

anglianwater

Water Design Guide

Section 1M – HEMS Design Guide

REVISION	DATE OF ISSUE	REASON FOR CHANGE
01	Jan 2018	

Contents

(1.0) Pipe sizes, colours and Materials for new mains	4
(2.0) Mains design.	5
(2.1) Planning Horizon	5
(2.2) Levels of Service Design Criteria.....	5
(2.3) Velocity and Headloss	6
(2.4) On Site Mains Design	6
(2.5) Off Site Mains Design	7
(2.6) Security of supply for new developments	9
(2.7) Design guidance on supplies to multi storey developments	10
(3.0) Pipeline design considerations.....	11
(3.1) Head loss through Fittings	11
(3.2) Surge and Fatigue	12
(3.3) Anchorages.....	12
(3.4) Water Quality.....	12
(3.5) Pressure / Leakage.....	13
(4.0) Operational activity.....	13
(4.1) Hygienic storage of pipes and fittings.....	13
(5.0) Mains Fittings	13
(5.1) General	13
(5.2) Valves	13
(5.3) Indicator Posts and Marker Plates	14
(5.4) Chambers and Covers	14
(5.5) Pressure reducing valves / other network control valves.....	14
(5.6) Extension spindles & Valve chambers.....	14
(5.7) Hydrants / washouts	14
(5.8) Air Valves.....	14
(6.0) Rehabilitation and New Mains Layout	15
(6.1) General	15
(6.2) Main Laying in Private Land	15
(6.3) Positioning of Mains.....	15
(6.4) Main Laying in Street	16
(6.5) Depth of Mains	16
(6.6) Main Laying Over or Under a Main River or Water Course	16
(6.7) Main Laying in Contaminated Land	16
(6.8) Construction Traffic.....	16
(6.9) Effect of Traffic Loading	16
(6.10) PE Mains Laid In Roads	17
(6.11) Main Laying Near railways.....	17
(6.12) Easements	17
(6.13) Excavation and Reinstatement	17
(6.14) Bed and Surround.....	17
(6.15) Dualling mains	17
(6.16) Mothballed mains.....	17
(6.17) Installation of temporary washouts	17
(7.0) Main laying	18
(7.1) General	18
(7.2) Installation Methods.....	18
(7.3) Training and Qualifications	18
(7.4) Bed, Surround and Backfill	18
(7.5) Marker Tape	18
(7.6) Connections.....	18
(7.7) Corrosion Protection	18
(7.8) Under pressure connections.....	18
(8.0) Installing Polyethylene Mains	19
(8.1) Jointing of PE pipes	19
(8.2) Squeeze-off Closures	19
(8.3) Under pressure connections on PE pipe	20
(8.4) Fittings and connections on PE pipe	20
(8.5) Anchorage and thrust blocks on PE	20
(8.6) Ducts.....	20
(8.8) Installing P.E barrier pipe.....	21
(8.9) Directional Drilling.....	21
(8.10) Winch loads on PE pipes during directional drilling.....	21
(8.11) Pipe Bursting	22
(8.12) Close fit insertion systems	22
(8.13) Road Crossings	22
(9.0) Ductile Iron & Bluto Mains	23
(9.1) General	23
(9.2) Pressure Rating	23
(9.3) Inspection	23

The information contained in this document can only be guaranteed valid on the day of printing

© Anglian Water 2018

Date of printing is: 24/01/2018. Check current version for validity

(9.4) Installation of Ductile iron & Blutop	23
(9.5) Wrapping of Ductile iron	23
(9.6) Anchorage of Ductile iron & Blutop	24
(9.7) Blutop system compatibility	24
(9.8) Blutop pipe embedment.....	24
(9.9) Bedding material for Ductile Iron & blutop pipe	24
(10.0) Pressure testing mains.....	25
(10.1) Pressure Testing PE and PE barrier pipe	25
(10.2) Pressure Testing for Ductile Iron and Steel pipes	25
(11.0) Commissioning of New Mains	26
(11.1) Swabbing of New Mains	26
(12.1) As constructed drawings (as-laid).....	27
(13.0) Service Laying.....	27
(13.1) Definitions	27
(13.2) Hygiene.....	27
(13.3) Training and Qualifications	27
(13.5) Material Service Pipes and fittings.....	27
(13.6) Communication Pipe Size.....	27
(13.7) Protection for non domestic connections.....	28
(13.8) Water connections to flats	28
(13.9) Service pipe sizes	28
(13.10) Cleaning & Disinfection.....	28
(13.11) Connection to the Main.....	29
(13.12) Provision of Stop Valve/Meter Chamber.....	29
(13.13) Installation	29
(13.14) Service pipes above ground	30
(14.0) Tapping of mains.....	30
(14.1) General	30
(14.2) PE Mains	30
(14.3) PVCu Mains.....	30
(14.4) Ductile Iron Mains	30
(14.5) Cast Iron Mains.....	30
(14.6) Asbestos Cement Mains.....	31
(14.7) PE Barrier pipe Mains.....	31
(15.0) Boundary boxes and Wall mounted boxes.....	31
(16.0) Fire mains to metered customers.....	31
Appendix 1: Electrofusion Jointing site guide	32

(1.0) Pipe sizes, colours and Materials for new mains

a) The pipe size and material must be chosen using table 1.0 which also details the standard nominal bore (NB) sizes for new mains. Pipe dimensions for HPPE pipe are detailed in Table 4.0

Table 1.0

Nominal Bore (mm)	Pipe OD (mm)	HPPE SDR11 16 bar	HPPE SDR17 10 Bar	HPPE SDR21 8 Bar	HPPE SDR26 6 Bar	PE barrier pipe	Blu top DI pipe	DI class K9
50	63	O	S	N/a	N/a	A	N/a	N/a
80	90	O	S	N/a	N/a	A	A	N/a
90	110	O	S	N/a	N/a	A	A	N/a
100	125	O	S	N/a	N/a	A	A	N/a
140	160	O	S	O	N/a	A	N/a	N/a
150	180	O	S	O	N/a	A	N/a	A
200	225	O	O	S*	N/a	A	N/a	A
250	280	O	O	S	OT	A	N/a	A
280	315	O	O	S	OT	N/a	N/a	N/a
300	355	O	O	S	OT	A	N/a	A
400	450	O	O	S	OT	N/a	N/a	A
450	500	O	O	S	OT	N/a	N/a	A

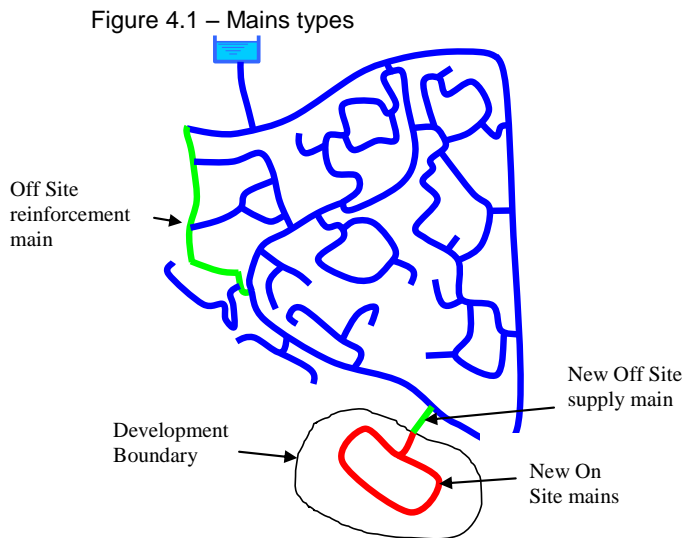
Key:

*	Not appropriate for pipe bursting / directional drilling due to wall thickness, use SDR17 in these instances
O	Use only when authorised by the senior engineer after submission of detailed structural design
S	Standard for new distribution mains.
A	Standard for all new mains in contaminated ground, or at risk of such. Supplier approved protection system shall be included as determined from ground survey and analysis.
OT	Optional for new trunk and strategic mains provided that PERSEUS design software (BSEN 1295) indicates as suitable, where local operating and ground conditions are appropriate and where future usage of pipeline is assured. Option to be confirmed by the formal approval process.'

- b) For HPPE SDR21 and SDR26 constructed by open cut in carriageway shall have Highways Authority compliant bedding and surround compacted to at least 90%.
- c) Ductile Iron and Steel may also be considered, along with HPPE on a scheme by scheme basis. The approved pipe material shall be chosen on engineering and financial grounds. No other material is to be used.
- d) The Regional Network Manager shall approve any variations from these SDR ratings at the design stage of the project. These variations shall only be in exceptional circumstances.
- e) In accordance with POSWSH PSW-STD-9.11 and PSW-STD-2.03 pipe colours shall be blue for potable and black for non-potable mains. However, fittings for use on potable water may be black.
- f) Approved materials are HPPE, MDPE, PE barrier pipe (as detailed by AW purchasing agreement), ductile iron and steel. No other pipe materials are approved for use.
- g) If cathodic protection is required due to the risk of external corrosion from soil resistance, specialist advice should be sought. All cathodic protection schemes should provide for regular inspections and checks.
- h) When laying ductile iron or steel an appropriate soil resistance test should be undertaken to assess the level of pipe protection required.
- i) In land that is contaminated or is at risk of contamination, ductile iron pipes or PE barrier pipe system should be used in conjunction with barrier service pipes or plastic coated copper service pipes. Refer to section PSW-STD-2 of POSWSH.

(2.0) Mains design.

New mains should be designed to meet OFWAT levels of service at all times including peak summer demand. The Housing Estate Mains (HEMS) team carry out 'On Site' mains design and the Asset Planning (AP) modellers design 'Off Site' mains. Off Site mains include the supply main to the site boundary and any reinforcements to the existing network as shown below.



Off site mains design should be carried out using calibrated models that have been maintained and updated to ensure they reflect real system pressures and flows. The modeller should consider the following aspects when carrying out any mains design work:

1. What is the age and confidence level of the model being used?
2. Do modelled flows and pressures need to be compared against actual flows and pressures?
3. What value of investment is required to achieve the required pressure?
4. What is the value of investment that is recoverable from a third-party (e.g. DADs)?
5. What will be the minimum pressures without investment?
6. How many properties would become DG2 reportable?
7. Is additional development proposed in the area?
8. What is the reduction in pressure across the network? (The magnitude of pressure reduction may be unacceptable or require customer management.)
9. What is the root cause – are lower cost solutions appropriate?
10. Is the demand increase such that an excessive demand would lead to supply failure?
11. Would the additional demand preclude proposed or potential pressure reduction strategies?

(2.1) Planning Horizon

The design horizon for HEMS schemes shall be 10 years.

(2.2) Levels of Service Design Criteria

Mains shall be designed to ensure efficient and effective operation without detriment to minimum levels of service which include water quality as well as pressure.

Water Quality

Water Quality is closely related to water velocity in a main and so designers need to consider the following:

- a) POSWSH section 2 and PSW-STD-8
- b) The Modelling Guidelines on the Effects of Velocity on Cohesive Layers (OMC-WNSA012). A "self cleansing main" requires a minimum velocity of 0.3 m/s for at least 1 minute every day. However, unlined cast iron mains require 0.2m/s for at least 1 hour twice a day.
- c) Schemes should be designed to minimise the number of dead ends.
- d) Adequate provision for permanent or temporary washout facilities should be provided to enable effective planned preventative maintenance (PPM) and flushing activities to be undertaken, refer to section 7.7 for further information.
- e) Consider turnover and phasing see 17.9 F

Pressure

- a) Mains design shall minimise the risk of DG2 incidents by ensuring pressures are not less than 20m head at any modelled node. This will provide a few meters headroom to take model limitations and node level inaccuracies into account.

- b) The maximum ground level must be considered within any new development site so that the pressure can be estimated at that point. If the pressure at this critical point is likely to fall below 20m during peak summer demand then a detailed analysis will be required to ensure on site mains headloss is considered.
- c) Where a new development causes model pressure at any node to fall below 20m then consideration shall be given to whether investment is appropriate to maintain existing pressure.
- d) If a new development causes large pressure variations (15m or more) or sudden change in pressure then consideration should be given to remedial investment. Large variations may increase leakage and bursts.
- e) Pressure control should be investigated where pressures exceed 25m at the critical point in the distribution system and if leakage rates are high.
- f) When the top floor of a property is less than 10.5m below the draw-off level of the supplying reservoir or tower, then 24 hours storage is required at the property. See the Water Industry Act 1991 - section 66
- g) Large water consumers should not be allowed to cause DG2 incidents and therefore they may be required to have storage or flow control systems installed.

(2.3) Velocity and Headloss

Velocity and Headloss per Kilometre (HLG) are inter-related and both should be considered during the design process.

- a) Minimum Velocity – The Modelling Guidelines on the Effects of Velocity on Cohesive Layers (OMC-WNSA012). A “self-cleaning main” requires a minimum velocity of 0.3 m/s for at least 1 minute every day. However, unlined cast iron mains require 0.2m/s for at least 1 hour twice a day. Raw water mains should be run at a higher minimum velocity of around 0.75m/s to keep them clean because they are likely to contain more suspended solids..
- b) The disadvantages of high velocities are:
 - a. High surge pressures when valves are operated,
 - b. More likely to damage the inside of pipes (especially lined pipes)
 - c. It requires higher pressures to ensure sufficient head is available at the end of systems, which will result in higher night pressure increasing leakage and bursts. Higher velocities in small pipes have a bigger impact on headloss.
- c) Headloss per Kilometre – The maximum recommended Headloss per Kilometre is 3 m/km this value may be exceeded in appropriate circumstances, typically over short distances and where system pressure is high and unlikely to be subject to future pressure management strategies. The R&V process should be used to assess any deviations
- d) The criteria detailed above should be utilised along with local conditions and scheme output requirements to design the most cost effective solution.

Table 2 Approximate Comparison between Headloss/km and Velocity for different sized mains.

Dia (mm)	Vel = 1 m/sec		HLG=3 m/Km		HLG=5 m/Km	
	HLG	Flow (lps)	Vel (m/s)	Flow (lps)	Vel (m/s)	Flow (lps)
90 (SDR17)	13.2 0	4.85	0.44	2.15	0.59	2.80
110	10.0 1	7.30	0.51	3.70	0.68	4.90
125	9.70	9.40	0.56	5.22	0.74	6.95
160	6.70	16.00	0.66	10.10	0.87	13.48
180	5.50	19.50	0.71	13.95	0.94	18.50
225 (SDR21)	4.20	32.50	0.84	27.20	1.11	36.05
280	3.20	50.00	0.97	48.70	1.29	64.40
355	2.40	80.50	1.14	91.57	1.50	121.00
400 (DI)(CML)	2.1	121.0	1.2	145.1	1.6	189.4
500 (DI)	1.6	191.0	1.4	264.9	1.8	345.3
600(DI)	1.3	277.0	1.6	431.8	2.0	562.3
800 (DI)	0.9	500.0	1.9	931.0	2.4	1212.3
1000 (DI)	0.7	780.0	2.4	1668.2	2.7	2168.7

Table 2 illustrates that high headloss will occur in small mains at velocities of 1m/s and high velocities will occur in very large mains at headloss gradients of 3m/km. Both velocity and headloss gradient should be considered during the design process.

