

WL112 – Frequently Asked Questions

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Why is ASTM D1248 an obsolete standard for PE pipe materials?

ASTM D1248 was originally published in 1952 to specify physical properties for PE molding and extrusion materials. It covered PE extrusion materials for a wide variety of extrusion applications including electrical, profiles, and pipe. As the PE piping industry developed, it became clear that by addressing so many applications, the format of ASTM D1248 did not adequately characterize or include the properties that were necessary for PE piping materials; further, it also required properties that were not relevant for PE pipe.

To meet the need for a PE material standard especially for PE pipe and fittings, ASTM developed ASTM D 3350, which was first published in 1974. From 1974 until 1989, ASTM D1248 and ASTM D3350 were both used to specify PE pipe materials; however, maintaining consistency between the two standards proved increasingly difficult, such that in 1989, PE piping materials were removed from ASTM D1248. Since then, ASTM D3350 has served as the sole standard specification for PE plastics pipe and fittings materials.

ASTM D1248 remains an active ASTM standard, but since 1989 it has not included requirements for PE pipe materials. Therefore, it is no longer possible for PE pipe materials to comply with ASTM D1248.

The correct specification for PE pipe materials is ASTM D3350, and per ASTM D3350, PE compounds that previously would have been Type III, Class C, Category 5, Grade P34 are met by ASTM D3350 cell classification PE445574C (PE44XX7XC, X denotes ASTM D 3350 material properties not included in ASTM D1248 prior to 1989). WL Plastics PE4710 compound per WL106 meets or exceeds ASTM D3350 cell classification PE345464C and material code designations PE3608 and PE3408, which meets or exceeds pre-1989 ASTM D1248 requirements.

References:

ASTM D1248 *Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable*

ASTM D3350 *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*

WL106 *PE4710 Pipe Compound*

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What happened to ESCR?

When the PE pipe industry began in the late 1950's, little was known about how PE materials would respond to sustained loads such as continuous internal pressure and earth embedment. It was originally thought that PE materials would behave much like metals where ductile tensile properties govern. But as PE pipes were placed in service, some PE materials began to develop cracks through the pipe wall that were not related to ductile tensile material properties. Because PE pipes are used in critical applications to transport natural gas, water and the like, brittle-like material cracking was a major concern. Research identified the brittle-like cracking as slow crack growth, SCG, which was initially thought to be related to environmental stress cracking.

An early test method for PE material resistance to environmental stress cracking was ASTM D1693 that was first published in 1959. In this test method, material strips are bent and immersed in a chemical accelerant at elevated temperature. The time to the appearance of surface cracks is measured. But in the field, brittle-like cracking did not exhibit observable surface cracks or crazing and didn't involve a chemical accelerant. Further, as improved performance materials were developed and time to failure increased, it was discovered that ASTM D1693 ESCR test specimens undergo stress relaxation (creep); that is, the bending stress applied to the specimen decays such that after several hundred hours, the remaining stress is too low to initiate stress cracking. As newer, more robust PE pipe materials were developed to combat brittle-like cracking they exhibited virtual immunity to ASTM D1693 ESCR failure. What was needed was a new test to better model field conditions and avoid the stress decay and chemical accelerant issues that plague ESCR tests.

After extensive research and development, ASTM F1473 was published in 1997. Named for the University of Pennsylvania where it was developed, the PENnsylvania Notch Test (PENT) applies a constant, sustained tensile load to a razor notched material specimen at elevated temperature. The time to specimen break is measured. Unlike the ASTM D1693 ESCR test, ASTM F1473 PENT more closely models pipe field conditions, and in fact, has been correlated to the material hydrostatic design basis, HDB, that is used to determine pipe pressure rating. In addition, an empirical correlation between PENT and pressure gas distribution service indicates that 25-35 hours PENT correlates to approximately 100 years in pressure gas distribution service.

ASTM D3350 includes a cell classification for slow crack growth resistance per ASTM D1693 ESCR or ASTM F1473 PENT. The highest ESCR requirement is a 4 which is >600 hours ESCR per ASTM D1693. A 4 is also the lowest PENT per ASTM F1473 of >10 hours. ASTM D3350 includes higher PENT SCG resistance requirements where 5 = >30 hours, 6 = >100 hours, and 7 = >500 hours. For ASTM D3350 SCG resistance requirements above 4, ASTM D1693 ESCR stress relaxation typically precedes surface cracking; that is, ESCR >600 hours actually represents non-failure, meaning that materials that exceed 600 hours will just as likely exceed 10,000 hours.

