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Thermoplastic and flexible metal pipework for underground installation at petrol filling stations

Tuyauteries enterrées thermoplastiques et en métaux flexibles pour stations service

Thermoplastische und flexible metallene Rohrleitungen für erdverlegte Installationen für Tankstellen

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Introduction

The purpose of this document is to ensure the suitability of underground pipework for conveying liquid fuels and their vapours at petrol filling stations.

Pipework should have a designated means of fitting specified by the manufacturer or supplier.

For the topic of environmental aspects see Annex C.

In this document the unit bar is used, due to its universal use in the gas industry. It should, however, be noted that bar is not an SI unit, and that the corresponding SI unit for pressure is Pa (1 bar = 10^5 Pa = 10^5 N/m^2).

1 Scope

This document specifies requirements for underground pipework systems used to transfer liquid fuels and their vapours at petrol filling stations. Minimum performance requirements covering fitness for purpose, safety and environmental protection are given.

This document is applicable to pipework made from thermoplastics, which can include some degree of reinforcement, and to flexible metal pipework. It does not apply to fibre reinforced thermosets, commonly referred to as glass fibre reinforced plastic (GRP), nor to rigid metals.

This document is applicable to:

— delivery pipes from tanks to dispensers, including positive pressure, vacuum suction and siphon modes;

— fill pipes from road tankers to tanks;

— vapour recovery and vent pipework;

— pipework for secondary containment;

— fittings.

It does not apply to pipework for use with liquefied petroleum gas.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1555-1, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 1: General*

EN 1555-2, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 2: Pipes*

EN 1555-3, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 3: Fittings*

EN 1555-4, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 4: Valves*

EN 1555-5, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 5: Fitness for purpose of the system*

EN 12201-1, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 1: General*

EN 12201-2, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 2: Pipes*

EN 12201-3, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 3: Fittings*

EN 12201-4, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 4: Valves*

EN 12201-5, *Plastics piping systems for water supply, and for drainage and sewerage under pressure - Polyethylene (PE) —Part 5: Fitness for purpose of the system*

EN 13160-1, *Leak detection systems — Part 1: General Principles*

EN 13160-2, *Leak detection systems — Part 2: Requirements and test/assessment methods for pressure and vacuum systems*

EN 13160-7, *Leak detection systems — Part 7: Requirements and test/assessment methods for interstitial spaces, leak detection linings and leak detection jackets*

EN 14214, *Liquid petroleum products — Fatty acid methyl esters (FAME) for use in diesel engines and heating applications - Requirements and test methods*

EN 15376, *Automotive fuels — Ethanol as a blending component for petrol — Requirements and test methods*

EN 15940, *Automotive fuels — Paraffinic diesel fuel from synthesis or hydrotreatment - Requirements and test methods*

EN 28510-1, *Adhesives — Peel test for a flexible-bonded-to-rigid test specimen assembly — Part 1: 90º peel*

EN ISO 1167-1, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method (ISO 1167-1)*

EN ISO 1167-2, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 2: Preparation of pipe test pieces (ISO 1167-2)*

EN ISO 1167-3, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 3: Preparation of components (ISO 1167-3)*

EN ISO 1167-4, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 4: Preparation of assemblies (ISO 1167-4)*

EN ISO 4892-2:2013, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps (ISO 4892-2:2013)*

EN ISO 8510-2, *Adhesives — Peel test for a flexible-bonded-to-rigid test specimen assembly — Part 2: 180 degree peel (ISO 8510-2)*

EN ISO 11306, *Corrosion of metals and alloys — Guidelines for exposing and evaluating metals and alloys in surface sea water (ISO 11306)*

EN ISO 11339, *Adhesives — T-peel test for flexible-to-flexible bonded assemblies (ISO 11339)*

EN ISO 13056, *Plastics piping systems — Pressure systems for hot and cold water — Test method for leaktightness under vacuum (ISO 13056)*