(2.4) On Site Mains Design

The HEMs team design the on site mains, which do not normally require the use of a network model, although for large developments may require modelling to ensure cost effective design and acceptable LOS.

(2.5) Off Site Mains Design

Off site supply mains design firstly requires the instantaneous peak demand to be calculated for the new development and then this can be applied to the network model to size the new supply main. This flow should not be used for any off site mains reinforcement design. If the peak instantaneous design flow pulls system pressure down below 20m or increases pressure variation by more than 15m at any point in the network then further analysis will be required using the correct 24 hour demand profiles for peak demand and it may then be necessary to look at mains reinforcement or alternative schemes to improve pressure.

2.5.1 Deriving Peak Instantaneous Demand

Data supplied by the developer should be used to size the supply main where it is provided. Demand may be domestic, industrial, commercial or a mixture of these. In each case the peak demand for the category will need to be determined and then aggregated to derive the peak instantaneous flow expected down the main.

Domestic Demand

Calculations within this are based on the data taken from the June Return 2010. (To be updated each AMP period)

ADC - Average daily consumption per person (l)	143 ¹
OCC - Average persons per property	2.3 Table 7 (Population Total /Households billed for water)
UFW – Unaccounted for Water (l/prop/d)	102 Total Leakage (Table 10) / Total Properties (Table 2)
SPF - Seasonal peaking factor metered props	1.277 ³

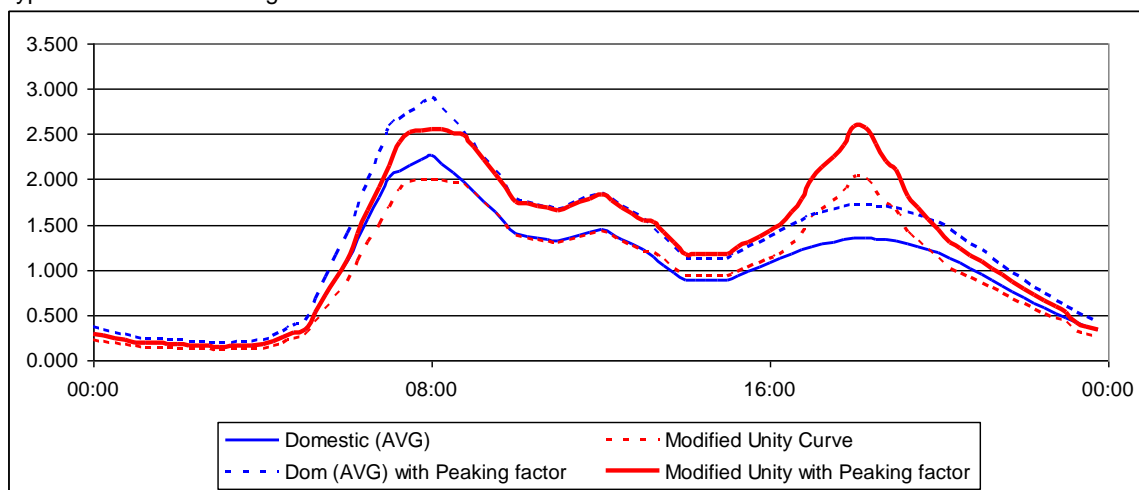
¹ Table 10 Per capita consumption (l/h/d) = 132.91 for meas'd h'hold and 162.60 unmeas'd h'hold (excl s/pipe leakage), which equals 142.9 when weighted in relation to the number of metered and unmetered properties supplied.

Although leakage should not occur in a new development it almost certainly will occur at some time in the future and for modelling purposes leakage is divided evenly over all the properties supplied.

Average consumption per property per day = (ADC x OCC) + UFW = 432 l/prop/day

Average daily consumption is believed to increase by 1.277 (**Water resources plan 2008**),³ during peak summer periods. The average domestic curve can be factored in a variety of ways as shown below. Factoring the average by a fixed value over the day may lead to a higher morning peak and lower evening peak but this is the simplest way of increasing demand and is currently the preferred route by the modelling team. With more information regarding seasonal flow it is also possible to create a more realistic seasonal curve.

Typical Seasonal Peaking



Demand shall be factored to derive the instantaneous peak seasonal flow from the average peak flow. This may then be applied to the peak summer model to size the new off site supply main.

Commercial Demand

If the developer provides a peak flow for the site then this should be used and applied to an appropriate curve (typically 10 hour) using the peak flow model. If no flows are provided but the number and type of fittings are supplied then the 'Loading Units' can be used to derive instantaneous peak flows.

If the developer has not requested a specific peak flow, or provided loading units then flows can be estimated based on the footprint area for the development. For Industrial & commercial use de 15 to 30m l/d/m2 may be used. Generally as all that is provided is the floor area an average of 22.5 l/d/m2 is used however there may be circumstances where 15 or 30 l/d/m2 is considered more appropriate. Typically this is converted to an average l/s and assigned using the 10HOUR profile.

Industrial & commercial. 15 to 30m l/d/m² floor area. Generally as all that is provided is the floor area an average of 22.5 l/d/m² is used however there may be circumstances where 15 or 30 l/d/m² is considered more appropriate. Typically this is converted to an average l/s and assigned using the 10HOUR profile.

This document also provides some useful information on a range of expected peak flows for various types of commercial user.

Table 3.0 Loading Units

	Loading units		Loading units
WC flushing cistern	2	Sink (tap size >15mm)	5
Washbasin in house	1.5	Spray tap	0.5
Washbasin elsewhere	3	Bidet	1.5
Bath (tap size 20mm)	10	Domestic appliances	3
Bath (tap size >20mm)	22	Communal/commercial appliance	10
Shower	3	Any other water fitting or outlet	3
Sink (tap size 15mm)	3		

Industrial Demand

Peak Flow requirements should be provided by the developer along with any fire fighting or sprinkler flows.

- Where a commercial developer specifies a peak flow rate then this should be used in the model. Consideration should be given to putting storage on site particularly if the proposed peak demand is sufficient to require off site reinforcement.
- All industrial applications shall be classed as non-standard connections and require network model analysis to see if off-site main reinforcement is required.

Fire Fighting Flows

Any specific fire flows requested by a developer should be added to the model to see what effect they have on the system. Sufficient storage shall be provided to prevent excessive pressure changes as a result of overdrawing the system and to provide security of supply for the customer. It is currently recommended that 24 hours be provided.

If the Fire Authority requires additional provision then the additional costs shall be borne by the Fire Authority or developer as appropriate. Appropriate consultation with the Fire Authority shall take place as described in the "[National guidance document on the provision of water for fire fighting 3rd Edition](#)" and [Fire services memorandum of understanding](#)

The potential demand for fire fighting purposes can be large in relation to normal demands. In these circumstances the fire authorities should seek alternative sources of emergency supply as detailed in (BSEN805:2000) and water for fire fighting purposes cannot be guaranteed. It is recommended that the customer provides an appropriate level of storage for this purpose.

AWS need to inform the Fire and Rescue Services if fire flows cannot be met.

2.5.2 Supply Main Sizing

The existing peak model for the area should be checked and then the new supply main added with a node created at the end of the main with a ground elevation equal to the highest point within the development area. The peak instantaneous demand should be applied to this and then different supply pipe sizes can be reviewed. The model will allow pressure to be obtained at the end node and velocity and headloss in the main can be obtained. Different sizes can be tested to obtain the optimum pipe size. It is only the new main that should be sized and not any existing pipes within the model, even if there is only a single main upstream of the new supply pipe.

If pressure is seen to fall below 20 m at the end node then further information and analysis will be required.

If there is no problem with pressure at the new node, or elsewhere in the network, then no further analysis is required. If pressure falls below 20 m anywhere where it was previously greater than this, or if any pressures that were less than this fall further then additional Strategic / Reinforcement Analysis is required.

Table 4.0 Pipe Flows (l/s) guidance

Pipe Size	SDR*	Internal Diameter	Flow (l/s) at min velocity (0.2m/s)	Flow (l/s) at max velocity (1m/s)	Flow at 3m/km Headloss
20mm MDPE	SDR 11	16.4	0.04	0.21	0.032
25mm MDPE	SDR 11	20.4	0.07	0.33	0.055
32mm MDPE	SDR 11	26.2	0.11	0.54	0.108
50mm MDPE	SDR 11	40.9	0.26	1.31	0.36
63mm MDPE	SDR 11	51.5	0.42	2.08	0.68

The information contained in this document can only be guaranteed valid on the day of printing

© Anglian Water 2018

Date of printing is: 24/01/2018. Check current version for validity

90mm HPPE	SDR 11	72.9	0.83	4.17	1.75
	<i>SDR 17</i>	78.7	0.97	4.86	2.15
125mm HPPE	SDR 11	101.3	1.61	8.06	4.24
	<i>SDR 17</i>	109.5	1.88	9.42	5.23
160mm HPPE	SDR 11	129.8	2.65	13.23	8.25
	<i>SDR 17</i>	140.3	3.09	15.46	10.15
	SDR 21	144.3	3.27	16.35	10.95
	SDR 26	147.4	3.41	17.06	11.59
180mm HPPE	SDR 11	146	3.35	16.74	11.3
	<i>SDR 17</i>	158	3.92	19.61	13.95
	SDR 21	162.3	4.14	20.69	14.99
	SDR 26	165.8	4.32	21.59	15.87
225mm HPPE	SDR 11	182.4	5.23	26.13	20.47
	SDR 17	197.3	6.11	30.57	25.24
	<i>SDR 21</i>	203	6.47	32.37	27.23
	SDR 26	207.4	6.76	33.78	28.83
280mm HPPE	SDR 11	227.4	8.12	40.61	36.84
	SDR 17	245.9	9.50	47.49	45.35
	<i>SDR 21</i>	252.6	10.02	50.11	48.71
	SDR 26	258	10.46	52.28	51.53
355mm HPPE	SDR 11	288.1	13.04	65.19	69.08
	SDR 17	311.5	15.24	76.21	84.98
	<i>SDR 21</i>	320.4	16.13	80.63	91.57
	SDR 26	327.6	16.86	84.29	97.13
400mm HPPE	SDR 11	324.6	16.55	82.75	94.79
	SDR 17	351.2	19.37	96.87	116.8
	SDR 21	361.1	20.48	102.41	125.7
	<i>SDR 26</i>	368.7	21.35	106.77	132.8
450mm HPPE	SDR 11	365.2	20.95	104.75	129.5
	SDR 17	395.2	24.53	122.67	159.6
	SDR 21	406.2	25.92	129.59	171.7
	<i>SDR 26</i>	414.8	27.03	135.13	181.4
400mm DI/CM		400	25.13	125.66	152.1
450mm DI/CM		450	31.81	159.04	207.3
500mm DI/CM		500	39.27	196.35	273.5
600mm DI/CM		600	56.55	282.74	441.4
750mm DI/CM		750	88.36	441.79	792.1
900mm DI/CM		900	127.23	636.17	1277

* Preferred SDR rating for PE pipe is in italics

(2.6) Security of supply for new developments

Alternative supply routes

- a) Consideration should be given during the mains design process to the provision of alternative supply routes when supplying more than 50 domestic properties, this should be undertaken where existing mains layouts make the option cost effective and where the proposed mainlaying route or proposed site layouts permit. This may be achieved by a number of approaches including dual mains, parallel paths, alternative sources and local loops. Where alternative feeds are provided they should only be installed in the public highway and not be laid through customer properties etc as this will create future access issues.

Dualling mains

The information contained in this document can only be guaranteed valid on the day of printing

© Anglian Water 2018

Date of printing is: 24/01/2018. Check current version for validity

- a) Reinforcement mains should be cross-connected; with locations agreed through the risk opportunity & value process.
- b) A consideration in the sizing of dual mains is the headloss in the remaining main if a section of one main is valved off for repair. Dual mains should be sized to provide adequate pressure if one section of one main is valved off.
- c) Similarly, multiple parallel mains should be sized to provide adequate pressure if one section of one main is valved off.
- d) Dual mains should be laid under major roads, major rivers or any railway line, where justified through the risk opportunity & value process.
- e) Where dual mains are laid, appropriate valving shall be installed to allow isolation of each individual main without affecting the operation of the other. An isolating valve should be installed on each side of the cross-connection on each main.

Loops

- a) A local loop with a single feed or with twin feeds that are hydraulically very close will have a balance point where the water may be stagnant or near stagnant throughout the day. The water quality consequences of such loops should be investigated and may benefit from some simple network modelling.
- b) If there is a water quality issue, it will be necessary to take action such as: implement two dead ends instead of the loop or install a length of small diameter main in the vicinity of the balance point and/or recommend that the main is flushed on a regular basis.

(2.7) Design guidance on supplies to multi storey developments

- a) All multi storey developments shall receive a supply by direct mains pressure in accordance with the companies' reference levels of 10m head and 9l/m flow.
- b) Conditions may exist where higher distribution pressures can be supplied but these are not guaranteed.
- c) Where floors exceed the top water level of the storage point supplying the property, thus preventing supply by gravity, the developer shall be responsible to supply these floors with adequate pressure at their own cost. In accordance with section 65 Water Industry Act. See section 3.1
- d) For multi storey domestic dwellings of 3 storeys or greater a pumped supply system is recommended.
- e) Where a pumping system is installed and the demand will exceed 12 litres/minute then a 'protected' break cistern will be required in accordance with regulation 5(1) Water Supply Regulations 1999 (WSR).
- f) If the property is 10.5m or less below the draw off level of the storage point then a roof level cistern is required under section 66 Water Industry Act. A minimum 8 hours storage provision is recommended.
- g) Where a multi-storey development is to be supplied on a bulk supply basis, the guidance given in the AW 'Metering Policy' included within the AW Charges Scheme (Part 3 – section 4) shall be followed.
- h) Where each dwelling within the development is to be separately occupied and charged individually, AW charges scheme (Part 3 section 2) policy should be followed
- i) The preferred location for the individual dwelling meters shall be as specified in AW charges scheme – (Part 3 section 5). Where meters are installed internally they should be located in areas to accommodate access/ reading. The requirement for pumping imposes limitations on the available meter locations.
- j) It is recommended that a bulk meter be installed at the property boundary for AW monitoring purposes.
- k) For separate occupation dwelling in multi-storey developments, it is recommended that supply arrangements be recorded and agreed between AW and the third party, particularly third party responsibilities for maintenance of pumping apparatus.
- l) A record of this agreement should be lodged against the corporate records for every dwelling within the development to aid dispute resolution. It is suggested that the AW billing system would be a suitable repository for this information.

