
	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
16	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-
40	2,0 [c]	2,3	-	-	-	-	-	-
50	2,4	2,8	2,0	2,3	-	-	-	-
63	3,0	3,4	2,5	2,9	-	-	-	-
75	3,6	4,1	2,9	3,3	-	-	-	-
90	4,3	4,9	3,5	4,0	-	-	-	-
110	5,3	6,0	4,2	4,8	-	-	-	-
125	6,0	6,7	4,8	5,4	-	-	-	-
140	6,7	7,5	5,4	6,1	-	-	-	-
160	7,7	8,6	6,2	7,0	-	-	-	-
180	8,6	9,6	6,9	7,7	-	-	-	-
200	9,6	10,7	7,7	8,6	-	-	-	-
225	10,8	12,0	8,6	9,6	-	-	-	-
250	11,9	13,2	9,6	10,7	-	-	-	-
280	13,4	14,9	10,7	11,9	-	-	-	-
315	15,0	16,6	12,1	13,5	9,7	10,8	7,7	8,6
355	16,9	18,7	13,6	15,1	10,9	12,1	8,7	9,7
400	19,1	21,2	15,3	17,0	12,3	13,7	9,8	10,9
450	21,5	23,8	17,2	19,1	13,8	15,3	11,0	12,2
500	23,9	26,4	19,1	21,2	15,3	17,0	12,3	13,7
560	26,7	29,5	21,4	23,7	17,2	19,1	13,7	15,2
630	30,0	33,1	24,1	26,7	19,3	21,4	15,4	17,1
710	33,9	37,4	27,2	30,1	21,8	24,1	17,4	19,3
800	38,1	42,1	30,6	33,8	24,5	27,1	19,6	21,7
900	42,9	47,3	34,4	38,3	27,6	30,5	22,0	24,3
1000	47,7	52,6	38,2	42,2	30,6	33,5	24,5	27,1
1200	57,2	63,1	45,9	50,6	36,7	40,5	29,4	32,5
1400	66,7	73,5	53,5	59,0	42,9	47,3	34,3	37,9
1600	76,2	84,0	61,2	67,5	49,0	54,0	39,2	43,3
1800	85,8	94,5	68,8	75,8	55,1	60,8	44,0	48,6
2000	95,3	105,0	76,4	84,2	61,2	67,5	48,9	53,9
2250	107,2	118,1	86,0	94,8	70,0	77,2	55,0	60,7
2500	119,1	131,2	95,6	105,2	77,7	85,6	61,2	67,5

[a] PN values are based on $C = 1{,}25$.
[b] Tolerances in accordance with grade V of ISO 11922-1:1997 [7].
[c] The calculated value of e_{min} (ISO 4065:1996 [5]) is rounded up to the nearest value of either 2,0, 2,3 or 3,0. This is to satisfy certain national requirements.

Table 3 - Wall thickness (PART 2)

NOTE 1: Grade V tolerances are in accordance with ISO 11922-1:1997 [7] and calculated from the following formula: (0,1emin + 0,1) mm, rounded to the next 0,1 mm higher.

For certain applications en > 30 mm tolerance grade T in accordance with ISO 11922-1:1997 [7] can be used and the tolerance calculated from the following formula: 0,15emin, rounded to next higher 0,1 mm.

D. COILED PIPE

During production the pipe shall be coiled such that localized deformation, e.g. buckling and kinking, is prevented.

The minimum internal diameter of the coil shall be not less than 18dn.

NOTE: If smaller coil diameters are necessary, they shall be agreed between the manufacturer and the end user.

E. PIPE LENGTHS

No requirements have been set concerning particular lengths of coiled or straight pipe or the tolerance thereon; hence it is necessary for lengths of pipe to be supplied by agreement between purchaser and manufacturer.

16.1.1.3. MECHANICAL CHARACTERISTICS

A. CONDITIONING

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C before testing in accordance with Table 4.

B. REQUIREMENTS

When tested in accordance with the test method as specified in

using the indicated parameters, the pipe shall have mechanical characteristics conforming to the requirements given in Table 4.

Characteristics	Requirements	Test parameters		Test method
		Parameters	Value	
Hydrostatic strength at 20 °C	No failure during test period of any test pieces	End caps Conditioning period Number of test pieces [b] Type of test Test temperature Test period Circumferential (hoop) stress for: PE 40 PE 80 PE 100	Type A [a] Shall conform to EN ISO 1167-1 3 Water-in-water 20 °C 100 h 7,0 MPa 10,0 MPa 12,0 MPa	EN ISO 1167-1 and EN ISO 1167-2
Hydrostatic strength at 80 °C	No failure during test period of any test pieces	End caps Conditioning period Number of test pieces [b] Type of test Test temperature Test period Circumferential (hoop) stress for: PE 40 PE 80 PE 100	Type A a Shall conform to EN ISO 1167-1 3 Water-in-water 80 °C 165 h [c] 2,5 MPa 4,5 MPa 5,4 MPa	EN ISO 1167-1 and EN ISO 1167-2
Hydrostatic strength at 80 °C	No failure during test period of any test pieces	End caps Conditioning period Number of test pieces [b] Type of test Test temperature Test period Circumferential (hoop) stress for: PE 40 PE 80 PE 100	Type A a Shall conform to EN ISO 1167-1 3 Water-in-water 80 °C 1000 h 2,0 MPa 4,0 MPa 5,0 MPa	EN ISO 1167-1 and EN ISO 1167-2
Elongation at break for $e_n \leq$ 5 mm	≥ 350 %	Test piece shape Speed of test Number of test pieces [b]	Type 2 100 mm/min Shall conform to EN ISO 6259-1	EN ISO 6259-1 and ISO 6259-3:1997
Elongation at break for 5 mm < $e_n \leq$ 12 mm	≥ 350 %	Test piece shape Speed of test Number of test pieces [b]	Type 1 [d] 50 mm/min Shall conform to EN ISO 6259-1	EN ISO 6259-1 and ISO 6259-3:1997
Elongation at break for $e_n >$ 12 mm	≥ 350 %	Test piece shape Speed of test Number of test pieces [b]	Type 1 [d] 25 mm/min Shall conform to EN ISO 6259-1:	EN ISO 6259-1 and ISO 6259-3:1997
		OR		
		Test piece shape Speed of test Number of test pieces [b]	Type 3 [d] 10 mm/min Shall conform to EN ISO 6259-1	

[a] Type B end caps may be used for batch release tests for diameters ≥ 500 mm.
[b] The number of test pieces given indicate the quantity required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan (for guidance see CEN/TS 12201-7 [3]).
[c] Premature ductile failures are not taken into account. For retest procedure see 7.3.
[d] Machined type 2 test pieces may be used for pipe wall thicknesses ≤ 25 mm. The test may be terminated when the requirement is met, without continuing until the rupture of the test piece.

Table 4 - Mechanical characteristics

C. RETEST IN CASE OF FAILURE AT 80 °C

A fracture in a brittle mode in less than 165 h shall constitute a failure; however if a sample in the 165 h test fails in a ductile mode in less than 165 h, a retest shall be performed at a selected lower stress in order to achieve the minimum required time for the selected stress obtained from the line through the stress/time points given in Table 5.

PE 40		PE 80		PE 100	
Stress MPa	Test period h	Stress MPa	Test period h	Stress MPa	Test period h
2,5	165	4,5	165	5,4	165
2,4	230	4,4	233	5,3	256
2,3	323	4,3	331	5,2	399
2,2	463	4,2	474	5,1	629
2,1	675	4,1	685	5,0	1 000
2,0	1 000	4,0	1 000		

Table 5 - Test parameters for the retest of the hydrostatic strength at 80 ºC

16.1.2. PIPE STIFFNESS FOR VACUUM SEWER SYSTEMS

Pipes for use in vacuum sewer systems shall have an initial ring stiffness Scalc ≥ 4. See Annex D from EN 12201-2:2011

16.1.3. PHYSICAL CHARACTERISTICS

A. CONDITIONING

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C before testing in accordance with Table 6.

B. REQUIREMENTS

When tested in accordance with the test methods as specified in Table 6 using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in Table 6.

Characteristics	Requirements	Test parameters		Test method
Melt mass-flow rate MFR for PE 40	After processing maximum deviation of ± 20 % of the value measured on the batch used to manufacture the pipe	Load Test temperature Time Number of test pieces [a]	2,16 kg 190 °C 10 min Shall conform to EN ISO 1133	EN ISO 1133
Melt mass-flow rate MFR for PE 80, and PE 100	After processing maximum deviation of ± 20 % of the value measured on the batch used to manufacture the pipe	Load Test temperature Time Number of test pieces [a]	5,0 kg 190 °C 10 min Shall conform to EN ISO 1133	EN ISO 1133
Oxidation induction time	≥ 20 min	Test temperature Test environment Specimen weight Number of test pieces [a,b]	200 °C [c] Oxygen (15±2) mg 3	ISO 11357-6
Longitudinal reversion Wall thickness ≤ 16 mm	≤ 3 % Original appearance of the pipe shall remain.	Test temperature Length of test piece Immersion time Test method Number of test pieces [a]	110 °C 200 mm Shall conform to EN ISO 2505 Free Shall conform to EN ISO 2505	EN ISO 2505
Effect on water quality [d]	National regulations apply.			

[a] The number of test pieces given indicate the quantity required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan (for guidance see CEN/TS 12201-7 [3]).
[b] Samples to be taken from the outer and inner wall surfaces.
[c] Test may be carried out as an indirect test at 210 °C or 220 °C providing clear correlation has been established. In cases of dispute the reference temperature shall be 200 °C.
[d] Test methods, parameters and requirements for all properties are under preparation. Until these European Standards are published National Regulations apply (see Introduction).

Table 6 - Physical characteristics

16.1.3.1. CHEMICAL CHARACTERISTICS OF PIPES IN CONTACT WITH CHEMICALS

If, for a particular installation, it is necessary to evaluate the chemical resistance of the pipe, then the pipe shall be classified in accordance with ISO 4433-1:1997 and ISO 4433-2:1997.

NOTE Guidance for the resistance of polyethylene pipes to chemicals is given in ISO/TR 10358:1993 [6].

16.1.3.2. PERFORMANCE REQUIREMENTS

When pipes conforming to this standard are assembled to each other or to components conforming to other Parts of EN 12201, the joints shall conform to the requirements of EN 12201-5.

16.1.3.3. MARKING

A. GENERAL

All pipes shall be permanently and legibly marked in such a way that the marking does not initiate cracks or other types of failure and that normal storage, weathering, handling, installation and use shall not affect the legibility of the marking.

If printing is used, the color of the printed information shall differ from the basic color of the product.

The marking shall be such that it is legible without magnification.

NOTE The manufacturer is not responsible for marking becoming illegible due to actions caused during installation and use such as painting, scratching, covering of the components or by use of detergents, etc. on the components unless agreed or specified by the manufacturer.

B. MINIMUM REQUIRED MARKING OF PIPES

The minimum required marking shall conform to Table 7, with the frequency of marking being not less than once per meter.

The pipes shall be marked for the intended use by using the appropriate codes in accordance with CEN/TR 15438. For example:

- W for pipes intended for the conveyance of water for human consumption;
- P for pipes intended for the sewer and drainage under pressure;
- W/P for both of the above.

Aspects	Marking or symbol
Standard Number	EN 12201
Manufacturer's name or trademark	Name or symbol
Dimensions ($d_n \times e_n$)	e.g. 110 × 10
SDR series	e.g. SDR 11
Intended use	e.g. W, P, or W/P
Material and designation	e.g. PE 100
Pressure rating in bars	e.g. PN 16
Manufacturer's information	e.g. 1009 [a]
Type of pipe if applicable	eg Co-extruded or Peelable Layer
[a] In clear figures or in code providing traceability to production period within year and month and if the manufacturer is producing at different sites, the production site.	

Table 7 - Minimum required marking

The length of coiled pipes is permitted to be indicated on the coil; the remaining length of pipe on drums or coils is permitted to be indicated on the pipe.

Coextruded and peelable pipe shall be marked accordingly, clearly identifying this type of pipe, including any specific instructions related to these types of pipe.

16.1.4. PP-R PIPING

16.1.4.1. GENERAL

The water distribution plumbing will be made in PP-R (Polypropylene random copolymer). It's a non-toxic material. This type of material has a very low chemical affinity with acidic and base substances like cement or lime, that usually are present in construction sites. This makes it particularly good in conditions in distributing very aggressive waters.

It also has a very low electrical conductivity making it very resistant to perforations due to electrical discharges that can occasionally occur. With a low thermal conductivity it guaranties a small loss of heat by the water it conducts, with an increase on energy savings since the time needed to transforms the water on ice is bigger. This provides a drastic reduction on the condensation effect on the pipe surface.

The structure of the pipes by being uniform and compact provides a smooth interior surface reducing the linear head loss inside the pipes and eventual obstruction by tanks. It also has a big acoustic isolation, decreasing the noise made by the hydraulic circuits, and upgrading the comfort.

By being light they can be easily transported and installed.

The Table 8 gives us the dimensional characteristics of the PP-R pipes.

PP-R PIPE		
	PN 20	
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)
16	10,6	2,7
20	13,2	3,4
25	16,6	4,2
32	21,2	5,4
40	26,6	6,7
50	33,2	8,4
63	42,0	10,5
75	50,0	12,5
90	60,0	15,0
110	74,0	18,0
125	-	-

Table 8 - Dimensional characteristics of PP-R pipes

16.1.4.2. PP-R PIPING INSTALLATION

The installation of this kind of pipe needs to obey the following steps:

- Cut the pipe by using a scissor proper to the job, and after clean all the parts that will be used on the thermal fusion.

- Heat the polyfuser, already equipped with the male/female matrixes, with the correspondent diameter to the pipe in question. Then insert the pipe in the respective matrix, and wait for the fusion by respecting the time for the process and indicated on the Table 9.

Diameter (mm)	Heating time (sec.)	Working Time (sec)	Cooling Time (sec)
16	5	4	2
20	5	4	2
25	7	4	2
32	8	6	4
40	12	6	4
50	18	6	4
63	25	8	6
75	30	8	8
90	40	8	8
110	50	10	8
125	60	10	8

Table 9 - Process times for fusion of PP-R piping

- After the cooling time, insert the pipe by pushing it against the accessory. Little adjustments are possible to be made on the first few instances right after the thermal fusion.

As precautionary measures to be taken we have the following:

- The pipes should never be installed on places exposed to U.V. rays, because this exposure will induce the ageing of the material, hence leading to the loss of the physical and the chemical characteristics.

- We must have the upmost careful when transporting and handling the pipes so not to damaged them. In low temperature locations the precautions should be even higher.

- If these pipes are to be installed in locations where the temperature can be below 0ª C we must ensure that the water inside can never drop the freezing point.

- The pipes should not be in direct contact with materials that damage it. This precaution should be taken when installing and also when storing it.

- When the accessories utilized are threaded ones we must use Teflon tape to protect it.

16.1.4.3. PP-R PIPING TESTING

The PP-R pipe must be subjected to a pressure test. This is due to the expansions of the pipe when submitted to pressure that can affect the test result. The result can also be affected by temperature differences. Thus the test should be kept always at constant temperature and be performed 1.5 times of the operating pressure. Using cold water, the pipe system should be filled slowly and bled completely using calibrated measuring instruments that indicate pressure changes of 0,1 bar wherever possible. Measurements should be taken at the lowest point of the pipe system.

Where pipes and fittings have been welded, the pressure test should not be performed before two hours have elapsed after the last welding operation. The pressure test consists of two stages: For the first stage, a test pressure equal to the permissible working pressure plus 5 bars should be applied twice within 30 minutes at 10 minute intervals. Then the pressure should be checked. In case more than a 0.6 bar drop occurs over a period of 30 minutes at a rate of 0.1 bar/min, then a leakage is reported. The second stage should follow the first stage without interval and should last minimum of 2 hours. Then the Pressure drop should be checked. If the pressure drop is more than 0,2 bars and the pipe work shows signs of leakage, then the network should be corrected and the test must be repeated.

16.2. VALVES FOR DOMESTIC WATER INSTALLATIONS

16.2.1. VALVES FOR PPR PIPES

Except where otherwise specificated, the valves to employ are to be in accordance with:

- Up to DN32 the valves shall be of the same material and brand as the pipes and are to be installed accordingly with the manufacturer instructions.
- For DN40 and upper the valves shall be in stamped brass and respect the composition described in the Table 10:

Components	Materials
Body	UNI EN 12165 CW617N
End connection	UNI EN 12165 CW617N
Ball	UNI EN 12165 CW617N
Ball seal	P.T.F.E
Stem	UNI EN 12164 CW614N
Rod seal O-Ring	NBR 70 Sh A (ASTM D 2240)
Alu handle	AL, painted

Components	Materials
Plastified steel handle	Steel ZN, plastic-covered
Butterfly handle	AL, painted
Screw	Zinc-plated Steel
Nut	Zinc-plated Steel
Nut*	UNI EN 12165 CW617N
Tang*	UNI EN 12165 CW617N
O-ring on pipe union*	NBR 70 Sh A (ASTM D 2240)

* With Pipe union

Table 10 - Stamped brass valves composition

16.2.2. GATE VALVES ABOVE GROUND FOR TEMPERATURES UP TO 100ºC (UP TO DN50)

The gate valves shall be of the dezincified brass type with brass gate, brass body, non-rising spindle and BSP threaded socket ends. The valve shall conform to BS 1952 or other relevant norm.

The valve shall be able to withstand a working pressure of 1600 kPa.

The valve shall be equipped with a hand wheel to close in a clockwise direction.

The valve shall be installed in an upright position or sideways to a maximum of 90º from upright and shall be so placed with other fittings to be removable without cutting the pipework.

16.2.3. NON-RETURN VALVES

16.2.3.1. NON-RETURN VALVES FOR COLD WATER (DN 65 AND LARGER)

The non-return valve shall be of the spring loaded dual flap plate type fitted between two flanges. (Wafer)

The non-return valve shall be equipped with a cast iron body, aluminum bronze plates, stainless steel springs and neoprene seals on the plates. The valves shall be suitable for a working pressure of 1600 kPa.

16.2.3.2. NON-RETURN VALVES FOR HOT WATER (UP TO DN 100) AND COLD WATER (UP TO DN 50)

The non-return valve shall be of the spring loaded piston type, with bronze or dezincified brass body, stainless steel spring and bronze disc with neoprene seal fitted with BSP threaded socket ends. The valve shall be suitable for a working pressure of 1600 kPa and a temperature of up to 90ºC. All valves shall be installed so as to be removable without extensive pipework removal.

16.2.4. VALVE TAG AND CHARTS

Provide on all valves and controls, identifying numbered metal tags, including letter to indicate system, fastened by heavy brass hooks or chain.

Tags: Not less than 50mm square, 1.25mm thick, aluminum with stamped numbers and letters filled in with black paint.

Provide separate diagrammatic charts showing essential features of each system with all valves and control lettered and numbered to correspond to designation on metal tags. Also furnish list of all valves and controls giving location and function.

Charts and lists: Type, size and character as approved. Mount in glazed metal frames permanently fastened in locations as approved by the consulting engineer.

16.3. STRAINERS

This strainer shall be of the Y-type with cast iron body, stainless steel or bronze strainer element and shall be equipped with flanged ends to relevant norms. The hole sizes of the strainer element shall be maximum 1mm Ø and be removable without dismantling of pipework. The strainer shall be suitable for a temperature of up to 90ºC at a 1600 kPa pressure rating and installed with the element facing downwards or a maximum of 45º sideways.

16.4. AIR RELEASE VALVES AND VACUUM BREAKERS

16.4.1. DOUBLE ORIFICE DOUBLE ACTING AIR RELEASE VALVES

Automatic air vent valve. 1/2”M threaded connection. Brass and chrome plated versions. Brass body and cover, PP float, brass obturator stem, EPDM O-Rings. Medium: water and glycol solutions. Maximum percentage of glycol 30%. Maximum working pressure 10 bar, maximum discharge pressure 2.5 bar. Maximum working temperature 120°C. Complete with hygroscopic safety cap in all fitting locations which cannot be inspected.

16.5. PRESSURE REDUCING VALVES (PRV)

16.5.1. SMALL PRESSURE REDUCING VALVES (DN 15 – DN 50)

The pressure reducing valve shall be equipped with brass body, balanced single seat and integral strainer. The valve shall be able to handle a wide range of incoming pressure while the downstream pressure stays constant with maximum inlet pressure of 1000 kPa and a maximum water temperature of 40ºC.

The valve shall be equipped with BSP male threaded brass union couplings.

16.6. **WATER METERS**

The meter shall be of the volumetric rotary piston type with brass body equipped with union couplers. The meter shall have an accuracy of not less than 90%. The meter must be able to operate up to a water pressure of 1000 kPa at a water temperature of 40ºC.

The meters shall be installed with leading and trailing lengths of pipes to the manufacturer's specifications.

16.7. **PUMPS**

The pumps shall be of the capacity and head as indicated in the project and in accordance with the technical files provided.

16.8. **WATER TREATMENT PLANT**

The water treatment plant shall be installed in accordance with the treatment needed to ensure the water characteristics after the evaluation of the actual water supply characteristics.

At minimum should ensure:

Elimination of suspended solids, matter, organic, turbidity and pathogenic microorganisms.

• Medium quality water treatment, with the following water characteristics:

- Concentration of suspended solids and turbidity: TSS <200 mg / l; Turbidity <20 NTU
- Concentration of dissolved solids: TDS <1500mg / l
- No presence of contaminants in concentration exceeding the allowable limits.

Should be considered a compact skid mounted treatment system, taking as referece SALHER PUR-F, with the following characteristics:

- Compact equipment for water purification, complying with R.D. 140/2003 and recommendations of the World Health Organization (WHO).
- High performance filters, in PRFV (Fiberglass Reinforced Polyester), with automatic cleaning system, equipped with flint and anthracite filling material, with selected granulometries according to the applications.
- Filter rings with different degrees of filtration, depending on the applications.
- System for supplying the filtration treatment consisting of centrifugal pumps, equipped with a flow regulation and control system, level regulators, etc.

- Disinfection and water quality control system in the tank consisting of a self-priming recirculation pump, equipped with an automatic chlorination station.
- Electrical panel for control and command of the treatment.
- Set of accessories consisting of interconnecting pipes between equipment, valves, sampling sockets, regulation and control systems, etc.
- FRP-SKID STRUCTURE with hydraulic and electrical interconnection of the different elements.