EN ISO 16871, *Plastics piping and ducting systems — Plastics pipes and fittings — Method for exposure to direct (natural) weathering (ISO 16871)*

EN ISO 19892, *Plastics piping systems — Thermoplastics pipes and fittings for hot and cold water — Test method for the resistance of joints to pressure cycling (ISO 19892)*

EN ISO 80079-36, *Explosive atmospheres — Part 36: Non-electrical equipment for explosive atmospheres — Basic method and requirements (ISO 80079-36)*

ISO 11922-1, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

3.1
pipework system
pipes and fittings used to convey or retain liquid fuels and their vapours

3.2
fittings
in-line connector, elbow, reducer, tee or cap, or flange or other component supplied to connect one pipe to another or pipework to equipment

3.3
flexible pipe
pipe that can be bent by hand to any radius above a set minimum without any change in performance

3.4
primary delivery pipework
pipework designed to convey liquid fuels by positive pressure or vacuum suction

3.5
permeation rate
rate ofmass loss from a test fuel per unit pipe surface typically expressed ingrams /(square meter × day) also written as $g \cdot m^{-2} \cdot d^{-1}$

3.6
fill pipework
pipework designed to convey liquid fuels from a delivery tanker to an underground storage tank by gravity discharge

3.7
multilayer pipe
pipe where more than one identified layer is present

3.8
vent pipework
pipework designed to convey vapour from a storage tank to the atmosphere

3.9
vapour recovery pipework
pipework designed to convey vapour (or condensate) to or from a storage tank

3.10
liquid fuel
commercially available petrol and diesel fuel comprising biofuels and biofuels blends

3.11
leakage containment
system which is designed to prevent leakage from a primary system entering the environment and which enables the detection of leakage

3.12
secondary containment
system which is designed to achieve leakage containment

3.13
design pressure
P_d
maximum effective pressure of the fluid in the piping system, expressed in bar, which is allowed in continuous use

4 Classes and dimensions

4.1 Classes of pipework

Pipes for underground fuel distribution shall conform to one of the following two classes:

— **Class 1** — Double wall pipework capable of containing and facilitating the detection of leakage from a primary delivery pipe.

— **Class 2** — Single wall pipework.

The primary pipe of Class 1, and pipes of Class 2, shall conform to one of Types A or B. The secondary pipe of Class 1 shall conform to one of Types C1 or C2.

a) **Type A.** Plastic systems.

Pipes shall be principally made of thermoplastic polymers, with some metal or fibre reinforcement optional.

b) **Type B**. Flexible metal systems.

Pipes shall comprise a fluid tight primary pipe made of a metal.

c) **Type C.** Secondary containment.

1) **Type CS**. System with continuous 360° separation between the primary containment and secondary containment.

   i. **Type CS1:** A pipe system designed to contain any leakage from the primary pipe. The system is at atmospheric pressure.

   ii. **Type CS2:** A pipe system designed to contain any leakage from the primary pipe. The system is designed to conform to the performance criteria of Class I leak detection systems in accordance with EN 13160-1, EN 13160-2 and EN 13160-7.

2) **Type CP:** System without continuous 360° separation between the primary containment and secondary containment.

   i. **Type CP1:** A pipe system designed to contain leakage from the primary pipe. The system is at atmospheric pressure.

ii. **Type CP2:** A pipe system designed to contain leakage from the primary pipe. The system is designed to conform to the performance criteria of Class I leak detection systems in accordance with EN 13160-1, EN 13160-2 and EN 13160-7.

4.2 Fittings

All pipework shall include fittings to provide leak-tight attachment to other systems, terminations, branches and changes of direction.

4.3 Dimensional tolerances

The external diameter and wall thickness shall be stated by the manufacturer. For plastic pipework the tolerance on the external diameter shall be in accordance with ISO 11922-1, Grade B, and the out-of-roundness shall be in accordance with ISO 11922-1, Grade N.

5 Physical properties

5.1 Pressure

5.1.1 General

Operating and test pressures shall be in accordance with Table 1 according to the application.