(3.0) Pipeline design considerations

(3.1) Head loss through Fittings

- a) Network modelling may presuppose straight pipe lengths through fittings but it is important not to overlook head loss through fittings. Head loss may be deduced by adding the actual pipe length to the equivalent length of the particular fitting, or by reference to the K value and the formula. - Head loss = $K (V^2/2g)$
(V=velocity, g=gravitational constant- 9.81)
- b) Equivalent pipe lengths and K values for common fittings are displayed in Table 5 below:

Table 5 Head loss

Type of Fitting	K	Length/Dia Approx.	Type of Fitting	K	Length/Dia Approx.
Elbows (R/D=1/2 approx)			Angle Branches		
22½°	0.20	9	Flow in Line	0.35	16
45°	0.40	18			
90°	1.00	45	B.S Tapers		
Close Radius Bends (R/D=1 approx)			Flow to small end		Negligible
22½°	0.15	7	Flow to large end		
45°	0.30	14	Inlet	Outlet	
90°	0.75	34	4	5	0.03
Long Radius Bends (R/D=2 to 7)			3	4	0.04
22½°	0.10	5	1	2	0.12
45°	0.20	9			
90°	0.40	18	Valves		
Tees flow in line	0.35	16	Gate valve-fully open	0.12	5
Tees line to branch or branch to line:			Gate Valve ¼ closed	1.00	45
Sharp-edged	1.20	54	Gate valve ½ closed	6.00	270
Radiused	0.80	36	Gate valve ¾ closed	24.0	1080
Sudden enlargements			Reflux valve	1.00	45
Inlet	Outlet	K	Butterfly valve	0.30	13
4	5	0.15	Sudden contractions	K	Length/Dia
3	4	0.20	Inlet	Outlet	Approx.
2	3	0.35	5	4	0.15
1	2	0.60	4	3	0.20
1	3	0.80	3	2	0.35
1	5+	1.00	2	1	0.60
			3	1	0.80
			5	1+	1.00

$$K = \frac{\text{Head Loss}}{V^2/2g} = \frac{\text{Head Loss}}{\text{Velocity Head}}$$

$$\text{Head loss in metres} = K \times \frac{V^2}{19.6}$$

where V is measured in m/s

Length/Diameter = $\frac{\text{Length of straight pipe to give equivalent loss of head (m)}}{\text{Pipe diameter (m)}}$

Equivalent length = (l/d) x diameter

(3.2) Surge and Fatigue

- a) Surge shall be considered for all pumped strategic mains. A transient analysis shall be undertaken across the length of the pipe to confirm the proposed pipeline is able to accommodate any identified surge conditions.
- b) Potable water pipelines shall be designed to operate at positive pressure through their length at all times.
- c) Air valves are not to be used as a method of surge protection to limit or prevent transient negative pressures (by permitting the uncontrolled admission of air or water into the pipeline) as this may allow contaminants into the pipeline, and for this reason air valves shall not open under transient conditions
- d) Pressure envelopes shall be plotted for all pipelines to determine the surge and working pressure that will develop at minimum, average and maximum anticipated flow rates. Pressures shall also be calculated at low points either side of pumping sets, at high spots and at terminal reservoirs, to determine the pressure rating(s) required by the pipeline.
- e) Where initial analysis indicates that the proposed pipeline installation will not accommodate the surge conditions or is borderline, detailed surge analysis shall be undertaken.
- f) The analysis will detail the surge conditions to be met and indicate measures necessary to contain the surge pressures within the parameters of the pipeline, such as soft start pumps and surge vessels.
- g) Reference shall be made to the following documents for further guidance:
 - IGN 4-37-02 “Design Against Surge and Fatigue Conditions for Thermoplastic Pipes”
 - BS EN 545 – Ductile iron pipes fittings accessories and their joints for water pipelines
 - BS EN 805 – Water Supply – Requirements for systems and components outside buildings
 - BS-EN 1916 – Concrete pipes and fittings, un reinforced, steel fibre and reinforced
 - BS EN 10224 – Non-alloy steel tubes and fittings for the conveyance of water and other aqueous liquids

(3.3) Anchorages

- a) In flexible jointed pipelines means of resisting unbalanced loads shall be provided, usually in the form of concrete thrust blocks designed to transmit the loads to the undisturbed adjacent ground. Unbalanced loads occur at valves (sluice, butterfly, PRV and PSV), tees, bends, tapers and end caps. Anchorages shall also be provided to counter vertical thrusts e.g. at bends in the vertical plane at stream crossings. When locating thrust blocks, care shall be taken to avoid the risk of subsequent operations removing the earth support.
- b) The following parameters for thrust block design for distribution mains in stable ground may be used in the absence of better information:
 - 1) The ground resistance taken as 110 kN/m^2 .
 - 2) Thrust block to be of class C20P sulphate resistant concrete.
 - 3) A minimum safety factor of 2.
- c) Manufacturers anchor joints should be considered ahead of thrust blocks where 3rd party activity is likely.
- d) For end load resistant PE pipe systems anchorage is not normally required at the junctions or bends.
- e) For non-end load resistant PE systems or where individual non-end load resistant fittings are used, anchor blocks, designed to withstand the resultant thrusts, must be provided. See section 10.5 for further guidance.
- f) It may be necessary to partially or completely surround PVC or PE pipe with concrete. To avoid possible damage during pouring or compaction, use a rubber or heavy-duty polyethylene membrane.
- g) When joining PE to an existing system containing non-end load resistant fitting e.g. Tyton jointed pipes, the last non-end load resistant fitting shall be adequately restrained against the loading the PE pipes will impose.
- h) Anchorages shall be designed in accordance with CESWI 7 . 5.6

(3.4) Water Quality

A water quality issue which is influenced by mains design is discolouration. Factors which increase the risk of this are:

- Mains where the normal daily peak velocity is low which allows deposition to take place.
- Occasional exception demands (e.g. for fire-fighting) which re suspend the particles.
- Inability or failure to clean those mains where deposition takes place.

There may also be potential issues of microbiological quality associated with long retention times and low disinfectant residuals.

In order to limit water quality problems, the following aspects should be considered: loops, dead ends, self-cleaning velocity and the provision of washouts. Where inadequate water quality is suspected, this should be referred to the Strategic Water Quality team.

(3.5) Pressure / Leakage

- a) Leakage is approximately proportional to pressure. Pressure control should be considered where pressures exceed 30m at the critical point in the distribution system. In these cases the OWN-P team should be consulted.
- b) When designing pressure control areas, the considerations include:
 - 1. It is recommended that controlled areas have a single feed.
 - 2. Pressure at the critical point should not fall below 20 m.
 - 3. Pressure control should be considered where pressures exceed 30m at the critical point, in these cases the OWN-P team should be consulted
 - 4. Areas should be selected to maximise average pressure reduction. (e.g. areas with a large variation in ground level will inevitably have large spatial variation in pressure.)
 - 5. Cavitation should be avoided.
 - 6. Valves should be correctly sized.
- c) Design of pressure control schemes is a specialist activity best carried out using network modelling software. This certainly applies to items 1, 2 and 3.
- d) Item 4 is dealt with in manufacturers' data sheets. However, a useful indication is given by:

$$\sigma = \frac{(P_2 - P_v)}{(P_1 - P_2)}$$

Where σ cavitation index

P_1 inlet pressure

P_2 outlet pressure

P_v vapour pressure

- e) If σ is less than 0.5, cavitation damage may occur. If σ lies between 0.5 and 0.8 cavitation noise and vibration may occur. Infrequent periods of short duration with $\sigma < 0.5$ are permissible.
- f) The formula shows that large drops across the valve and low values of outlet pressure are to be avoided. In some circumstances, the former may be avoided by installing a long length of smaller diameter pipe. The latter may sometimes be avoided by repositioning the valve at a lower ground level whilst leaving the controlled area largely unchanged.
- g) Manufacturer's data is also available to size valves to suit the expected flow rate. A common mistake is to oversize the valve by choosing a diameter equal to the pipe diameter.
- h) Note (1) It can be useful, when a large pressure drop is needed in a new main, to install a smaller diameter main and a PRV with a smaller headloss rather than a larger main and a larger drop across the PRV. The cavitation index (above) should be used to determine an acceptable drop across the valve.

(4.0) Operational activity**(4.1) Hygienic storage of pipes and fittings**

- a) For guidance refer to WSV-RWI-121 "Hygienic Storage of Pipes & Fittings"

(5.0) Mains Fittings**(5.1) General**

- a) When locating valves and other mains fittings, consideration shall be given to accessibility and safe operation in conjunction with health and safety and CDM regulations 2015.
- b) When working on a pressurised distribution system the procedure "Permit for pressurised assets" shall be adhered to.

(5.2) Valves

- a) To allow safe accessibility for operational purposes valves shall be, where possible, located in the verge or footpath rather than the carriageway, consideration shall be given to the requirements of the CDM regs 2015 and the Traffic Management Act.
- b) Consideration should be given to the installation of isolating valves on 2 of the 3 branches of a junction when there is an alternative supply route to the properties on each branch and where it is cost effective to do so
- c) All new valves shall be clockwise closing valves. (Right handed valves) and comply with BS EN 1074-1&2
- d) The maximum interval between valves on an urban distribution system shall not generally exceed 100 props. Valves shall be installed with future operational requirements taken into consideration.
- e) Control valves for DZs and DMAs shall be provided as required. When designing new or redesigning existing DMA's PSW-PRO-1.6, assessment, guarding & operation of distribution system valves shall be followed.
- f) The location of in line valves on rural distribution system / strategic mains shall be determined through the risk opportunity & value process and shall be located in operationally accessible locations generally not exceeding 1.5km
- g) The size of valves installed must be agreed through the risk opportunity & value process however; the size selected must not impact adversely on the operation of the network.
- h) The provision of bypasses for valves greater than 400mm shall be provided.

- i) Telescopic extension spindles or poly top and tube chambers shall be used for valves and other fittings.
- j) Reinforcement mains shall be cross-connected; with locations agreed through the risk opportunity & value process.
- k) All valves on a strategic main or distribution main shall be installed to allow surface operation and for inspection and maintenance purposes and should be designed in accordance with:
 - 1) Preferred arrangement drawing. SD/W/01 – Sluice valve chamber 300mm-500mm pipe diameter
- l) Non return valves shall be installed in accordance with PA-W-0029
- m) OXO installations shall be installed according to PA-W-0027

(5.3) Indicator Posts and Marker Plates

- a) Indicator posts with marker plates shall be used to mark the position of key valves and other apparatus where required. Marker plates shall be installed and maintained in accordance with procedure PSW-POL-8.1.
- b) Where the main crosses open country away from the road, indicator posts shall be provided at all field boundaries in such a manner that the line of the main may be clearly ascertained.
- c) Marker plates shall comply with BS3521
- d) Where 4 or more fittings are installed in close proximity a single valve marker plate shall be used detailing the mains layout.

(5.4) Chambers and Covers

- a) Chambers shall be of an appropriate size to allow operation of the mains fitting.
- b) Sluice valve chambers shall be poly top & tube construction
- c) Large chamber sections shall be composite or concrete and shall comply with BS 5834
- d) Covers shall comply with BS EN 124 D400(carriageway) or BS EN 124 B125 (other locations)

(5.5) Pressure reducing valves / other network control valves

- a) Location, pressure settings and maintenance tasks for pressure control valves shall be agreed with the Infrastructure maintenance programme engineer, water operations and asset planning prior to installation.

(5.6) Extension spindles & Valve chambers

- a) Poly top and Tube or extension spindles shall be used for chambers on gate valves up to 300mm.
- b) For larger valve installations or other fittings, GRP modular chamber systems shall be used.

(5.7) Hydrants / washouts

- a) Washouts shall be installed at the end of mains, at high and low points and at changes in mains diameter on the distribution system, unless installation is not feasible. This will enable each section of the pipeline to be emptied or expel air when the main is recharged following a shutdown. Locations shall be determined through the risk opportunity & value process
- b) Hydrants & washouts shall have a fixed washer plate
- c) Where high discharge volumes are required then a “throughbore/clearway” type of washout should be used. These shall be installed in a standard sized hydrant chamber.
- d) Where mains of 8” or above are installed the use of the “throughbore/clearway” hydrant should be considered instead of the traditional hydrant type. This should be decided through consultation with the local network manager and the risk opportunity & value process
- e) Washouts should be installed alongside valves on strategic / rural mains to aid with flushing or the removal of air during / following mains recharge.
- f) Hydrants for fire fighting purposes shall be installed as required by the Fire Authority under the provisions of the Water Industry Act.
- g) Washouts shall be installed each side of a DZ or DMA valve to allow the flushing of “dead ends”.
- h) Hydrants & washouts shall be installed in chambers and be located directly above the main and not offset.
- i) All hydrants and washouts shall be compliant to BS750 and be a minimum 80mm NB
- j) Hydrants & washouts shall be such that a 100mm swab can be removed without unbolting the apparatus.

(5.8) Air Valves

- a) Air valves are required on lines for filling and emptying the pipelines, and for the release of air under normal operation
- b) Single air valves automatically release air that has accumulated in the main during normal operation. They comprise of a small orifice only and shall be located at all local high points, e.g. bridge crossing, downstream of pumps and on pressure reducing valves.
- c) Double air valves vent air automatically when a main is filled or emptied but it will also automatically release air that has accumulated in the main during normal operation. They comprise of a large orifice and a small orifice air valve and shall be located at all topographical high points, high points relative to the hydraulic gradient and at significant changes in the pipeline gradient.
- d) To ensure that air travels to the air valves, pipes should be laid with maximum possible rise and fall with a minimum permissible gradient of 1 in 500.
- e) Air valve installations on both potable and raw water mains shall be designed to prevent the uncontrolled admission of air or water into the pipeline, for this reason air valves shall not open under transient conditions. (See 5.2 Surge & Fatigue)

- f) Air valves shall be designed and located to categorise them as low risk in accordance with the requirements of POSWSH PSW-POL-1.1 and PSW-POL-2.4
- g) If an air valve has to be sited in a POSWSH medium/high risk location in order to maintain effective network operation, then approval shall be obtained from asset planning, the network manager and the regional network engineer at the design stage of the project.
- h) Air valve chambers shall be free draining and must not be located below ground water level or any flood level within flood plains or areas known to be subject to regular flooding. If this is unavoidable then alternative methods should be considered e.g. Washouts. Where possible, they should be located in footpaths, grass verges, adjacent to the road or at field boundaries.
- i) Consideration should be given to future access and maintenance requirements.
- j) Air valves shall be installed in line with the above requirements through the risk opportunity & value process considering the mains profile and local topography with installations where appropriate. See section 7.1c

(6.0) Rehabilitation and New Mains Layout

(6.1) General

- a) All mains shall be designed in accordance with CDM Regulations 2015.
- b) All mains should be designed within the verge, footpath or service strip. Where a main is laid in the carriageway all reasonable steps must be taken to reduce the risk to those involved in the operation of valves, washouts and fire hydrants.
- c) When designing connections on all mains it shall be considered that, where appropriate, the serviceability of the old water main be maintained until the new water main asset is proven.
- d) Consideration shall be given at the design stage to the methodology for commissioning new water mains particularly with regard to availability of water supply and connection arrangements.