16.9. DOMESTIC WATER SUPPLY SYSTEM

16.9.1. GENERAL

Provide complete domestic hot and cold water supply systems, including connection to supply authority, hot water heating equipment and required hot and cold water connection to plumbing fixtures, kitchen and other equipment requiring same all as indicated.

Run piping free of traps wherever possible, and grade and valve for complete control and drainage of system with drain cocks at low points and at base of risers.

Provide, when required, on main water branches to dishwashers, domestic washing machines and where noted, properly sized shock absorbers.

16.9.2. PREVENTION OF WATER CONTAMINATION

Wherever possible, provide over-rim water supplies to plumbing fixtures and equipment. Provide necessary below-rim connections, water closet and urinal flush valves, hose bibs and hose connections with approved vacuum breakers and/or check valves as noted or required.

Kitchen or other equipment supplied under other divisions of work and/or by owner, and having below-rim water supply connections, may not arrive on job in code approved condition, in which case Subcontractor shall provide missing vacuum breakers and/or check valves, or re-locate same to code approved positions.

16.9.3. INSULATION

The Subcontractor shall provide insulation as specified herein on all water pipes and hot water heaters.

The Contractor shall provide a suitable storage area for all insulation on site prior to fitment. The Contractor will be liable for replacement of same due to damage, as determined by the Engineer.

Pipes shall be insulated with “Armaflex” self-adhesive pipe insulation sheets with 25 mm thickness and 0.033 W/m.K (at 0ºC). This insulation shall be used with pipe systems where the maximum temperature is 85ºC.

All bends and T-pieces shall be cut in 45º metre box to form a neat joint. All joints shall be glued together with a contact adhesive as supplied by the manufacturer.

16.9.4. PRESSURE GAUGES

Provide a pressure gauge on each water service at meter location, on discharge headers, on house and hydropneumatic tank pumps, on inlet and outlet of each master pressure reducing valve assembly, and where noted.

Pressure gauges shall be calibrated in bars or mbar and shall be prepared to withstand the pressure range of the network.

16.9.5. TESTS

Test piping and prove tight as specified and/or required by Authorities having jurisdiction; in presence of Engineer and said Authorities, who shall be given 48 hours notice in advance before tests are made. Make preliminary tests and prove satisfactory before requesting witnessing of final tests. Make tests in stages if so ordered by the Engineer to facilitate work of others. Repair defects disclosed by tests or if required by Engineer, replace defective work.

Subcontractor shall be required to attend with the Engineer and give all assistance required and provide such tools, materials, implements and instruments as are necessary for tests. The Engineer reserves the right to call for such additional tests, such as dynamic tests, as he may consider necessary.

Subcontractor shall be responsible for work of other Trades disturbed or damaged by tests or repair and replacement of work and shall cause work so disturbed or damaged to be restored to its original condition.

The pipe installation shall be hydraulically pressure tested by means of a suitable manually operated or mechanically driven pressure pump.

A pressure of at least 1.5 times the working pressure of the class rating of pipes, or fittings, with a minimum of 9 (nine) bar, shall be applied for a period of time specified in the specifications or as recommended by the manufacturers.

Tests should not be performed against closed valves.

Leakage which occurs shall be measured and calculated and checked against the allowable losses.

If the completed section of pipe complies with all specifications and passes the tests and inspection, it could be approved and the contractor may be instructed to backfill the open sections of trench at the joints and connections, where applicable.

The contractor shall then proceed to build all the valve chambers, inspection chambers etc.

16.9.6. STERILISING OF WATER PIPES

Before any pipeline is taken into use, it shall be sterilised over its complete length and including the fittings. The pipe shall be filled with potable water chlorinated to a concentration of 15 mg of chlorine per litre of water which shall remain in contact with the inner surface of the pipeline for a period of not less than 24 hours. The pipeline shall be filled for sterilising in such a manner that no chlorine shock is created or air is trapped in the pipeline.

At least 14 days prior to the commencement of sterilising the contractor shall submit the full details of the proposed method of sterilising the pipeline to the engineer for his approval.

The contractor shall provide all necessary materials, tools, equipment and labour necessary to sterilise the pipeline. After sterilising the pipeline the contractor shall, at no extra cost, empty the pipeline and dispose of the water in a manner approved by the engineer.

The contractor may use the following products as a source of chlorine:

After sterilisation, an approved water quality test to a minimum number of 10% of the total water points, randomly selected, evenly spread and marked on drawings, shall be carried out. These tests shall include a full bacteriological test as per the relevant norm and the results shall be handed to the engineer for approval. Each abortive test shall be for the contractor's account.

After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material which shall provide a dosage of not less than 50 parts per million and shall be introduced into the water lines in an approved manner.

The treated water shall be retained in the pipe long enough to destroy all non-sporic-forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 10 parts per million of chlorine throughout the line at the end of the retention period.

All valves on the lines being disinfected shall be opened and closed several times during the contract period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 parts per million. From several points the contractor shall take samples of water in properly sterilised containers for bacterial examination. The disinfection shall be repeated until tests indicate the absence of pollution for at least 2 days. The unit will not be accepted until satisfactory bacteriological results have been obtained. The contractor shall arrange for a field laboratory, approved by the Consultant, to conduct all bacterial examinations required. It is required to take a control sample of the incoming water at the same time as the other samples are taken.

16.10. WATER STORAGE

16.10.1. COLD WATER STORAGE

The water storage deposit shall be suitable for potable water and shall not temper with the qualities of the water stored in normal conditions.

The water storage deposit shall be in accordance with the prescribed by the engineer, being manufactured in Glass Fiber Reinforced Polyester (GFRP) with orthophthalic resins. The format of the deposit is cylindrical with flat base and open top with GFRP cover.

16.10.2. HOT WATER HEATER

Hot water generators shall be semi pressure vessels of Horizontal or vertical configuration as indicated. The size and capacity of the generator shall be as indicated on the drawings.

The deposit will be in steel with hygienic treatment inside for use with sanitary hot water in Vitrified, as DIN4753.

It incorporates a dismountable serpentine system, manufactured in stainless steel, to produce sanitary hot water through external heat source.

The thermal insulation will be in rigid foam polyurethane of high density and reducing coefficient of heat transmission, injected into mould and free of CFC. The average insulation thickness will be 80mm with λ of 0.024 W/m.K.

All models incorporate connections for the assembly of Electrical resistances as a complementary energy support system.

It will also incorporate a series of permanent cathodic protection system "Correx-up".

The system shall be as specificated by the Engineer and be installed as indicated by the manufactured.

17. FIREFIGHTING PLUMBING

17.1. PIPING

17.1.1. PIPEWORK IN POLYETHYLENE HDPE PE80 PN10

Consult Chapter 16.1.1

17.1.2. GALVANIZED STEEL PIPE

17.1.2.1. MANUFACTURING PROCESS

a) Steelmaking Process

The steelmaking process is at the discretion of the manufacturer. The steel shall be fully killed.

b) Tube Manufacturing Process

The tubes shall be manufactured by a seamless (S) or longitudinally welded (W) process, as specified (Seamless or Welded tube manufacturing process (S or W)).

Cold formed tubes of Type L shall be heat treated (see 1.15.2.7.b)). The other series and types of tubes may be heat treated at the discretion of the manufacturer

Tubes shall not include welds used to join lengths of strip prior to forming the tube.

17.1.2.2. DELIVERY CONDITIONS

a) General

Unless otherwise specified (see 1.15.2.2.b) to 1.15.2.2.d)) the tubes shall be supplied bare with plain ends. The tube ends shall be cut nominally square to the axis of the tube and shall be free from excessive burrs.

b) Alternative Finishes And Protection Of The Tube Ends

Alternative types of end finish may be obtained by selecting from the following options:

Option 1: Tube ends shall be supplied with external taper threads in accordance with EN 10226-1 / EN 10226-2.

Option 2: Tube shall be supplied with one socket per tube. The socket shall be in accordance with EN 10241 or EN 10242 and unless Option 3 is requested the choice of standard and the socket type shall be at the discretion of the manufacturer. The purchaser shall be informed to which standard and of which type of socket is to be supplied.

Option 3: The purchaser shall specify the standard, and which type of socket is to be supplied in accordance with Option 2.

NOTE Purchasers who require tubes to be threaded and supplied with a socket should specify either Options 1 and 2 or Options 1 and 3.

Protection, to prevent ingress of foreign matter or physical damage or rusting of the threads, may be obtained by selecting from the following options:

Option 4: One cap or plug fitted to each tube end to prevent ingress of foreign matter; the type is at the discretion of the manufacturer.

Option 5: The tube shall be supplied with the thread varnished or with thread protection. The type of protection is at the discretion of the manufacturer.

c) Suitability For Hot Dip Galvanizing

Option 6: The tubes shall be suitable for galvanizing to EN ISO 1461 or to EN 10240 coating quality A.2, A.3, B.1, B.2 or B.3.

Option 7: The tubes shall be suitable for galvanizing to EN 10240 coating quality A.1 (see 1.15.2.3.c) 9)).

d) Hot Dip Galvanized Condition

Option 8: The tubes shall be supplied galvanized according to EN ISO 1461.

Option 9: The tubes shall be supplied galvanized according to EN 10240; the coating quality shall be specified by the purchaser at the time of enquiry and order.

17.1.2.3. REQUIREMENTS

a) Chemical Composition And Mechanical Properties

1. The chemical composition and the mechanical properties shall conform to the requirements of Table 12.

Steel Grade		Chemical composition %				Mechanical Properties		
						Upper Yield strength	Tensile strength	Elongation
Steel Name	Steel Number	C max	Mn max	P max	S max	R_{eH} min. (MPa)	R_m (MPa)	A min. %
S 195T	1.0026	0,20	1,40	0,035	0,030	195	320 to 520	20

Table 11 – Chemical Composition and mechanical properties of Galvanized steel pipes

NOTE The steel specified in this document is weldable, however when subsequently welding tubes produced according to this document account should be taken of the fact that the behaviour of the steel during and after welding is dependent not only on the steel but also on the conditions of preparing for and carrying out the welding.

2. Tubes shall be suitable for cold bending and threading.

NOTE When bending tubes produced in accordance with this document, appropriate tooling should be correctly used.

b) Appearance

1. The tubes shall be free from such external and internal surface defects that can be detected by visual examination.

2. The internal and external surface finish of the tubes shall be typical of the manufacturing process and, where applicable, the heat treatment employed. The finish and surface condition shall be such that any surface imperfections or marks requiring dressing can be identified.

3. It shall be permissible to dress, only by grinding or machining, surface imperfections provided that, after doing so, the tube thickness in the dressed area is not less than the specified minimum wall thickness. All dressed areas shall blend smoothly into the contour of the tube.

4. Surface imperfections which encroach on the specified minimum wall thickness shall be considered defects and tubes containing these shall be deemed not to conform to this document.

c) Dimensions, Masses And Tolerances

1. Specified outside diameters (D), wall thicknesses (T) and masses per unit length Medium and Heavy series tubes are listed in Table 13.

Specified outside diameter[a]	Thread Size[a]	Outside diameter		H			M		
				Heavy series			Medium series		
				Wall thickness	Mass per unit length of bare tube		Wall thickness	Mass per unit length of bare tube	
D	R	max.	min.	T	Plain end	Socketed	T	Plain end	Threaded and socketed
(mm)		(mm)	(mm)	(mm)	(kg/m)	(kg/m)	(mm)	(kg/m)	(kg/m)
10,2	1/8	10,6	9,8	2,6	0,487	0,490	2,0	0,404	0,407
13,5	1/4	14,0	13,2	2,9	0,765	0,769	2,3	0,641	0,645
17,2	3/8	17,5	16,7	2,9	1,02	1,03	2,3	0,839	0,845
21,3	1/2	21,8	21,0	3,2	1,44	1,45	2,6	1,21	1,22
26,9	3/4	27,3	26,5	3,2	1,87	1,88	2,6	1,56	1,57
33,7	1	34,2	33,3	4,0	2,93	2,95	3,2	2,41	2,43
42,4	1 1/4	42,9	42,0	4,0	3,79	3,82	3,2	3,10	3,13
48,3	1 1/2	48,8	47,9	4,0	4,37	4,41	3,2	3,56	3,60
60,3	2	60,8	59,7	4,5	6,19	6,26	3,6	5,03	5,10
76,1	2 1/2	76,6	75,3	4,5	7,93	8,05	3,6	6,42	6,54
88,9	3	89,5	88,0	5,0	10,3	10,5	4,0	8,36	8,53
114,3	4	115,0	113,1	5,4	14,5	14,8	4,5	12,2	12,5
139,7	5	140,8	138,5	5,4	17,9	18,4	5,0	16,6	17,1
165,1	6	166,5	163,9	5,4	21,3	21,9	5,0	19,8	20,4

[a] For relationship between specified outside diameter (D), thread size (R) and nominal diameter (DN), see Annex A.

T = specified wall thickness.

Table 12 – Dimensions, diameter tolerance and mass per unit length

2. Specified outside diameters (D), wall thicknesses (T) and masses per unit length for tube Types L, L1 and L2 are listed in Table B.1, B.2 and B.3 (see 1.15.2.7).

3. The tolerance on out of roundness is included in the diameter tolerance.

4. For welded tubes the tolerance on wall thickness is:

   - ± 10 % .for M and H series and Type L ;
   - -8 % with the plus tolerance limited by the mass tolerance, for Types L1 and L2.

5. The mass tolerance on welded tubes is:

   - ± 7,5 % on bundles of 10 tons or more, for M and H series and Type L ;

- +10% -8% on individual tubes for Types L1 and L2.

6. For seamless tubes the tolerance on wall thickness is ± 12,5 %. The maximum tolerance does not apply if the actual weight of a bundle does not exceed the theoretical weight, calculated from the nominal mass per unit length, by more than + 7,5 %.

7. The external weld bead of electric welded tubes shall be trimmed to an essentially flush condition.

8. The height of the internal weld seam of welded tubes shall not exceed 60 % of the specified wall thickness (T).

9. When welded tubes are specified as suitable for galvanizing to EN 10240 quality A.1 (Option 7) or galvanized to EN 10240 quality A.1 (Option 9), the internal weld bead shall have no sharp edges or porosity. The height of the internal weld seam shall not exceed 0,3 mm + 0,05 T and the internal weld seam profile shall blend smoothly into the contour of the tube.

10. Unless Option 10 is specified, tubes shall be delivered in one standard length per order item, either 6 m or 6,4 m at the discretion of the manufacturer.

Option 10: The tubes shall be supplied in the standard length, either 6 m or 6,4 m, or an alternative type of length given in Table 3 as specified by the purchaser at the time of enquiry and order.

Type of length	Length (L) (m)	Tolerance	
		Welded	Seamless
Standard	6 or 6,4	$^{+150}_{-50}$ mm	± 500 mm
Random	$4 \leq L \leq 16$ with a range of 2 m per order item	Up to 10 % of tubes supplied may be below the minimum length ordered, but not shorter than 75 % of the minimum range length	
Exact	$L \leq 6$	$^{+10}_{0}$ mm	
	$6 < L \leq 12$	$^{+15}_{0}$ mm	
	$L > 12$	$^{+by\ agreement}_{0}$	

Table 13 – Type of length and tolerance

11. For tubes with a specified outside diameter equal to or greater than 33,7 mm, the deviation from straightness over any tube length L, where L is the manufacturer's delivered length, shall not exceed 0,002 L.

NOTE It is not possible to specify a straightness requirement for this product with D less than 33,7 mm due to bending during processing and subsequent handling, however they should be reasonably straight.

17.1.2.4. INSPECTION

a) Type Of Inspection

Conformity to the requirements of the order shall be checked by non-specific inspection and testing in accordance with EN 10021.

b) Inspection Documents

Unless Option 11 is specified, tubes shall be supplied with an inspection document type 2.1, in accordance with EN 10204.

Option 11: The tubes shall be supplied with an inspection document type 2.2, in accordance with EN 10204.

c) Tensile Test

The tensile test shall be performed on bare tube in accordance with EN 10002-1 and the following shall be determined;

- the tensile strength (Rm),

- the upper yield strength (ReH) or,

- if a yield phenomenon is not present, either the 0,2 % proof strength (Rp 0,2) or the 0,5 % total elongation (Rt 0,5),

- the percentage elongation after fracture (A) with a gauge length L0 = 5,65 √ S0,

- if a non-proportional test piece is used, the percentage elongation value obtained shall be converted to the value for a gauge length L0 = 5,65 √ S0 using the conversion tables given in EN ISO 2566-1.

In cases of dispute, Rt 0,5 for the yield strength and a gauge length L0 = 5,65 √ S0 for elongation shall be used.

d) Bend Test

The bend test shall be applied to bare tubes with specified outside diameters (D) of 17,2 mm up to and including 60,3 mm and shall be carried out in accordance with EN 10232 to an angle of 90°.

The groove in the forming tool shall have a width that fits the tube diameter accurately and a depth not less than 0,5 D. The radius at the bottom of the groove of the former shall be as given in Table 15.

Welded tubes shall be bent with the weld at the outside of the bend.

The tubes shall show no cracks visible without magnifying aids.

Dimensions in millimetres

D	17,2	21,3	26,9	33,7	42,4	48,3	60,3
Bending radius	50	65	85	100	150	170	220

Table 14 – Specified outside diameter (D) and corresponding bending radius

e) Flattening Test

The flattening test shall be applied to bare tubes with specified outside diameters (D) greater than 60, 3 mm and shall be carried out in accordance with EN 10233.

Welded tubes shall be flattened with the weld placed alternately at 0 or 90° (12 or 3 o'clock) to the direction of the flattening.

The tube section shall be flattened in a press until the distance between platens, measured under load, reaches 75 % of the original outside diameter of the tube. The tube shall show no cracks or flaws visible without magnifying aids.

No cracks or flaws visible without magnifying aids shall occur in the metal other than in the weld until the distance between platens, measured under load, reaches 60 % of the original outside diameter.6u

Slight premature failure at the edges shall not be considered as a cause for rejection.

f) Leak Tightness Test

Each tube (before threading, if applicable) shall be tested for leak-tightness.

At the discretion of the manufacturer, the test can be either a hydrostatic test at a minimum of 50 bar for at least 5 s, or an electro-magnetic test in accordance with EN 10246-1.

g) Dimensional Inspection

Specified dimensions shall be verified.

h) Visual Examination

Tubes shall be visually examined to ensure compliance with 1.15.2.3.b).

17.1.2.5. MARKING

a) The tubes shall be marked by suitable and durable methods with at least:

- the manufacturer's mark;

- the symbol to indicate the series (H or M) (see Table 2) or the type (L, L1 or L2) (see 1.15.2.7.);
- the symbol S (seamless) or W (welded), to indicate the tube manufacturing process;

Marking shall appear at least once within 1 m of one end of each tube.

At the discretion of the manufacturer, the series or type marking may be replaced by colour coding as follows:

- Heavy: red;

- Medium: blue;

- Types: see 1.15.2.7.

Colour coding bands shall be approximately 50 mm wide.

b) Each bundle shall have a label attached which contains the following minimum information:

- the manufacturer's name or mark;
- the number of this European Standard EN 10255;
- the symbol S (seamless) or W (welded), to indicate the tube manufacturing process;
- the D (specified outside diameter) or R (thread size);
- the series or type or specified wall thickness.

17.1.2.6. TEMPORARY PROTECTIVE COATING

Unless Option 12 is specified, the tubes are supplied bare.

Option 12: The tube shall be supplied with a temporary protective coating.

17.1.2.7. TYPES OF TUBES WITH WALL THICKNESS DIFFERENT FROM MEDIUM AND HEAVY SERIES (ANNEXB)

a) General

This chapter give the dimensions of Types of tubes which have wall thickness different from those included in Table 2.

b) Requirements

The tubes shall conform to the technical requirements specified in Clauses 1.15.2.1., 1.15.2.2., 1.15.2.3., 1.15.2.4., 1.15.2.5. and 1.15.2.6, except for dimensions, masses and tolerances on diameter, which shall be in accordance with Tables B.1. B.2 or B.3, as applicable.

Cold formed tubes of Type L included in Table B.1 shall be heat treated.

c) Marking

Tubes of Type L shall be marked L and when colour coding replaces the marking, the colour shall be green.

Tubes of Type L1 shall be marked L 1 and when colour coding replaces the marking, the colour shall be white.

Tubes of Type L2 shall be marked L 2 and when colour coding replaces the marking, the colour shall be brown.

Table B.1 — Dimensions, diameter tolerance and mass per unit length of tubes: Type L

Specified outside diameter [a]	Designation of thread [a]	Outside diameter		Wall Thickness	Mass per unit length of bare tube	
D	R	max.	min.	T	Plain end.	Threaded and socketed
(mm)	--	(mm)	(mm)	(mm)	(kg/m)	(kg/m)
13,5	1/4	13,9	13,2	2,0	0,567	0,571
17,2	3/8	17,4	16,7	2,0	0,750	0,756
21,3	1/2	21,7	21,0	2,3	1,08	1,09
26,9	3/4	27,1	26,4	2,3	1,40	1,41
33,7	1	34,0	33,2	2,9	2,20	2,22
42,4	1 1/4	42,7	41,9	2,9	2,82	2,85
48,3	1 1/2	48,6	47,8	2,9	3,25	3,29
60,3	2	60,7	59,6	3,2	4,51	4,58
76,1	2 1/2	76,0	75,2	3,2	5,75	5,87
88,9	3	88,7	87,9	3,2	6,76	6,93
101,6	3 1/2	101,2	100,3	3,6	8,70	8,88
114,3	4	113,9	113,0	3,6	9,83	10,1
139,7	5	140,8	138,5	4,5	15,0	15,5
165,1	6	166,5	163,9	4,5	17,8	18,4

[a] For relationship between specified outside diameter (D), thread size (R) and nominal diameter (DN), see Annex A.

T = specified wall thickness.