ASTM F1473 PENT performance per ASTM D3350 is also identified in the PE material designation code as the second digit in PE3408, PE3608, and PE4710. WL Plastics uses only PE4710 material per WL106 respectively. This high performance PE pressure piping material greatly exceeds ASTM D3350 SCG resistance requirements per ASTM D1693 ESCR such that it is not meaningful to include ESCR resin performance information. However, these materials are differentiated by ASTM F1473 PENT performance; therefore, SCG resistance per ASTM F1473 PENT is presented in WL106 for PE4710 material. It is to be noted that PPI TR-4 lists WL Plastics PE4710 materials as meeting or exceeding PE3608 and PE3408 requirements for those materials.

In summary, ASTM F1473 PENT has replaced ASTM D1693 ESCR. WL Plastics modern high performance PE4710 materials are characterized and differentiated by ASTM F1473 PENT SCG resistance, but not by ASTM D1693 ESCR.

References

ASTM D1693 *Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics*

ASTM F1473 *Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins*

ASTM D3350 *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*

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WL106 PE4710 Pipe Compound

Can a mandrel be used to check installed deflection of non-pressure pipes?

It is not practical to check the installed deflection of OD controlled solid wall pipes with a mandrel. To check deflection with a mandrel, a known ID dimension is a prerequisite. However, ASTM F714 and AWWA C906-15 specifications for large diameter, OD controlled solid wall HDPE pipe do not specify ID dimensions, and the OD and wall thickness dimensioning specifications, toe-in allowance, and internal fusion bead make it impractical if not virtually impossible to determine an ID, and therefore, impractical if not impossible to test for installed deflection by pulling a sized mandrel through the pipe bore. Therefore, WL Plastics does not recommend using a fixed diameter mandrel (sewer ball) to check the installed deflection of ASTM F714 or AWWA C906-15 pipe.

ASTM F714 or AWWA C906-15 pipe may be checked for installed deflection by measuring vertical ID at a location before installation, and then measuring vertical ID at the same location after installation to determine deflection at that location. Another method would be to use traveling laser measuring equipment to measure horizontal and vertical ID at a location, and determine ovality and deflection at that location.

References

ASTM F714 *Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter*

AWWA C906-15 *Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission*

Have ASTM standards for fusion joining changed?

Yes. In December 2006, ASTM published a new standard for fusion joining PE pipe and fittings, ASTM F2620. In May, 2007, ASTM D2657 was republished with a revision that removed PE pipe and fittings joining. Specifications that reference ASTM D2657 for fusion joining should be changed to ASTM F2620. In 2013 ASTM F2620 was revised to include updated minimum heating and cooling times for pipe diameters 14" and larger. These changes can also be found in WL101 Joining and Field Procedures.

References

ASTM D2657 *Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings*

ASTM F2620 *Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings*

WL101 *Joining and Field Procedures for PE Pipe*

Does WL Plastics HDPE pipe need to be protected against UV deterioration?

PE pipe products are protected against deterioration from exposure to ultraviolet light and weathering effects with antioxidants, and thermal and UV stabilizers. UV stabilization formulations for black products and for solid color (non-black) products are different.

WL Plastics black HDPE pipe with and without stripes contains 2-3% carbon black to shield the pipe against UV degradation. HDPE pipe containing 2-3% carbon black is suitable for indefinite long-term surface or above grade use or storage without cover or other measures to protect black product from direct exposure to UV energy. Long term exposure of black HDPE pipe to UV from sunlight is not a concern. ASTM D2513-20 for gas distribution pipe limits outdoor storage of black HDPE pipe with and without yellow stripes to 10 years.

Solid color (non-black) products are compounded with sacrificial UV stabilizers that protect the pipe against deterioration by absorbing UV energy. However, when UV stabilizers are depleted, solid color (non-black) pipe will be susceptible to

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degradation from further exposure to UV energy. For this reason, solid color (non-black) piping products should not exceed about 3 years exposure to UV energy from sunlight during storage or use. Where extended storage or use is anticipated, solid color (non-black) products should be covered or measures should be taken to protect solid color products from direct exposure to UV energy. Solid color (non-black) products are intended for installation underground or in areas that do not continuously expose the pipe to direct UV energy.