(6.2) Main Laying in Private Land

- a) Pipe laying in private land shall be carried out under Section 159 to 169 and Schedule 6 of the Water Industry Act. The minimum notice period shall be three months except:
 - 1) When an existing pipe is being altered the minimum notice period shall be 42 days.
 - 2) When complying with a duty under Section 41 of the Water Industry Act for a mains requisition.
 - 3) Early entry by agreement with landowner.
- b) Compensation for loss is payable, Savilles shall be informed of any main laying on private land prior to the notice being served. Savilles will make appropriate compensation arrangements.
- c) All pipe laying in private land shall be carried out in accordance with Anglian Water's Code of Practice for Laying and Maintaining Pipes in Private Land Water Industry Act 1991 Standard Procedure, Notices and Letters (amended April 2005).

(6.3) Positioning of Mains

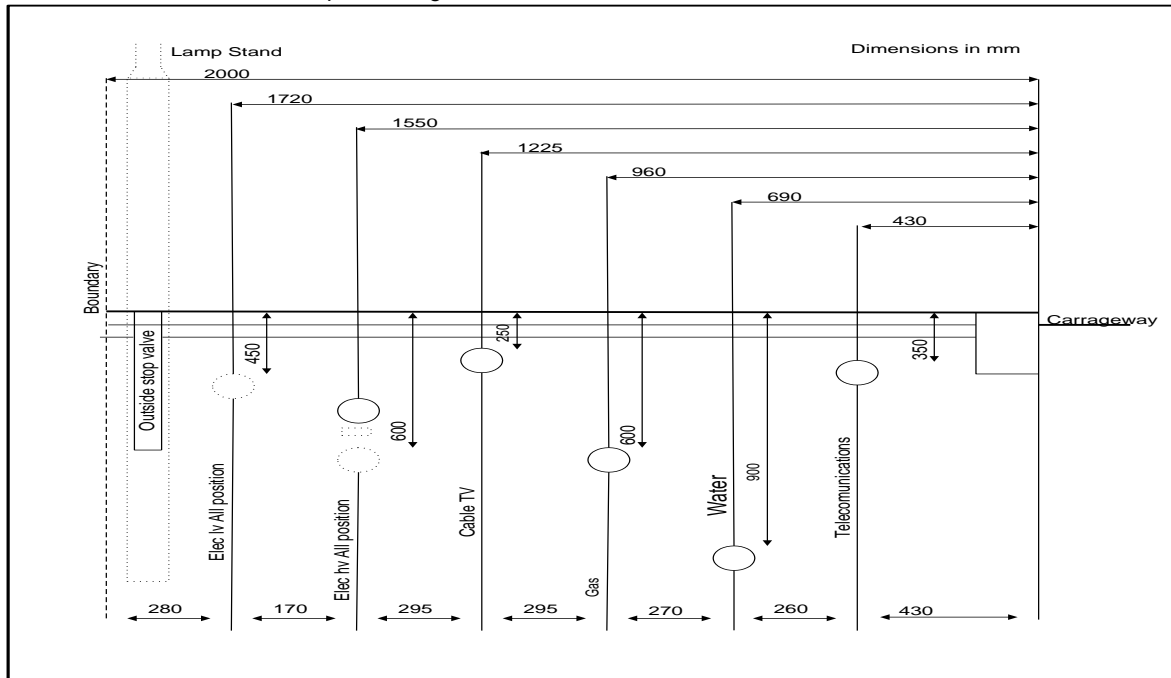
Non-Estate:

- a) For mains constructed for replacement or reinforcement consider the following:
 - 1) Where possible, mains shall be positioned within an un-surfaced area e.g. a grass verge. Where this is difficult, consideration shall be given to laying the main in an area to be covered by a footpath.
 - 2) Mains shall be laid on the side of the street serving the most properties to minimise communication pipe length
 - 3) Consideration shall be given to laying mains in or across private land, as opposed to the street, for lengths where no service connections are required.
 - 4) Consideration shall be given in design to future maintenance and operation of the main and fittings.
 - 5) The mains shall be located such that it will not interfere with access to other utility apparatus.
 - 6) Joint excavations/main laying with other utilities may be considered where economies can be made or where environmental / public relations issues might be satisfied.

New Estate:

- b) For mains laid on new development sites the following principles shall be observed:
 - 1) Generally, mains shall be positioned within public verge, footpath or service strips as recommended by publication Number 7 of the National Joint Utilities Group ". Table 6
 - 2) Where long service pipes are designed, refer to POSWSH PSW-PRO-8.4
 - 3) Single, as opposed to dual, main layouts shall be used wherever an economy can be achieved.
 - 4) Where possible, ring mains shall be incorporated.
 - 5) Mains shall be located on the side of the street serving the most properties to minimise the length of communication pipe.
 - 6) For clarification on dead ends refer to PSW-POL-2.4
 - 7) Mains shall be designed to ensure turnover every 7 days upon full commissioning. During commissioning, refer to POSWSH PSW-PRO-2.3 for guidance on flushing frequency prior to or during connection of services, to ensure mains shall be flushed, until sufficient connections have been made
 - 8) Consideration shall be given to using 63mm HPPE for dead end legs of main that are not more than 100m in length or supply more than 25 properties
 - 9) Investigate the options of providing more than one feeder main supplying an estate in line with the current DG3 trigger points.

Table 6 Recommended positioning of Utilities Mains” and “Plant for New Works” December 1996



(6.4) Main Laying in Street

When main laying takes place in a street it shall comply with the New Roads and Street Works Act, 1991 and the Traffic Management Act 2006.

(6.5) Depth of Mains

- The depth of cover for all mains should be a minimum of 750mm for public highway and 900mm for private land but this may vary and be dependant upon obstacles encountered, local land use or other special circumstances.
- The depth of main should be adequate to protect the main dependant upon the land use e.g. farm land. In such circumstances, local knowledge and engineering judgement shall be considered.
- Written permission of the regional network manager is required where there is a need to lay a main at an excessively deep or a very shallow depth.

(6.6) Main Laying Over or Under a Main River or Water Course

The consent of the Environment Agency, British waterways board for canals or local drainage board shall be obtained for the laying of a water main over or under a main river or other water course in accordance with Section 29 of the Land Drainage Act 1976.

(6.7) Main Laying in Contaminated Land

- For land that is, or is at risk of contamination, ductile iron pipes or a PE barrier pipe system shall be used in conjunction with barrier service pipes or plastic coated copper service pipes.
- See section 10.4 for PE barrier pipe and section 11.5 for ductile iron mains.
- Refer to section PSW-STD-2 of POSWSH Standards for main laying in contaminated land.
- When making a connection or joint between dissimilar materials or different manufacturer products in contaminated ground, this shall be undertaken using a gate valve

(6.8) Construction Traffic

Particular care shall be taken to ensure that mains are not subjected to abnormal loads during construction of mains or roads etc. when there may be reduced cover and/or abnormally heavy construction plant.

(6.9) Effect of Traffic Loading

The effect of traffic loading on a pipeline need only be evaluated where the main is to be laid with less than 900 mm cover, or is SDR21 / SDR26 HPPE.

(6.10) PE Mains Laid In Roads

- a) Mains subjected to heavy loading, highway, construction or agricultural traffic shall be designed in accordance with BSEN1295
- b) For MDPE and HPPE mains laid in roads, the following shall apply:
 - 1) Particular care shall be taken to ensure maximum pipe support from the bed and surround material, whether selected as dug or imported. This shall apply particularly to HPPE SDR21 where Highways Authority accepted bed and surround, compacted to not less than 90% shall be constructed.
 - 2) Reference shall be made to the NRSWA and appropriate Highway Authority guidance, regarding the road types 0 to 4 and any special engineering requirements.
 - 3) The size and strategic importance of the main in conjunction with the type and classification of the road shall determine the need for ducting.

(6.11) Main Laying Near railways

- a) Approval of network rail is required prior to undertaking any main laying under or near railway lines.
- b) Notification shall be given to Network Rail at an early stage of the design process if work is to take place within 50m of a railway line to ascertain whether approval is required
- c) Where mains are laid under railway lines any apparatus shall be outside the network rail boundary to aid ease of inspection.

(6.12) Easements

- a) Anglian Water is entitled to protect its pipe work from damage by building or other operations carried out on the land and that access will not be unreasonably restricted. This is often described as a “statutory easement”.

Pipe Size mm	Easement protection required (m) Overall distance
< 149	4.5
150-449	6.0
450-749	9.0
750 >	12.0

- b) When designing mainlaying schemes consideration should be given to cater for appropriate logistics and access within the easement to allow pipe laying and jointing to be carried out safely and efficiently.

(6.13) Excavation and Reinstatement

- a) Before excavating the guidance contained in “permit for pressurised assets” shall be adhered to.
- b) All reinstatements shall comply with Standards for Reinstatements of Highways and NRSWA.
- c) All excavations shall comply with the information found in HSE – safety in excavations HSG185 and NRSWA.

(6.14) Bed and Surround

- a) As dug material shall be used as a back-fill where suitable
- b) Where granular materials are required they shall comply with WIS 4-08-02 Bedding and side fill materials for buried pipelines

(6.15) Dualling mains

- a) Some main laying schemes may present the option to provide dual feeds due to inherent risks associated with laying under a major road, river or railway line etc.
- b) For such major crossings, the risk opportunity & value process shall be followed to ascertain the most appropriate course of action.
- c) Where dual mains are laid, appropriate valving shall be installed to allow isolation of each individual main without affecting the operation of the other.

(6.16) Mothballed mains

- a) This is not an agreed practice.
- b) In the event that no other option is available then the regional network manager and scientific approval must be sought in conjunction with the risk opportunity & value process.

(6.17) Installation of temporary washouts

- a) When temporary washouts are installed during mains replacement activities on non polyethylene mains.

(7.0) Main laying**(7.1) General**

- a) All work shall be carried out in accordance with POSWSH section 8
- b) PSW-STD-1 and Anglian Water's GSS Scheme shall be followed for interruptions to supply.

(7.2) Installation Methods

- a) Installation methods shall be selected on a scheme by scheme basis based on the nature of the scheme and the local conditions encountered.

(7.3) Training and Qualifications

- a) All personnel undertaking main laying and/or service-laying activities shall hold NVQ, City and Guilds or other appropriate qualifications for the work activity being undertaken and the machinery/tools used.
- b) An Anglian Water skills assessment test at an approved assessment venue shall also be undertaken.
- c) All personnel shall have been trained in accordance with POSWSH PSW-STD-12

(7.4) Bed, Surround and Backfill

- a) Imported bed and surround is not required for PE pipe where ground conditions will not cause mechanical damage to the pipe. For HPPE SDR21 in carriageway see Section 8.9
- b) When required, bed and surround shall be placed and compacted over the full width of the trench in layers not exceeding 150mm before compaction to a finished thickness of 300mm above the pipe crown.
- c) Wherever possible 'as-dug' or recycled backfill material shall be used for backfill. This applies to highway, verge and field excavation. This is without prejudice to the New Roads and Street works Act 1991 with regard to specification in the highway.

(7.5) Marker Tape

- a) All mains in 'open cut' shall be laid with marker tape containing an electrically conductive metallic wire.
- b) Tape shall be laid at a minimum depth of 450 mm and be blue for potable and red for raw water mains.

(7.6) Connections

- a) Prior to breaking the pipe, it must be positively identified as potable, in service and an Anglian Water main.

(7.7) Corrosion Protection

- a) It is recommended that site surveys be undertaken to assess soil corrosivity. Survey results shall determine the levels of corrosion protection required for ferrous pipes and fittings.
- b) If corrosive ground conditions exist, ferrous pipes and fittings shall be protected in accordance with the manufacturer's requirements.
- c) Fittings with damaged coatings shall not be used and should be returned to the logistics centre/supplier.
- d) All cathodic protection schemes should provide for regular inspections and checks after installation.
- e) Denso tape is approved for use when protecting fittings against corrosion on metal pipelines.
- f) Denso tape shall not be used on plastic pipelines to protect fittings against corrosion (e.g. pvc or standard MDPE/HPPE)
- g) Denso tap shall only be used to protect fittings on PE barrier pipe when approved by the regional scientific team and engineering standards. If approved for use the Denso tape shall be under wrapped with an additional barrier of adhesive aluminium tape on the sections where it overlaps onto the barrier pipe. The aluminium tape shall extend a minimum of 5mm beyond the Denso tape at the end so that it does not come into contact with the pipe surface, see diagram 1a

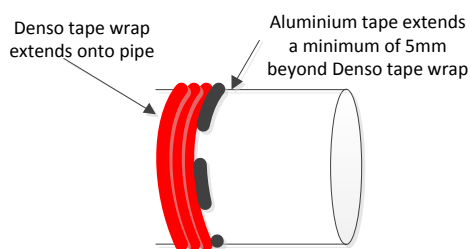


Diagram 1a Application of Denso tape to PE barrier pipe

(7.8) Under pressure connections

- a) Under pressure connections shall be assessed in accordance with PSW-PRO-1.11 and shall take into account local requirements.
- b) Connections to existing mains of any material shall be made using under-pressure tees wherever possible. Connections should be made according to PSW-PRO-1.11
- c) Under pressure connections shall be pressure tested prior to tapping the main.
- d) All under pressure connections shall have a sluice valve bolted to the tee branch.