All pressures in Table 1 are gauge pressures.

Table 1 — Operating and test pressures for pipework

Application	Operating pressure bar	Test vacuum bar	Lower test pressure bar	Higher test pressure bar
Primary delivery pipework: positive pressure	+3,5	—	+5,0 ± 0,1	+30,0 ± 1,0
Primary delivery pipework: vacuum suction including siphons	−0,6	−0,9 ± 0,05	+5,0 ± 0,1	
Vents and vapour recovery pipework	1,0	−0,9 ± 0,05	+5,0 ± 0,1	
Fill pipework	1,0	—	+5,0 ± 0,1	
Secondary containment Type CP1 and CS1	+0,5	—	+1,0 ± 0,02	+5,0 ± 0,1
Secondary containment Type CP2 and CS2	−0,5 to +4,5	−0,6 ± 0,05	+5,0 ± 0,1	+10 ± 0,2

5.1.2 Hydrostatic pressure

This requirement applies to all pipes and fittings.

When tested in accordance with 7.2.1.1, all pipes and fittings, sampled in accordance with 7.1.2 and connected together as one or more assemblies, shall:

— withstand the lower test pressure in Table 1 for no less than 5 min with no signs of leakage.

When tested in accordance with 7.2.1.2, all pipes and fittings, sampled in accordance with 7.1.2 and connected together as one or more assemblies, shall:

— withstand the lower test pressure in Table 1 for no less than 5 min with no signs of leakage;

— withstand the higher test pressure in Table 1 for no less than 1 min with no signs of leakage.

5.1.3 Vacuum

This requirement applies to all pipes and fittings intended for vacuum suction, including siphons, vent and vapour recovery and secondary containment, Type CP2 and CS2.

When tested in accordance with 7.2.2, all pipes and fittings, sampled in accordance with 7.1.2, shall:

— withstandthevacuumspecifiedinTable 1fornolessthan30 min.Thelossofvacuumshallnotexceed 0,05 bar and there shall be no signs of collapse.

5.1.4 Cyclic pressure

This requirement applies to pipes and fittings for all applications except secondary containment.

When tested in accordance with 7.2.3, a sample of pipes and fittings selected in accordance with 7.1.1 and 7.1.2 shall withstand the test conditions without leakage.

5.2 Estimated working life

Design plans shall be available for all pipework which demonstrate that the pipework is designed to have an estimated working life of at least 30 years.

NOTE The pressure design of polymeric pipes where only one layer contributes to the pressure rating of the pipe will be designed through a regression curve generated in accordance with EN ISO 9080. In the case of a polymeric multilayer pipe construction, where more than one layers contribute to the pressure rating of the pipe, the stress base design can be measured (procedure II) or calculated (procedure I) as defined in ISO 17456.

When tested in accordance with EN ISO 1167-1 through EN ISO 1167-4, pipes, fittings and assemblies shall not leak under the following test conditions:

a) a 1 h hydrostatic pressure test, at (20 ± 2) °C, at 1,5 times the design pressure P_d, or at 9 bar for primary pipe and 3 bar for secondary containment Type CP2 and CS2 piping, whichever is the greater;

b) a 1 000 h hydrostatic pressure test, at (80 ± 2) °C, at 0,8 times the design pressure P_d, or at 5 bar for primary piping and 2,6 bar for secondary containment Type CP2 and CS2 piping, whichever is the greater.

5.3 Temperature

There shall be two temperature classes:

— Temperature Class T1: Underground pipework shall be fully operational between −40 °C and +50 °C.

— Temperature Class T2: Underground pipework shall be fully operational between −20 °C and +50 °C, but suitable for transport and storage at −40 °C and +50 °C.

Pipework that passes the tests in 7.2.1.1, 7.2.5.3, 7.2.6 and 7.2.7.3 at the appropriate temperature shall be deemed to conform this requirement.

5.4 Mechanical tests

5.4.1 Crush test

This requirement applies to all pipes and fittings.