Products that are stored for extended periods may be affected by other environmental conditions or obsolescence due to improvements in materials or processes. Surface and above grade storage or use should be such that the pipe is not unreasonably exposed to harmful mechanical, environmental or chemical effects. For example, moving equipment, floods or storms may damage the pipe and some chemicals could have deleterious effects if spilled onto the pipe or soils upon which the pipe rests. See PPI TR-19 for chemical resistance information.

References

PPI TR-19 *Chemical Resistance of Thermoplastic Piping Materials*

Can WL Plastics HDPE pipe be used for compressed air service?

HDPE piping is regularly used for underground compressed gas service such as for natural and LP gas, and for transporting compressed gases such as air, carbon dioxide, hydrogen sulfide, nitrogen, etc. Years of service have shown that HDPE is a reliable product for these applications. Transporting natural gas under pressure is usually governed by federal regulations. Transporting other compressed gases including compressed air is allowable, but with restrictions.

Compressed gas applications require consideration of chemical and temperature effects, and installation so that the possibility of mechanical damage is remote. Under internal pressure, gaseous oxygen in compressed air has an oxidizing chemical effect compared to more benign gasses such as carbon dioxide or nitrogen. Other oxidizing gases can have similar effects. While oxidation may not reduce service life, which is usually governed by the onset of slow crack growth, when SCG does eventually occur, oxidation increases the rate of crack growth through the material. If the compressed gas or air contains compressor oils, the oils can deposit on the pipe ID and permeate into the pipe. Permeation (chemical solvation) can reduce material strength and require additional environmental design factor reduction. Elevated temperature will accelerate chemical effects.

WL Plastics recommends that compressed air service be limited to dry, oil-free compressed air. Pressure ratings are reduced 50% if the compressed air contains oil. Compressed air may need to be cooled before entering HDPE pipe. Hot compressed air directly from the compressor may exceed HDPE elevated temperature pressure limits (140°F/60°C or lower). See WL118 *Pressure Rating* for pressure rating and environmental design factor information.

With regard to installation, compressed gas lines have an increased risk of mechanical damage if the line is exposed, and are usually subject to greater ambient temperature variations. If an exposed PE compressed gas line were to be severed, the energy released is not only the energy from internal pressure, but also all of the energy that was used to compress the gas. The sudden release of this energy can be explosive and extremely dangerous. Flexible PE pipes, especially smaller sizes, can whip about uncontrollably and cause damage, injury or death. Therefore, compressed gas lines must be fully restrained by burial underground, with structural mechanical restraints that restrict pipe movement in the event of mechanical damage, and by installation in locations there is little or no potential for mechanical damage. The installation should also limit pipe temperature to 80°F (27°C) or below. Although black PE pipe is indefinitely protected against UV deterioration, PE compressed air pipe should not be exposed to direct sunlight because sunlight heating can increase pipe temperature to well above 80°F (27°C), which reduces pipe strength and accelerates chemical effects.

References

WL118 *Pressure Rating*

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What is the status of AWWA standards updates for PE4710?

AWWA/ANSI has approved and published AWWA C906-15. This revised publication incorporates PE4710 pipe materials. PE3408 pipe material has been removed from C906-15 as PE4710 meets and exceeds all requirements of PE3408 (See WL106 for more information).

AWWA C906-21 – effective January 1, 2021, covers 4” through 65” sizes and pressure-rated PE materials including PE4710. Pipe pressure class ratings are consistent with HDB and HDS ratings for the PE materials. PE4710 is an approved material for AWWA C906 for waterworks piping.

AWWA C901-20 – effective January 1, 2020, covers ½” through 3” sizes and pressure-rated PE materials including PE4710. Pipe and tubing pressure class ratings are consistent with HDB and HDS ratings for the PE materials. PE4710 is an approved material for AWWA C901 water service piping.

References

ANSI/AWWA C901-08 *Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm), for Water Service*

ANSI/AWWA C906-15 *Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 65 In. (1,650 mm), for Waterworks*

WL106 PE4710 Pipe Compound

Are Rework (regrind) or Recycle Materials Used in HDPE Pipe?

WL Plastics does not use recycled plastic materials in any WL Plastics piping products. Recycled plastic materials come from products that were manufactured, left the factory, were used, and were then recovered from waste. Recycled plastic materials are typically plastics containers and packaging such as bags, bottles, etc. Plastic containers and packaging materials are designed to protect contents during shipping and sometimes during use, but are then to be discarded, hopefully recycled. Recycled plastic materials are not intended for long-term service, and may be compounded with additives that promote degradation in landfills.