The information contained in this document can only be guaranteed valid on the day of printing

© Anglian Water 2018

Date of printing is: 24/01/2018. Check current version for validity

- e) In exceptional circumstances, due to dangerous access conditions, a second valve may be installed as close to the tee as is safe with the first valve buried. Both valves shall still be marked on record systems.
- f) Only fittings approved for use on the specific mains material shall be used.
- g) For under pressure connections to PE pipe see section (10.3)
- h) For under pressure connections to asbestos cement pipe, the use of suitably pressure rated steel and ductile iron fittings are acceptable. The diameter of AC main can only be guaranteed at the pipe ends, so wider tolerance fittings may be required. The risks associated with drawing debris in the main should be addressed in the impact plan.
- i) For under pressure connections to PVCu pipe, local liaison will be required to ascertain whether shutdown, depressurisation or an under pressure connection is acceptable for connections. These factors should be addressed in the impact plan.

(8.0) Installing Polyethylene Mains

- a) PE pipe shall be purchased through the regional purchase agreement
- b) PE pipe is referred by external diameter as detailed in table 1
- c) PE should be laid from coils or in straight lengths
- d) When laying 180 mm MDPE pipe from coils or drums, it may be necessary to straighten and re-round before laying. The re-rounding process reduces the diameter of the pipe and therefore may require expanding to specification size at electro-fusion and mechanical joints. The supplier's recommendations shall be followed.
- e) The wall thickness of a PE pipe bears a constant ratio to the outside diameter for any particular class of pipe. This relationship is called the Standard Dimension Ratio (SDR): -

$$\text{SDR} = \text{Average outside diameter} / \text{Minimum wall thickness}$$

(8.1) Jointing of PE pipes

- a) Joints between MDPE and HPPE shall be identified for record purposes.
- b) Under normal circumstances, butt fusion jointing shall be used but alternative-jointing methods may be provided in the following circumstances: -
 - 1) Electro fusion couplings shall be used where joints cannot be made on the surface. E.g. day joints in a congested urban area or the joining of 2 coiled lengths of pipe
 - 2) For hydrant installations on new pipe electro-fusion hydrant, tees and duck foot bends shall be used.
 - 3) Under pressure hydrant branch saddles shall be used for under pressure hydrant installations on live mains. Standard under pressure branch saddles / stub flanges shall not be used, as flange plates are not fixed.
 - 4) Pipped stub flanges shall be used for joints between PE pipes and flanged metal fittings only. E.g. 2 x PE stub flanges back to back is not approved. This is because backing rings, which are thin and not fixed, tend to bend and loosen over time and may also misalign the two stub flanges or the rubber between the stub flanges.
 - 5) A solution to this is to separate the stub flanges with a short ductile iron distance piece
 - 6) Mechanical couplings (type1 end load resistant joints) shall be used for the insertion of repair lengths or post-commissioning connections only. These are not to be used if the main is under pressure.
 - 7) All nuts/bolts shall be tightened to the correct torque using a torque wrench.
- c) Spigot and socket joints are not approved for use on PE pipe.
- d) Site fusion jointing of PE pipes shall be carried out in accordance with water industry specification (W.I.S. No. 4-32-08), (*File location: G:\AW_Aset_Mgt\Global\IR&V\Standards\Manual of water Distribution*)
- e) Hand scrapers are only approved for installing service saddles; rotary scrapers shall be used on all other installations. Guillotines shall be used to cut pipe ends
- f) Site fusion jointing shall be carried out utilising automatic butt fusion, electro-fusion socket or electro-fusion saddle jointing methods only.
- g) Fusion machines shall be downloaded weekly and printouts obtained by the Anglian Water project engineer.
- h) Beads from butt fusion joints shall be numbered and tested in accordance with WIS. 4-32-08.

(8.2) Squeeze-off Closures

- a) The following principles shall be applied when planning and executing a squeeze off:
 - 1) Only specially designed equipment with a set squeeze-off limit appropriate to the size and SDR rating of pipe shall be used. Pipe over-squeeze will cause damage and is likely to lead to premature failure.
 - 2) For PE 80/100, SDR17 / 21 squeeze offs are permitted on mains up to and including 225mm. Squeeze offs may be considered on larger diameter mains in consultation with the local manager and the pipe supplier.
 - 3) For PE 80/100, SDR11 squeeze offs are permitted on mains up to and including 180mm. Squeeze offs may be considered on larger diameter mains in consultation with the local manager and the pipe supplier.
 - 4) If the wall thickness of the pipe is unknown then it shall be treated as SDR11
 - 5) A squeeze off shall not be within 5 pipe diameters of a fitting, joint or a previous squeeze-off.
- b) On release of the squeeze-off the following shall be undertaken:
 - 1) Pipe shall be inspected and re-rounded if necessary
 - 2) Pipe shall be renewed if there is any indication of damage.
 - 3) For pipes greater than 125mm a stainless steel repair clamp shall be fitted over the squeeze off point to provide additional support.
- c) The location of the squeeze-off shall be marked on the pipe using special "squeeze off applied" self-adhesive marker tape, the length of which shall be five times the pipe diameter. The tape shall be applied along the pipe of equal length either side of the point at which the squeeze-off was applied.

(8.3) Under pressure connections on PE pipe

- a) Only electro-fusion under pressure fittings, are approved for PE pipe.
- b) Mechanical fittings for PE require a liner, the insertion of which requires mains shut down and cannot be used for under pressure connections.
- c) In exceptional circumstances e.g. regulatory requirements, deviation from this policy may be considered but will require written approval from the Regional Network Manager.
- d) All under pressure connections shall be pressure tested to 1.5 times pipe rated pressure prior to cutting the host main.

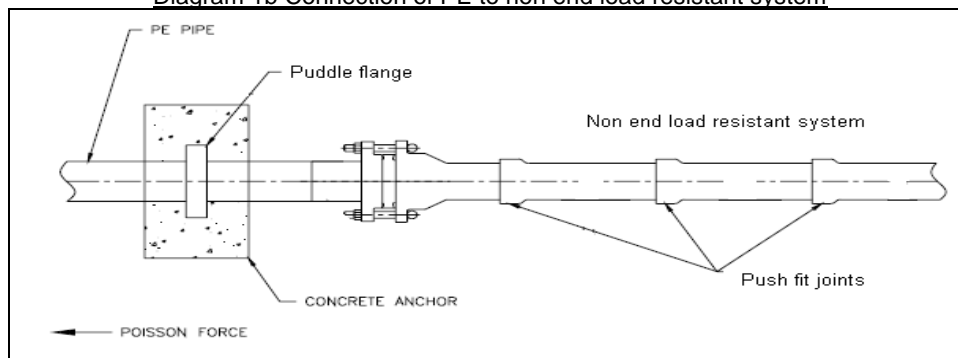
(8.4) Fittings and connections on PE pipe

- a) Fittings shall be purchased through the regional purchase agreement
- b) All vertical connections shall be 80 mm NB and be flanged.
- c) Installation of inline and terminal washouts up to 225mm shall be installed using the appropriate electro-fusion duck foot kit.
- d) Duck foot bends and tees for PE and pipes of size greater than 225 mm shall be fabricated of ductile iron and shall have flanges to connect to stub flanges, butt welded to the PE pipe.
- e) Electro-fusion elbows shall be used in preference to pupped elbows or swept bends, where available, and where hydraulic considerations permit.
- f) Swept bends and pupped fittings shall be joined to the pipe using butt fusion in preference to electro-fusion couplers.

(8.5) Anchorage and thrust blocks on PE

- a) All joints provided shall be type 1 end load resistant.
- b) When connecting to non end-load resistant pipe systems, inline anchor blocks must be provided to resist axial stresses arising from thermal or pressurisation effects on pipelines jointed by the above fully end-load resistant methods. See diagram 1b.
- c) These stresses known as the Poisson effect can occur down stream of the transition point between the two systems and result in joints on the non PE system being pulled apart.
- d) The PE pipe itself may be partially or completely surrounded by concrete but should be protected against fretting from any slight movement during normal operational by a heavy-duty polyethylene membrane. With a minimum overall membrane thickness of 3 mm. The membrane should extend outside of the concreted area to avoid possible damage during pouring or compaction and to minimise local stresses.
- e) Where a concrete surround to the pipe barrel is to be provided as anchorage, forces may be transmitted to the concrete via an integral stub flange or similar fitting to form a puddle flange. Electrofusion saddles can be effective where relatively low thrust loads are involved.

Diagram 1b Connection of PE to non end load resistant system

**(8.6) Ducts**

- a) Ducts for PE pipes shall be coloured blue or black with blue markings.
- b) Black can be used as a non preferred option where the above materials are unavailable
- c) Ducts are not adequate protection against contamination.
- d) The duct shall be marked on the corporate mapping system with its diameter and depth.
- e) Where ducts are laid under railway lines, they shall be extended beyond the network rail boundary to aid ease of inspection.
- f) Where a PE pipe is installed through a deeply buried duct, the structural nature of the duct and the surrounding ground should be considered during installation.
- g) If the duct is structural, no special requirements are needed.
- h) If the duct is non-structural, the following ground conditions are more important:
 - 1) In deep, firm ground, a loose fit can be tolerated between the pipe and the duct, irrespective of the SDR of the PE pipe.
 - 2) In unreliable ground or where the duct is shallow buried, the difference between the two pipe sizes (the duct ID - PE pipe OD) should be no more than 5% and the PE pipe should be thick walled in case the duct collapses due to ground movement. In such cases (or where differences of more than 5% exist) the pipe manufacturer should be consulted.

(8.8) Installing P.E barrier pipe

- a) Only barrier pipe and fittings approved through the regional purchase agreement shall be laid.
- b) Approved mechanical, butt fusion and electro-fusion jointing methods are approved for use on barrier pipe
- c) Directional drilling and pipe bursting methods are not approved for barrier pipe installation.
- d) Squeeze offs on barrier pipe shall be conducted in accordance with section 10.2 and section 9.7 for the application of denso tape shall be fitted over the squeeze off point to provide additional support and protection.
- e) Care shall be taken when handling barrier pipe to ensure the integrity of the protective layer is maintained.
- f) Passing the AWS approved training course is required for jointing barrier pipe by electrofusion or butt fusion
- g) Pipe ends shall be prepared with an approved rotary scraper and guillotine for electrofusion or butt fusion
- h) Only approved hydraulic pumps and fluid are permitted for use when installing fluid compression fittings.
- i) Pipe shall be installed and jointed in accordance with the EF jointing guide detailed in Appendix 1
- j) All 63mm connections shall be undertaken using the 63mm protectaline ferrule .
- k) If the outer skin of the barrier pipe is damaged it should be repaired in accordance with the manufacturers guidelines to reinstate the aluminium barrier, photographs of the repair shall be taken. The use of Denso tape may be used to protect the any newly applied adhesive aluminium tape; this shall only be undertaken once approval has been given. Refer to section 9.7g for further guidance.

(8.9) Directional Drilling

- a) POSWSH PSW-PRO-2.3 shall be adhered to.
- b) The distance between adjacent services and those being drilled shall be a minimum of 1m
- c) For schemes where directional drilling is employed the following shall apply:
 - 1) The leading pipe end of a pipe being drilled into the ground shall be attached to the pulling eye with a sealed, watertight connection designed to allow no ingress of external matter into pipe during its installation.
 - 2) The pulling eye shall be detached from the pipe above the top of the drilling/reception pit and the bore visually checked for contamination.
 - 3) A watertight end cap (i.e. of pressure resistant type) shall then immediately be fitted to the pipe end.
- d) If a material other than water has been used as a drilling lubricant in PE pipes, the leading pipe end shall be:
 - 1) Protected by incorporation of a 'double blanking plate' immediately behind the towing head.
 - 2) If the above protection device is not utilized, the main shall be inspected using 'clean water only' CCTV.
 - 3) The trailing end of a pipe being drilled into the ground shall be sealed with a pressure resistant cap, e.g. stub & blank flange or electro-fusion end cap.
- e) The end of any pipe within a drilling/reception pit shall be kept above the top of the pit and sealed with a watertight end cap at all times. (E.g. Flange adapter with blank flange or a welded end cap.)
- f) Drilling/reception pits shall be emptied of any drilling lubricant during, or immediately following drilling operations.
- g) Prior to the jointing of two drilled pipe lengths within a pit, the pit shall be completely emptied of all groundwater and/or drilling lubricant, to a level of at least 300mm below the invert level of the drilled pipes.
- h) Extreme care shall be taken to ensure that no debris, pipe-bedding material, groundwater, drilling lubricant or any other contaminant is within the pipe or enters the pipe during the jointing process.
- i) In cases where a visual inspection cannot give assurance of a clean/clear pipe, inspection using 'clean water only' CCTV may be required.

(8.10) Winch loads on PE pipes during directional drilling

- a) Where the rehabilitation method requires that the pipe be pulled through the host pipe or the ground, this will result in tensile forces being applied to a polyethylene pipe.
- b) The maximum pulling load on the pipe must be specified to avoid excessive stretching of the pipe and ultimately it could avoid tearing (ductile failure) of the material during installation.
- c) When subjected to a tensile load, such as that imposed by winching a pipe through an old pipeline, the pipe will undergo some stretching, the magnitude of which is dependent on the applied load, the time it is applied for, and the temperature of the material.
- d) To prevent damage to the pipe during installation, and to minimise the degree of strain on the material, the load should be limited to half the short-term yield strength of the material at its given temperature.
- e) Table 8.0 stipulates the maximum towing load to be applied for temperatures up to and including 20°C, for common pipe sizes in both PE80 and PE100 materials.
- f) Where the temperature of the pipe exceeds 20°C, it is recommended that the maximum towing load should be reduced.
- g) Where PE is to be installed with temperatures greater than 20° C for prolonged periods the pressure resistance of PE pipes changes by 1.3% per degree Centigrade change in temperature.
- h) When inserting the pipe it is recommended that the pipe be installed beyond the required position to allow for any shrinkage that may be caused by recovery of the strain imposed during the installation.
- i) As an approximate guide, the pipe should be left for a period of time equal to at least 5 times the period for which the pipe was under load before making the fitting connections.
- j) Consideration should be given to measuring and recording the loads imposed on pipes during directional drilling activities.