When tested in accordance with 7.2.4, a sample of pipes and fittings selected in accordance with 7.1.1 and 7.1.2 shall:

— recover to not less than 90 % of their original diameter within 5 min of the load being removed;

— show no visible sign of leakage or cracking;

— when tested in accordance with 7.1.3 show no signs of leakage and, where vacuum testing is specified, show no signs of collapse.

5.4.2 Bend radius test

This requirement applies to all pipes and in-line connectors.

When tested in accordance with 7.2.5, a sample of pipes and straight connectors selected in accordance with 7.1.1 and 7.1.2 shall:

— show no visible sign of leakage or cracking;

— when tested in accordance with 7.1.3 show no signs of leakage and, where vacuum testing is specified, show no signs of collapse.

The sample of pipes chosen in accordance with 7.1.1 shall include that pipe diameter for which the bending strain is greatest. The bending strain is equal to $\frac{d}{2R}$, where d is the outer diameter of the pipe and R the bending radius specified by the manufacturer.

5.4.3 Impact test

This requirement applies to all pipes and fittings.

When tested in accordance with 7.2.6, a sample of pipes and fittings selected in accordance with 7.1.1 and 7.1.2 shall:

— show no visible sign of leakage or cracking; in Type B pipes there shall be no through-thickness damage to any protective coating;

— when tested in accordance with 7.1.3 show no signs of leakage and, where vacuum testing is specified, show no signs of collapse.

5.4.4 Puncture test

This requirement applies to all pipes.

When tested in accordance with 7.2.7, a sample of pipes selected in accordance with 7.1.1 and 7.1.2 shall:

— show no visible sign of leakage or cracking;

— when tested in accordance with 7.1.3 show no signs of leakage and, where vacuum testing is specified, show no signs of collapse.

5.4.5 Pull test

This requirement applies to all pipes and straight connectors intended for positive pressure and vacuum suction applications.

When tested in accordance with 7.2.11, a sample of pipes and straight connectors selected in accordance with 7.1.1 and 7.1.2 and connected to pipes to form assemblies, shall:

— show no visible sign of slippage;

— when tested in accordance with 7.1.3 show no signs of leakage and, where vacuum testing is specified, show no signs of collapse.

The samples of pipes and fittings chosen in accordance with 7.1.1 shall include those with the lowest diameter and those with the lowest diameter > 63 mm.

5.5 Fuel tests

5.5.1 Fuel compatibility

This requirement applies to all pipes and fittings.

When tested in accordance with 7.2.8, a sample of pipes and fittings selected in accordance with 7.1.1 and 7.1.2 shall:

— show no signs of damage or swelling, for example of seals, which could impair correct functioning of the pipework;

— when tested in accordance with 7.1.3 show no signs of leakage and, where vacuum testing is specified, show no signs of collapse;

— pipes with a multi-layer construction where the layers are all flexible, shall be subjected to peel test in accordance with 7.2.8.2.1;

— pipes with a multi-layer construction where the layers are flexible-rigid shall be subjected to peel test in accordance with 7.2.8.2.2;

— in each case the mean peel strength shall be a minimum of 15 N/cm and the ratio of the mean peel strength to the unexposed samples shall be not less than 0,8.

5.5.2 Fuel permeability

This requirement applies to all pipes of Types A, CP1, CS1, CP2, CS2. Permeability classes are defined in accordance with the maximum level of permeability as stated in Table 2. See Annex A for national deviations.

Table 2 — Maximum fuel permeability of underground pipes

Application	Fuel permeability $g \cdot m^{-2} \cdot d^{-1}$	Maximum fuel permeability $g \cdot m^{-2} \cdot d^{-1}$
Primary delivery pipework: positive pressure and vacuum suction including siphons	$0_{0}^{0,2}$	—
Vents and vapour recovery pipework	—	2,0
Fill pipework	—	2,0
Secondary containment	—	24,0

When tested in accordance with 7.2.9 a sample of pipes selected in accordance with 7.1.1 and 7.1.2 shall conform to the values given in Table 2 for Test Fuel 1, Test Fuel 2, Test Fuel 3 and Test Fuel 4 (according to 7.1.6), in accordance with the application or permeability class. The sample of pipes chosen in accordance with 7.1.1 shall include the pipes with the lowest diameter having the same design.

