

MS-3/2009
HDPE (High Density Polyethylene)
Pipe and Fittings Specification for
Buried Potable Water



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SECTION 026XX HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

PART 1 – GENERAL

The scope of this model specification is for municipal water pipelines which conform to AWWA standards. This guideline specification may be adopted in full or modified by the specifier to fit the project. [Options for the specifier are denoted by square brackets and italics.]

This model specification provides minimum requirements for HDPE pipe and fittings to be used in the design and construction of municipal pressure piping projects.

1.01 DESCRIPTION:

- A. Scope – This section specifies high density polyethylene pipe (HDPE) and fittings for water utility use as indicated on the Drawings, and as specified herein.
- Furnish, Install, and Test HDPE pipe as indicated and specified in this section, and as referred to in related sections, and the Drawings for *[Insert name of contract]*
 - The primary installation method is burial. The means and methods, including the testing for acceptance shall conform to all applicable standards as noted herein with the intention of providing a leak-free system to the owner.
- B. Special Instructions: *[Insert here special instructions with respect to the scope that are not obvious, or covered elsewhere]*

1.02 RELATED WORK

- A. The following sections are incorporated by reference, *[Reference the other sections of the contract that influence the HDPE- such as soil and site excavation, control of material at site – payment schedule etc]*
- a. Section 01300: Submittals
 - b. Section 01315: Coordination and Meetings
 - c. Section 01400 : Quality Control
 - d. Section 01600: Materials and Equipment
 - e. Section 022xx: Excavation, Backfill, Fill and Grading
 - f. Section 025xx: Utility Relocation
 - g. Section 26xx: Testing, Disinfection and Commissioning

1.03 REFERENCES

- A. To the extent referenced in this specification section, the standards and documents listed below are included, and made a part of this specification.
- B. In the event of a conflict, the requirements of this specification section prevail.

C. Unless otherwise specified, references to documents shall mean the latest published edition of the referenced document in effect at the bid date of the project.

ANSI/AWWA www.awwa.org

- ANSI/AWWA C901-08 Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm) for Water Service
- ANSI/AWWA C906-07 Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission
- ANSI/AWWA C651 Standard for Disinfecting Water Mains
- AWWA M55 Manual of Water Supply Practices, PE Pipe–Design and Installation

Plastics Pipe Institute, PPI www.plasticpipe.org

- PPI Handbook of Polyethylene Pipe – 2009 (2nd Edition)
- PPI TR-33 Generic Butt Fusion Joining Procedure for Polyethylene Gas Pipe
- PPI TR-34 Disinfection of Newly Constructed Polyethylene Water Mains
- PPI TR-41 Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping
- PPI TN-42 Recommended Minimum Training Guidelines for PE Pipe Butt Fusion Joining Operators for Municipal and Industrial Projects (2009)

NSF www.nsf.org

- NSF / ANSI 61 Drinking Water System Components–Health Effects

ASTM www.astm.org

- ASTM F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
- ASTM F905 Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
- ASTM F 1055 Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
- ASTM F 1290 Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
- ASTM F 1412 Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems
- ASTM F1417 Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

- ASTM F 2164 Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
- ASTM F2206 Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock
- ASTM D 2239 Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
- ASTM D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
- ASTM F 2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
- ASTM D 2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
- ASTM D 2737 Standard Specification for Polyethylene (PE) Plastic Tubing
- ASTM D 2774 Standard Practice for Underground Installation of Thermoplastic Pressure Piping
- ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
- ASTM D 3350-08 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

1.04 SYSTEM DESIGN PARAMETERS

- A. The *polyethylene* system working pressure rating *accommodates* the normal operating pressure and the repetitive surges. The pressure rating applies at 80°F or less.
- B. Per AWWA 901 and C906, the repetitive surge pressure allowance is one half the pressure class of the pipe, and the occasional surge over pressure allowance is equal to the pressure class of the pipe. Allowable Total Pressure during Recurring Surge conditions equals 1.5 times the pipe's pressure class. Allowable Total Pressure during Occasional Surge conditions equals 2.0 times the pipe's pressure class.

Table 1 gives the Pressure Class per AWWA C901, Pressure Rating and Allowable Total Pressure During Recurring and Occasional Surge for **PE4710** pipe at 80°F or less. For PE 3608, refer to Table 2.