Table 8.0 Maximum recommended pulling loads for PE pipes and liners at 20°C

Maximum pulling loads at 20°C

Nominal PE Pipe Size (mm)	SDR	Max OD	PE80		Excel* (PE100)				
			20°C load (tonnes)	20°C load (tonnes)	20°C load (tonnes)	20°C load (tonnes)			
20	8.7	20.3	0.10	N/A	355	26	357.1	11.2	15.0
25	11	25.3	0.12	N/A	355	21	357.1	13.7	18.3
32	11	32.3	0.20	N/A	355	17	357.1	16.8	22.4
50	11	50.4	0.50	N/A	355	11	357.1	25.0	33.4
63	11	63.4	0.80	N/A	400	26	402.3	14.2	19.0
90	17	90.6	1.1	1.4	400	21	402.3	17.4	23.3
90	11	90.6	1.6	2.1	400	17	402.3	21.3	28.4
110	17	110.6	1.6	2.1	400	11	402.3	32.0	42.4
110	11	110.6	2.4	3.1	450	26	452.6	18.0	24.0
125	17	125.6	2.1	2.7	450	21	452.6	22.1	29.5
125	11	125.6	3.1	4.1	450	17	452.6	26.9	35.9
160	26	161.0	2.3	3.1	450	11	452.6	40.0	53.6
160	21	161.0	2.8	3.7	500	26	502.9	22.2	29.6
160	17	161.0	3.4	4.5	500	21	502.9	27.2	36.3
160	11	161.0	5.1	6.8	500	17	502.9	33.2	44.4
180	26	181.2	3.0	3.8	500	11	502.9	50.0	66.2
180	21	181.2	3.5	4.7	560	26	563.2	27.9	37.2
180	17	181.2	4.3	5.7	560	21	563.2	34.2	45.6
180	11	181.2	6.4	8.6	560	17	563.2	41.7	55.6
200	26	201.2	3.6	4.8	560	11	563.2	62.5	83.0
200	21	201.2	8.0	10.6	630	26	633.7	35.3	47.1
200	17	201.2	5.3	7.1	630	21	633.7	43.2	57.7
200	11	201.2	11	13	630	17	633.7	52.8	70.4
225	26	226.4	4.5	6.0	630	11	633.7	79.0	105.2
225	21	226.4	5.5	7.4	710	26	714.0	44.8	59.8
225	17	226.4	6.7	9.0	710	21	714.0	54.9	73.3
225	11	226.4	10.0	13.4	710	17	714.0	67.0	89.5
250	26	251.5	5.6	7.42	800	26	804.6	56.9	75.9
250	21	251.5	6.8	9.1	800	21	804.6	69.7	93.0
250	17	251.5	8.3	11.1	800	17	804.6	85.1	113.6
250	11	251.5	12.5	16.6	900	26	905.0	72.0	96.0
280	26	281.7	7.0	9.3	900	21	905.0	88.2	117.8
280	21	281.7	8.5	11.4	900	17	905.0	107.8	143.7
280	17	281.7	10.4	13.9	1000	26	1005.0	88.8	118.5
280	11	281.7	15.5	20.8	1000	21	1005.0	108.9	145.4
315	26	316.8	8.8	11.8	1000	17	1005.0	132.0	177.5
315	21	316.8	10.8	14.4					
315	17	316.8	13.2	17.6					
315	11	316.8	20.0	26.3					

OD = Outside Diameter
SDR = Standard Dimensional Ratio

(8.11) Pipe Bursting

- a) As a general guide to avoid damage to third party services the minimum clearance between adjacent services should be 300mm from electric and 250mm from others or one and a half times the diameter of the pipe being burst. See HSE guidance document “HSG 47 – Avoiding danger from underground services”.
- b) Trial holes , refer to the appropriate section of POSWSH

(8.12) Close fit insertion systems

- a) Close fit insertion systems offer two major advantages, they never require grouting and in most cases even though there is a slight reduction in diameter the improved hydraulic characteristics enable flows to be increased.
- b) Such systems are:
 - i. Roll down - Pre-welded strings of PE pipe are reduced in diameter by approximately 10%. The reduced diameter pipe string is then inserted into the old pipeline and re-expanded by water pressure to take up a close fit
 - ii. Subline – For pipes greater than 180mm, they are deformed into a C cross section by jacking through a mechanical plough and trough. The liner SDR is generally chosen to ensure that the reverted liner is pushed out into a tight fit
 - iii. Swage lining – Pulling a pre-welded string through a reducing die and into an old pipeline in one operation

(8.13) Road Crossings

- a) Refer to the appropriate section of POSWSH

(9.0) Ductile Iron & Blutop Mains

(9.1) General

- a) The standard jointing method for ductile iron is the spigot and socket joint.
- b) Care should be taken when cutting pipe lengths as the diameter of the pipe can only be guaranteed at the pipe ends.
- c) Ductile iron pipes shall be compliant with the principles of BS EN 545

(9.2) Pressure Rating

- a) Maximum working pressure for unrestrained flanged joints is 16 bar and therefore the pressure rating of a ductile iron pipeline shall be taken as 16 bar unless specifically designed to have a greater value.

(9.3) Inspection

- a) Before laying, each pipe should be inspected for any damage to the external protection system of the pipe such as:
 - 1) Cuts or tears to the wrapping
 - 2) Loss of bitumen / epoxy coating
 - 3) Check spigot-jointing surfaces for correct chamber protrusions in socket and for paint build up in socket area.
 - 4) Check no foreign matter has entered the pipe.
- b) Any damage to the protection system shall be repaired in accordance with the manufacturer’s guidelines.
- c) Mortar lining may contain small shrinkage cracks, which will not affect stability. Permissible crack widths are shown in the table below.
- d) Where cracks exceed these values, repairs shall be undertaken in accordance with the manufacturer’s guidelines in table 9.0

Table 9.0 Maximum crack widths

Nominal Size DN	Maximum crack width and radial displacement (mm)	
	Water pipes and fittings	PAM integral pipes & fittings
60-300	0.4	0.6
350-600	0.5	0.7
700-1200	0.6	0.8
1400-2000	0.8	0.8

(9.4) Installation of Ductile iron & Blutop

- a) When stringing pipes out along the line of the main, avoid dragging or dropping the pipes and check for sharp objects that may damage the coating or lining.
- b) To protect the pipe integrity, they shall not be rolled in from the side of the trench or rolled or dragged along the ground.
- c) Pipes shall only be lifted into the trench using webbing slings or padded hooks. Care should be taken when removing these to protect the pipe.
- d) Pipes that have protective wrappings around them for transportation and handling should be laid with this still in position.
- e) Installation of pipes and fittings shall be undertaken in accordance with the manufacturer’s guidelines for pipe and jointing methods.

(9.5) Wrapping of Ductile iron

- a) In certain ground conditions in order to protect the integrity of the pipe from corrosion there will be a need to provide additional protection in the form of tape wrap.
- b) Tables 9.1 and 9.2 provide details of the conditions of when this additional protection is required.
- c) Other protection systems may be considered dependant upon the soil conditions, further guidance should be obtained from the manufacturer. E.g. high performance coating
- d) The additional protection in the form of tape wrap is only required where the prohibitive ground conditions exist.
- f) Denso tape is approved for use when protecting fittings against corrosion on metal pipelines.

Table 9.1 Recommended Protection systems

Typical ground conditions (for corrosion purposes only. Unless otherwise stated it is assumed that selected as dug material is to be used for bed and surround.)	Seasonal or permanent water logging?	
	Yes	No
Natural soils with resistivity above 2500 Ω-cm	1 or 2	1 or 2
Natural soils with resistivity between 1500 and 2500 Ω-cm	1 or 3	1 or 2
Natural soils with resistivity between 750 and 1500 Ω-cm	1 or 4	1 or 3
Natural soils with resistivity below 750 Ω-cm	4	4
Natural soils containing coal, iron stone shale or peat		3* or 4
Natural soils with a pH less than 5	4	3* or 4
Made ground containing clinker, bricks, flints or other materials likely to cause mechanical damage	5	3* or 4
Made ground with light chemical contaminants e.g. refuse sites, farmyard waste.	4	3* or 4
Made ground with heavy chemical contamination e.g. disused gas plants, industrial sites, mines, chemical plants	5	5
Stray electrical currents e.g. close proximity to CP. Pipelines, DC traction systems	4	4
Tidal waters e.g. estuaries, shorelines	5	5

* Resistivity based on soil measurements

Table 9.2 Type of protection system

Ref No	Description	Protection
1	Slight to moderately aggressive and aggressive	Zinc-aluminium and epoxy – PAM Natural or PAM integral Plus (available on 5.5m long pipes up to and including DN800 only)
2	Slight to moderately aggressive	Zinc and bitumen/ epoxy coating
3	Aggressive	Zinc and bitumen/ epoxy coating plus PE sleeving (pipes >DN800)
4	Highly aggressive	Zinc and bitumen/ epoxy coating plus tape wrap (25mm overlap)
5	Highly aggressive	Zinc and bitumen/ epoxy coating plus tape wrap (55 % overlap)
*		Recommended coating plus and imported bed and surround

(9.6) Anchorage of Ductile iron & Blutop

- a) Consideration shall be given to using the pipe manufacturers design software / technical advice when designing the number, type and location of anchor points on ductile iron mains. This will enable the appropriate number of anchor points to be used and prevent over design.

(9.7) Blutop system compatibility

- a) Spigots of the following pipes can be inserted into Blutop pipe and connector sockets:
- b) PVC conforming to EN1452
- c) HPPE conforming to EN12201
- d) Blu top pipe spigots must not be fitted into sockets designed for other joints such as plastic, pvc or other iron pipes

(9.8) Blutop pipe embedment

- a) The pipe should be laid
 - Either on a laying bed which is 10mm thick comprising of graded backfill materials
 - Or directly on the bottom of the trench, if the in situ soil comprises fine and homogenous granular material
- b) In either case a recess must be provided for the sockets

(9.9) Bedding material for Ductile Iron & blutop pipe

- a) When laying pipe care shall be taken to ensure that pipes are properly supported with the correct bedding materials
- b) When installing pipes in carriageways bedding material shall comply with HAUC specifications
- c) Where granular bedding materials are used they shall comply with the requirements of WIS 4-08-02 Bedding and side fill materials for buried pipelines

(10.0) Pressure testing mains

(10.1) Pressure Testing PE and PE barrier pipe

- a) PE mains shall be pressure tested in maximum possible lengths, with an upper limit of 1500 m.
- b) The test shall be carried out in accordance with one of the two test methods set out in the WRc MDPE Manual:
 - WRc Type 1 test method may be used for short lengths of small diameter main of 15m or less where there is no risk of air in the test section. An AWS member of staff shall witness the test.
 - WRc Type 2 test method shall be used in all other circumstances.
- c) For PE pipe the test pressures should always be a maximum of 1.5 times the rated pressure of the lowest rated component or 20 bar maximum if any mechanical fittings are present.
- d) With these provisos, the test pressure should be 1.5 times the pipe rated pressure, when this is up to 10 bar, and 1.5 times the mean working pressure of the system, for pipes rated at 12.5 bar and above.
- e) Where SDR 11 pipe is installed for pipe wall thickness to utilise no dig techniques, the pipe should be tested to a minimum 12bar The pressure test shall be carried out using a pressure logger with printout facilities.
- f) A record of the pressure record during each pressure test carried out shall be attached to the mains completion certificate together with the results of the test.
- g) The pressure test printout shall clearly define the section of mains that has been tested.
- h) Where trunk mains will operate with a measure of certainty over their operational lives, they can be tested at 1.5 times operating pressure. This is inappropriate for distribution mains as the future configuration is unknown.

(10.2) Pressure Testing for Ductile Iron and Steel pipes

- Gauges used for testing ductile iron pipelines shall either be of the conventional "Bourdon" type, not less than 200 mm diameter which are calibrated in metres head water, or shall have a digital indicator capable of reading increments of 0.1m head.
- Gauges shall be checked independently and a dated certificate of its accuracy shall be provided. Gauges shall be recalibrated at intervals and if damage is suspected.

c) Methodology

- 1) Before testing, valves shall be checked, sections of main filled with water and the air released.
- 2) Hydrants shall be locked off whilst the pressure test is undertaken.
- 3) During testing and commissioning, no connection shall be permitted to live "in-service" mains except for filling purposes. Hydrant standpipes and other temporary connections for filling purposes shall be fitted with double check valves for backflow prevention.
- 4) After having been filled, pipelines shall be left full under 50% of the test pressure for 24 hours so as to achieve conditions as stable as possible for testing. No test shall take place against closed isolation valves.
- 5) The pressure in the pipeline shall be raised steadily until the specified test pressure is reached in the lowest part of the section, the pressure shall be maintained at this level by pumping, if necessary, for one hour.
- 6) The pump shall then be disconnected and no further water shall be permitted to enter the pipeline for a further period of one hour.
- 7) At the end of this period, pumping shall restore the original pressure. The loss shall be measured by drawing off water from the pipeline until the pressure, as at the end of the test, is again reached.
- 8) The measured water loss at the end of the first hour of the test period, shall not exceed the value calculated using the following formula (see BS EN 805 for further details):

$$\Delta V_{max} = 1.2 * V * \Delta p * ((1 / Ew) + (D / (e * Er)))$$

ΔV_{max} - Allowable water loss in litres

1.2 - Allowance factor for air during test

V - Volume of tested pipe section in litres

Δp - Allowable pressure loss in kilopascals - 20Kpa / hr / km

Ew - Bulk modulus of water in kilopascals - 2100 kilopascals

D - Internal diameter in metres

E - wall thickness of pipe in metres

Er- Modulus of elasticity of the pipe

DI = 170000 kilopascals, Steel = 190000 kilopascals

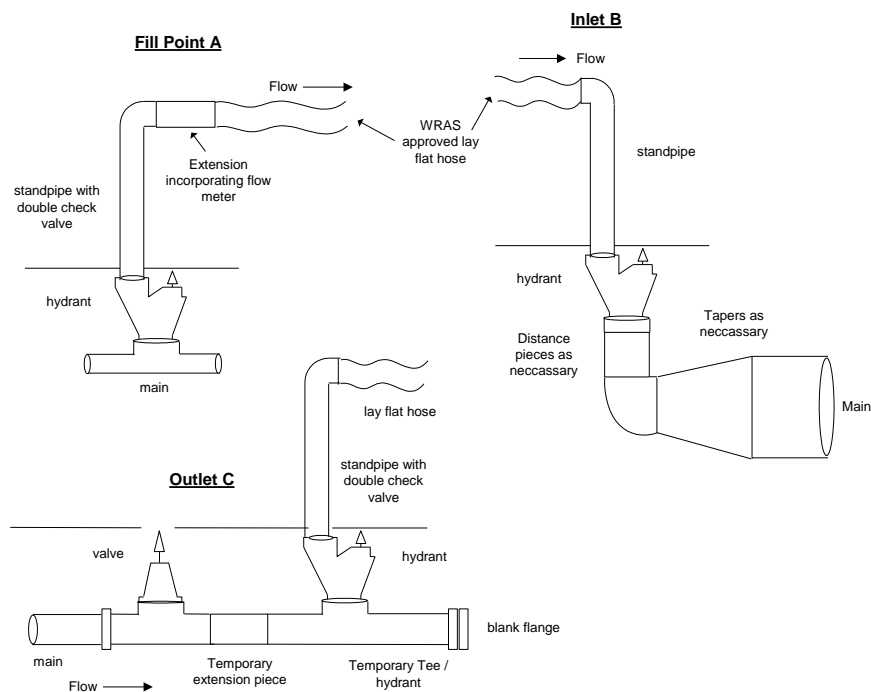
- 9) Click on link for [worksheet to calculate pressure loss](#). (File location: G:\AW_Asset_Mgt\Global\IR&V\Standards\Manual of water Distribution)
- 10) Test pressures for distribution pipelines shall be 1.5 x working pressure of the main or 9 bar, whichever is the higher value. Pressure tests shall be agreed at design stage and shall be verified by network modelling
- 11) Where trunk mains will operate with a measure of certainty over their operational lives, they can be tested at 1.5 times operating pressure.
- 12) The test pressure of the main shall be recorded on the as laid drawing of the scheme to be recorded on GIS. This data shall be made available for reference purposes.
- 13) Where a new pipeline is to connect to an operational pipeline, the joints of the final connection shall be inspected visually under normal operating pressure and there shall be no visible leakage.