5.5.3 Swelling

For pipes intended for positive pressure and vacuum suction delivery, the swelling when tested in accordance with 7.2.10 using Test Fuel 2 shall not exceed 0,2 %.

5.6 Static electricity

5.6.1 General

Ignition hazards by static electricity caused by fuel pipe systems shall be avoided. In 5.6.2 to 5.6.3 corresponding requirements for the various pipe types are stated.

Classification of pipes:

The following boundary limits are used for classifying the resistance of piping according to ISO 8031, into the categories given as follows:

Conductive:	resistance per unit length < $10^3\ \Omega\ m^{-1}$
Dissipative:	$10^3\ \Omega\ m^{-1} \leq$ resistance per unit length $\leq 10^6\ \Omega\ m^{-1}$
Insulating:	resistance per unit length > $10^6\ \Omega\ m^{-1}$

The resistance per unit length shall include the effect of one coupling connection.

More information about electrostatic hazards can be found in Annex B and EN ISO 80079-36.

5.6.2 Requirements for insulating plastic pipe systems

To avoid pin holing insulating plastic pipe should have an electrical breakthrough strength across the pipe exceeding 100 kV, measured in accordance with EN 60243-2. A polyethylene layer of at least 4 mm in thickness usually exceeds this breakthrough strength.

5.6.3 Requirements for plastic pipe systems with conductive or dissipative linings

The conductive liners or conductive layers shall encircle the whole pipe profile and shall be securely electrostatically connected with each other and electrostatically grounded.

5.7 Weathering

Three assemblies consisting of two sections of pipe each having a minimum length of 375 mm and joined by a straight connector shall be preconditioned in accordance to a cumulative solar radiation of ≥ 3,5 $GJ \cdot m^{-2}$ using natural weathering in accordance with EN ISO 16871 or artificial weathering by using method A, cycle 1 of Table 3 of EN ISO 4892-2:2013. After exposure the assembly shall show no visible signs of cracking when tested in accordance with 7.2.6. If black PE material is used to manufacture pipe and fittings according to EN 1555-1 through EN 1555-5 and EN 12201-1 through EN 12201-5, this requirement shall be considered as fulfilled.

5.8 Corrosion resistance

All metallic parts that are designed to be directly buried in the ground shall be tested in accordance with EN ISO 11306 by exposure to water and surface sea water to establish the effectiveness of corrosion resistance for an expected life period of 30 years. In addition, an assessment shall be made to ensure that adequate external corrosion resistance exists in respect to damage caused by stray electrical currents for the same period of time. The coating of the pipework shall be tested for integrity and holidays with 5 kV mm^{-1} thickness of the coating, but with not more than 20 kV.

NOTE For cathodic protection, see EN 13636.

5.9 Summary of tests

Testing of requirements 5.1 to 5.7 shall be carried out in accordance with Table 3 according to the type.