Table 1. Pressure Class per AWWA C901 for **PE 4710** at 80°F or less

Pipe Dimension Ratio (DR)	Pressure Class	Pressure Rating	Allowable Total Pressure During Recurring Surge	Allowable Total Pressure During Occasional Surge
<i>DR 9</i>	<i>250 psi</i>	<i>250 psi</i>	<i>375 psi</i>	<i>500 psi</i>
<i>DR 11</i>	<i>200 psi</i>	<i>200 psi</i>	<i>300 psi</i>	<i>400 psi</i>
<i>DR 14.3</i>	<i>150 psi</i>	<i>150 psi</i>	<i>225 psi</i>	<i>300 psi</i>
<i>DR 17</i>	<i>125 psi</i>	<i>125 psi</i>	<i>185 psi</i>	<i>250 psi</i>
<i>DR 21</i>	<i>100 psi</i>	<i>100 psi</i>	<i>150 psi</i>	<i>200 psi</i>

Table 2 gives the Pressure Class per AWWA C901 and C906 , Pressure Rating and Allowable Total Pressure During Recurring and Occasional Surge for **PE3608** pipe at 80°F or less.

Table 2. Pressure Class per AWWA C901 and C906 for **PE 3608** at 80°F or less

Pipe Dimension Ratio (DR)	Pressure Class	Pressure Rating	Allowable Total Pressure During Recurring Surge	Allowable Total Pressure During Occasional Surge
<i>DR 9</i>	<i>200 psi</i>	<i>200 psi</i>	<i>300 psi</i>	<i>400 psi</i>
<i>DR 11</i>	<i>160 psi</i>	<i>160 psi</i>	<i>240 psi</i>	<i>320 psi</i>
<i>DR 14.3</i>	<i>120 psi</i>	<i>120 psi</i>	<i>180 psi</i>	<i>240 psi</i>
<i>DR 17</i>	<i>100 psi</i>	<i>100 psi</i>	<i>150 psi</i>	<i>200 psi</i>
<i>DR 21</i>	<i>80 psi</i>	<i>80 psi</i>	<i>120 psi</i>	<i>160 psi</i>

1.05 SUBMITTALS

A. Quality Assurance / Control Submittals

1. Affirmation that product shipped meets or exceeds the standards set forth in this specification. This shall be in the form of a written document from the manufacturer attesting to the manufacturing process meeting the standards. *[The specifier can also ask for various test results to be supplied that are done according to the standards]*
2. Manufacturers recommended fusion procedures for the products.

1.06 DELIVERY – STORAGE – HANDLING

- A. Handle the pipe in accordance with the *PPI Handbook of Polyethylene Pipe (2nd Edition), Chapter 2* using approved strapping and equipment rated for the loads encountered. Do not use chains, wire rope, forklifts or other methods or equipment

that may gouge or damage the pipe or endanger persons or property. Field storage is to be in compliance with AWWA Manual of Practice M55 Chapter 7.

- B. If any gouges, scrapes, or other damage to the pipe results in loss of 10% of the pipe wall thickness, cut out that section or do not use.

PART 2 A– PRODUCTS FOR 3 INCH AND SMALLER PIPE PER AWWA C901

2A.01 PIPE

- A. Polyethylene pipe shall be made from a HDPE material having a minimum material designation code of PE 4710 or PE 3608. The material shall meet the requirements of ASTM D 3350 and shall have a minimum cell classification of PE445474C for PE 4710 and PE345464C for PE 3608. In addition, the pipe shall be listed as meeting NSF-61.
- B. The pipe shall meet the requirements of AWWA C901
- C. HDPE pipe shall be rated for use at a pressure class of _____ *[User specified]* psi. *[The specifier chooses the pressure class from Table 1 or Table 2 in Section 1.04 above].* The outside diameter of the pipe shall be based upon the IPS, CTS, or SIDR sizing system. *[User to specify the appropriate sizing system on the plans.]*
- D. Approved manufacturers are: *[The specifier is referred to the list of manufacturers as shown on the PPI website*
http://plasticpipe.org/municipal_pipe/mi_members.html]

2A.02 FITTINGS

- A. Butt Fusion Fittings - Fittings shall be made of either PE4710 or PE 3608, with a minimum Cell Classification as noted in 2A.01A. Butt Fusion Fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans.

Markings for molded fittings shall comply with the requirements of ASTM D 3261. Fabricated fittings shall be marked in accordance with ASTM F 2206. Socket fittings shall meet ASTM D 2683.