Table B.2 — Dimensions, diameter tolerance and mass per unit length of tubes Type L1

Specified outside diameter [a]	Designation of thread [a]	Outside diameter		Wall Thickness	Mass per unit length of bare tube	
D	R	max.	min.	T	Plain end	Threaded and socketed
(mm)	--	(mm)	(mm)	(mm)	(kg/m)	(kg/mm)
13,5	1/4	13,9	13,2	2,0	0,570	0,574
17,2	3/8	17,4	16,7	2,0	0,742	0,748
21,3	1/2	21,7	21,0	2,3	1,08	1,09
26,9	3/4	27,1	26,4	2,3	1,39	1,40
33,7	1	34,0	33,2	2,9	2,20	2,22
42,4	1 1/4	42,7	41,9	2,9	2,82	2,85
48,3	1 1/2	48,6	47,8	2,9	3,24	3,28
60,3	2	60,7	59,6	3,2	4,49	4,56
76,1	2 1/2	76,3	75,2	3,2	5,73	5,85
88,9	3	89,4	87,9	3,6	7,55	7,72
114,3	4	114,9	113,0	4,0	10,8	11,1

[a] For relationship between specified outside diameter (D), thread size (R) and nominal diameter (DN), see Annex A.

T = specified wall thickness.

Table B.3 — Dimensions, diameter tolerance and mass per unit length of tubes Type L2

Specified outside diameter [a]	Designation of thread [a]	Outside diameter		Wall Thickness	Mass per unit length of bare tube	
D	R	max.	min.	T	Plain end	Threaded and socketed
(mm)	--	(mm)	(mm)	(mm)	(kg/m)	(kg/m)
13,5	1/4	13,6	13,2	1,8	0,515	0,519
17,2	3/8	17,1	16,7	1,8	0,670	0,676
21,3	1/2	21,4	21,0	2,0	0,947	0,956
26,9	3/4	26,9	26,4	2,3	1,38	1,39
33,7	1	33,8	33,2	2,6	1,98	2,00
42,4	1 1/4	42,5	41,9	2,6	2,54	2,57
48,3	1 1/2	48,4	47,8	2,9	3,23	3,27
60,3	2	60,2	59,6	2,9	4,08	4,15
76,1	2 1/2	76,0	75,2	3,2	5,71	5,83
88,9	3	88,7	87,9	3,2	6,72	6,89
114,3	4	113,9	113,0	3,6	9,75	10,0

[a] For relationship between specified outside diameter (D), thread size (R) and nominal diameter (DN), see Annex A.

T = specified wall thickness.

17.2. **ACCESSORIES**

17.2.1. SUPPORTS

Pipes installed in view shall be supported with the devices defined in this document, indicated in the following figure, and according to the procedures recommended by the manufacturer of the supports, always avoiding the formation of galvanic corrosion.

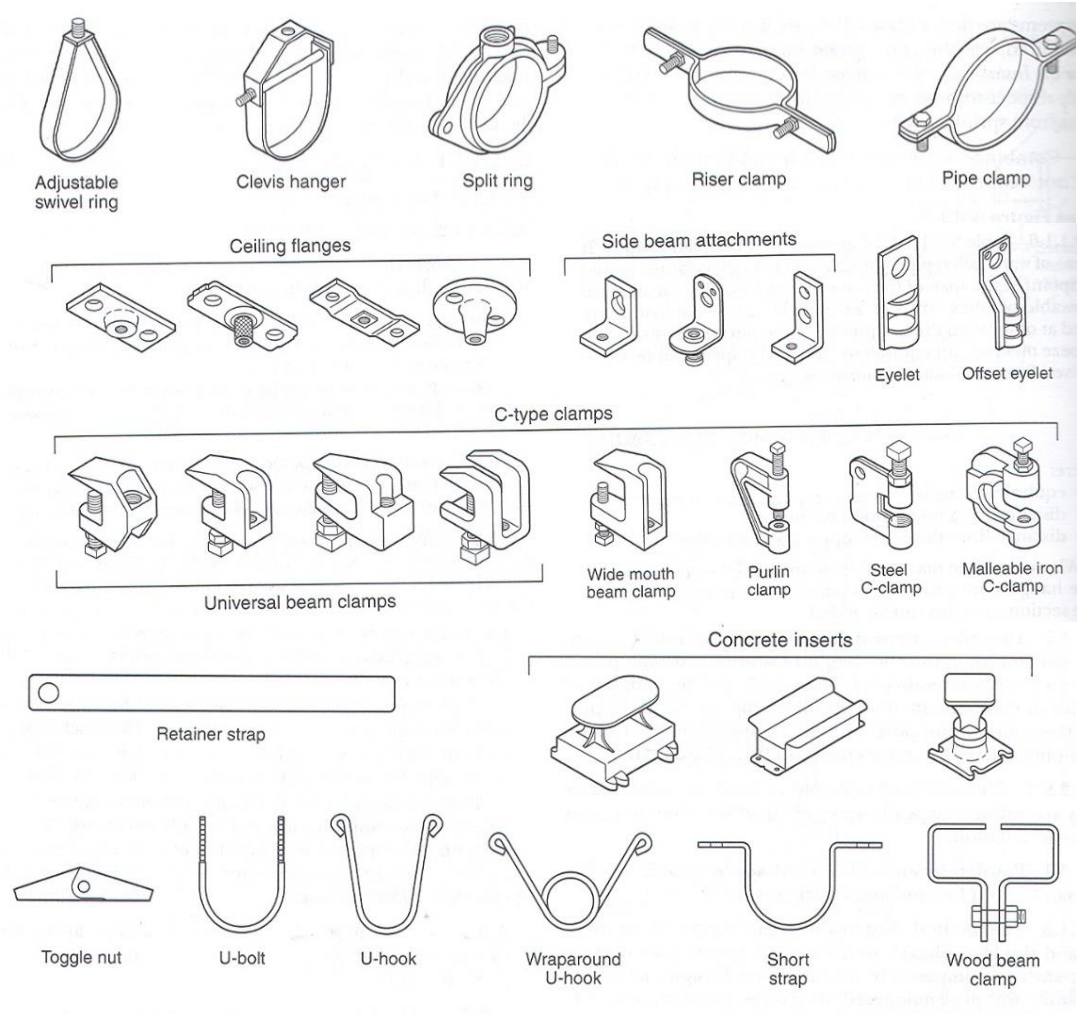


Figure 1 - Support types and components

Bolts, nuts and washers should be electro-zinc-plated.

The material constituting the supports to be used in the pipelines will be a function of these, and the best suited to each case should be selected.

The exposed pipes shall be fastened by cable ties and shall be insulated electrically from the pipes by suitable joints of rubber or polyurethane.

The points of change of direction of the piping and those corresponding to the location of the connecting accessories are mandatory points of support.

17.2.2. VALVE

17.2.2.1. SEALING GATE VALVE

a) Product Description

- Flanged soft sealing gate valve series 3000
- Range DN 40 up to DN 500
- PN 10/16
- Face-to-face length – S14
- Service temperature from 0ºC (excluding frost) to 70ºC

b) Standards

- Designed according to EN 1074 part 1 & 2 and EN 1171
- Flange drilling to EN 1092-2 PN 10/16
- Face-to-face according to EN 558 series 14

c) Tests

- All valves are individually hydrostatically tested according to EN 1074-1/2 and EN 12266:
- Seal:
    - High pressure 1.1 x PN (in bar)
    - Low pressure 0.5 (in bar)
    - Body: 1.5 x PN (in bar)
- Operation torque test

d) Corrosion Protection

- Epoxy powder coating RAL 5005
- Applied internal and external with a minimum coating thickness of 250 µm

- Potable water approved epoxy coating, fusion bonded according DIN 30677-2, DIN 3476 and GSK approved

e) Features

- Isolation valve approved for drinking water
- Full bore
- Low operating torque
- The valves from DN 250 to DN 300 are equipped with an axial bearing, from DN 350 to DN 500 are equipped with two thrust bearings to ensure reduced operating torque
- Stainless steel stem with rolled threads produced by cold rolling process, which keeps the steel structure and increase its mechanical resistance
- Stem sealing system with 4 O-rings in EPDM
- O-ring stem sealing exchangeable under pressure
- Wedge fully vulcanized with drinking water approved EPDM
- Top of the wedge conceived with “soft stop” system, which acts as an end stop for the fully open valve
- Wedge with brass nut fixed in the wedge core preventing vibration and ensure a long life span
- Wedge and body designed with “monorail” system
- Round EPDM bonnet gasket fixed in a recess, surrounding the bolts, ensuring a perfect seal
- Body/bonnet bolts in stainless

17.2.2.2. SWING CHECK VALVE

a) Main Features

- Prevent back flow.
- Metal/metal sealing.
- The water flow sense should agree with the sense of the marked body arrow.
- Have lifting eye starting from DN 200.

- The valve could be installed on the horizontal position.

component	material	norma standard
body	ductile iron (EN-GJS-500-7)	DIN EN 1563
bonnet	ductile iron (EN-GJS-500-7)	DIN EN 1563
obturator	stainless steel AISI420 (X20 Cr13)	EN 10088-1
body seat	bronze CuSn7Zn4Pb7 (Rg7)	DIN EN 1982
bonnet gasket	elastomer EPDM with CE marking	BS EN 681-1
arm	ductile iron (EN-GJS-500-7)	DIN EN 1563
shaft	stainless steel AISI420 (X20 Cr13)	EN 10088-1
bolts and washers	stainless steel A2 (X5 CrNi 18-10)	EN 10088-1
nuts	stainless steel A4 (X5 CrNiMo 17-12-2)	EN 10088-1
coating inside and outside	epoxy paint potable RESICOAT 9000 R4 BLUE applied electrostatically with thickness ≥ 250 µm	DIN 30677

b) Main Features

- Compact design requires little space for assembly.
- Easy maintenance.
- In case of the components wear, these can be easily replaced, the removal there of can be
- done without removing the valve from the pipeline , through the loosening of the screws
- from the system that removes the seal, shutter arm and shaft gland.
- Full complete passage without obstacles, avoiding head loss
- Reduced force in opening and closing.
- Effect of cavitation almost null, due to geometric configuration of the valve.
- Reliability and stability of the obturator, with the arm with double support

- Possibility of applying plug to check and clean.

DN	código - code PN 10	código - code PN 16	D PN 10	D PN 16	C	L	H	Ø de furação / nº e Ø dos furos hole Ø / Ø and nº of holes PN 10	Ø de furação / nº e Ø dos furos hole Ø / Ø and nº of holes PN 16	peso - weight (kg) PN 10	peso - weight (kg) PN 16
50	10752010	10752010	165	165	110	200	108	125ø - 4 x 19ø	125ø - 4 x 19ø	9.0	9.0
60	10752020	10752020	175	175	123	240	119	135ø - 4 x 19ø	135ø - 4 x 19ø	10.8	10.8
65	10752030	10752030	185	185	123	240	119	145ø - 4 x 19ø	145ø - 4 x 19ø	11.6	11.6
80	10752040	10752040	200	200	140	260	137	160ø - 8 x 19ø	160ø - 8 x 19ø	14.5	14.5
100	10752050	10752050	220	220	168	300	157	180ø - 8 x 19ø	180ø - 8 x 19ø	20.7	20.7
125	10752060	10752060	250	250	215	350	185	210ø - 8 x 19ø	210ø - 8 x 19ø	32.0	32.0
150	10752070	10752070	285	285	242	400	210	240ø - 8 x 23ø	240ø - 8 x 23ø	41.0	41.0
200	10752080	10752085	340	340	295	500	242	295ø - 8 x 23ø	295ø - 12 x 23ø	60.1	60.1
250	10752090	10752095	400	400	377	600	296	350ø - 12 x 23ø	355ø - 12 x 28ø	93.3	93.3
300	10752100	10752105	455	455	427	700	325	400ø - 12 x 23ø	410ø - 12 x 28ø	135.2	135.2
350	10752110	10752115	505	520	480	800	400	460ø - 16 x 23ø	470ø - 16 x 28ø	143.7	150.2
400	10752120	10752125	565	580	531	900	435	515ø - 16 x 28ø	525ø - 16 x 31ø	267.2	276.2
450	10752130	10752135	615	640	585	1000	460	565ø - 20 x 28ø	585ø - 20 x 31ø	377.0	392.0
500	10752140	10752145	670	715	640	1100	485	620ø - 20 x 28ø	650ø - 20 x 34ø	404.0	429.0
600	10752150	10752155	780	840	750	1300	585	725ø - 20 x 31ø	770ø - 20 x 37ø	602.0	652.0

17.2.2.3. BALANCED FLOAT VALVE

a) Main Features

Automatic control of water level:

a. Reduce and then closes the feeding when the maximum level is reached.

b. Open progressively when the level begins to fall down.

DN	código - code PN 10	código - code PN 16	D PN 10	D PN 16	C	L	E	H	Ø de furação / nº e Ø dos furos hole Ø / Ø and nº of holes PN 10	Ø de furação / nº e Ø dos furos hole Ø / Ø and nº of holes PN 16	peso - weight (kg) PN 10	peso - weight (kg) PN 16
50	10767100	10767100	165	165	136	400	1410	108	125ø - 4 x 19ø	125ø - 4 x 19ø	15.8	15.8
60	10767110	10767110	175	175	136	400	1410	108	135ø - 4 x 19ø	135ø - 4 x 19ø	16.2	16.2
65	10767025	10767025	185	185	136	400	1410	108	145ø - 4 x 19ø	145ø - 4 x 19ø	16.2	16.2
80	10767120	10767120	200	200	150	400	1635	128	160ø - 8 x 19ø	160ø - 8 x 19ø	21.8	21.8
100	10767130	10767130	220	220	150	400	1635	128	180ø - 8 x 19ø	180ø - 8 x 19ø	22.6	22.6
125	10767140	10767140	250	250	184	500	2215	159	210ø - 8 x 19ø	210ø - 8 x 19ø	39.6	39.6
150	10767150	10767150	285	285	184	500	2215	159	240ø - 8 x 23ø	240ø - 8 x 23ø	40.7	40.7
200	10767070	10767160	340	340	273	500	2620	204	295ø - 8 x 23ø	295ø - 12 x 23ø	89.8	89.8
250	10767080	10767170	400	400	273	500	2620	204	350ø - 12 x 23ø	355ø - 12 x 28ø	96.4	96.4

pressão de ensaio hidráulico/hydraulic pressure test (bar)		
PN	vedação/sealing	corpo /body
10	11	17
16	18	25

Todas as válvulas são individualmente ensaiadas em fábrica.
All the valves are individually tested at factory.

temperatura máxima de trabalho maximum working temperature
até 70°C up to 70°C

component	material	norma standard
body	ductile iron (EN-GJS-500)	DIN EN 1563
bonnet	ductile iron (EN-GJS-500)	DIN EN 1563
obturator	ductile iron (EN-GJS-500)	DIN EN 1563
sealing ring	EPDM elastomer with CE marking	BS EN 681-1
membrane	EPDM elastomer with CE marking	BS EN 681-1
shaft	stainless steel AISI 420 (X20 Cr13)	EN 10088-1
control arm	ductile iron (EN-GJS-500)	DIN EN 1563
float shaft	stainless steel AISI 304 (X5 CrNi 18-10)	EN 10088-1
refining arm	stainless steel AISI 304 (X5 CrNi 18-10)	EN 10088-1
float	polyvinyl chloride	-
bolts, nuts and washers	stainless steel A2 (X5 CrNi 18-10)	EN 10088-1
coating inside and outside	epoxy paint potable RESICOAT 9000 R4 BLUE applied electrostatically with thickness ≥ 250 µm	DIN 30677

17.2.2.4. AIR VALVE VM 6126M

- Air valve that will ensure the proper operation of the pipeline network allowing the release of air pockets during working conditions, the evacuation and entrance of large volumes of air during filling and draining operations.
- Pressure rating PN 16.
- Pressure rating connecting flange PN 16.
- Max. Temperature +60°C.
- Min. pressure in pipeline 0,2 bar.
- Single chamber.

- Full bore.
- Internal ribs for consistent and accurate guiding of the mobile block.
- Aerodynamic deflector in stainless steel to avoid premature closures.
- Drainage valve for chamber control and pressure relief during maintenance.
- Mobile block composed of a cylindrical float and upper disk in solid polypropylene, joined together by the air release system.
- The solid cylindrical floats, obtained by CNC machining, avoid deformations and ensure a great sliding precision inside the body processed ribs and a perfectly vertical thrust.
- Nozzle and gasket holder entirely made in AISI 316 and designed with gasket compression control to prevent aging process and consequent leakage during working conditions.
- Cover in ductile and screen in stainless steel as a standard execution to prevent the entrance of insects, with three more optional outlets (for submerged applications, air inlet only, air outlet only).

Body, cap	ductile iron EN-JS1040
Screen	stainless steel EN 1.4301
Nozzle subset	stainless steel EN 1.4401
Float	polypropylene
Seat	stainless steel EN 1.4301
O-rings	NBR
Studs, nuts	stainless steel EN 1.4301
Drain valve	stainless steel EN 1.4305
Coating	epoxy blue RAL 5005

17.2.3. SWING TYPE FIRE HOSE REEL (MANUAL)

17.2.3.1. GENERAL

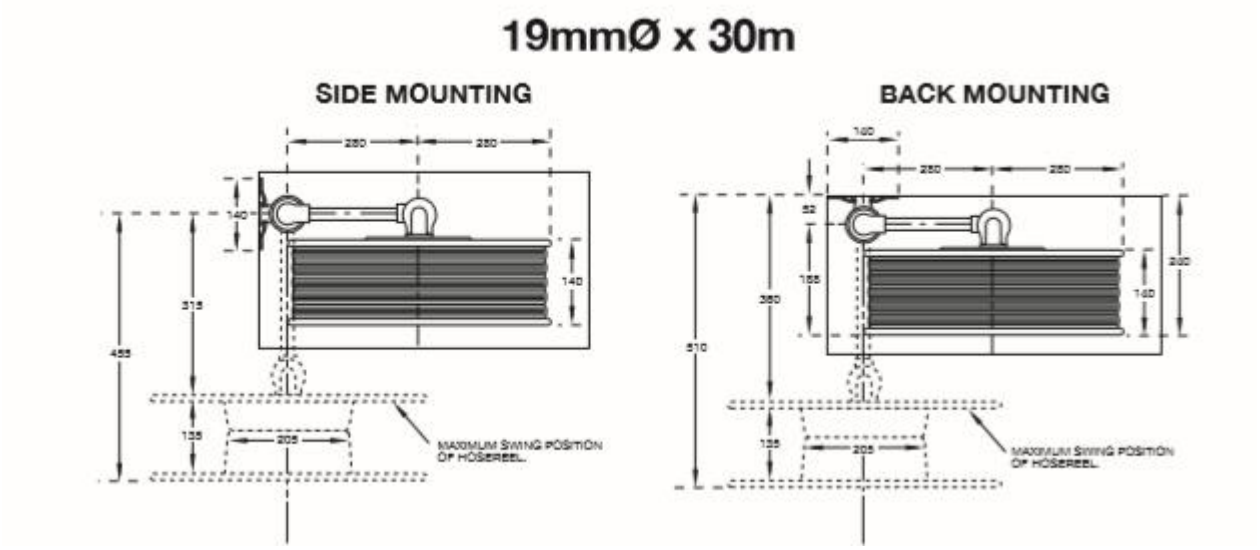
"AE" Model 99-N (19mm) swing type, manual operated fire hose reel are manufactured within a strict quality controlled environment to ISO 9001:2008 and conformed to BS EN 671-1 specifications. The elegant design with double pivoted joints allows the installer the flexibility to fix the hose reel at the back wall or at either left or right side wall mounting. This installation flexibility greatly helps designers in deciding the appropriate size of the recessed hose reel compartment, especially in areas where space constraints are critical. Another unique feature in the hose reel design is the "slide-in" wall mounting bracket which is a separate strong and rigid galvanised steel bracket that is initially installed onto the concrete wall without the hose reel. The complete hose reel is then "slide in" from the top and sits in a fitting and rigid position. The water supply piping is then connected to the inlet of the hose reel. The materials used in the manufacture of the fire hose reel are of the highest quality such as the combination of Grade 304 stainless steel, high grade aluminium alloy and/or LG2 gunmetal waterway assembly all of which are corrosion

resistant and of high impact strength. The fire reel discs are pressed steel of 1.2mm thickness and epoxy/polyester powder coated. The hub is made of deep drawn galvanised steel.

17.2.3.2. FEATURES

- Elegant and compact design.
- Robust construction.
- Easy and flexible installation.
- Reliable performance with minimum maintenance.

17.2.3.3. OPERATING & TEST PRESSURES



17.2.4. PRESSURE GAUGE

17.2.4.1. GENERAL

WIKA type 111.12 gauges feature a black plastic case, snap-in plastic window and a centre back mount (CBM) rear connection. With an industry recognized ASME 3/2/3% of span accuracy, WIKA type 111.12 gauges are the industry standard in the commercial gauge line. Available in a variety of sizes, mounting

styles and optional configurations, type 111.12 gauges are suitable for many tough applications including regulators, medical, pneumatic controllers, compressors, valve positioners and pumps.

17.2.4.2. STANDARD FEATURES

- Size: 1½", 2", 2½" & 4"
- Case: Black ABS
- Wetted Parts: Copper alloy
- Window: Clear plastic
- Dial: White ABS; (4") aluminum
- Pointer: Black ABS; (4") aluminum
- Accuracy: ± 3/2/3% of span ASME B40.100 Grade B
- Connection: Center back mount

17.2.5. SLEEVES

Provide sleeves large enough to accommodate pipe and its covering passing entirely through floors, ceiling, walls, or partitions. Pack sleeves through firewalls or slabs in accordance with engineer's requirements.

Provide cast iron or steel pipe sleeves for pipes passing through exterior walls, footings or beams or through floors (interior) or machinery rooms containing Plumbing, Heating, Ventilation, or Air Conditioning equipment, and here extending 50mm above finished floor. Provide sleeves through exterior walls below grade and floors specified above with continuously welded centre flange buried in construction. At exterior walls, make pipe watertight in sleeve with oakum packing and caulked lead joints on both sides of wall.

Except as otherwise noted, provide 0,710mm galvanised iron sleeves for all pipes passing through roof slabs, interior floors, ceilings, walls or partitions, unless framed opening is provided in general construction.

Copper pipes shall have PVC sleeves or be covered with "Thermoflex" or equal protection strip where they pass through walls. Sleeves shall extend 10mm beyond finished surface.

17.3. EQUIPMENTS

17.3.1. FIRE FIGHTING PUMP

It's proposed to have Grundfos Pumping unit, model FH/EN Y 2A/02 (5,5+5,9kW) + CR1-15 or equivalent, according to EN 12 845.