(11.0) Commissioning of New Mains

- a) All new mains shall be commissioned in accordance with PSW-PRO-2.3.
- b) Where pipe has a factory fitted towing head installed then it shall be commissioned in accordance with POSWSH PSW-PRO-2.3 section 3.
- c) The commissioning of short lengths of main, laid under a road, shall adhere to POSWSH PSW-PRO-2.3
- d) Connections to live mains shall only be carried out by personnel cleared for restricted operations and the connection shall be disinfected and sampled as required for a mains repair by POSWSH, PSW-PRO-8.3 Methodology for Mains Opening.
- e) Water used during the disinfection process shall be de-chlorinated prior to discharge, to drains or watercourses. No water shall be discharged into a watercourse through any pipe, the diameter of which exceeds 229 mm, without the consent of the Environment Agency (Sections 165 & 166 of the Water Industry Act 1991)

(11.1) Swabbing of New Mains

- a) When POSWSH procedures dictate that swabbing is required within the commissioning process then mains shall be swabbed in the following manner and the pipe work arrangement for swabbing shall be as follows:
 - 1) Fill point (A) shows a standpipe incorporating double check valve and flow meter, on a washout, on an existing water main with WRAS approved lay flat hose, connecting the standpipe to the inlet standpipe.
 - 2) Inlet (B) shows a standpipe on a washout, connected to an 80mm nominal bore riser pipe and taper-piece to the pipe nominal bore. For pipe nominal bores up to 100mm, the swab may be inserted through the washout and taper and for larger nominal bores; the swab must be inserted in the pipe before the taper is connected.
 - 3) Outlet (C) shows a standpipe on a washout connected to the pipe to be swabbed with lay flat hose connected to suitable discharge point. The detailed arrangement will allow the swab to be extracted without draining down the pipe length.
 - 4) Outlet (C) should be at the highest point on non-PE mains where practical as there is potential for the valve to be forced off when the temp end is removed by the weight of the water in the main. This should be accounted for before removing the temporary wash out and extension piece.
 - 5) If a pipeline is split into separate lengths for swabbing, there shall be a physical break (e.g. back-to-back arrangement) between the length being swabbed and any adjacent lengths.



- b) The swabbing operation shall be as follows:
 - 1) Insert swab and connect pipe work.
 - 2) Open washouts and adjust flow-rate to provide proposed water velocity in pipe to be swabbed.
 - 3) The scheme engineer, team manager construction or AWS authorised new mains tester, shall monitor discharge water at outlet C. Record the presence of any debris. The discharge water will become more discoloured / turbid as the swab approaches. The water flow will become severely restricted as the swab reaches the outlet end and blocks the water passage to the washout.
 - 4) Close washouts and remove swab without draining down the pipe length.
 - 5) Repeat sequence as many times as necessary until the water just in front of the swab is clear with no particulate material present. The final swab should not have any ingrained material present nor be discoloured.
 - 6) Remove lay flat hose at outlet C, flush and check for clarity in clear container.
 - 7) Close washouts and remove swab without draining down the pipe length.
 - 8) Confirm entry and removal of all swabs utilised.

(11.2) As constructed drawings (as-laid)

- a) As constructed drawings shall contain the following information:
 - i Grid Refs at the start and end of the main and connection points.
 - ii Road names
 - iii Grid lines
 - iv North point and drawing scale
 - v Mainlaying route detailing surface category, dimensions off fixed buildings, road /kerb edges or boundaries
 - vi Pipe size, material, SDR/ pressure rating, and linings (where applicable) with potable / non potable indicated
 - vii Depths if greatly variant from normal (eg directionally drilled)
 - viii Installation date (month, year)
 - ix All fittings including Air valve type (single (AV) or double(DAV)), SV, WO, FH, PRV, PSV, NRV, Meter etc to be shown and dimensioned
 - x Decommissioned mains identified
 - xi Connection details including pipe work, all fittings and thrust blocks
 - xii Major utilities crossing or adjacent to the main as appropriate
 - xiii Valve set up (open / close) as agreed in the commissioning plan
 - xiv Easement width

(12.0) Service Laying**(12.1) Definitions**

- a) The "service pipe" is so much of a pipe which is (or will be) connected with a water main for supplying water from that main to any premises and,
 - 1) Is subject to water pressure from that main, or
 - 2) Would be subject to water pressure from that main but for the closing of a valve.
- b) The "communication pipe" is so much of a service pipe, which is owned by the water company.
- c) The "supply pipe" is so much of a service pipe, which is not a communication pipe.

(12.2) Hygiene

All work shall be carried out in accordance with POSWSH.

(12.3) Training and Qualifications

- a) All personnel undertaking service-laying activities shall hold NVQ, City and Guilds or other appropriate qualifications for the work activity being undertaken and the machinery/tools used.
- b) An Anglian Water skills assessment test at an approved assessment venue shall also have undertaken.
- c) All personnel shall have been trained in accordance with POSWSH PSW-STD-12

(12.5) Material Service Pipes and fittings

- a) The standard material for new service pipes shall be MDPE.
- b) Departure from the standard pipe material shall only take place when the material is laid in ground where contamination has occurred or is likely to occur. Reference should be made to PSW-STD-2.24 (Standards for main laying in contaminated land). In such a situation use either of the following
 - 1) Copper (which shall be supplied with blue polyethylene sheathing).
 - 2) An approved barrier pipe.
- c) All fittings shall be WRAS approved and shall be installed in accordance with the "water supply (Water Fittings) regulations 1999" and in accordance with POSWSH section 8
- d) Service pipe fittings shall be of the MDPE electro-fusion type or of the mechanical type. Electro-fusion is the preferred option for new pipes and mechanical is the preferred option for repair or replacement.
- e) Mechanical fittings shall be of copper alloy or of engineering quality plastic. Copper alloy fittings shall be dezincification resistant.
- f) A list of service pipe fittings can be found on the regional purchase agreement

(12.6) Communication Pipe Size

- a) New services shall be of sizes 25 mm, 32 mm, 50 mm, 63 mm MDPE or greater.
- b) The standard size of a new communication pipe to a dwelling shall be 25 mm MDPE.
- c) In exceptional circumstances, e.g. where the service pipe is very long or where there is a combination of a high flow requirement and low pressure, the communication pipe may be 32 mm MDPE.
- d) The standard size of a new communication pipe serving 2 dwellings shall be 32 mm MDPE.
- e) The standard size of a new communication pipe serving 3 - 8 dwellings inclusive shall be 50 mm MDPE.
- f) The standard size of a new communication pipe serving more than 8 dwellings shall be 63mm
- g) These communication pipe sizes should be verified with a network model prior to installation
- h) A communication pipe serving an industrial/commercial customer shall be sized from the information supplied by the customer. The network modelling team shall predominantly undertake this assessment.
- i) Maximum velocity shall not exceed 3m/s and the average velocity of flow shall not exceed 1m/s.

(12.7) Protection for non domestic connections

- a) Non-domestic connections shall have a single check valve compliant with BS EN 1074-3 installed at time of connection.

(12.8) Water connections to flats

See section (2.7)

(12.9) Service pipe sizes

Table 10 is given for guidance when choosing service pipes at an early stage of the design process. It does not indicate rigid limits on flow and headloss.

Table 10 Service pipe flow guidance

Pipe Size	SDR*	Internal Diameter	Flow (l/s) at a min velocity of 0.3 m/s	Flow (l/s) at a velocity of 1m/s	Flow (l/s) at 3m/km headloss
20mm MDPE	SDR 11	16.4	0.06	0.21	0.032
25mm MDPE	SDR 11	20.4	0.10	0.33	0.055
32mm MDPE	SDR 11	26.2	0.16	0.54	0.108
50mm MDPE	SDR 11	40.9	0.39	1.31	0.36

For guidance on service pipe diameters refer to Table 11

Table 11: Diameter of Water Supply Service Pipes for Non-standard Applications

Nos Props	Length m								
	50	100	200	300	400	500	600	700	800
1	25	25	25	32	32	32	32	50	50
2	25	32	32	50	50	50	50	50	50
3	32	50	50	50	50	50	63	63	63
4	50	50	50	50	63	63	63	63	63
5	50	50	50	63	63	63	63	63	63
6	50	50	63	63	63	63	63	63	90
7	50	50	63	63	63	63	63	90	90
8	50	63	63	63	63	90	90	90	90
9	63	63	63	63	90	90	90	90	90
10	63	63	63	63	90	90	90	90	90

- a) Data assumes the distribution system is at minimum pressure and that customer receives a DG2 compliant supply.
- b) Data assumes no more than 4m head loss or 1m/s velocity.
- c) The information presented in the above table has assumed daily water consumption per property of <0.5m³ and a normal day's maximum demand flow of 9 l/min. Consideration to boosting and/or storage may be required in areas where pressure is at the regulatory minimum.
- d) Service diameter is to maintain an adequate hydraulic profile. Tapping, boundary box and termination shall be made using standard 25mm fittings (or 32 mm as necessary) for single or double properties.
- e) Better information may be used if available design data must be kept with the scheme details.
- f) All non-standard service design shall ensure adequate turn over of water in that service. (POSWSH PSW-STD-8). Particular attention shall be made to residence time and minimum velocity.

(12.10) Cleaning & Disinfection

- a) Disinfection of service pipes shall not normally be carried out. Flushing shall be the standard procedure for cleaning. Refer to POSWSH PSW-PRO-8.4 (Methodology for working on services) for details.
- b) Large or long service pipes as explained in POSWSH shall be pressure tested, swabbed, chlorinated and sampled as per PSW-PRO-2.3 (New Mains Installation) and PSW-PRO-8.4 (Methodology for working on Services).

The information contained in this document can only be guaranteed valid on the day of printing

© Anglian Water 2018

Date of printing is: 24/01/2018. Check current version for validity

(12.11) Connection to the Main

- a) A communication pipe shall serve each separate new premise or dwelling with a separate tapping to the main, except for the following circumstances:
 - 1) Long-side connections may be made using a split communication pipe, with only one tapping to the main serving 2 dwellings.
 - 2) Where properties are supplied from a manifold.
 - 3) In exceptional circumstances, a communal communication pipe may be installed with only one tapping to the main, e.g. Block of flats, apartments or offices, conversion of large house to flats.
- b) Connections of size 32 mm MDPE shall be made by using a tapping tee with an outlet size of 32mm PE.
- c) The service pipe shall be connected with an electro-fusion coupler or reducing coupler.
- d) Connections of size 63 mm MDPE shall be made by using a tapping tee with an outlet size of 63mm PE.
- e) The service pipe shall be connected with an electro-fusion coupler.

(12.12) Provision of Stop Valve/Meter Chamber

- a) Each separate new premise (including flats where practicable) shall have a separate supply pipe, which shall be connected to a stop valve/meter chamber which may be situated adjacent to the property, elsewhere within the property boundary property or the highway as close to the property boundary as practicable.
- b) Boundary boxes shall be purchased through the regional purchasing agreement
- c) The standard stop valve/meter chamber for all new 25 mm MDPE services, and for new 32 mm MDPE services with a maximum flow rate of less than 1.5 or 2.5 m³/hour respectively, shall be the wall mounted box or a boundary box.
- d) The wall-mounted box shall be located on an accessible face of the dwelling where possible.
- e) The standard replacement stop valve/meter chamber for all existing services of size up to and including 25 mm MDPE and of size 32 mm MDPE (1") with a maximum flow rate of less than 4 m³ / hour, shall be a boundary box.
- f) The boundary box shall be sited to avoid vehicle-crossing points where practical.
- g) In situations where it is impossible to site the boundary box to avoid continuous or heavy vehicle traffic, a meter chamber shall be provided.
- h) A meter chamber shall be provided as the stop valve/meter chamber for 40 mm MDPE services with a maximum flow rate of less than 10m³/hour and for all larger services (Ref section 6.1 for meter sizing).
- i) A manifold chamber or multiples as required in accordance with PA-W-0013 / PA-W-0014 shall be provided as a communal boundary box for a new development when wall mounted boxes are impractical or on existing sites, provided that the following conditions are met,
 - 1) Communal communication pipe is installed.
 - 2) Each dwelling has a 25 mm MDPE supply pipe.
 - 3) All the supply pipes are made ready for connection to the manifold at one visit.
 - 4) It is sited as close as possible to the property boundaries with no intermediate road crossings.
 - 5) It is clearly identified which service pipe serves each property to aid with accurate meter installation.

(12.13) Installation

- a) Service pipes shall be laid at a standard depth of 750 mm below ground level. In particular circumstances (e.g. to avoid obstructions) service pipes may be laid at a depth between 750 mm and 1350 mm below ground level.
- b) Thrust boring is the preferred method of installation of new service pipes.
- c) Service pipes shall be provided with a bed and surround of selected as-dug material.
- d) Care shall be taken to ensure that the pipe is not placed next to hard, angular stones etc.
- e) Tracer tape shall not normally be laid with communication pipes.
- f) In particular circumstances tracer tape may be laid e.g. where the communication pipe,
 - 1) Is long and follows an unlikely route.
 - 2) Serves a large industrial/commercial customer.
 - 3) Is likely to be subject to second-comer disturbance.
- g) Communication pipes shall be connected to the main, which shall remain under positive pressure.
- h) Communications pipes shall only be installed when one of the following conditions applies,
 - 1) The customer's plumbing has passed a Water Supply (Water Fittings) Regulations 1999 inspection.
 - 2) The customer's plumbing has been deemed satisfactory for Water Supply (Water Fittings) Regulations 1999 criteria in accordance with PSW-PRO-9.1.
 - 3) A builder's standpipe, temporarily fed from a service connection, which will eventually be utilised as a conventional service. The standpipe must be of an approved pattern, and Anglian Water shall be informed when the connection is ready for transfer to the permanent supply pipe in order that "Water Supply (Water Fittings) Regulations 1999" inspection may be given.
 - 4) A builder's standpipe temporarily fed from a service connection, which will eventually be disconnected. The standpipe must be of an approved pattern and Anglian Water shall be informed when the connection is ready for disconnection.
- j) The communication pipe shall be installed in accordance with PSW-PRO-8.4 (Methodology for working on services).
- k) Care shall be taken to ensure that the stop valve/meter chamber components are clean and free from all contamination prior to installation and that a meter shall be fitted.