- B. Electrofusion Fittings - Fittings shall be PE4710 or PE 3608, with a minimum Cell Classification as noted in 2A.01A. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans.
- C. Flanges and Mechanical Joint Adapters (MJ Adapters) – Flanges and Mechanical Joint Adapters shall be PE4710 or PE 3608, with a minimum Cell Classification as noted in 2A.01A. Flanged and Mechanical Joint Adapters can be made to ASTM D 3261 or if machined, must meet the requirements of ASTM F 2206. Flanges and MJ Adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans. Markings for molded or machined

flange adapters or MJ Adapters shall be per ASTM D 3261. Fabricated (including machined) flange adapters shall be per ASTM F 2206.

Van-Stone style, metallic (including stainless steel), convoluted or flat-plate, back-up rings and bolt materials shall follow the guidelines of Plastic Pipe Institute Technical Note # 38, and shall have the bolt-holes and bolt-circles conforming to one of these standards: ASME B-16.5 Class 150, ASME B-16.47 Series A Class 150, ASME B-16.1 Class 125, or AWWA C207 Class 150 Series B, D, or E. The back-up ring shall provide a long-term pressure rating equal to or greater than the pressure-class of the pipe with which the flange adapter assembly will be used, and such pressure rating shall be marked on the back-up ring. The back-up ring, bolts, and nuts shall be protected from corrosion by a system such as paint, coal-tar epoxy, galvanization, polyether or polyester fusion bonded epoxy coatings, anodes, or cathodic protection, as specified by the project engineer.

- D. Service connections shall be electrofusion saddles with a brass or stainless steel threaded outlet, electrofusion saddles, sidewall fusion branch saddles, tapping tees, or mechanical saddles.

For electrofusion saddles with threaded outlet the size of the outlet shall be one inch IPS unless a larger size is shown on the plans. Electrofusion saddles shall be made from materials required in part 2A.02 B. Electrofusion Fittings.

For sidewall fusion saddles, the size of the saddle shall be as indicated on the plans. The saddle can be made in accordance to ASTM D 3261 or ASTM F 2206. After installation, approximately ¼” of the PE pipe shall be visible beyond the saddle to confirm that proper surface preparation occurred. Saddle faces that do not provided ¼ inch of area beyond the saddle are not acceptable.

Tapping tees shall be made to ASTM D3261 or D2683.

Mechanical strap-on saddles can only be used where there use on PE pipe is approved by the mechanical saddle manufacturer. The body of the saddle shall be stainless steel, epoxy coated cast iron or brass. The gasket material and design must be acceptable for PE pipe. The outlet shall be threaded for one inch IPS unless a larger size is shown on the plans. Mechanical strap-on saddles will be installed per the manufacturer’s instructions.

2A.03 PIPE AND FITTING IDENTIFICATION

- A. The pipe shall be marked in accordance with the standards to which it is manufactured.
[or alternative as above]
- B. Color identification by the use of stripes on pipe to identify pipe service shall be optional. If used, stripes or colored exterior pipe product shall be blue for potable water. *[Optional]*

- C. Tracing wire shall be placed parallel and above, but separate from the pipe and shall be 10 AWG or engineer approved equal. *[The specifier can change this to the preferred material or method, all pipes should have a methodology to be locatable]*
- D. Marking tape shall be approved by the engineer and placed between 6 and 12 inches above the crown of pipe. *[Optional]*

PART 2 B– PRODUCTS FOR 4 INCH AND LARGER PIPE PER AWWA C906

2B.01 – PIPE

- A. Polyethylene pipe shall be made from HDPE material having a material designation code of PE3608 or higher. The material shall meet the requirements of ASTM D 3350 and shall have a minimum cell classification of PE345464C. In addition, the material shall be listed as meeting NSF-61.
- B. The pipe and fittings shall meet the requirements of AWWA C906.
- C. HDPE pipe shall be rated for use at a pressure class of _____ *[User specified]* psi. *[The specifier chooses the pressure class from Table 2 in Section 1.04 above].* The outside diameter of the pipe shall be based upon the IPS or DIPS sizing system. *[User to specify the appropriate sizing system on the plans.]*
- D. Approved manufacturers are: *[The specifier is referred to the list of manufacturers as shown on the PPI website http://plasticpipe.org/municipal_pipe/mi_members.html]*

2B.02 FITTINGS

- A. Butt Fusion Fittings - Fittings shall be made of HDPE material with a minimum material designation code of PE3608 and with a minimum Cell Classification as noted in 2B.01A. Butt Fusion Fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All fittings shall meet the requirements of AWWA C906.

Markings for molded fittings shall comply with the requirements of ASTM D 3261. Fabricated fittings shall be marked in accordance with ASTM F 2206. Socket fittings shall meet ASTM D 2683.