The pumping station shall consist of the following equipment:

- One electric jockey pump;
- One electric main pump;
- One diesel reserve pump;
- Flowmeter Kit DN 50 x 32P mm;
- 2 suction side Kit DNA 50 X DNS 80/PN16;
- 1 electric panel for remote status and alarm monitoring

18. SEWERAGE AND SANITARY PLUMBING

18.1. PVC PIPE INSTALLATIONS

18.1.1. MATERIAL

18.1.1.1. RAW MATERIAL

The raw material shall be PVC-U to which are added those additives that are needed to facilitate the manufacture of components conforming to the requirements of the standards.

When calculated on the basis of a known formulation, or in case of dispute or unknown formulation, determined in accordance with legal standards, the PVC-content shall be at least 80 % by mass for pipes and 85 % by mass for injection-moulded fittings.

A further reduction of the PVC-U content to ≥ 75 % by mass for pipes only is permitted provided the PVC-U is substituted by coated or uncoated CaCO3 conforming to the legal standard.

18.1.1.2. PIPE MATERIAL

When tested in accordance with the test method as specified in the legal standard, using the indicated parameters, the pipe material shall have characteristics conforming to the requirements given in it.

The pipe material shall be tested in the form of a pipe.

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure	No failure during the test period	End caps	Type A or B conforming to EN ISO 1167-1:2006	EN ISO 1167-1:2006
		Test temperature	60 °C	
		Orientation	Free	
		Number of test pieces	3	
		Circumferential (hoop) stress	10 MPa	
		Conditioning period	1 h	
		Type of test	Water-in-water	
		Test period	1 000 h	

Table 15 - Pipe material test requirements

18.1.1.3. FITTING MATERIAL

When tested in accordance with the test method as specified in the legal standard, using the indicated parameters, the fitting material shall have characteristics conforming to the requirements given in it.

The fitting material shall be tested, in the actual formulation, in the form of an extruded or injection-moulded pipe.

Fabricated fittings or parts of fabricated fittings shall be made from pipes conforming to the legal standard, except for the requirements for the wall thickness, and/or mouldings from PVC-U which conforms to material, mechanical and physical characteristics.

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure	No failure during the test period	End caps	Type A or B conforming to EN ISO 1167-1:2006	EN ISO 1167-1:2006
		Dimensions	50 mm $\leq d_n \leq$ 110 mm 3 mm $\leq e \leq$ 5 mm	
		Free length for injection-moulded pipe	≥ 140 mm	
		Test temperature	60 °C	
		Orientation	Free	
		Number of test pieces	3	
		Circumferential (hoop) stress	6,3 MPa	
		Conditioning period	1 h	
		Type of test	Water-in-water	
		Test period	1 000 h	

Table 16 - Fitting material test requirements

18.1.1.4. UTILISATION OF NON-VIRGIN MATERIALS

Conditions and requirements for the utilisation of non-virgin materials are given in the legal standard.

18.1.1.5. SEALING RING RETAINING MEANS

It is permitted that sealing rings are retained using means made from polymers other than PVC-U.

18.1.2. GENERAL CHARACTERISTICS

18.1.2.1. APPEARANCE

When viewed without magnification, the following requirements apply:

a) the internal and external surfaces of pipes and fittings shall be smooth, clean and free from grooving, blistering, impurities and pores and any other surface irregularity likely to prevent their conformity to the legal standard;

b) pipe ends shall be cleanly cut and the ends of pipes and fittings shall be square to their axis.

18.1.2.2. COLOUR

The pipes and the fittings shall be coloured through the wall.

The colour should preferably be orange-brown (approximately RAL 8023 1)) or dusty grey (approximately RAL 7037 1)). Other colours may be used.

18.1.3. GEOMETRICAL CHARACTERISTICS

18.1.3.1. GENERAL

Dimensions shall be measured in accordance with legal standards.

18.1.3.2. DIMENSIONS OF PIPES

18.1.3.2.1. *OUTSIDE DIAMETERS*

The mean outside diameter shall be conform the legal standard.

18.1.3.2.2. *OUT OF ROUNDNESS*

The out-of-roundness, measured directly after production, shall be less than or equal to 0,024dn.

18.1.3.2.3. *LENGTH OF PIPES*

The effective length of a pipe, l, shall be not less than that declared by the manufacturer.

18.1.3.2.4. *CHAMFERING*

If a chamfer is applied, the angle of chamfering shall be between 15 ° and 45 ° to the axis of the pipe The remaining wall thickness of the end of the pipe shall be at least 1⁄3 of emin.

18.1.3.2.5. *WALL THICKNESS*

The wall thickness, e, shall conform the standard, where a maximum wall thickness at any point up to 1,2emin is permitted provided that the mean wall thickness, em, is less than or equal to the specified em, max.

For U application, DN 200 and greater, a reduction of emin up to 5 % is permitted, provided em is equal or exceeds the values of emin given in the standard. In such case, the ring stiffness shall be measured according to legal standard and shall be greater than or equal to the nominal value.

18.1.3.3. DIMENSIONS OF FITTINGS

18.1.3.3.1. *OUTSIDE DIAMETERS*

The mean outside diameter, dem, of the spigot shall conform to the legal standard.

The out-of-roundness shall conform to the requirements given previously.

18.1.3.3.2. *DESIGN LENGTHS (Z)*

The Z-length(s) of fittings shall be given by the manufacturer.

18.1.3.3.3. *WALL THICKNESSES*

Minimum wall thickness, emin, of the body or the spigot of a fitting shall be conform the legal standard, except that a reduction of 5 % resulting from core shifting is permitted. In such a case, the average of two opposite wall thicknesses shall be equal to or exceed the values given in it.

Where a fitting or adaptor provides for a transition between two nominal sizes, the wall thickness of each connecting part shall conform to the requirements for the applicable nominal size. In such a case, the wall thickness of the fitting body is permitted to change gradually from the one wall thickness to the other.

Wall thickness of the cover of the saddle branch shall be equal or greater than emin of the applicable size and series of the inlet.

Wall thickness of fabricated fittings, except for spigot and socket, may be changed locally by the fabrication process, providing that the minimum wall thickness of the body conforms to the legal standard.

18.1.3.4. DIMENSIONS OF SOCKETS AND SPIGOTS

18.1.3.4.1. *ELASTOMERIC RING SEAL SOCKETS AND SPIGOTS*

Diameters and lengths:

The diameters and lengths of elastomeric ring seal sockets and spigots shall be conform the legal standard.

Where sealing rings are firmly retained, the dimensions for the minimum value for A and the maximum value for C shall be measured to the effective sealing point as specified by the manufacturer. This point shall give a full sealing action.

Different designs of elastomeric ring seal sockets and spigots are permitted, provided the joints conform to the requirements given in the standard.

Wall thicknesses of sockets:

The wall thicknesses of sockets, except the socket mouth, shall be conform the legal standard.

A reduction of 5 % of e2 and e3 (according the legal standard) resulting from core shifting is permitted.

In such a case the average of two opposite wall thicknesses shall be equal to or exceed the values given in the standard.

Where a sealing ring is located by means of a retaining cap or ring the wall thickness in this area shall be calculated by addition of the wall thickness of the socket and the wall thickness of the retaining cap or ring at the corresponding places in the same cross section.

Dimensions for "O-ring type" sockets:

The dimensions of "O-ring type" sockets with a nominal diameter, dn, up to and including 710 shall be conform the standard. For higher diameters, dimensions shall be given by the manufacturer.

18.1.3.4.2. *SOLVENT CEMENT SOCKETS AND SPIGOTS*

Diameters and lengths

The diameters and lengths of solvent cement sockets and spigots shall be conform the legal standard.

The manufacturer shall declare whether the socket is designed tapered or parallel. If parallel or near parallel, the mean inside diameter of the socket, dsm, shall apply over the entire length of the socket. If the

socket is tapered, then the limits for dsm shall apply at the mid point of the socket with a maximum taper angle of 20' (minutes) per side to the axis of the socket.

Wall thicknesses of sockets

The wall thicknesses of sockets shall be conforming the legal standard.

18.1.3.5. TYPES OF FITTINGS

This specification is applicable for the following types of fittings. Other designs of fittings are permitted.

a) Bends;

1. Unswept or swept angle;
2. spigot/socket and socket/socket;

NOTE 1 Preferred nominal angles α are the following: 15°, 30°, 45°, 67°30', 87°30' to 90°.

b) Couplers and slip couplers;

c) Reducers;

d) Branches and reducing branches;

1. Unswept or swept angle;
2. spigot/socket and socket/socket;

NOTE 2 Preferred nominal angles α are the following: 45°, 67°30', 87°30' to 90°.

e) Saddle branches;

1. Nominal angle α may be equal to 87°30' to 90° only when dn2/dn1 ≤ 2/3;
2. Minimum axial cover L:
3. For saddles having dn1 < 315 mm, the cover shall be not less than half a circumference;
4. For saddles having dn1 ≥ 315 mm, the side cover a shall not be less than 80 mm;

NOTE 3 Preferred nominal angle α is: 45°.

f) Plugs;

1. Minimum length of spigot, Mmin = (Cmax + 10) mm.

18.1.3.6. MECHANICAL CHARACTERISTICS OF PIPES

18.1.3.6.1. *GENERAL REQUIREMENTS*

When tested in accordance with the test method as specified in the legal standard, using the indicated parameters, the pipe shall have general mechanical characteristics conforming to the requirements given in the following table.

Characteristic	Requirements	Test parameters		Test method
Impact resistance [a] (round-the-clock method)	TIR ≤ 10 %	Test/conditioning temperature Conditioning medium Type of striker Mass of striker for: d_n = 110 mm d_n = 125 mm d_n = 160 mm d_n = 200 mm d_n = 250 mm $d_n \geq$ 315 mm Fall height of striker for: d_n = 110 mm $d_n \geq$ 125 mm	0 °C Water or air d90 conforming to EN 744:1995 1,0 kg 1,25 kg 1,6 kg 2,0 kg 2,5 kg 3,2 kg 1 600 mm 2 000 mm	EN 744:1995
[a] If the manufacturer chooses to use indirect testing (see prCEN/TS 1401-2:2007 [1]), the preferred temperature is (23 ± 2) °C.				

Table 17 - Pipe mechanical test requirements

18.1.3.6.2. *ADDITIONAL MECHANICAL REQUIREMENTS*

Pipes intended to be used in areas where installation is usually carried out at temperatures below −10 °C, may be required, in the national foreword, to conform to the requirements of an impact test (staircase method) as specified in the following table and shall be marked with the symbol of an ice crystal.

Characteristic	Requirements	Test parameters		Test method
Impact resistance (staircase method)	H50 ≥ 1m max. one break below 0,5 m	Test/conditioning temperature Type of striker Mass of striker for: d_n = 110 mm d_n = 125 mm d_n = 160 mm d_n = 200 mm $d_n \geq$ 250 mm	−10 °C d90 conforming to EN 1411:1996 4 kg 5 kg 8 kg 10 kg 12,5 kg	EN 1411:1996

Table 18- Pipe additional mechanical test requirements

18.1.3.7. MECHANICAL CHARACTERISTICS OF FITTINGS

When tested in accordance with the test methods as specified in the legal standard using the indicated parameters, the fitting shall have mechanical characteristics conforming to the requirements given in it.

18.1.4. PHYSICAL CHARACTERISTICS

18.1.4.1. PHYSICAL CHARACTERISTICS OF PIPES

When tested in accordance with the test methods as specified in the legal standard using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in it.

18.1.4.2. PHYSICAL CHARACTERISTICS OF FITTINGS

When tested in accordance with the test methods as specified in the legal standard if applicable using the indicated parameters, the fitting shall have physical characteristics conforming to the requirements given in it, as applicable.

18.1.4.3. PERFORMANCE REQUIREMENTS

When tested in accordance with the test methods as specified in the legal standard using the indicated parameters, the joints and the system shall have fitness for purpose characteristics conforming to the requirements given in it.

18.1.4.4. SEALING RINGS

Sealing ring shall have no detrimental effects on the properties of the pipe and the fitting and shall not cause the test assembly to fail.

Materials for sealing rings shall conform to legal standards, as applicable.

18.1.4.5. ADHESIVES

The adhesive shall be solvent cement and shall be as specified by the manufacturer of pipes or fittings. The adhesive shall have no detrimental effects on the properties of the pipe and of the fitting and shall not cause the test assembly to fail.

18.1.5. MARKING

18.1.5.1. GENERAL

Marking elements shall be printed or formed directly on the component or be on a label, in such a way that after storage, weathering and handling and installation, the required legibility is maintained.

One of the following three levels of legibility of the marking on components is specified for the individual marking aspects given in the standard. The required durability of marking is coded with decreasing stringency as follows:

a) Durable in use;

b) Legible until the system is installed;

c) Marking on the packaging, legible until the component is installed.

NOTE: The manufacturer is not responsible for marking being illegible, due to actions caused during installation and use such as painting, scratching, covering of the components or by use of detergents etc. on the components unless agreed or specified by the manufacturer.

Marking shall not initiate cracks or other types of defects, which adversely influence the performance of the pipe or the fitting.

Marking by indentation reducing the wall thickness not more than 0,25 mm shall be deemed to conform to this clause without infringing the requirements for the wall thickness.

If printing is used, the colouring of the printed information shall differ from the basic colouring of the pipe or fitting.

The size of the marking shall be such that the marking is legible without magnification.

18.1.5.2. MINIMUM REQUIRED MARKING OF PIPES

Pipes shall be marked at intervals of maximum 2 m, at least once per pipe.

The minimum required marking of pipes shall conform to the following.

Aspects	Marking or symbols	Minimum durability of legibility of marking
– Number of standard	EN 1401	a
– Application area code	Either U or UD	a
– Manufacturer's name and/or trade mark	XXX	a
– Nominal size	e.g. 200	a
– Minimum wall thickness or SDR	e.g. either 4,9 or SDR 41	a
– Material	Either PVC-U or PVC	a
– Nominal ring stiffness	e.g. SN 4	a
– Manufacturer's information	[a]	a
– Cold climate performance [b]	❄ (ice crystal)	b

[a] For providing traceability the following details shall be given:
1) the production period, year and month, in figures or in code;
2) a name or code for the production site if the manufacturer is producing in different sites, nationally and/or internationally.

[b] This marking is only applicable to pipes which by testing have proven to conform to 7.1.2.

Table 19 – Minimun required marking of pipes

18.1.5.3. MINIMUM REQUIRED MARKING OF FITTINGS

The minimum required marking of fittings shall conform to the following.

Aspects	Marking or symbols	Minimum durability of legibility of marking
– Number of standard	EN 1401	b
– Application area code	Either U or UD	a
– Manufacturer's name and/or trade mark	XXX	a
– Nominal size	e.g. 200	a
– Nominal angle	e.g. 45°	b
– Minimum wall thickness or SDR	e.g. either 4,9 or SDR 41	b
– Material	Either PVC-U or PVC	a
– Manufacturer's information	[a]	b

[a] For providing traceability the following details shall be given:

1) the production period, year, in figures or in code;
2) a name or code for the production site if the manufacturer is producing in different sites, nationally and/or internationally.

Table 20 – Minimun required marking of fittings

18.1.5.4. ADDITIONAL MARKING

Pipes and fittings conforming to BS EN 1401, which also conform to other standard(s), may be additionally marked with the minimum required marking in accordance with this/those other standard(s).

Pipes and fittings conforming to the legal standard which are third party certified may be marked accordingly.

NOTE Attention is drawn to the possible need to include CE marking when required for legislative purposes.

18.1.6. TYPES OF JOINTS

18.1.6.1. GENERAL

18.1.6.1.1. *INTRODUCTION*

Unplasticized PVC pipes and fittings complying with the requirements of legal standards are jointed preferably by push-fit (insertion) joints. For pipe up to 315 nominal sizes, it is permitted to use solvent cement joints. A pipe can be plain ended for jointing by means of separate double-socketed couplings. Alternatively it can have an integral socket, either formed upon or fixed to one or both ends. For insertion of junctions in an existing pipeline or for effecting repairs, double-socketed couplings without a central register should be used.

18.1.6.1.2. *PUSH-FIT (INSERTION) JOINTS*

The push-fit joint, in which the elastomeric sealing ring is automatically compressed to form a seal when the spigot is inserted into the socket, provides a rapid method of jointing pipes. Sealing rings should be made from natural or synthetic rubber complying with the requirements of the legal standard applicable. The sealing ring is housed in the socket, and its cross section, and that of the socket, varies according to the

manufacturer. It is therefore important that the sealing rings used should be only those supplied by the manufacturer for the particular joint. The rings are often supplied captive in position, but if they are supplied loose, care has to be taken to use the correct rings. Satisfactory assembly of a push-fit joint requires provision of a chamfer on the pipe and proper lubrication of the spigot end before insertion into the socket. Only the lubricant supplied or recommended by the supplier should be used.

18.1.6.1.3. ***SOLVENT CEMENT JOINTS***

A solvent cement joint is one in which a solvent cement is applied to both the pipe end (spigot) and to the socket before assembling by pushing the spigot fully home into the socket. The solvent cement forms a "cold weld". This technique becomes less easy in sizes greater than nominal size 160 and is not normally recommended for sizes in excess of 315 nominal size without reference to the manufacturer. For pipes complying with the requirements of legal standard aplicable, only cements complying with the requirements of legal standard aplicable should be used. For smaller pipes complying with the requirements of legal standard aplicable, either this cement or one recommended by the manufacturer may be used.

18.1.6.2. JOINTING PROCEDURE

18.1.6.2.1. ***PUSH-FIT JOINTS***

Jointing should be carried out strictly in accordance with the pipe manufacturer's instructions. The following is the normal jointing procedure.

a) In the case of a pipe cut on site, the end to be jointed should be cut square and chamfered in a similar manner to the pipes and fittings supplied by the manufacturer, and all swarf removed.

b) The pipe end, the socket and the ring location should be thoroughly cleaned and the sealing ring seated correctly into its location.

c) The correct lubricant should be applied all round the chamfered end.

d) The pipe end should be carefully aligned with the adjoining pipe socket and pushed in without delay, to the correct insertion depth. If a lever is used on the pipe to push the joint home, a block of wood should be inserted between the lever and the end of the pipe to prevent damage.

e) It is unnecessary to allow any waiting period before applying a pressure test to a push-fit joint.

18.1.6.2.2. ***SOLVENT CEMENT JOINTS***

Jointing should be carried out strictly in accordance with the instructions of the manufacturer of the pipe and the manufacturer of the solvent cement. The use of solvent cements and degreasing agents may involve fire and toxic hazards; particular care has to be taken in following instructions on these matters. The following is the normal jointing procedure.

a) In the case of a pipe cut on site, the end to be jointed should be cut square and chamfered in a similar manner to the pipes and fittings made by the manufacturer, and all swarf removed.

b) The pipe end and the socket should be thoroughly cleaned.

c) The cleaned surfaces should then be lightly and uniformly roughened with clean medium grade glass paper or emery cloth and then cleaned using a suitable degreasing solvent (e.g. methylene chloride).

d) One even coat of cement should be applied to both of the surfaces to be jointed, stroking the cement along, and not around, the surfaces.

   Application of excessive cement should be avoided.

e) The pipe end should immediately be pushed fully home, without twisting, and held for not less than 10 s. If a lever is used on the pipe to hold the joint in position, a block of wood should be inserted between the lever and the end of the pipe to prevent damage. Surplus cement should be removed.

f) After completion, allow 1 h for the joint to set before applying a pressure test.

18.1.6.3. STORAGE, HANDLING AND TRANSPORT

18.1.6.3.1. ***STORAGE***

The following recommendations relate to the storage of unplasticized PVC pipes

a) Pipes should be stacked on a reasonably flat surface free from sharp projections, stones and other protuberances. Side support should be provided at intervals of not more than 1.5 m and these supports should preferably consist of battens not less than 75 mm wide.

b) Pipes should be preferably uniformly supported throughout their length. If this is not possible, timber battens at least 75 mm wide, at spacings not greater than 1 m centres, should be placed beneath the pipes. Preferably, pipes of different size and wall thickness should be stacked separately, or where this is not possible, those with larger diameters and thicker walls should be at the bottom. It is preferable that pipes should not be stored one inside another.

c) If spigot and socket pipes are stacked, sockets should be placed at alternate ends of the stack with sockets protruding so that pipes are evenly supported along their entire length. Pipe stacks should not exceed 7 layers, with a maximum height of 2 m.

18.1.6.3.2. ***HANDLING***

Pipes made from unplasticized PVC are strong, though lightweight, and are therefore very easily handled. However, it is necessary to take care to prevent damage; in particular, pipes should not be thrown, dropped or dragged along. If pipes are moved by rolling, it is necessary to ensure that they are adequately supported along their length and properly restrained on inclines.

If pipes are loaded or unloaded by mechanical means (fork lift truck, cranes, etc.) care should be exercised to avoid damaging them. They should be suitably supported at two places when being lifted. Preferably, protected slings should be used, but if metal hooks, chains, etc. are used, padding should be placed between them and the pipes. If pipes are delivered one inside the other, special care should be taken to avoid damage during unloading. The impact strength of unplasticized PVC is reduced in cold weather during which extra care in handling should be exercised.

18.1.6.3.3. ***TRANSPORT***

Vehicles with a flat bed should be used for the transport of pipes. The bed should be free from nails and other projections. Each pipe should be supported uniformly along its length.Vehicles should have adequate side supports at not more than 1.5 m spacing and pipes should be effectively secured during transit. All uprights should be flat and free from sharp edges.When loading spigot and socket pipes, they should be stacked in alternate layers so that the sockets do not carry any load. If pipes are transported one inside another, it is essential to take necessary precautions to prevent them damaging each other.Pipes should be loaded on to a vehicle in such a way that any overhang does not exceed 1 m. Thick-walled pipes should be loaded before thin-walled pipes.

18.1.6.3.4. ***INSPECTION***

The pipes and fittings should be visually checked for any damage immediately prior to installation.

18.1.6.4. INSTALLATION

18.1.6.4.1. ***GENERAL***

The ability of a rigid pipe to support the total load transmitted to it is established by reference to actual crushing tests to cause fracture.

Flexible pipes such as those made from unplasticized PVC do not fracture under load but they are liable to deformation. The extent of this deformation depends largely upon the compaction of the immediate surrounding fill. For this reason, flexible pipes should always be surrounded with non-cohesive. This surround should extend to the trench width in normal trench situations.