(12.14) Service pipes above ground

- a) Where a service pipe has to be laid above ground, such as bridge crossings it shall be insulated in accordance with AW spec 24.04 Insulation & Trace Heating.
- b) The insulated service pipe shall then be fed through a duct to protect the insulation from deterioration by weathering.

(13.0) Tapping of mains**(13.1) General**

- a) Tapping of mains shall be carried out with the main under positive pressure except in the case of PVC pipe where the guidance in section 18.3 shall be followed.
- b) The connection to the main shall be made at right angles to the main, facing the direction of the service pipe. The service pipe shall be slightly snaked within the trench to avoid tension on the coupler.
- c) Changes in direction or level of the service pipe shall be made by gradual curvature of the pipe, as far away as possible from the coupler to the mains connection.
- d) Service saddles and mains fittings shall be WRAS approved and be suitable for the mains material upon which they are to be installed.
- e) Saddles and fittings shall be installed in accordance with manufacturer's instructions.
- f) All under pressure connections shall be pressure tested prior to tapping the main.

(13.2) PE Mains

- a) Service pipes and saddle outlets are to be scraped with a radial scraper, not a flat hand scraper. The tools shall be inspected every 6 months and records kept of the inspection.
- b) Tapping of PE mains shall be carried out using electro-fusion self-tapping tees (32 mm outlet) or high volume tees (63 mm outlet) of the same material as the main.
- c) The use of ferrule straps or self-tapping straps on PE mains shall not be permitted.
- d) The electro-fusion tee terminates in a stub of PE pipe. This shall be connected to the communication pipe using an electro-fusion coupler or reducer.
- e) Connections to the main for service pipes greater than 63 mm MDPE shall be made using electro-fusion branch saddles.
- f) All electro-fusion service tees shall be pressure tested prior to tapping the main.
- g) For practical considerations, the guideline distance between tapings on a PE main shall be 300 mm.

(13.3) PVCu Mains

- a) Tapping of PVCu mains shall be carried out using ferrule straps where available, or ferrules with saddle straps.
- b) The ferrule straps shall be self-tapping for mains sizes up to and including 200 mm NB.
- c) When the ferrule strap or saddle strap is clamped to the PVCu main, care shall be exercised to ensure that the sealing gland is sufficiently compressed to form a watertight seal without over tightening and thus overstressing the PVCu pipe.
- d) The size of the tapping to a PVCu main utilising a ferrule strap, or ferrule with saddle strap, shall not exceed $D/4$ where D equals the nominal bore of the main. The maximum size of such a tapping shall not exceed $1\frac{1}{2}$ ".
- e) The minimum distance between tapings on a PVCu main shall be 500 mm or $5 \times D$ whichever is the greater.
- f) Larger tapings shall be made using an iron repair clamp (with outlet if required) and ferrule.
- g) Under-pressure connections to the main of size greater than 2" B.S.P. shall be made using an iron repair clamp incorporating a flanged branch, a flanged stainless steel clamp (Note: Careful consideration must be given to the pressure rating of stainless steel clamps) or other approved flanged under pressure fittings.
- h) See section [9.8 Under Pressure Connections](#) for further guidance and procedure on under pressure connections.

(13.4) Ductile Iron Mains

- a) Tapping of ductile iron mains shall be carried out using ferrules with saddle straps.
- b) Ferrules without saddle straps shall not be used on ductile iron pipe.
- c) The size of the tapping to a ductile iron utilising a ferrule with saddle strap shall not exceed $D/4$ where D equals the nominal bore of the main.
- d) Larger tapings may be made using an iron repair clamp (with outlet if required) and ferrule.
- e) Under-pressure connections to the main of size greater than 2" B.S.P. shall be made using an iron repair clamp incorporating a flanged branch, a flanged stainless steel clamp (Note: Careful consideration must be given to the pressure rating of stainless steel clamps) or other approved flanged under pressure fittings.
- f) For practical considerations the guideline distance between tapings on a DI main shall be 300 mm.

(13.5) Cast Iron Mains

- a) Tapping of cast iron mains shall be carried out using ferrules.
- b) The size of the tapping to a cast iron main shall not exceed $D/4$ where D equals the nominal bore of the main.
- c) Larger tapings may be made using iron repair clamps (with outlet if required) and ferrules.
- d) Under-pressure connections to the main of size greater than 2" B.S.P. shall be made using an iron repair clamp incorporating a flanged branch, a flanged stainless steel clamp (Note: Careful consideration must be given to the pressure rating of stainless steel clamps) or other approved flanged under pressure fittings.
- e) For practical considerations the guideline distance between tapings on a CI main shall be 300 mm.

(13.6) Asbestos Cement Mains

- a) Tapping of A.C. mains shall be carried out using ferrule straps where available, or ferrules with saddle straps. The ferrule straps shall be self-tapping for mains sizes up to and including 150 mm. Ferrules without saddle straps shall not be used on A.C. pipe.
- b) The size of the tapping to an A.C. main utilising a ferrule strap, or ferrule with saddle strap, shall not exceed $D/4$ where D equals the nominal bore of the main.
- c) Larger tapings may be made using an iron repair clamp (with outlet if required) and ferrule.
- d) Information provided by Eternit TAC Ltd in compliance with the Health & Safety at Work Act 1974, Section 6 (as amended) states that there is no dust, which can be inhaled, created during under-pressure drilling and tapping operations.
- e) Where practical, tapping shall be carried out against a counter flow of water to minimise the amount of cutting debris entering supply.
- f) The maximum size of service connections made under-pressure shall be 2" B.S.P. to minimise the amount of cutting debris entering supply.
- g) For practical considerations the guideline distance between tapings on an AC main shall be 300 mm.

(13.7) PE Barrier pipe Mains

- a) Tapping of protecta-line barrier pipe shall only be carried out using gunmetal self-tapping ferrule straps, designed specifically for use on barrier pipe.
- b) For practical considerations, the guideline distance between tapings on a PE main shall be 300 mm.
- c) When making 63mm connections refer to manufacturers instructions

(14.0) Boundary boxes and Wall mounted boxes

- a) The service pipe from the ferrule connection to the wall box shall be in a straight line. See section 18.1b
- b) The wall box shall be installed on an accessible elevation of the property, preferably the front.
- c) For installation of wall boxes refer to manufacturers guidelines.
- d) Boundary boxes shall be installed in the following situations:
 - For all new installations
 - Where a boundary box is installed in lieu of repairing an existing conventional stop valve installation or meter chamber.
- e) All boundary boxes shall have a double non return valve fitted, with both valves able to operate independently.
- f) For installation refer to mains maintenance section.
- g) At the time the boundary box is installed it shall be clearly identified and confirmed which property is supplied to aid with meter installation and billing.
- h) When the meter is installed it shall be tagged showing the meter serial number and the installation job number.
- i) Boundary boxes that are suitable for purpose and wall mounted boxes should be used in contaminated ground.

(15.0) Fire mains to metered customers

- a) Where a separate un-metered supply is required for fire fighting, reference should be made to drawing PA-W-0009 (Continued fire and metered service connection, up to $2.5\text{m}^3/\text{hr}$)
- b) A check valve compliant with BS EN 1074-3 shall be installed downstream of the normally closed valve on the un-metered fire supply (see drawing PA-W-0016).
- c) A closed valve potable water indicator plate shall be provided adjacent to the closed fire-fighting valve.
- d) Metering of fire mains should be considered to measure leakage / usage
- e) Meters should be of such a design as to not restrict the flow of the pipe e.g. Full bore electro magnetic.

Appendix 1: Electrofusion Jointing site guide**Electrofusion Jointing Site Guide****Pre Jointing Checks**

1. Use equipment that is clean, in good condition and regularly maintained.
2. Mechanical pipe preparation tooling **must** be used wherever possible.
3. Ensure that cutters/blades of mechanical scrapers and cutting equipment are clean and in good condition.
4. Check that you have somewhere clean and dry to place tools and equipment during the electrofusion process, and enough access to the work area.
5. Pipes and fittings must be checked for defects prior to commencement of any jointing operation.

Do's**• DO WORK SAFELY**

6. Do understand the principals of electrofusion (refer to pipe manufacturers details in van pack provide during training).
7. Do use a shelter and ground sheet, both in dry and wet conditions, to minimise contamination, and end protection to pipes, (plugs or caps) to eliminate draughts.
8. Do always use appropriate clamps for the true alignment, restraining and re-rounding, of all pipes, both sticks and coils.
9. Do ensure control box voltage is compatible with fitting.
10. Do ensure pipe and fittings to be jointed are compatible with each other.
11. Do cut pipe ends square for all electrofusion socket fittings as per tolerance table (see table 1 below)
12. Do fully prepare pipe ends (Protecta-line pipe ends **must** be prepared to the dimensions as stated in table 2 below using only a **Protecta-line Surprep scraper**).
13. Do ensure wherever possible a continuous triple ribbon of PE/AL/PE material is removed from Protecta-line pipes.
14. Do remove any residual aluminium on Protecta-line pipe ends with a hand scraper.
15. Do fully prepare all spigot surfaces using a standard rotary scraper removing a continuous ribbon of 0.2-0.4mm from pipe surface.
16. Do keep prepared pipe and/or spigot surfaces and fittings clean.
17. Do apply fitting in bag on 1st pipe end to protect whilst preparing 2nd pipe end.
18. Do only use **Protecta-line badged Durafuse EF** fittings when welding Protecta-line pipe.
19. Do assemble joint and fuse immediately following pipe preparation
20. Do check that the fusion time displayed by the Electrofusion Control Unit (automatic or manual) matches the fusion time on the fitting. In the case of automatic recognition, if the time is different to that shown on the fitting, do not weld.
21. Do ensure correct fusion and cooling times are observed and adhered to.
22. Do always input **correct operator** code and **job code** to allow for **full traceability** with ECUs with data retrieval facilities.
23. Do mark joint with joint number, operator initials, date, heat time, cool time, clamp removal time.
24. Do ensure fusion cycle is observed throughout.
25. Do ensure full cooling cycle is followed.
26. Do ensure that fusion indicators have risen, there is no evidence of molten material having flowed from the coupler, and pipes are aligned if there is no apparent movement of one or both of the indicators, the joint should be cut out and a new joint made (WIS 4-32-08).
27. Do ensure when jointing Protecta-line pipe the finished joint still meets pipe preparation criteria for prepared depths (table 2).
28. Do ensure that when jointing tapping tees the fitting is correctly positioned on the pipe before fusion.
29. Do only use Protecta-line badged mechanical fittings with Protecta-line pipes (AW currently do not permit the use of EF welded saddles on Protecta-line pipe systems).
30. Do ensure that following installation of any service saddle quality inspections are carried out and pressure testing of saddle fittings is also carried out prior to the main being tapped through

Other EF fittings

Other manufacturers EF fittings **must** not be used with Protecta-line systems.

Some manufacturers EF fittings may not be bagged when supplied, therefore must be checked and wiped with a prescribed wet wipe, - (min 90% Iso-Propyl Alcohol 10% water mix).

Don'ts

31. Do not start any electrofusion joint unless it can be completed without interruption.
32. Under no circumstances shall an attempt be made to carry out a second fusion cycle on any fitting. This is a WIS 4-32-08 Specification and shall be adhered to.
33. Do not use dirty or contaminated fittings.
34. Do not use fittings from split or torn bags, all fittings should be bagged until immediately prior to use (see above).
35. Do not ever touch prepared fusion/jointing surfaces.
36. Do not allow prepared fusion/jointing surfaces to become wet or damp.
37. Do not remove clamps from fitting until cooling time has elapsed.
38. Do not remove integral cutter from the stack/saddle. (Contamination risk)

The use of Wet Wipes

All pipe ends and spigots must be wiped once following scraping, only prescribed Wet Wipes shall be used, - (90% Iso-Propyl Alcohol 10% water mix). Separate fresh wet wipes shall be used for the scraped pipes and fitting if contaminated. Whether wiping both scraped pipe or fitting or just one of them, wiped surfaces must be allowed to visibly dry (do not touch the wet surface) failure to allow the jointing surfaces to visually dry will increase the risk of voids at the weld interface.

No need to wipe inside of fitting if in sealed bag (see section above regarding un-bagged fittings)

Health & Safety

GPS make every effort in the design and manufacture of their Pipes, and Fittings to ensure safety in use. The following precautions are however worth bearing in mind:

- Never allow hot polyethylene to come into contact with the skin. In such an event cold water should be used to cool the affected area. Expert medical advice must be sought.
- **Under no circumstances should any attempt be made to remove any material that becomes stuck on the skin without medical supervision, as this would risk more serious injury**
- Heavy pipes, fittings and equipment should not be handled without assistance or mechanical aid. The requirements of Manual Handling Operations Regulation should be adhered to.
- GPS recommend the wearing of Personal Protective Equipment in compliance of statutory legislation such as gloves, safety glasses and safety boots whilst carrying out electrofusion joints.
- Care should be exercised, by taking normal precautions, when using electrical equipment on site, particularly in wet conditions. Electrofusion Control Units are not intrinsically safe and should not be taken into trenches
- Normal precautions should be observed when handling electrical equipment and, for safety reasons, all 110v portable generator sets should be 'Centre Tapped' for site use +55/0/-55 volts.

Always remember that where joint records are automatically stored, these should be downloaded on a regular basis to allow full traceability and integrity of workmanship

Table 1 cut tolerances for PE pipe

Nominal pipe diameter in mm	Maximum tolerance mm
25	2
32	2
40	2
50	2
63	2
75	2
90	2
110	3
125	3
140	3
160	3
180	4
225	5
250	5
315	5
355	7

Table 2 pipe preparation depths for Protecta-line.

Size	Length	Min preparation depth / insertion depth.	Max preparation depth
90	127	62	67
110	135	66	71
125	147	72	77
160	164	80.5	85.5
180	167	82	87
225	220	106	111
250	224	108	113
280	256	124	129
315	291	141.5	146.5
355	295	143.5	148.5