- B. Electrofusion Fittings - Fittings shall be made of HDPE material with a minimum material designation code of PE 3608 and with a minimum Cell Classification as noted in 2B.01A. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electrofusion fittings shall be suitable for use as pressure conduits, and have nominal burst values of four times the Working Pressure Rating (WPR) of the fitting. Markings shall be according to ASTM F 1055.
- C. Flanges and Mechanical Joint Adapters (MJ Adapters) – Flanges and Mechanical Joint Adapters shall have a material designation code of PE3608 or higher and a

minimum Cell Classification as noted in 2B.01A. Flanged and Mechanical Joint Adapters can be made to ASTM D 3261 or if machined, must meet the requirements of ASTM F 2206. Flanges and MJ Adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans. Markings for molded or machined flange adapters or MJ Adapters shall be per ASTM D 3261. Fabricated (including machined) flange adapters shall be per ASTM F 2206.

Van-Stone style, metallic (including stainless steel), convoluted or flat-plate, back-up rings and bolt materials shall follow the guidelines of Plastic Pipe Institute Technical Note # 38, and shall have the bolt-holes and bolt-circles conforming to one of these standards: ASME B-16.5 Class 150, ASME B-16.47 Series A Class 150, ASME B-16.1 Class 125, or AWWA C207 Class 150 Series B, D, or E. The back-up ring shall provide a long-term pressure rating equal to or greater than the pressure-class of the pipe with which the flange adapter assembly will be used, and such pressure rating shall be marked on the back-up ring. The back-up ring, bolts, and nuts shall be protected from corrosion by a system such as paint, coal-tar epoxy, galvanization, polyether or polyester fusion bonded epoxy coatings, anodes, or cathodic protection, as specified by the project engineer.

- D. Service connections shall be electrofusion saddles with a brass or stainless steel threaded outlet, electrofusion saddles, sidewall fusion branch saddles, tapping tees, or mechanical saddles.

For electrofusion saddles with threaded outlet the size of the outlet shall be one inch IPS unless a larger size is shown on the plans. Electrofusion saddles shall be made from materials required in part B. Electrofusion Fittings.

For sidewall fusion saddles the size of the saddle shall be as indicated on the plans. The saddle can be made in accordance to ASTM D 3261 or ASTM F 2206. After installation, approximately ¼" of the PE pipe shall be visible beyond the saddle to confirm that proper surface preparation occurred. Saddle faces that do not provided ¼ inch of area beyond the saddle are not acceptable.

Tapping tees shall be made to ASTM D3261 or D2683.

Mechanical strap-on saddles can only be used where there use on PE pipe is approved by the mechanical saddle manufacturer. The body of the saddle shall be stainless steel, epoxy coated cast iron or brass. The gasket material and design must be acceptable for PE pipe. The outlet shall be threaded for one inch IPS unless a larger size is shown on the plans. Mechanical strap-on saddles will be installed per the manufacturer's instructions.

2B.03 PIPE AND FITTING IDENTIFICATION

- A. The pipe shall be marked in accordance with the standards to which it is manufactured.
[or alternative as above]

- E. Color identification by the use of stripes on pipe to identify pipe service shall be optional. If used, stripes or colored exterior pipe product shall be blue for potable water, or green for wastewater/sewage, or purple (lavender) for reclaimed water. *[Optional]*
- F. Tracing wire shall be placed parallel and above, but separate from the pipe and shall be 10 AWG or engineer approved equal. *[The specifier can change this to the preferred material or method, all pipes should have a methodology to be locatable]*
- G. Marking tape shall be approved by the engineer and placed between 6 and 12 inches above the crown of pipe. *[Optional]*

PART 3 – EXECUTION

3.01 JOINING METHODS

- A. Butt Fusion: The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians per PPI TN-42.
- B. Saddle fusion: Saddle fusion shall be done in accordance with ASTM F 2620 or TR-41 or the fitting manufacturer's recommendations and PPI TR-41. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past year on the equipment to be utilized on this project. *[Saddle fusion is used to fuse branch saddles, tapping tees, and other HDPE constructs onto the wall of the main pipe] (ASTM F905).*
- C. Socket Fusion: Molded socket fusion fittings are only to be used for joining of HDPE pipe from 1/2 inch to 2" in size. Socket fusion shall be done in accordance with ASTM F 2620 or the fitting manufacturer's recommendations. Socket fusion is the process of fusing pipe to pipe, or pipe to fitting by the use of a male and female end that are heated simultaneously, and pressed together so the outside wall of the male end is fused to the inside wall of the female end. Qualification of the fusion technician shall be demonstrated by evidence of socket fusion training within the past year on the equipment to be utilized on this project. *[Socket fusion is not widely used, and the specifier may decide to prohibit its use]*
- D. Electrofusion: Electrofusion joining shall be done in accordance with the manufacturers recommended procedure. Other sources of electrofusion joining information are ASTM F 1290 and PPI TN 34. The process of electrofusion requires an electric source, a transformer, commonly called an electrofusion box that has wire leads, a method to read electronically (by laser) or otherwise input the barcode of the fitting, and a fitting that is compatible with the type of electrofusion box used. The electrofusion box must be capable of reading and storing the input parameters and the fusion results for later download to a record file. Qualification of the fusion technician shall be demonstrated by evidence of