The external loads (backfill and surcharge) imposed on a pipe of rigid material (such as vitrified clay, concrete, asbestos cement or cast iron) are supported mainly (sometimes wholly) by the resistance of the pipe to circumferential bending. On the other hand unplasticized PVC pipes, being relatively flexible, offer less resistance to circumferential deformation and rely partly on external support to resist deformation. Therefore, it is of primary importance for unplasticized PVC pipes that fill material, particularly the bedding and sidefill, should be properly compacted in order to prevent excessive deformation.It is desirable that vertical deformation should be limited to 5 % on completion of the backfilling, which can only be achieved by proper compaction of the backfill. It is essential to avoid high stress concentrations, and sharp objects such as large stones or flints should not be allowed to come into contact with the surface of the pipe.

Attention is drawn to the tests for determining the suitability of “as dug” material for use as bedding and surround.

The flexible nature of unplasticized PVC pipes helps them to accommodate deformations resulting from ground movement or from other differential settlement under normal circumstances.

Except in special circumstances, e.g. at very shallow cover depths or where it is necessary to safeguard the foundations of existing structures, the use of concrete for bedding or surrounding the pipes is unnecessary.

Normally drainage pipework is laid in straight lines. However, in special circumstances and subject to approval it may sometimes be acceptable to “spring” the jointed pipes to a slight curve to avoid an obstacle, or to follow the curvature of a street. In such cases, accurate records should be kept to assist subsequent relocation.

If jointed pipes are laid in a slight curve, and the joints are of the push-in type, care has to be taken not to spring the pipework to too sharp a curve or the joints may be over-strained and fail later.

The manufacturer should be consulted as to the minimum radius that can be accommodated in this way. As a guide, the minimum cold-bend radius for unplasticized PVC pipes is about 20 m per 100 mm of diameter. Straining of the joints can be minimized by firmly backfilling a short length of pipe following a joint before bending the remaining length of pipe.

The pipe should be anchored in this position by further backfilling before the next joint is made, and the process repeated as necessary.

The trench may need to be widened on the outside of the curve to accommodate the pipe in its straight position. It is essential that jointing is always carried out in the straight position.

18.1.6.4.2. ***TRENCH PREPARATION***

The trench should not be opened too long in advance of pipe laying and should be backfilled as soon as possible.

It is essential to ensure that the sides of the trenches are adequately supported in accordance with the requirements of legal standard aplicable.

To minimize a possible hazard, a trench should be open for the minimum time practicable.

At the crown of the pipe and for 300 mm, or one pipe diameter if greater, above it the width of the trench within any timbering should be as narrow as is practicable, but not less than the outside diameter of the pipe plus sufficient extra width (usually about 150 mm) on each side of the pipe to provide access for making the joints and placing and compacting sidefill. Above this level, the trench may be of any convenient width.

If the as-dug material is suitable for use as bedding, the bottom of the trench may be trimmed to form the pipe bed. Otherwise, the trench should be excavated to an adequate depth below the invert level of the pipe to allow for the necessary thickness of bedding material.

The thickness of bedding under the barrel of the pipes should be a minimum of 100 mm, but in very wet or soft conditions or where the trench bottom is very irregular, it may be necessary to increase this thickness.

Bedding should be properly compacted and finished so as to provide uniform support for the pipe.

It is essential that bricks or other hard materials are not placed under the pipes for temporary or permanent support. Material to be used for bedding and surrounding the pipes should be selected granular material, either available locally or, if necessary, brought to the site.

Alternatively, granular material in accordance with the legal standard may be used.

18.1.6.4.3. ***PIPE LAYING***

The pipes should be jointed in the trench and laid on the prepared bed so that the barrel of the pipe maintains substantially continuous contact.

Small depressions should be made to accommodate the pipe sockets or couplings, which should be carefully filled after the pipe has been laid, taking care that no voids remain under or around the socket.

Traffic, including heavy construction vehicles, should not be allowed to pass over pipes which have less than 0.9 m of cover, unless suitable protection is provided.

Care should be taken to prevent pipes from deviating from their designed level and line due to flotation prior to backfilling. Any struts used for this purpose should be removed as backfilling proceeds.

Where a pipe is required to go through the wall or foundation of a building or other rigid structure other than at an inspection chamber or manhole, a sleeve should be built into the wall or structure. The inside sleeve diameter should be not less than the outside diameter of the pipe plus 20 mm. The annular space between pipe and sleeve should be stopped with a suitable material which is compatible with the pipe material and which should be non-hardening, non-cracking and resistant to moisture and gas.

Pipe joints should not occur within the sleeve. Alternatively, a lintel or relieving arch may be formed in the structure to leave 20 mm clearance above the crown of the pipe which should be filled as indicated above.

Where a pipe passes through a wall at a point below the level of the natural water table, a puddle-flanged pipe or a purpose-made unplasticized PVC sleeve-coupler should be used to prevent ingress of water.

The provision of at least one flexible joint is recommended within 300 mm of the external face of the wall of any building and at each entry or exit point of all manholes and inspection chambers.

Where abnormal settlement is expected, it is desirable to incorporate two flexible joints to form a “rocker” length of pipe.

18.1.6.4.4. ***SIDEFILL AND BACKFILL***

After the pipes have been laid and tested, more of the selected granular material should be placed evenly on both sides of the pipes up to a level above the pipe crown and compacted.

Pipes larger than 315 mm may require an intermediate stage of compaction.

If the main backfill over the pipes is liable to contain particles exceeding 40 mm, or where the trench is deeper than 2 m to 3 m in unstable soil, the granular material should extend to at least 100 mm above the pipe crown.

Any trench supports should be withdrawn in stages so that the sidefill can be properly compacted between the pipe and the trench walls. In all cases material should be worked under the sides of the pipes to eliminate voids as much as possible.

It may be advantageous, if the pipes are tested by water pressure, to carry out the backfilling operation with the pipes full of water.

Unless otherwise specified or the statutory authorities require a different material, the material excavated from the trench may be used for the remainder of the backfill, but if the granular material does not extend to at least 100 mm above the pipe crown the first 300 mm of backfill should be selected to be free of stones exceeding 40 mm in size.

The backfill should be compacted in 300 mm layers or in compliance with the requirements of statutory authorities. Heavy compactors should not be used until the pipes have at least 300 mm of cover, but suitable light vibratory tampers may be used with discretion at any stage of the work to aid compaction.

Pipes at depths less than 0.6 m not under a road should, where necessary, be protected against risk of damage, for example, by placing over them a layer of concrete paving slabs with at least 75 mm layer of granular material between pipes and slabs.

Pipes laid at a depth less than 0.9 m below the finished surface of a road should be suitably protected with a reinforced concrete surround or by means of reinforced bridging slabs of adequate strength.

When pipes are laid under buildings the rigidity of a concrete bed and surround may be undesirable and in this case only single-size aggregate or material having a compaction fraction of 0.20 or less, when tested in the manner described in legal standard, should be used.

The surround and the backfill should be continued with similar material up to the underside of the oversite concrete.

18.1.6.5. CONNECTION INTO EXISTING DRAINS AND SEWERS

18.1.6.5.1. *SEWERS*

Connections to sewers should be made only as directed by the drainage authority responsible for the sewer, and should only be made using purpose-made junctions or saddles.

Unplasticized PVC pipes

A connection into an unplasticized PVC pipe can be effected by inserting a junction into the line. This is achieved by cutting out the appropriate length of unplasticized PVC pipe, preparing the cut ends for jointing and placing one repair coupling (or two if a plain ended junction piece is used) into position on the prepared ends.

The junction pipe is fitted into position and repair coupling(s), which are double socketed and have no centre stop, are then slipped into position to complete the insertion, after which the new branch connection can be made.

As an alternative to the use of a junction, a saddle connection may be made. This may be either by means of solvent cementing or by mechanical means such as a purpose-made clamp and saddle incorporating a sealing ring. Care should be taken to avoid solvent cement entering the existing pipe.

The saddle should be placed in its intended location and its position marked.

The position of the inlet hole should be marked on the outside of the pipe using the saddle or a purpose-made template.

The inlet hole can be made by drilling a small hole and cutting out the profile with a keyhole saw.

It is essential to remove all swarf and rough edges.

If the saddle is to be solvent cement jointed, the surfaces of the pipe and saddle should be prepared as described previously, coated with cement and jointed. The joint should be held securely in position until sufficient strength has been achieved in the joint as indicated by the manufacturer; in general, at least 15 min should be allowed.

Saddle connections by mechanical means should be made in accordance with the manufacturer's instructions.

Jointing to pipes of other materials

Branch connections into pipes of other materials should be made using a junction piece or saddle appropriate to the existing pipeline.

The connection to the branch can be made using an appropriate unplasticized PVC adaptor.

Where a cement mortar joint is to be used, the unplasticized PVC fittings should be treated and the surfaces prepared to ensure adhesion to the cement mortar when required.

The unplasticized PVC surface should be roughened and cleaned, coated with solvent cement and immediately sprinkled with clean dry sand. When this has dried it will provide a suitable key for the cement mortar.

The adaptors shall be also suitable for use to effect a change of material along a straight pipeline.

Connectors with flexible joints are available for some sizes of pipes and are generally to be preferred.

18.1.6.5.2. *INSPECTION CHAMBERS, MANHOLES AND ACCESS POINTS*

Unplasticized PVC channel fittings for benching in cement mortar are available for use in brick manholes, constructed in accordance with legal standards, or pre-cast concrete manholes complying with the requirements of legal standard aplicable.

Where retaining clips or other mechanical devices are not incorporated into channel fittings, the surface in contact with cement mortar should be treated to promote adhesion. Connection to an inspection chamber or manhole constructed entirely of other materials may be made according with the legal standard.

Unplasticized PVC drop pipes may be placed inside the chamber and should be supported at intervals not greater than 1.8 m.

Where a back drop is used outside a chamber, which is to be surrounded by concrete, the back drop should be incorporated into the concrete surround.

In other cases, subject to regulations, granular material may be placed and compacted around the drop pipe connection and under the bend to ensure support.

Special access units, inspection chamber bases and complete inspection chambers manufactured from various plastics materials, are available for use with unplasticized PVC underground drains. These should be installed strictly in accordance with the manufacturers' or suppliers' instructions.

Where access is required for rodding at the head of the drain or at a branch, a rodding eye may be used. This may be purpose-made or constructed from unplasticized PVC fittings complying with the requirements of legal standard aplicable.

18.1.6.6. INSPECTION AND TESTING

All newly installed pipes, manholes, inspection chambers and access points should be tested in accordance with appropriate regulations and bye-laws.

Requirements may vary according to the locality of the installation.

Compliance with the recommended limit on deformation may be checked by pulling a sphere, or similar object, of an appropriate dimension through the pipework.

18.1.6.7. CLEANING AND REPAIR

Conventional rods, implements and specialist power assisted equipment may be used for cleaning unplasticized PVC drains.

It is necessary to ensure that cleaning equipment, particularly the end implement, will not cause damage to pipe walls.

In the event of a repair being necessary to an unplasticized PVC drain a new section of pipe may be inserted using repair couplings.

18.2. HDPE PIPE INSTALLATIONS

18.2.1. PIPEWORK IN POLYETHYLENE HDPE PE80 PN10

18.2.1.1. GENERAL CHARACTERISTICS

a) Appearance

When viewed without magnification the internal and external surfaces of pipes shall be smooth and clean and shall have no scoring, cavities, and other surface defects to an extent that would prevent conformity to this standard. The ends of the pipe shall be cut cleanly and square to the axis of the pipe.

b) Colour

Pipes intended for the conveyance of water for human consumption shall be black or blue. In addition, black pipes may be identified by blue stripes, according to national preference. Blue pipes or black pipes with blue stripes are intended for the conveyance of water for human consumption only. Pipes intended for other purposes, drainage and sewerage shall be black or black with brown stripes or according to national preference.

For others coextruded layer of coextruded pipes or the outer peelable layer of peelable layer pipes made conform to EN 12201-1.

NOTE 1: In some countries, pipes made from non-pigmented compound in conjunction with an external peelable layer are permitted, providing the compound conforms to the requirements of this standard. If this is allowed in a country, this should be clearly stated in the national foreword.

NOTE 2: For above ground installations, all components other than black should be protected from direct UV light.

NOTE 3: The national preference for colour should be stated in the National Foreword.

c) Effect On Water Quality

For compounds intended to be used for components in contact with water for human consumption, attention is drawn to the requirements of national regulations.

18.2.1.2. GEOMETRICAL CHARACTERISTICS

a) Measurements

The dimensions of the pipe shall be measured in accordance with EN ISO 3126 and rounded to the next 0.1 mm. In the case of dispute the measurements of dimensions shall be made not less than 24 h after manufacture after being conditioned for at least 4 h at (23 ± 2) °C.

NOTE 1: Indirect measurement during the stage of production is allowed at shorter time periods providing evidence is shown of correlation.

NOTE 2: The national preference for pipe size and PN rating may be given in the National Foreword.

b) Mean Outside Diameter, Out-Of-Roundness (Ovality) And Tolerances

The mean outside diameters, dem, and the out-of-roundness (ovality) shall be in accordance with Table 7. For coiled pipes, the maximum out of roundness shall be specified by agreement between the manufacturer and the end-user. Pipe extruded from PE 40 materials shall be limited to diameters up to and including 63 mm.

NOTE 1: In some countries pipe in PE 40 materials may be used in diameters up to and including 90 mm. If this is the case this should be stated in the National Foreword.

Nominal size DN/OD	Nominal outside diameter d_n	Mean outside diameter [a] $d_{em,min}$	Mean outside diameter [a] $d_{em,max}$	Maximum out-of-roundness (ovality) [b,d]
16	16	16,0	16,3	1,2
20	20	20,0	20,3	1,2
25	25	25,0	25,3	1,2
32	32	32,0	32,3	1,3
40	40	40,0	40,4	1,4
50	50	50,0	50,4	1,4
63	63	63,0	63,4	1,5
75	75	75,0	75,5	1,6
90	90	90,0	90,6	1,8
110	110	110,0	110,7	2,2
125	125	125,0	125,8	2,5
140	140	140,0	140,9	2,8
160	160	160,0	161,0	3,2
180	180	180,0	181,1	3,6
200	200	200,0	201,2	4,0
225	225	225,0	226,4	4,5
250	250	250,0	251,5	5,0
280	280	280,0	281,7	9,8
315	315	315,0	316,9	11,1
355	355	355,0	357,2	12,5
400	400	400,0	402,4	14,0
450	450	450,0	452,7	15,6
500	500	500,0	503,0	17,5
560	560	560,0	563,4	19,6
630	630	630,0	633,8	22,1
710	710	710,0	716,4	24,9
800	800	800,0	807,2	28,0
900	900	900,0	908,1	—
1 000	1 000	1 000,0	1 009,0	—
1 200	1 200	1 200,0	1 210,8 [c]	—
1 400	1 400	1 400,0	1 412,6 [c]	—
1 600	1 600	1 600,0	1 614,4 [c]	—
1 800	1 800	1 800,0	1 816,2 [c]	—
2 000	2 000	2 000,0	2 018,0 [c]	—
2 250	2 250	2 250,0	2270,3 [c]	—
2 500	2 500	2 500,0	2522,5 [c]	—

[a] In accordance with ISO 11922-1:1997 [7] grade B for sizes ≤ 630 and grade A for sizes > 710 except for dn 40 and 50.
[b] In accordance with ISO 11922-1:1997 [7] grade N for sizes ≤ 630 and is measured at the point of manufacture.
[c] Tolerance calculated as 0,009dn and does not conform to grade A in ISO 11922-1:1997 [7].
[d] For straight lengths of pipe with diameters ≥ 900 the maximum out-of-roundness shall be agreed between the manufacturer and the purchaser.

Table 21 – Mean outside diameters and out-of-roudness

NOTE 2 Tolerance bands in accordance with ISO 11922-1:1997 [7] are calculated using the following formulae, as applicable.

a. Grade A: 0,009dn rounded to the next greater 0,1 mm with a minimum value of 0,3 mm and a maximum value of 10,0 mm;

b. Grade B: 0,006dn rounded up to the next greater 0,1 mm with a minimum value of 0,3 mm and a maximum value of 4,0 mm;

c. Grade N:

- for diameters ≤ 75 mm: (0,008 d n + 1) mm;
- for diameters ≥ 90 mm and ≤ 250 mm: (0,02 d n) mm;
- for diameters > 250 mm: (0,035 d n) mm;
- rounded to next greater 0,1 mm.

c) Wall Thicknesses And Their Tolerances

The wall thickness shall be in accordance with Table 8.

	Pipe series											
	SDR 6 S 2,5		SDR 7,4 S 3,2		SDR 9 S 4		SDR 11 S 5		SDR 13,6 S 6,3		SDR 17 S 8	
	Nominal pressure, PN [a] in bar											
PE 40	—		PN 10		—		PN 6		—		PN 4	
PE 80	PN 25		PN 20		PN 16		PN 12,5		PN 10		PN 8	
PE 100	—		PN 25		PN 20		PN 16		PN 12,5		PN 10	
Nom. size DN/OD	Wall thicknesses [b]											
	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
16	3,0 [c]	3,4	2,3 [c]	2,7	2,0 [c]	2,3	-	-	-	-	-	-
20	3,4	3,9	3,0 [c]	3,4	2,3	2,7	2,0 [c]	2,3	-	-	-	-
25	4,2	4,8	3,5	4,0	3,0 [c]	3,4	2,3	2,7	2,0 [c]	2,3	-	-
32	5,4	6,1	4,4	5,0	3,6	4,1	3,0 [c]	3,4	2,4	2,8	2,0 [c]	2,3
40	6,7	7,5	5,5	6,2	4,5	5,1	3,7	4,2	3,0	3,5	2,4	2,8
50	8,3	9,3	6,9	7,7	5,6	6,3	4,6	5,2	3,7	4,2	3,0	3,4
63	10,5	11,7	8,6	9,6	7,1	8,0	5,8	6,5	4,7	5,3	3,8	4,3
75	12,5	13,9	10,3	11,5	8,4	9,4	6,8	7,6	5,6	6,3	4,5	5,1
90	15,0	16,7	12,3	13,7	10,1	11,3	8,2	9,2	6,7	7,5	5,4	6,1
110	18,3	20,3	15,1	16,8	12,3	13,7	10,0	11,1	8,1	9,1	6,6	7,4
125	20,8	23,0	17,1	19,0	14,0	15,6	11,4	12,7	9,2	10,3	7,4	8,3
140	23,3	25,8	19,2	21,3	15,7	17,4	12,7	14,1	10,3	11,5	8,3	9,3
160	26,6	29,4	21,9	24,2	17,9	19,8	14,6	16,2	11,8	13,1	9,5	10,6
180	29,9	33,0	24,6	27,2	20,1	22,3	16,4	18,2	13,3	14,8	10,7	11,9
200	33,2	36,7	27,4	30,3	22,4	24,8	18,2	20,2	14,7	16,3	11,9	13,2
225	37,4	41,3	30,8	34,0	25,2	27,9	20,5	22,7	16,6	18,4	13,4	14,9
250	41,5	45,8	34,2	37,8	27,9	30,8	22,7	25,1	18,4	20,4	14,8	16,4
280	46,5	51,3	38,3	42,3	31,3	34,6	25,4	28,1	20,6	22,8	16,6	18,4
315	52,3	57,7	43,1	47,6	35,2	38,9	28,6	31,6	23,2	25,7	18,7	20,7
355	59,0	65,0	48,5	53,5	39,7	43,8	32,2	35,6	26,1	28,9	21,1	23,4
400	-	-	54,7	60,3	44,7	49,3	36,3	40,1	29,4	32,5	23,7	26,2
450	-	-	61,5	67,8	50,3	55,5	40,9	45,1	33,1	36,6	26,7	29,5
500	-	-	-	-	55,8	61,5	45,4	50,1	36,8	40,6	29,7	32,8
560	-	-	-	-	62,5	68,9	50,8	56,0	41,2	45,5	33,2	36,7
630	-	-	-	-	70,3	77,5	57,2	63,1	46,3	51,1	37,4	41,3
710	-	-	-	-	79,3	87,4	64,5	71,1	52,2	57,6	42,1	46,5
800	-	-	-	-	89,3	98,4	72,6	80,0	58,8	64,8	47,4	52,3
900	-	-	-	-	-	-	81,7	90,0	66,1	72,9	53,3	58,8
1000	-	-	-	-	-	-	90,8	100,0	73,4	80,9	59,3	65,4
1200	-	-	-	-	-	-	-	-	88,2	97,2	71,1	78,4
1400	-	-	-	-	-	-	-	-	102,9	113,3	83,0	91,5
1600	-	-	-	-	-	-	-	-	117,5	129,4	94,84	104,4
1800	-	-	-	-	-	-	-	-	-	-	106,6	117,4
2000	-	-	-	-	-	-	-	-	-	-	118,4	130,4

[a] PN values are based on $C = 1,25$.
[b] Tolerances in accordance with grade V of ISO 11922-1:1997 [7].
[c] The calculated value of e_{min} (ISO 4065:1996 [5]) is rounded up to the nearest value of either 2,0, 2,3 or 3,0. This is to satisfy certain national requirements.