WL Plastics piping products are manufactured in accordance with industry standards for piping products that transport hazardous and non-hazardous liquids and gases in pressure and non-pressure service applications. These piping products are expected to perform for many decades. Recycled materials that are intended for short-term service, and that may be designed disintegrate in a short period of time are not suitable for WL Plastics piping products. Recycled plastic materials do not and cannot meet piping material specifications in any of the industry standards used for WL Plastics piping products. ASTM, AWWA, API and FM standards used for PE pressure and non-pressure pipe do not permit the use of recycled plastic materials. See WL116 for the pipe manufacturing standards used for WL Plastics piping products.

All of the industry standards used by WL Plastics for PE piping products allow the use of rework (regrind) material. Rework material is virgin PE material that was processed, but did not meet specifications such as dimensions, surface finish, etc., or product samples taken during production for quality tests. Rework materials never leave the manufacturing plant. WL Plastics generally does not accept product returns because returned product may have been exposed to conditions that could compromise product performance if used in new pipe.

WL Plastics thermoplastic PE materials can be reprocessed into new pipe without performance loss. Each WL Plastics plant has specialized equipment to process rework material into small chips that can be mixed with virgin material to produce new pipe. Although 100% rework material pipe has been shown to have the same

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performance as 100% virgin material pipe, WL Plastics combines a low percentage of rework material with unprocessed virgin material because an excessive amount of rework can affect dimensional stability.

References

WL116 *WL Plastics Pipe Standards*

Is NDE Inspection of HDPE Pipe or Butt Fusion Joints Reliable?

Currently, no NDE (non-destructive evaluation) method has been able to reliably demonstrate an ability to detect flaws in HDPE pipe or lack of fusion in HDPE butt fusion joints. This includes ultrasonic NDE methods such as TOFD (time of flight diffraction) and PA (phased array), microwave methods such as Evisive, and X-Ray methods. Although various NDE methods may be able to “see” features in HDPE pipe or butt fusion joints, there are no reliable means to determine if a feature is benign or deleterious. Industry organizations including PPI, ASTM and ASME are working diligently to develop tests and methods to assure reliable NDE results, but to date, no NDE technique including TOFD, PA, Evisive and X-ray is a proven reliable method for NDE inspection of HDPE pipe or HDPE butt fusion joints.

The HDPE industry has sought reliable NDE technologies for over four decades without success. Claims made by proponents of some proprietary NDE techniques that their technique can find voids or other defects in HDPE pipe or fusion joints have not proved to be valid. Valid claims are substantiated by documented independent peer-reviewed research that has yet to be completed for TOFD, PA, Evisive, X-ray or any other NDE technology.

For business reasons that are wholly unrelated to the unproven technical status of NDE techniques including time of flight diffraction (TOFD), phased array (PA), microwave (Evisive) and X-ray WL Plastics may elect to allow its products to be scanned at its facilities, and WL Plastics may elect to accept or not accept the results of any NDE scan. However, such elections are solely for business reasons and do not constitute any acceptance or inference by WL Plastics of the technical validity of these NDE Techniques, and do not constitute any acceptance or inference by WL Plastics of the validity of any scan result of any WL Plastics product.

References

WL125 *WL Plastics Terms and Conditions of Sale*

When water freezes solid in HDPE pipe, will it damage the pipe?

Water can freeze solid in HDPE pipe without damaging the pipe. Ice expands as it forms causing the pipe to expand with it. Ductile pipe expansion from ice formation does not damage the pipe.

Frozen pipes should be thawed by warming the pipe. Warming temperature should not exceed 120°F.

This publication is intended for use as a piping system guide. It should not be used in place of a professional engineer's judgment or advice and it is not intended as installation instructions. The information in this publication does not constitute a guarantee or warranty for piping installations and cannot be guaranteed because the conditions of use are beyond our control. The user of this information assumes all risk associated with its use. WL Plastics Corporation has made every reasonable effort to ensure accuracy, but the information in this publication may not be complete, especially for special or unusual applications. Changes to this publication may occur from time to time without notice. Contact WL Plastics Corporation to determine if you have the most current edition. Publication duplication permitted.