electrofusion training within the past year on the equipment to be utilized for this project.

E. Mechanical:

1. Mechanical connection of HDPE to auxiliary equipment such as valves, pumps, and fittings shall use mechanical joint adapters and other devices in conformance with the PPI Handbook of Polyethylene Pipe, Chapter 9 and AWWA Manual of Practice M55, Chapter 6.
2. Mechanical connections on small pipe under 3" are available to connect HDPE pipe to other HDPE pipe, or a fittings, or to a transition to another material. The use of stab-fit style couplings is allowed, along with the use of metallic couplings of brass and other materials. All mechanical and compression fittings shall be recommended by the manufacturer for potable water use. When a compression type or mechanical type of coupling is used, the use of a rigid tubular insert stiffener inside the end of the pipe is recommended.
3. Mechanical couplings that wrap around the pipe and act as saddles are made by several manufacturers specifically for HDPE pipe. All such saddles, tapping saddles, couplings, clamps etc. shall be recommended by the manufacturer as being designed for use with HDPE pipe at the pressure class listed in this section.
4. Unless specified by the fitting manufacturer, a restraint harness or concrete anchor is recommended with mechanical couplings to prevent pullout.
5. Mechanical coupling shall be made by qualified technicians. Qualification of the field technician shall be demonstrated by evidence of mechanical coupling training within the past year. This training shall be on the equipment and pipe components to be utilized for this project.

F. Joint Recording - The critical parameters of each fusion joint, as required by the manufacturer and these specifications, shall be recorded either manually or by an electronic data logging device. All fusion joint data shall be included in the Fusion Technician's joint report.

G. The specifier is referred to the list of manufactures as shown on the PPI website http://plasticpipe.org/municipal_pipe/mi_members.html.

3.02 INSTALLATION

- A. Buried HDPE pipe and fittings shall be installed in accordance with ASTM D2321 or ASTM D2774 for pressure systems and AWWA Manual of Practice M55 Chapter 7.
- B. Pipe embedment - Embedment material should be Class I, Class II, or Class III , materials as defined by ASTM D-2321 Section 6. The use of Class IV and Class V materials is not recommended, however it may be used only with the approval of the engineer and appropriate compaction.
- C. Bedding: Pipe bedding shall be in conformance with ASTM D2321 Section 8. Compaction rates should be as specified in ASTM D2321. Deviations shall be approved by the engineer.

- D. Haunching and backfill shall be as specified in ASTM D 2321 Section 9 with Class I, II, or III materials. Compaction shall be in excess of 85% Proctor [*Specifier to put in the percent compaction and other site specific information as needed*]

3.03 TESTING

- A. Hydrostatic leakage testing is recommended and shall comply with ASTM F 2164, ASTM F 1412, AWWA Manual of Practice M55 Chapter 9, and PPI Handbook of Polyethylene Pipe Chapter 2 (2nd Edition). If the test section fails this test, the Contractor shall repair or replace all defective materials and/or workmanship at no additional cost to the Owner.
- B. Pneumatic (compressed air) leakage testing of HDPE pressure piping is prohibited for safety reasons.

3.04 CLEANING AND DISINFECTING

- A. Cleaning and disinfecting of potable water systems shall be in accordance with AWWA C651 and AWWA Manual of Practice M55 Chapter 10, and PPI Handbook of Polyethylene Pipe Chapter 2 (2nd Edition).
- B. After installation and pressure testing, new water mains should be disinfected according to AWWA C651.
- C. The disinfection chemicals should be limited to less than 12% active chlorine. The duration of the disinfection should not exceed 24 hours.
- D. Upon completion, the system should be thoroughly flushed with fresh water, and retested to verify the disinfectant chlorine level has been reduced to potable drinking water concentrations in all service water tubing and branch lateral pipes.

End