Table 22 – Wall thickness

	Pipe series							
	SDR 21 S 10		SDR26 S 12,5		SDR 33 S 16		SDR 41 S 20	
	Nominal pressure, PN [a] in bar							
PE 40	—		—		—		—	
PE 80	PN 6		PN 5		PN 4		PN 3,2	
PE 100	PN 8		PN 6		PN 5		PN 4	
Nom. size DN/OD	Wall thicknesses [b]							
	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
16	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-
40	2,0 [c]	2,3	-	-	-	-	-	-
50	2,4	2,8	2,0	2,3	-	-	-	-
63	3,0	3,4	2,5	2,9	-	-	-	-
75	3,6	4,1	2,9	3,3	-	-	-	-
90	4,3	4,9	3,5	4,0	-	-	-	-
110	5,3	6,0	4,2	4,8	-	-	-	-
125	6,0	6,7	4,8	5,4	-	-	-	-
140	6,7	7,5	5,4	6,1	-	-	-	-
160	7,7	8,6	6,2	7,0	-	-	-	-
180	8,6	9,6	6,9	7,7	-	-	-	-
200	9,6	10,7	7,7	8,6	-	-	-	-
225	10,8	12,0	8,6	9,6	-	-	-	-
250	11,9	13,2	9,6	10,7	-	-	-	-
280	13,4	14,9	10,7	11,9	-	-	-	-
315	15,0	16,6	12,1	13,5	9,7	10,8	7,7	8,6
355	16,9	18,7	13,6	15,1	10,9	12,1	8,7	9,7
400	19,1	21,2	15,3	17,0	12,3	13,7	9,8	10,9
450	21,5	23,8	17,2	19,1	13,8	15,3	11,0	12,2
500	23,9	26,4	19,1	21,2	15,3	17,0	12,3	13,7
560	26,7	29,5	21,4	23,7	17,2	19,1	13,7	15,2
630	30,0	33,1	24,1	26,7	19,3	21,4	15,4	17,1
710	33,9	37,4	27,2	30,1	21,8	24,1	17,4	19,3
800	38,1	42,1	30,6	33,8	24,5	27,1	19,6	21,7
900	42,9	47,3	34,4	38,3	27,6	30,5	22,0	24,3
1000	47,7	52,6	38,2	42,2	30,6	33,5	24,5	27,1
1200	57,2	63,1	45,9	50,6	36,7	40,5	29,4	32,5
1400	66,7	73,5	53,5	59,0	42,9	47,3	34,3	37,9
1600	76,2	84,0	61,2	67,5	49,0	54,0	39,2	43,3
1800	85,8	94,5	68,8	75,8	55,1	60,8	44,0	48,6
2000	95,3	105,0	76,4	84,2	61,2	67,5	48,9	53,9
2250	107,2	118,1	86,0	94,8	70,0	77,2	55,0	60,7
2500	119,1	131,2	95,6	105,2	77,7	85,6	61,2	67,5

[a] PN values are based on $C = 1,25$.
[b] Tolerances in accordance with grade V of ISO 11922-1:1997 [7].
[c] The calculated value of e_{min} (ISO 4065:1996 [5]) is rounded up to the nearest value of either 2,0, 2,3 or 3,0. This is to satisfy certain national requirements.

Table 23 – Wall thickness (continued)

NOTE 2: Grade V tolerances are in accordance with ISO 11922-1:1997 [7] and calculated from the following formula:

(0,1emin + 0,1) mm, rounded to the next 0,1 mm higher.

For certain applications en > 30 mm tolerance grade T in accordance with ISO 11922-1:1997 [7] can be used and the tolerance calculated from the following formula: 0,15emin, rounded to next higher 0,1 mm.

d) Coiled Pipe

During production the pipe shall be coiled such that localised deformation, e.g. buckling and kinking, is prevented.

The minimum internal diameter of the coil shall be not less than 18dn.

NOTE If smaller coil diameters are necessary, they shall be agreed between the manufacturer and the end user.

e) Pipe Lengths

No requirements have been set concerning particular lengths of coiled or straight pipe or the tolerance thereon; hence it is necessary for lengths of pipe to be supplied by agreement between purchaser and manufacturer.

18.2.1.3. MECHANICAL CHARACTERISTICS

a) Conditioning

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C before testing in accordance with Table 10.

b) Requirements

When tested in accordance with the test method as specified in Table 10 using the indicated parameters, the pipe shall have mechanical characteristics conforming to the requirements given in Table 10.

Characteristics	Requirements	Test parameters		Test method
		Parameters	Value	
Hydrostatic strength at 20 °C	No failure during test period of any test pieces	End caps Conditioning period Number of test pieces [b] Type of test Test temperature Test period Circumferential (hoop) stress for: PE 40 PE 80 PE 100	Type A [a] Shall conform to EN ISO 1167-1 3 Water-in-water 20 °C 100 h 7,0 MPa 10,0 MPa 12,0 MPa	EN ISO 1167-1 and EN ISO 1167-2
Hydrostatic strength at 80 °C	No failure during test period of any test pieces	End caps Conditioning period Number of test pieces [b] Type of test Test temperature Test period Circumferential (hoop) stress for: PE 40 PE 80 PE 100	Type A a Shall conform to EN ISO 1167-1 3 Water-in-water 80 °C 165 h [c] 2,5 MPa 4,5 MPa 5,4 MPa	EN ISO 1167-1 and EN ISO 1167-2
Hydrostatic strength at 80 °C	No failure during test period of any test pieces	End caps Conditioning period Number of test pieces [b] Type of test Test temperature Test period Circumferential (hoop) stress for: PE 40 PE 80 PE 100	Type A a Shall conform to EN ISO 1167-1 3 Water-in-water 80 °C 1000 h 2,0 MPa 4,0 MPa 5,0 MPa	EN ISO 1167-1 and EN ISO 1167-2
Elongation at break for $e_n \leq$ 5 mm	≥ 350 %	Test piece shape Speed of test Number of test pieces [b]	Type 2 100 mm/min Shall conform to EN ISO 6259-1	EN ISO 6259-1 and ISO 6259-3:1997
Elongation at break for 5 mm < $e_n \leq$ 12 mm	≥ 350 %	Test piece shape Speed of test Number of test pieces [b]	Type 1 [d] 50 mm/min Shall conform to EN ISO 6259-1	EN ISO 6259-1 and ISO 6259-3:1997
Elongation at break for $e_n >$ 12 mm	≥ 350 %	Test piece shape Speed of test Number of test pieces [b]	Type 1 [d] 25 mm/min Shall conform to EN ISO 6259-1:	EN ISO 6259-1 and ISO 6259-3:1997
		OR		
		Test piece shape Speed of test Number of test pieces [b]	Type 3 [d] 10 mm/min Shall conform to EN ISO 6259-1	

[a] Type B end caps may be used for batch release tests for diameters ≥ 500 mm.
[b] The number of test pieces given indicate the quantity required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan (for guidance see CEN/TS 12201-7 [3]).
[c] Premature ductile failures are not taken into account. For retest procedure see 7.3.
[d] Machined type 2 test pieces may be used for pipe wall thicknesses ≤ 25 mm. The test may be terminated when the requirement is met, without continuing until the rupture of the test piece.

Table 24 – Mechanical characteristics

c) Retest In Case Of Failure At 80 °C

A fracture in a brittle mode in less than 165 h shall constitute a failure; however if a sample in the 165 h test fails in a ductile mode in less than 165 h, a retest shall be performed at a selected lower stress in order to achieve the minimum required time for the selected stress obtained from the line through the stress/time points given in Table 11.

PE 40		PE 80		PE 100	
Stress MPa	Test period h	Stress MPa	Test period h	Stress MPa	Test period h
2,5	165	4,5	165	5,4	165
2,4	230	4,4	233	5,3	256
2,3	323	4,3	331	5,2	399
2,2	463	4,2	474	5,1	629
2,1	675	4,1	685	5,0	1 000
2,0	1 000	4,0	1 000		

Table 25 – Test parameter for the retest of the hydrostatic strenght at 80ºC

d) Pipe Stiffness For Vacuum Sewer Systems

Pipes for use in vacuum sewer systems shall have an initial ring stiffness Scalc ≥ 4. See Annex D from EN 12201-2:2011.

18.2.1.4. PHYSICAL CHARACTERISTICS

a) Pipe Stiffness For Vacuum Sewer Systems

Pipes for use in vacuum sewer systems shall have an initial ring stiffness Scalc ≥ 4. See Annex D from EN 12201-2:2011

18.2.1.5. PHYSICAL CHARACTERISTICS

b) Conditioning

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C before testing in accordance with Table 12.

c) Requirements

When tested in accordance with the test methods as specified in Table 12 using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in Table 12.

Characteristics	Requirements	Test parameters		Test method
Melt mass-flow rate MFR for PE 40	After processing maximum deviation of ± 20 % of the value measured on the batch used to manufacture the pipe	Load Test temperature Time Number of test pieces [a]	2,16 kg 190 °C 10 min Shall conform to EN ISO 1133	EN ISO 1133
Melt mass-flow rate MFR for PE 80, and PE 100	After processing maximum deviation of ± 20 % of the value measured on the batch used to manufacture the pipe	Load Test temperature Time Number of test pieces [a]	5,0 kg 190 °C 10 min Shall conform to EN ISO 1133	EN ISO 1133
Oxidation induction time	≥ 20 min	Test temperature Test environment Specimen weight Number of test pieces [a,b]	200 °C [c] Oxygen (15±2) mg 3	ISO 11357-6
Longitudinal reversion Wall thickness ≤ 16 mm	≤ 3 % Original appearance of the pipe shall remain.	Test temperature Length of test piece Immersion time Test method Number of test pieces [a]	110 °C 200 mm Shall conform to EN ISO 2505 Free Shall conform to EN ISO 2505	EN ISO 2505
Effect on water quality [d]	National regulations apply.			

[a] The number of test pieces given indicate the quantity required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan (for guidance see CEN/TS 12201-7 [3]).
[b] Samples to be taken from the outer and inner wall surfaces.
[c] Test may be carried out as an indirect test at 210 °C or 220 °C providing clear correlation has been established. In cases of dispute the reference temperature shall be 200 °C.
[d] Test methods, parameters and requirements for all properties are under preparation. Until these European Standards are published National Regulations apply (see Introduction).

Table 26 – Physical characteristics

18.2.1.6. CHEMICAL CHARACTERISTICS OF PIPES IN CONTACT WITH CHEMICALS

If, for a particular installation, it is necessary to evaluate the chemical resistance of the pipe, then the pipe shall be classified in accordance with ISO 4433-1:1997 and ISO 4433-2:1997.

NOTE Guidance for the resistance of polyethylene pipes to chemicals is given in ISO/TR 10358:1993 [6].

18.2.1.7. PERFORMANCE REQUIREMENTS

When pipes conforming to this standard are assembled to each other or to components conforming to other Parts of EN 12201, the joints shall conform to the requirements of EN 12201-5.

18.2.1.8. MARKING

a) General

All pipes shall be permanently and legibly marked in such a way that the marking does not initiate cracks or other types of failure and that normal storage, weathering, handling, installation and use shall not affect the legibility of the marking.

NOTE The manufacturer is not responsible for marking becoming illegible due to actions caused during installation and use such as painting, scratching, covering of the components or by use of detergents, etc. on the components unless agreed or specified by the manufacturer.

If printing is used, the colour of the printed information shall differ from the basic colour of the product.

The marking shall be such that it is legible without magnification.

b) Minimum Required Marking Of Pipes

The minimum required marking shall conform to Table 13, with the frequency of marking being not less than once per metre.

The pipes shall be marked for the intended use by using the appropriate codes in accordance with CEN/TR 15438. For example:

- W for pipes intended for the conveyance of water for human consumption;
- P for pipes intended for the sewer and drainage under pressure;
- W/P for both of the above.

Aspects	Marking or symbol
Standard Number	EN 12201
Manufacturer's name or trademark	Name or symbol
Dimensions ($d_n \times e_n$)	e.g. 110 × 10
SDR series	e.g. SDR 11
Intended use	e.g. W, P, or W/P
Material and designation	e.g. PE 100
Pressure rating in bars	e.g. PN 16
Manufacturer's information	e.g. 1009 [a]
Type of pipe if applicable	eg Co-extruded or Peelable Layer
[a] In clear figures or in code providing traceability to production period within year and month and if the manufacturer is producing at different sites, the production site.	

Table 27 – Minimum required marking

The length of coiled pipes is permitted to be indicated on the coil; the remaining length of pipe on drums or coils is permitted to be indicated on the pipe.

Coextruded and peelable pipe shall be marked accordingly, clearly identifying this type of pipe, including any specific instructions related to these types of pipe.

18.3. CONCRETE MANHOLES

18.3.1. TERMS AND DEFINITIONS

For the purpose of this specification, the terms and definitions and the following apply.

18.3.1.1. CEMENTITIOUS CONTENT

Amount of cement plus any pozzolanic or latent hydraulic addition in the concrete mix

18.3.1.2. CORBEL SLAB

Component without a joint or installed step incorporating a load-bearing overhang, used to adjust the total

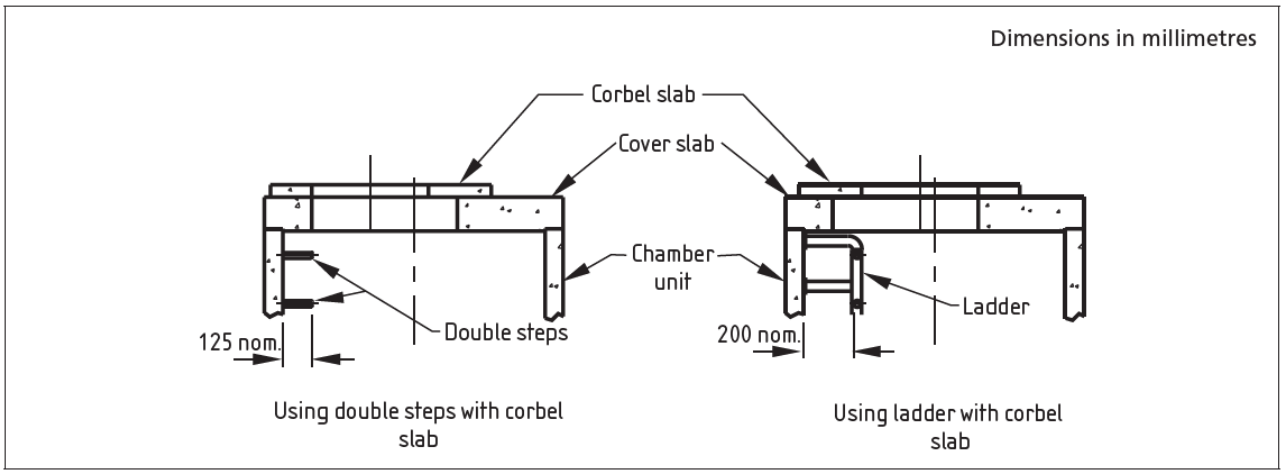


Figure 1 - Use of corbel slabs in conjunction with double steps or ladder

height of a structure and/or to accommodate an appropriate frame or cover

18.3.1.3. ELASTOMERIC SEAL AND LOAD DISTRIBUTING ELEMENT

Combination of seal and load distributing element designed to be watertight and evenly distribute vertical loads generally manufactured in EPDM

18.3.1.4. LANDING SLAB

Component forming an intermediate horizontal platform within a manhole and having an access opening

18.3.1.5. MANUFACTURING DIAMETER

Diameter of a circular unit that a manufacturer seeks to achieve

18.3.1.6. MANUFACTURING SIZE

Dimensions of a rectangular unit that a manufacturer seeks to achieve

18.3.1.7. PLASTOMETRIC SEAL

Deformable non-cured compound of rubber and mineral fibre

18.3.1.8. SOAKAWAY

Vertical chamber of circular cross-section, perforated to allow the passage of water and with or without an access shaft

18.3.1.9. RECTANGULAR OPENING

Shaped access hole whose corners may be relieved by nominal 75 mm × 75 mm chamfers, or by nominal 75 mm radii

18.3.2. GENERAL REQUIREMENTS

18.3.2.1. APPLICATION

For units with nominal size or nominal length not exceeding DN 1250 or LN 1250, respectively, the requirements of this specification shall be in addition to those specified in BS EN 1917 and for the purposes of the latter.

For manholes with nominal sizes greater than DN 1250, landing slabs, corbel slabs and soakaways, the requirements apllied shall also apply, except as otherwise required by, or stated in, this chapter.

18.3.2.2. CONCRETE – COMPOSITION

18.3.2.2.1. *TYPES OF CEMENT*

The cement used shall conform to Table 22.

18.3.2.2.2. *CEMENTITIOUS CONTENT*

The fully compacted concrete shall have a minimum cementitious content of not less than the relevant amount shown in Table 22. The composition/specification of cement groups shall be as shown in Table 23.

Type	Notation	British Standard	Broad designation	Grouping used in BRE SD1:2005
Portland cement	CEM I	BS EN 197-1	CEM I	A
Portland silica fume cement [A]	CEM II/A-D	BS EN 197-1	IIA	A
Portland limestone cement	CEM II/A-L	BS EN 197-1	IIA	B [B] or C [B]
	CEM II/A-LL	BS EN 197-1	IIA	B [B] or C [B]
Portland slag cements	CEM II/A-S	BS EN 197-1	IIA	A
	CEM II/B-S	BS EN 197-1	IIB-S	A
Portland fly ash cements	CEM II/A-V	BS EN 197-1	IIA	A
	CEM II/B-V	BS EN 197-1	IIB-V	A
	CEM II/B-V+SR [C]	BS EN 197-1	IIB+SR	D
Blastfurnace cements	CEM III/A	BS EN 197-1 or	IIIA	A
	CEM III/A+SR [D]	BS EN 197-4	IIIA+SR	D
	CEM III/B	BS EN 197-1 or	IIIB	A
	CEM III/B+SR [D]	BS EN 197-4	IIIB+SR	F
Pozzolanic cement	CEM IV/B(V)	BS EN 197-1 or BS EN 14216	IVB-V	E
Sulfate-resisting Portland cement	SRPC	BS 4027	SRPC	G
Combinations conforming to BS 8500-2:2006, Annex A, manufactured in the concrete mixture from Portland cement and fly ash, ground granulated blast furnace slag (ggbs) or limestone fines:				
CEM I cement conforming to BS EN 197-1 with a mass fraction of 6% to 20% of combination of fly ash conforming to BS EN 450-1	CIIA-V	BS 8500-2:2006, Annex A	IIA	A
CEM I cement conforming to BS EN 197-1 with a mass fraction of 21% to 35% of combination of fly ash conforming to BS EN 450-1	CIIB-V	BS 8500-2:2006, Annex A	IIB-V	A
	CIIB-V+SR [C]		IIB+SR	D
CEM I cement conforming to BS EN 197-1 with a mass fraction of 36% to 55% of combination of fly ash conforming to BS EN 450-1	CIVB-V	BS 8500-2:2006, Annex A	IVB-V	E
CEM I cement conforming to BS EN 197-1 with a mass fraction of 6% to 20% of combination of ggbs conforming to BS EN 15167-1	CIIA-S	BS 8500-2:2006, Annex A	IIA	A
CEM I cement conforming to BS EN 197-1 with a mass fraction of 21% to 35% of combination of ggbs conforming to BS EN 15167-1	CIIB-S	BS 8500-2:2006, Annex A	IIB-S	A
CEM I cement conforming to BS EN 197-1 with a mass fraction of 36% to 65% of combination of ggbs conforming to BS EN 15167-1	CIIIA	BS 8500-2:2006, Annex A	IIIA	A
	CIIIA+SR [D]		IIIA+SR	D
CEM I cement conforming to BS EN 197-1 with a mass fraction of 66% to 80% of combination of ggbs conforming to BS EN 15167-1	CIIIB	BS 8500-2:2006, Annex A	IIIB	A
	CIIIB+SR [D]		IIIB+SR	F
CEM I cement conforming to BS EN 197-1 with a mass fraction of 6% to 20% of combination of limestone fines conforming to BS 7979	CIIA-L	BS 8500-2:2006, Annex A	IIA	B [B] or C [B]
	CIIA-LL		IIA	B [B] or C [B]

[A] When IIA or IIA-D is specified, CEM I and silica fume may be combined in the concrete mixer using the *k*-value concept; see BS EN 206-1:2000, **5.2.5.2.3**.

[B] The classification is B if the cement or combination strength is class 42,5 or higher and C if it is class 32,5.

[C] With a minimum proportion of fly ash of 25%.

[D] Where the alumina content of the slag exceeds 14%, the tricalcium aluminate content of the Portland cement fraction should not exceed 10%.

Table 28 - General purpose cements and combinations

DC-class (design chemical class)	Max. water content ratio	Min. cement or combination content in kg/m³ for max. aggregate sizes (mm) of:				Cement and combination types[A]	Grouping used in BRE SD1:2005
		≥40	20	14	10		
DC-1 [B]	—	—	—	—	—	All in Table 2	A to G
DC-2	0.55	300	320	340	360	IIB-V+SR, IIIA+SR, IIIB+SR, IVB-V	D, E, F
	0.50	320	340	360	380	CEM I, SRPC, IIA-D, IIA-S, IIA-V, IIB-S, IIB-V, IIIA, IIIB	A, G
	0.45	340	360	380	380	IIA-L or LL ≥ class 42,5	B
	0.40	360	380	380	380	IIA-L or LL class 32,5	C
DC-2z	0.55	300	320	340	360	All in Table 2	A to G
DC-3	0.50	320	340	360	380	IIIB+SR	F
	0.45	340	360	380	380	IVB-V	E
	0.40	360	380	380	380	IIB-V+SR, IIIA+SR, SRPC	D, G
DC-3z	0.50	320	340	360	380	All in Table 2	A to G
DC-4	0.45	340	360	380	380	IIIB+SR	F
	0.40	360	380	380	380	IVB-V	E
	0.35	380	380	380	380	IIB-V+SR, IIIA+SR, SRPC	D, G
DC-4z	0.45	340	360	380	380	All in Table 2	A to G
DC-4m	0.45	340	360	380	380	IIIB+SR	F

[A] For the sulfate-resisting characteristics of other cements and combinations, see BRE SD1 [1] and IP 17/05 [2].

[B] If the concrete is reinforced or contains embedded metal, the minimum concrete quality for 20 mm maximum aggregate size is C25/30, 0.65, 260 or designated concrete RC25/30.

Table 29 - Limiting value of composition and properties for concrete where a DC-class is specified

18.3.2.2.3. ***MIXING WATER***

Mixing water for concrete shall conform to legal standard.

18.3.2.3. FINISH – SURFACE VOIDS

With the exception of the external edges of slabs and of adjusting units and of corbel slabs, when tested, surfaces of units and components shall be free from voids that permit diametrically opposite points of the rim of the gauge to touch the surface of the unit or component simultaneously.

Units and components exhibiting any surface void greater than 12 mm deep shall be deemed not to conform to this chapter.

NOTE Voids up to and including 12 mm deep may be made good by the manufacturer

18.3.2.4. GEOMETRICAL CHARACTERISTICS

18.3.2.4.1. ***GENERAL***

Subject to the requirements of this clause, the dimensions and thickness of units and components shall conform to those stated in the factory documents.

18.3.2.4.2. ***NOMINAL SIZES***

NOTE 1 Nominal size is defined as a numerical designation of the size of a component within a structure, which is a convenient integer approximately equal to the manufacturing dimension in millimetres; for a circular unit it is the internal diameter (DN), and for a unit having a rectangular or elliptical internal shape it is the internal length/width (LN/WN).

The nominal sizes of circular and rectangular vertical units and tapers for use with them shall be those given in Table 24 and Table 25, respectively. Steps shall not be permitted in DN 900 shafts or associated components.

NOTE 2 DN 900 units are intended only to be used as a winch shaft because, if fitted with steps or a ladder, the clear space to the back of the shaft would be less than the 900 mm as recommended in the HSE publication, “Safe work in confined spaces” and, ladders should not be fitted to DN 1050 units.

18.3.2.4.3. ***INTERNAL MANUFACTURING DIAMETER AND MANUFACTURING SIZE OF VERTICAL UNITS***

The internal manufacturing diameters and manufacturing sizes of circular and rectangular vertical units shall not be outside the limits given in Table 24 and Table 25, respectively.

Nominal size of chamber and shaft units	Limits of internal manufacturing diameter		Tolerance on actual diameter from manufacturer's stated diameter A)
	Minimum	Maximum	
DN	mm	mm	mm
900	900	950	±8
1050	1050	1100	±8
1200	1200	1250	±9
1350	1350	1400	±10
1500	1500	1550	±11
1800	1800	1850	±12
2100	2100	2150	±14
2400	2400	2450	±15
2700	2700	2750	±15
3000	3000	3050	±15
NOTE Capping units are currently not manufactured in the United Kingdom.			
A) See 3.4.			

Table 30 - Nominal sizes, internal manufacturing diameters and tolerances of circular units

Preferred nominal size LN/WN	Limits of internal manufacturing size		Tolerance on actual size from manufacturer's stated size
	Minimum mm	Maximum mm	mm
900/675	900/675	925/700	±6
1200/675	1200/675	1250/700	±6
1200/750	1200/750	1250/800	±7
1000/1000	1000/1000	1025/1025	±8
1250/1250	1250/1250	1300/1300	±9

Table 31 - Nominal sizes, internal manufacturing sizes and tolerances of rectangular units

18.3.2.4.4. ***CHANNELS AND BENCHING IN BASE UNITS***

The provisions for benching arrangements shall be in accordance with legal standard

NOTE Typical units are shown in Figure 4.

18.3.2.4.5. ***SHAPE, SIZE AND POSITION OF OPENINGS IN SLABS, ADJUSTING UNITS AND CORBEL SLABS***

The shape, size and position of openings in slabs, adjusting units and corbel slabs shall be in accordance with Table 26 and Table 27. The tolerance on the sizes of openings in cover slabs, adjusting units and corbel slabs shall be +200 mm.

NOTE It is permissible for the vertical face(s) of an opening to be cast with a nominal release angle away from the opening.

Type of unit	Shaft or chamber nominal size DN or LN/WN	Opening configuration		
		Size mm	Location	Reference
Cover slab – circular	900	600 × 600 675 × 675	Central	Figure 5
	1050	600 × 600 675 × 675	Eccentric	
		750 × 750	Central	
	1200, 1350 and 1500	600 × 600 675 × 675 750 × 600	Eccentric	
		1200 × 675	Central	
	1800, 2100, 2400, 2700 and 3000	1200 × 675	Eccentric	
Cover slab – rectangular	900/675 1200/675 1200/750	600 × 600 675 × 675 750 × 600	Eccentric	Figure 6
	1000/1000	600 × 600 675 × 675	Eccentric	
		750 × 750	Central	
	1250/1250	600 × 600 675 × 675 750 × 600	Eccentric	
		1200 × 675	Central	
Adjusting unit	—	600 × 600 675 × 675 750 × 600 1200 × 675	Central	Figure 7
Corbel slab	—	600 × 600	Eccentric	Figure 8

NOTE 1 The sizes of the openings are generally consistent with the safety guidelines given in the HSE publication "Safe work in confined spaces" [3] and in BS EN 752:2008, Table NA.22.

NOTE 2 "Adjusting units" and "corbel slabs" were both previously described as "cover frame seating rings".

Table 32 - Shape, size and position of openings in cover slabs, adjusting units and corbel slabs

Type of unit or component	Chamber nominal size	Shaft nominal size	Opening configuration		
			Size	Location	Reference
	DN	DN	mm		
Reducing slab	1200 to 3000	900	900	Eccentric	Figure 9
	1500 to 3000	1050	1 050	Eccentric	
	1800 to 3000	1200	1 200	Eccentric	
Landing slab	1500 to 3000	—	900	Eccentric	Figure 10

Table 33 - Shape, size and position of openings in reducing and landing slabs

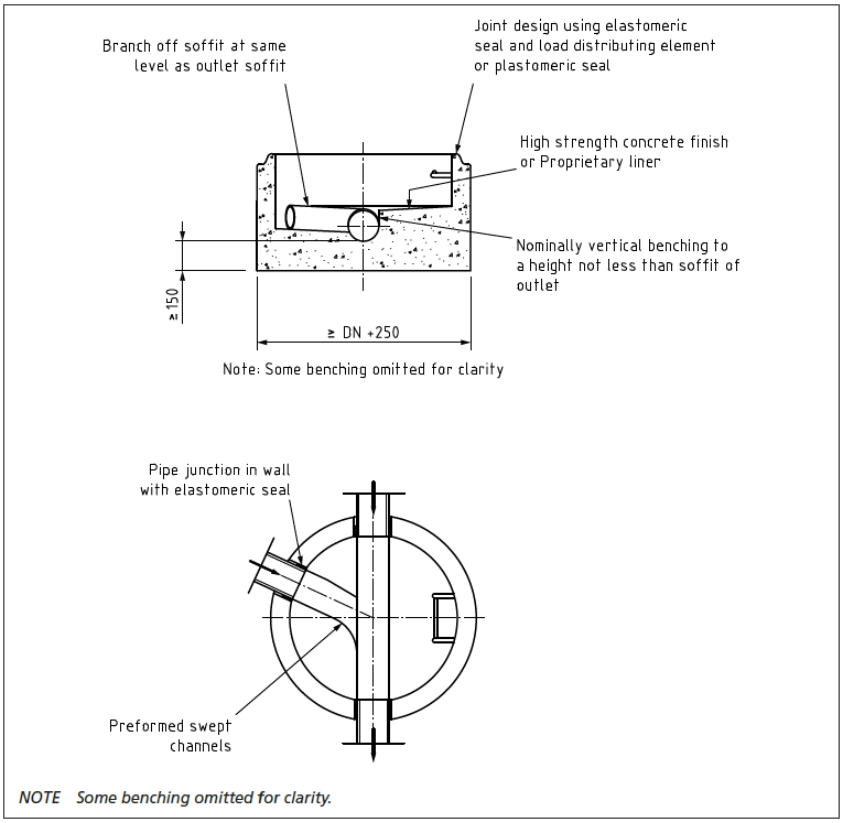


Figure 2 - Typical base unit - circular

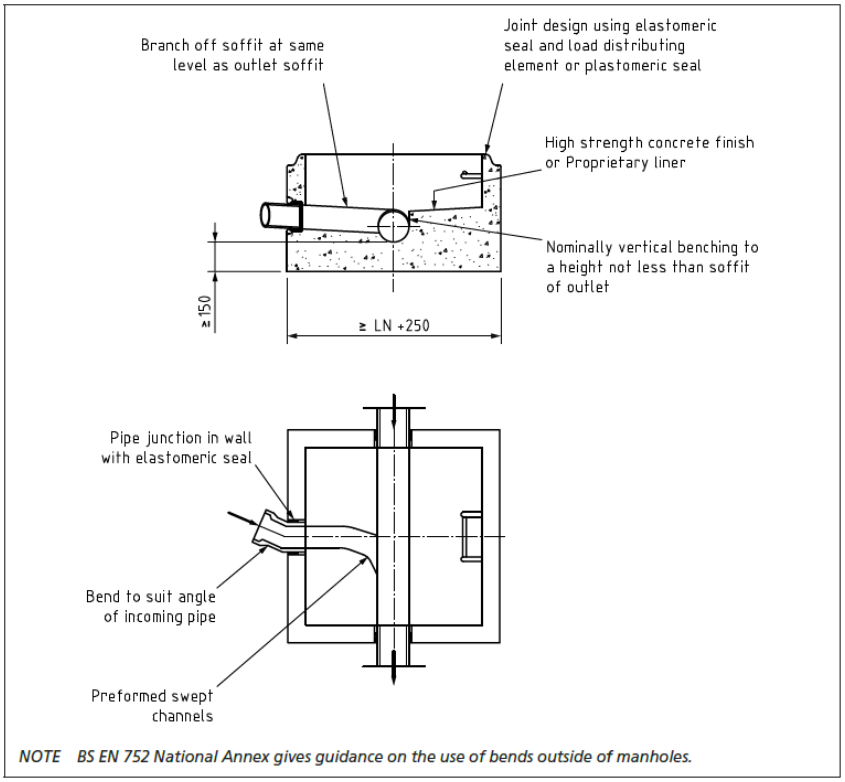


Figure 3 - Typical base unit - rectangular

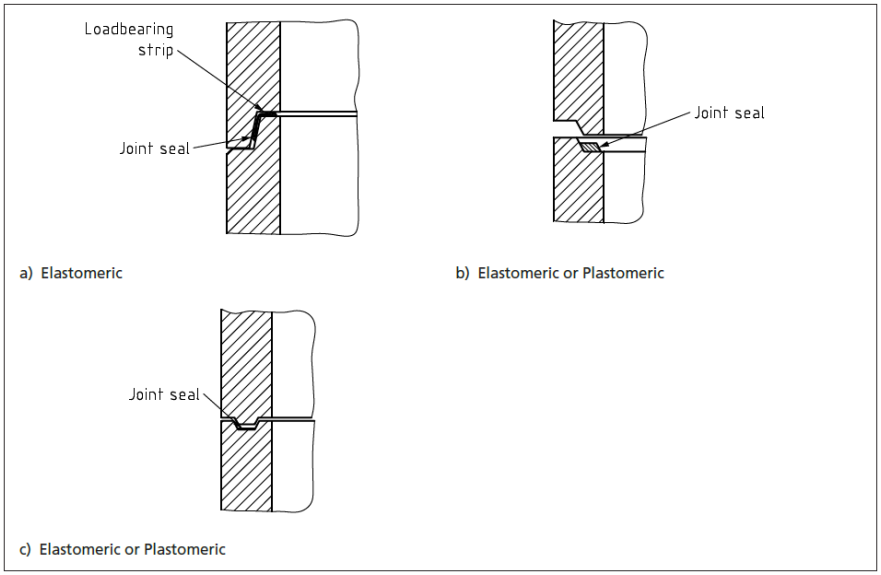


Figure 4 - Typical joint profiles

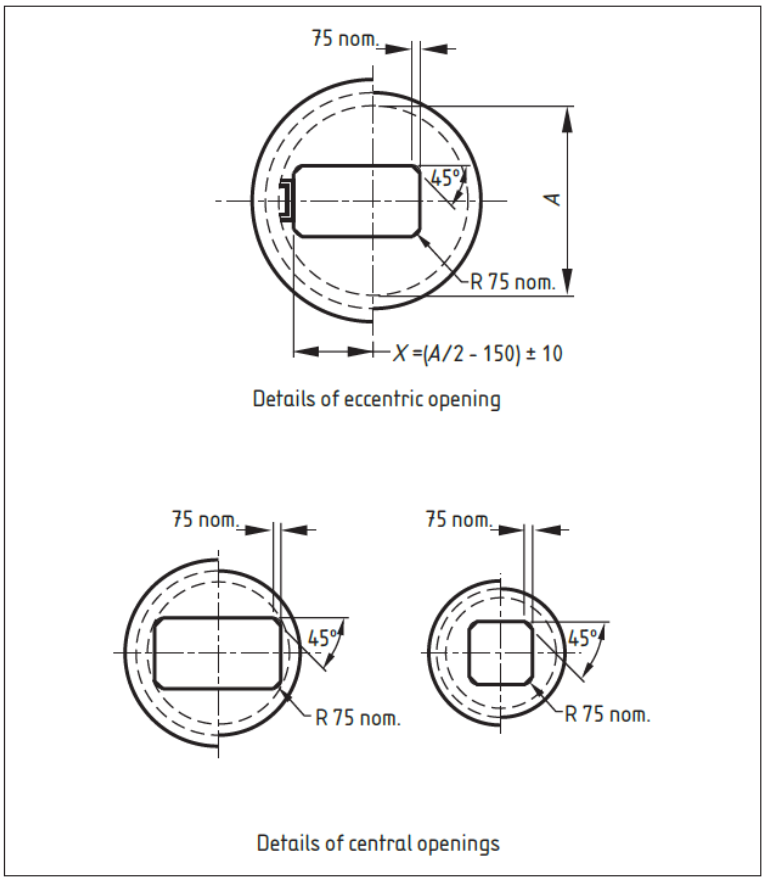


Figure 5 - Openings in circular cover slabs

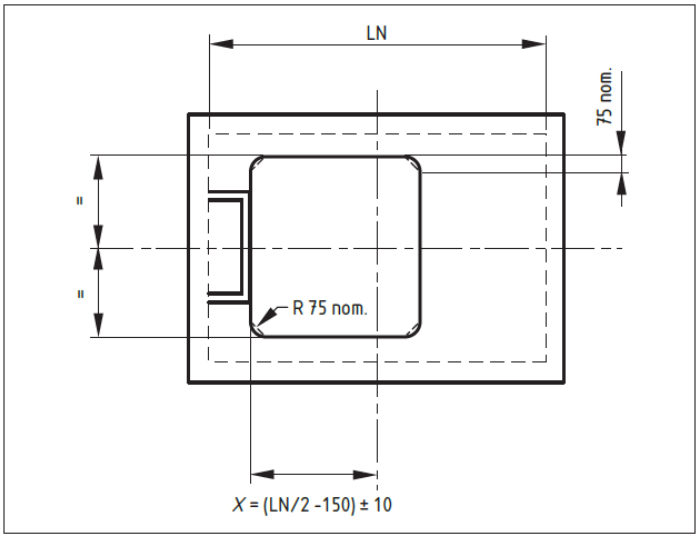


Figure 6 - Openings in rectangular cover slabs

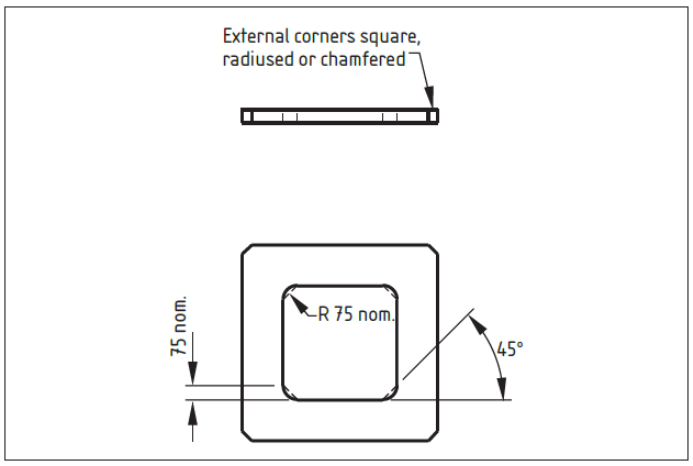


Figure 7 - Typical adjusting unit

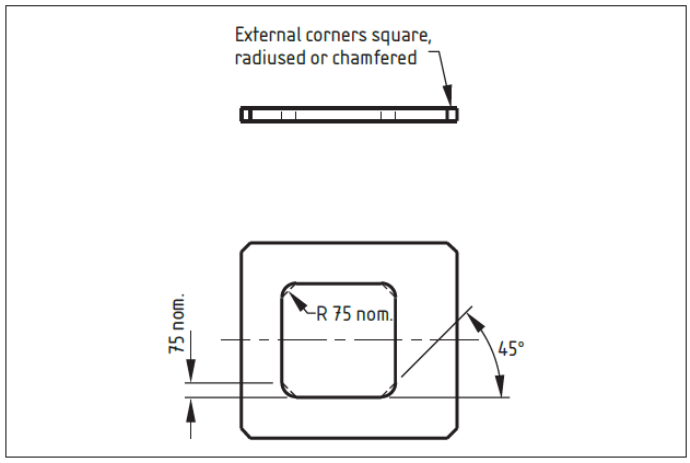


Figure 8 - Typical corbel slabs

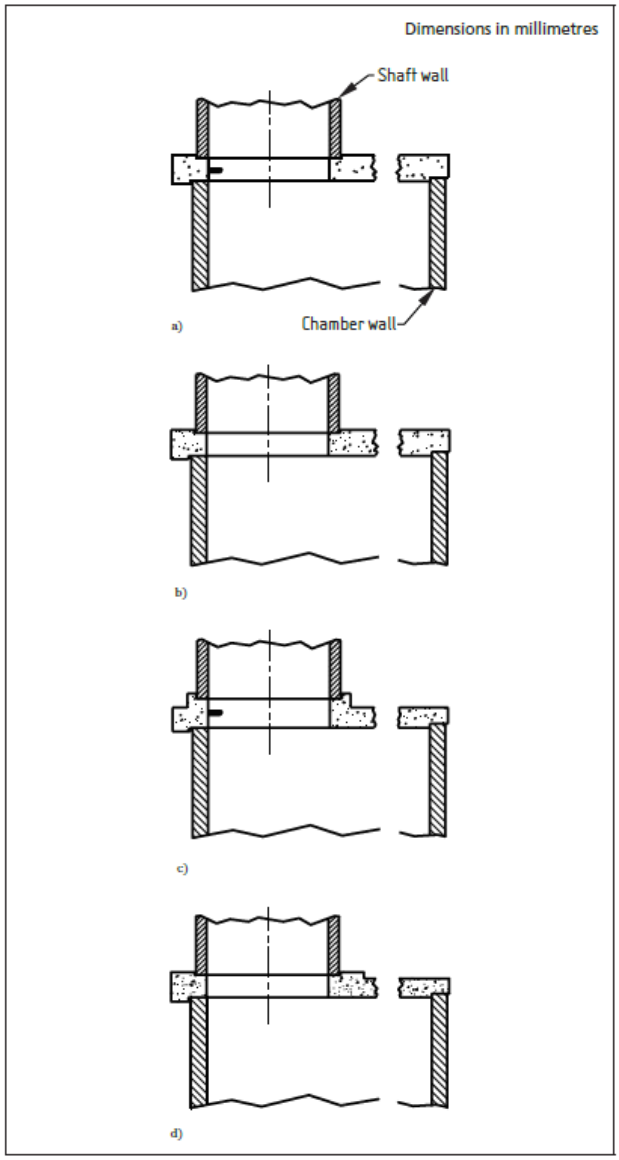


Figure 9 - Typical reducing slabs

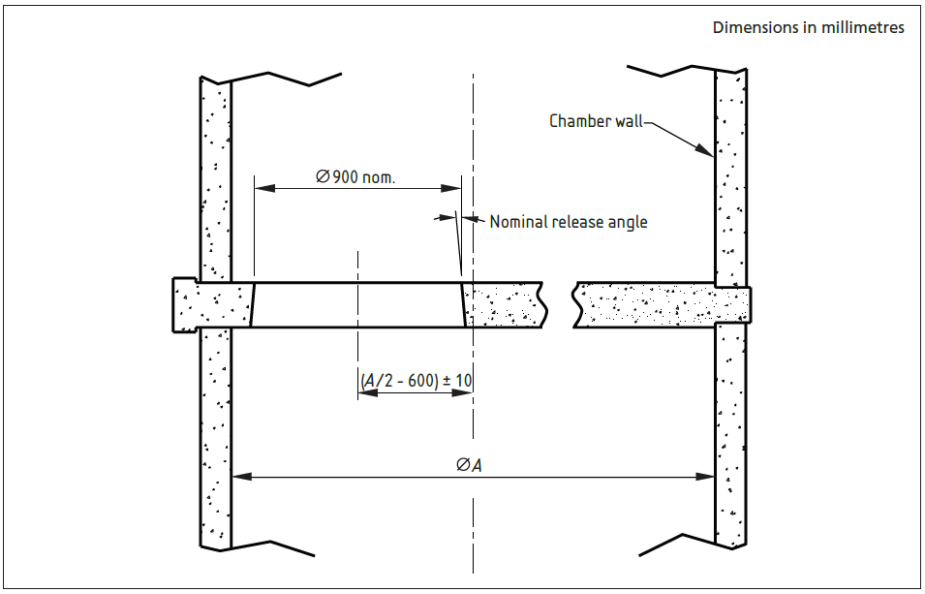


Figure 10 - Typical landing slabs

18.3.2.4.6. ***SIZES AND NUMBER OF APERTURES IN SOAKAWAYS***

Soakaway chamber units shall have holes not less than 45 mm and not greater than 80 mm in diameter, or slits not less than 15 mm or not greater than 25 mm wide, spaced around the circumference. The number and area of holes or slits shall be such that there is a minimum aperture area in each unit of 50 000 mm^2 per metre of effective height per metre of nominal size of chamber.

18.3.2.4.7. ***DIMENSIONAL TOLERANCES***

Tolerances on the internal diameter of circular vertical units:

The tolerances on the internal manufactured diameter of circular vertical units and related tapers shall be ±(3 + 0.005DN) mm (rounded to the nearest millimetre), limited to ±15 mm (see Table 24). When measured, no individual measurement shall be outside the specified limits.

Tolerances on the internal size of rectangular vertical units:

The tolerances on the internal manufactured size of rectangular vertical units shall be ±(3 + 0.005WN) mm (rounded to the nearest millimetre), limited to ±15 mm (see Table 25). When measured, no individual measurement shall be outside the specified limits.

Tolerance on the thickness:

When measured, any value of thickness shall be not less than the value stated in the factory documents.

Squareness of ends:

Vertical units shall be capable of being jointed with their relevant axes coincident. For circular chamber and shaft units, this requirement shall apply in any orientation.

NOTE Squareness of ends is significant only to the extent that it relates to type of sealing material and to the performance of a joint assembly.

18.3.2.5. CRUSHING STRENGTH OF CHAMBER AND SHAFT UNITS

NOTE Strength class is defined by legal standard, as the minimum crushing load in kilonewtons per metre, divided by one thousandth of either a unit's nominal size (DN) or nominal length (LN).

The strength classes and corresponding minimum crushing loads of circular and rectangular chamber and shaft units shall be in accordance with Table 28.

For the purposes of carrying out the test, on chamber and shaft units greater than DN 1250, the maximum width of bearing strips shall be 150 mm for units not greater than DN 2500 and 200 mm for larger units.

Nominal size DN	Nominal length LN	Single strength class	Minimum crushing load F_n (rounded up to nearest kN/m)
—	900	30	27
—	1000	30	30
—	1000	50	50
—	1200	25	30
—	1250	24	30
—	1250	50	63
900	—	30	27
1050	—	30	32
1200	—	25	30
1350	—	22	30
1500	—	20	30
1800	—	20	36
2100	—	18	38
2400	—	18	44
2700	—	18	49
3000	—	18	54

NOTE The maximum installation depth for rectangular units is dependent on nominal size and strength class. For advice refer to Annex F, or the manufacturer.

Table 34 - Strengh classes and corresponding minimum crushing loads for circular and rectangular chamber and shaft units.

18.3.2.6. WATERTIGHTNESS OF VERTICAL UNITS

The requirements of legal standards, shall not apply to soakaways, nor to vertical units with nominal sizes greater than DN 1250.

NOTE For nominal sizes greater than DN 1250, which often have a low ratio of effective height to nominal size, safety considerations call into question the tests required by legal standard. However, such sizes will have thicker walls and so this, together with the requirement for maximum water absorption of the concrete, is considered to provide adequate assurance of the durability.

18.3.2.7. STEPS

Steps shall be Type D Class I double steps conforming to legal standard and shall be manufactured from one of the materials specified the same, excluding flake graphite (grey) cast iron.

The minimum length of tread as defined by legal standard shall be 320 mm.

18.3.2.8. LIFTING ANCHORAGES FOR SLABS

In slabs using lifting anchorages, a minimum of three per slab shall be provided.

A lifting anchorage shall be safe and fit for purpose as demonstrated in accordance with Annex E, by the application of a test load on each single anchorage. When tested in accordance with Annex E, the anchorage shall remain intact and there shall be no visible damage caused to either the anchorage or the adjacent concrete.

For slabs with three anchorages, the test load shall be 1.5 times the maximum weight of the whole unit and for slabs with four anchorages, the test load shall be 1.2 times the maximum weight of the whole unit.

18.3.2.9. RESISTANCE OF MANHOLE JOINTS TO VERTICAL LOADING

When tested in accordance with legal standard, the manhole joint shall withstand vertical loading with no concrete-to-concrete contact. Typical joint profiles are shown in Figure 5.

NOTE A joint when subject to a vertical load "F_V" as specified legally, should not exhibit concrete-to-concrete contact.

18.3.2.10. SEALS

18.3.2.10.1. ***GENERAL***

Products might be sold with or without seals. The need and type of seal to provide water tightness shall be specified as a purchaser requirement. The specification of elastomeric seals requires selection of a manhole unit with a suitable joint design. Plastomeric seals shall be specified as an alternative especially for manhole units with a joint design unsuitable for elastomeric seals.

NOTE 1 The use of the manhole, e.g. foul or surface water, ground stability and external depth of water table should also be taken into account.

NOTE 2 If required the manhole and seal manufacturers should be contacted for specific advice.

18.3.2.10.2. ***ELASTOMERIC SEALS***

Joint seals for connections between vertical units for assemblies shall be in conform

18.3.2.10.3. ***PLASTOMERIC SEALANT***

Where compliance with legal standard, is provided by plastomeric material, the manufacturer shall reasonably demonstrate the long term effectiveness of such sealant to resist both internal and external sustained water pressure of 0.5 bar by specifying:

a) cross section of sealant;

b) composition in terms, percentage and type of rubber and filler;

c) properties in terms of specific gravity and penetration; and

d) type testing (e.g. increased pressure, increased joint gap, vacuum testing or temperature) and associated calculation appropriate to the behaviour of the sealant material.

Where specific preparatory or assembly processes are required to be followed on site in order to replicate water-tightness demonstrated by the specifications given in a) to d) these shall be clearly set out in the manufacturers' installation guidelines for the system including the requirements of legal standard aplicable

18.3.3. CONFORMITY EVALUATION

18.3.3.1. APPLICATION

The conformity evaluation requirements by legal standards shall apply to this specification supplemented by the procedures.

18.3.3.2. FINISH

When tested, the finish of any unit or component (except for the external edges of slabs and of adjusting units and corbel slabs) shall conform for surface voids.

18.3.3.3. GEOMETRICAL CHARACTERISTICS

Sampling procedures to evaluate the conformity of internal diameter, internal size and thickness, shall be in accordance with those for "Geometrical characteristics – Units".

18.3.3.4. VERTICAL STRENGTH OF LANDING SLABS AND CORBEL SLABS

Sampling procedures to evaluate the conformity of the vertical strength of landing slabs and corbel units shall be in accordance with those for "Vertical strength"

18.3.3.5. LIFTING ANCHORAGES FOR SLABS

Sampling procedures to evaluate the conformity of lifting anchorages shall comprise an initial type test for each nominal size of slab.

18.3.4. MARKING

In addition, each unit component shall be marked “& BS 5911-3” immediately following “BS EN 1917” and with the letter “R” if it is a reinforced concrete unit or component.

18.4. GREASE SEPARATOR

18.4.1. GENERAL CHARACTERISTICS

Grease Separator shall be in accordance with EN-1825. General characteristics are the following:

- Tank made of reinforced concrete;

- With integrated sludge trap;

- One-piece construction;

- With integrated connection for sampling;

- With inner coating which complies with Standard;

- Inner parts made of PEHD;

- Anti-floatation;

- Adjustable top;

18.4.2. TECHNICAL CHARACTERISTICS

Technical specifications shall be in accordance with figure 14, table 29 and the technical data sheet supllied.

Nominal size	6
Sluge trap (L)	1080
Grease store (L)	880
Overall (L)	1880
Inlet/Outlet DN/OD (mm)	DN125/Ø125

Table 35 – Grease Separator

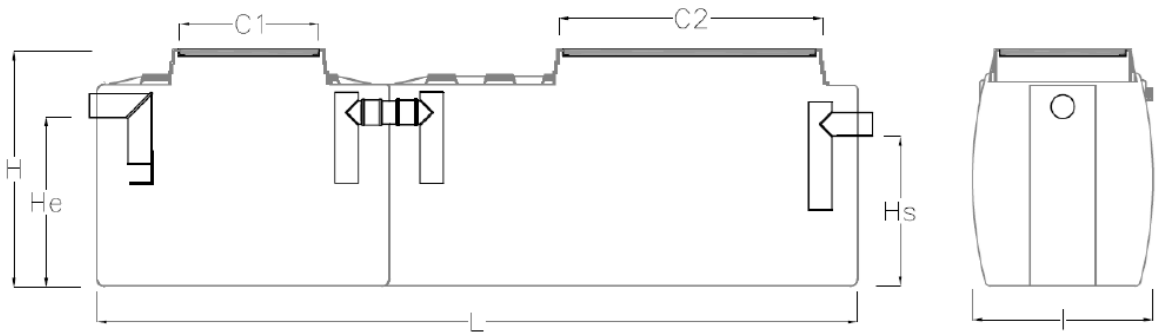


Figure 11 – Grease Separator

19. STORM WATER PLUMBING

19.1. CONCRETE MANHOLES

Consult Chapter 18.3

19.2. CONCRETE GULLYS

19.2.1. TERMS AND DEFINITIONS

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

"unit" - gully (whether trapped or untrapped) or a gully cover slab

NOTE Although unreinforced, the concrete in units conforming to this part of BS 5911 may be strengthened for handling purposes.

"type" - units of the same manufacturing process and design

"gully" - Device for the interception of silt and debris from surface water being discharged into a drainage system

"untrapped gully" - Hollow cylinder, with base, manufactured from concrete with an outlet to facilitate the connection of a pipeline, which acts as a rodding eye

NOTE It is permissible for the outlet to incorporate a permanent former, with or without a jointing profile, for the connection of pipelines.

"trapped gully" - Gully as described but with the outlet designed to form a water seal, and provided with a rodding eye

NOTE It is permissible for the outlet to incorporate a permanent former, with or without a jointing profile, for the connection of pipelines.

"**gully cover slab**" - Frame or surround manufactured from concrete, with or without a drainage slot, to accommodate a road gully grating and frame

nominal size - For a gully, the expression of nominal section and nominal depth separated by solidus (e.g. "450/900" or "300/385/900"); for a gully cover slab, the nominal section of the gully with which it is designed to fit

"nominal section" - Numerical designation of the plan shape of a gully which for circular sections is a convenient integer approximately equal to the internal diameter in millimetres and for rectangular sections is convenient integers approximately equal to the internal length and width in millimetres

"nominal depth" - Numerical designation of the depth of a gully, or gully outlet, which is a convenient integer approximately equal to the internal depth in millimetres

"manufacturing dimension" - Dimension of section, diameter or depth which a manufacturer seeks to achieve

"actual dimension" - Dimension of section, diameter or depth as measured

"cementitious content" - Amount of cement plus any pozzolanic or latent hydraulic addition in the concrete mix

"inspection" - Process of measuring, examining, testing, gauging or otherwise comparing a unit with the applicable requirements

"routine inspection" - Inspection by sampling at prescribed intervals in order to determine the acceptability of the items represented by the samples

"continuous inspection" - Routine inspection according to a sampling plan which indicates the number of units from a specific process evaluated to have attained, and continue to be in, a state of control, and the associated acceptance criteria

"sample" - One or more units selected at random without regard to their quality

"specific process" - Manufacture of units of the same nominal size and type, essentially under the same conditions over any period of time

"switching rules" - Rules that govern the decision to increase or decrease the severity of inspection

19.2.2. GENERAL REQUIREMENTS

19.2.2.1. MATERIALS

19.2.2.1.1. *CEMENTS*

Cements shall conform to **Types of cement**.

19.2.2.1.2. *AGGREGATES*

Aggregates shall conform to legal standards.

NOTE it is permited special aggregate gradings where these are needed to suit the manufacturing process, provided the special grading envelopes are defined using the R20 series of sieves by legal standard and incorporating the appropriate sieves from a specified range of sizes.

19.2.2.1.3. *ADMIXTURES*

Admixtures shall conform to legal standards.

19.2.2.1.4. *ADDITIONS*

Additions shall be in the form of ground granulated blastfurnace slag (ggbs) or pulverized-fuel ash (pfa), respectively.

19.2.2.1.5. *MIXING WATER*

Mixing water for concrete shall conform to legal standards.

NOTE potable water does not need testing.

19.2.2.2. CONCRETE

19.2.2.2.1. *CONCRETE MATERIALS*

Only materials described shall be used.

NOTE Although unreinforced, the concrete in units conforming to this specification may be strengthened for handling purposes.

19.2.2.2.2. *CONCRETE QUALITY*

The concrete in any unit shall be dense, homogeneous and conform to the requirements

19.2.2.2.3. *WATER CONTENT OF CONCRETE*

Concrete shall have such a composition that the ratio of water to cementitious content in the fully compacted state is not greater than 0.45 and is consistent with the serviceability conditions

19.2.2.2.4. *TYPES OF CEMENT*

The cement used shall conform to Table 2.

19.2.2.2.5. *CEMENTITIOUS CONTENT*

The fully compacted concrete shall have a minimum cementitious content of not less than the relevant amount shown in Table 2. The composition/specification of cement groups shall be as shown in Table 3.

DC-class (design chemical class)	Max. water content ratio	Min. cement or combination content in kg/m³ for max. aggregate sizes (mm) of:				Cement and combination types[a]	Grouping used in BRE SD1:2005
		≥40	20	14	10		
DC-1[b]	—	—	—	—	—	All in Table 3	A to G
DC-2	0.55	300	320	340	360	IIB-V+SR, IIIA+SR, IIIB+SR, IVB-V	D, E, F
	0.50	320	340	360	380	CEM I, SRPC, IIA-D, IIA-S, IIA-V, IIB-S, IIB-V, IIIA, IIIB	A, G
	0.45	340	360	380	380	IIA-L or LL ≥ class 42,5	B
	0.40	360	380	380	380	IIA-L or LL class 32,5	C
DC-2z	0.55	300	320	340	360	All in Table 3	A to G
DC-3	0.50	320	340	360	380	IIIB+SR	F
	0.45	340	360	380	380	IVB-V	E
	0.40	360	380	380	380	IIB-V+SR, IIIA+SR, SRPC	D, G
DC-3z	0.50	320	340	360	380	All in Table 3	A to G
DC-4	0.45	340	360	380	380	IIIB+SR	F
	0.40	360	380	380	380	IVB-V	E
	0.35	380	380	380	380	IIB-V+SR, IIIA+SR, SRPC	D, G
DC-4z	0.45	340	360	380	380	All in Table 3	A to G
DC-4m	0.45	340	360	380	380	IIIB+SR	F

[a] For the sulfate-resisting characteristics of other cements and combinations, see BRE SD1 [1] and IP 17/05 [2].
[b] If the concrete is reinforced or contains embedded metal, the minimum concrete quality for 20 mm maximum aggregate size is C25/30, 0.65, 260 or designated concrete RC25/30.

Table 1 - Limiting values of composition and properties for concrete where a DC-class is specified

Type	Notation	British Standard	Broad designation	Grouping used in BRE SD1:2005
Portland cement	CEM I	BS EN 197-1	CEM I	A
Portland silica fume cement[a]	CEM II/A-D	BS EN 197-1	IIA	A
Portland limestone cement	CEM II/A-L CEM II/A-LL	BS EN 197-1 BS EN 197-1	IIA IIA	B[b] or C[b] B[b] or C[b]
Portland slag cements	CEM II/A-S CEM II/B-S	BS EN 197-1 BS EN 197-1	IIA IIB-S	A A
Portland fly ash cements	CEM II/A-V CEM II/B-V CEM II/B-V+SR[c]	BS EN 197-1 BS EN 197-1 BS EN 197-1	IIA IIB-V IIB+SR	A A D
Blastfurnace cements	CEM III/A CEM III/A+SR[d] CEM III/B CEM III/B+SR[d]	BS EN 197-1 or BS EN 197-4 BS EN 197-1 or BS EN 197-4	IIIA IIIA+SR IIIB IIIB+SR	A D A F
Pozzolanic cement	CEM IV/B(V)	BS EN 197-1 or BS EN 14216	IVB-V	E
Sulfate-resisting Portland cement	SRPC	BS 4027	SRPC	G
Combinations conforming to BS 8500-2:2006, Annex A, manufactured in the concrete mixture from Portland cement and fly ash, ground granulated blast furnace slag (ggbs) or limestone fines:				
CEM I cement conforming to BS EN 197-1 with a mass fraction of 6% to 20% of combination of fly ash conforming to BS EN 450-1	CIIA-V	BS 8500-2:2006, Annex A	IIA	A
CEM I cement conforming to BS EN 197-1 with a mass fraction of 21% to 35% of combination of fly ash conforming to BS EN 450-1	CIIB-V CIIB-V+SR [c]	BS 8500-2:2006, Annex A	IIB-V IIB+SR	A D
CEM I cement conforming to BS EN 197-1 with a mass fraction of 36% to 55% of combination of fly ash conforming to BS EN 450-1	CIVB-V	BS 8500-2:2006, Annex A	IVB-V	E
CEM I cement conforming to BS EN 197-1 with a mass fraction of 6% to 20% of combination of ggbs conforming to BS EN 15167-1	CIIA-S	BS 8500-2:2006, Annex A	IIA	A
CEM I cement conforming to BS EN 197-1 with a mass fraction of 21% to 35% of combination of ggbs conforming to BS EN 15167-1	CIIB-S	BS 8500-2:2006, Annex A	IIB-S	A
CEM I cement conforming to BS EN 197-1 with a mass fraction of 36% to 65% of combination of ggbs conforming to BS EN 15167-1	CIIIA CIIIA+SR[d]	BS 8500-2:2006, Annex A	IIIA IIIA+SR	A D
CEM I cement conforming to BS EN 197-1 with a mass fraction of 66% to 80% of combination of ggbs conforming to BS EN 15167-1	CIIIB CIIIB+SR[d]	BS 8500-2:2006, Annex A	IIIB IIIB+SR	A F
CEM I cement conforming to BS EN 197-1 with a mass fraction of 6% to 20% of combination of limestone fines conforming to BS 7979	CIIA-L CIIA-LL	BS 8500-2:2006, Annex A	IIA IIA	B[b] or C[b] B[b] or C[b]

[a] When IIA or IIA-D is specified, CEM I and silica fume may be combined in the concrete mixer using the *k*-value concept; see BS EN 206-1:2000, 5.2.5.2.3.
[b] The classification is B if the cement or combination strength is class 42,5 or higher and C if it is class 32,5.
[c] With a minimum proportion of fly ash of 25%.
[d] Where the alumina content of the slag exceeds 14%, the tricalcium aluminate content of the Portland cement fraction should not exceed 10%.

Table 2 - General purpose cements and combinations

19.2.2.2.6. *CHLORIDE CONTENT*

The amount of chloride ion in the concrete shall be evaluated by calculation and shall not exceed 1.0 % by mass of the cementitious content, or 0.4 % if the concrete contains steel for handling purposes.

19.2.2.2.7. *WATER ABSORPTION*

When tested the water absorption of the concrete shall not exceed 6 % by mass.

19.2.2.3. UNITS

19.2.2.3.1. *GENERAL*

Units shall conform to the following requirements at the time of delivery.

19.2.2.3.2. *FABRICATION*

Where a gully is to be assembled from fabricated sections, they shall be bonded together with special mortar.

19.2.2.3.3. *FINISH*

Units exhibiting any surface void greater than 12 mm deep shall be deemed not to conform to this specification. A surface void not exceeding 12 mm deep and any damage affecting the performance of a unit, including joints but excluding the external edges of gully cover slabs, shall be made good. After any final treatment, a unit shall conform to all relevant requirements of this specification.

19.2.2.3.4. *GEOMETRICAL CHARACTERISTICS*

General:

Subject to the requirements of this clause, the dimensions, thickness and configuration of units shall conform to those stated in the factory documents.

Nominal sizes

The nominal sizes of gullies shall be those given in Table 4. The nominal sizes of gully cover slabs shall be 375, 450 and 300/385.

Dimensions and configuration of gullies

The dimensions and configuration of a gully shall conform to the requirements in Table 4 when tested

External manufacturing section and top flange

The external manufacturing section of a gully shall be not less than 1.15 times the internal manufacturing diameter or length or width and the top flange shall be of width not less than 0.15 times that diameter, length or width

Gully outlet:

The diameter of a gully outlet shall be 150 mm ± 5 mm.

Gully cover slab thickness:

The thickness of a gully cover slab shall be not less than 65 mm when tested.

19.2.2.3.5. ***WATERTIGHTNESS***

When tested a gully shall not show any leakage.

NOTE Moisture appearing on the surface in the form of patches or beads is acceptable.

19.2.2.3.6. ***SERVICEABILITY***

Units conforming to this specification are at least suitable for use in humid conditions and a slightly aggressive chemical environment (i.e. for most soils and groundwaters). Special attention needs to be paid if more severe conditions are expected; primarily the manufacturer shall adjust as necessary the amount of cement plus any pozzolanic or latent hydraulic addition in the concrete.

NOTE The durability of installed units is specifically ensured by the following requirements:

— a maximum water/cement ratio of the concrete

— a maximum chloride content of the concrete

— a maximum water absorption of the concrete

Nominal size of gully (see 3.7)			Limits of internal manufacturing section of gully (see 3.10)	Deviation of actual internal manufacturing depth (see 3.10)	Limits of internal manufacturing depth (see 3.10)	Deviation of actual internal depth from internal manufacturing depth	Minimum thickness of base	Maximum inside depth to centre of outlet (untrapped) or rodding eye (trapped)	Maximum outside depth of outlet (see 3.7)	Trapped gullies only			
										Minimum dimension of riser	Minimum cross sectional area of riser	Minimum internal diameter of rodding eye	Minimum depth of water seal
Nominal section		Nominal depth	A		B		C	D	E	F		G	H
Nominal diameter	Nominal width/ length		mm	mm	mm	mm	mm	mm	mm	mm	mm^2	mm	mm
375		750	365 to 385	6	740 to 760	25	50	300	400	90	8 000	100	85
		900			890 to 910								
450		750	435 to 465	9	740 to 760	25	50	300	400	90	8 000	100	85
		900			890 to 910								
		1 050			1 040 to 1 060								
		1 200			1 180 to 1 210								
	300/385	700	AW 290 to 310	6	690 to 710	25	50	335	430				
			AL 375 to 395										
	300/385	750	AW 290 to 310	6	740 to 760	25	50	335	430				
			AL 375 to 395										
	300/385	700	AW 290 to 310	6	690 to 710	25	50	195	290	N/A	8 000	100	80
			AL 375 to 395										
NOTE Typical arrangements for gullies and the dimensions A, B, C, D, E, F, G and H are shown in Figure 1, Figure 2, Figure 3 and Figure 4.													

Table 3 - Nominal sizes dimensions for gullies

19.2.3. TEST REQUIREMENTS FOR FINISHED PRODUCTS

Finished products shall be tested in accordance with the test requirements in Table 5.

Clause	Requirement	Gullies		Gully cover slabs
		Untrapped	Trapped	
5.2.7	Water absorption	T/R	T/R	T/R
5.3.3	Visual inspection of finish	T/R	T/R	T/R
5.3.4.3 and 5.3.4.6	Dimensions: gullies gully cover slabs	 T/R —	 T/R —	 — T/R
5.3.5	Watertightness	T/R	T/R	—
T means initial type test; R means routine inspection test.				

Table 4 - Summary of test requirements

19.2.4. MARKING

Each unit shall be marked indelibly and in a clearly visible manner. Identification of the unit(s) shall be made in such a way that no doubt is possible.

Marking shall include the following minimum information:

a) the manufacturer's name, trade mark or identification mark, and site of production;

b) the identifier of this specification

c) the date of manufacture;

d) identification of serviceability conditions other than normal;

e) Identification of any third party certification body.

19.3. HDPE PIPE INSTALLATIONS

Consult chapter 18.2

19.4. PVC PIPE INSTALLATIONS

Consult chapter 18.1

19.5. PUMPS

Pumps shall be conform to legal standards and comply with technical data sheet supplied.

Installation and maintenance shall be done in accordance with the suppliers instructions.