Table 3 — Tests survey

Test	Clause	Applies to	Type A	Type B	Type CP1 and CS1	Type CS2 and CP2
Estimated working life	5.2	pipes and fittings	yes	yes	yes	yes
Hydrostatic pressure at 50 °C	7.2.1.1	pipes and fittings to pressures in Table 1	yes	yes	yes	yes
Hydrostatic pressure at 23 °C	7.2.1.2	pipes and fittings to pressures in Table 1	yes	yes	yes	yes
Hydrostatic burst pressure	7.2.1.3	secondary containment CP1 and CP2	no	no	yes (CP1 only)	yes (CP2 only)
Vacuum	7.2.2	pipes and fittings for vacuum suction applications	yes	yes	no	yes
Static electricity	5.6	pipes and fittings	yes	yes	yes	yes
Weathering	5.7	pipes and straight connectors	yes	yes	yes	yes
Corrosion resistance	5.8	all metallic parts designed to be directly buried	yes	yes	yes	yes
Cyclic pressure	7.2.3	pipes and fittings for positive pressure applications	yes	yes	no	no
Crush	7.2.4	pipes and fittings	yes	yes	yes	yes
Bend radius	7.2.5	pipes and straight connectors	yes	yes	yes	yes
Impact	7.2.6	pipes and fittings	yes	yes	yes	yes
Puncture	7.2.7	pipes only	yes	yes	yes	yes
Fuel compatibility	7.2.8	pipes and fittings	yes	yes	yes	yes
Fuel permeability	7.2.9	pipes only	yes	no	yes	yes
Swelling	7.2.10					
Pull-out	7.2.11	pipes and straight connectors for positive pressure and vacuum suction	yes	yes	no	no
Fitting pull out test	7.2.12	secondary containment CP1 and CP2	no	no	yes (CP1 only)	yes (CP2 only)

6 Production control

A factory production control scheme shall be established and documented in a manual prior to a new product type being placed on the market. Subsequently, any fundamental changes in raw materials and additives, manufacturing procedures or the control scheme that affects the properties or use of a product shall be recorded in the manual.

The manual shall include the factory production control procedures relevant to the declared properties, as confirmed by the initial type tests.

The factory production control procedures shall consist of a system for the permanent internal control of the production of the products to ensure that such products subsequently placed on the market conform to this document and that the measured values conform to the declared values.

The manufacturer shall specify a batch or lot number which shall be marked on the product.

7 Testing

7.1 General items referring to the test methods

7.1.1 Selection of test samples from a product range

Hydrostatic testing to 7.2.1 and, for vacuum suctionapplications, vacuum testing to 7.2.2, shall be applied to all sizes and types of pipe and fitting.

Where a product with a range of sizes consisting of identical materials and similar design is under test, construct a programme for the remaining tests in which each test is applied to a minimum of two sizes of pipe and fitting.

7.1.2 Number of samples

Three samples shall be used for each test. Unless otherwise specified the samples shall be assemblies consisting of lengths of pipe, one of which shall have a minimum free length of 375 mm or three times the external diameter, whichever is the greater, together with examples of the fittings as appropriate. Fit fittings in accordance with the manufacturer's instructions.

7.1.3 Tests following conditioning

The requirement for hydrostatic pressure testing (5,0 bar or 1,5 bar) and vacuum testing (−0,9 bar) after conditioning tests according to7.2.4 to 7.2.11 depends on the application, as detailed in Table 4. Where such testing is required, fit the samples with an end seal at one end and with a pressure fitting at the other. These fittings can be fitted before or after the conditioning test.

After the conditioning test proceed as follows.

If vacuum testing is required, condition the samples in at a temperature of (23 ± 2) °C for not less than 16 h. Then apply to each sample an internal pressure of (−0,9 ± 0,05) bar [(0,1 ± 0,05) bar absolute]. Isolate the sample from the vacuum pump and maintain for 5 min at a temperature of (23 ± 2) °C. During this period there shall be no loss of vacuum. Inspect the exterior and, after disassembly, the interior of the sample for signs of leakage or collapse.

If hydrostatic pressure testing is required, fill the samples with water and keep them in an environment maintained at a constant temperature of (23 ± 2) °C for a minimum of 1 h. Apply an internal pressure as defined in Table 4 at the same temperature. Inspect the samples for leaks.

Table 4 — Test pressure after conditioning

Application	Test pressure[a] bar	Test vacuum[a] bar	Test duration min
Primary delivery pipework: positive pressure	(5,0 ± 0,1)	—	5
Primary delivery pipework: vacuum suction including siphons	(5,0 ± 0,1)	(−0,9 ± 0,05)	5
Vent and vapour recovery pipework	(5,0 ± 0,1)	(−0,9 ± 0,05)	5
Fill pipework	(5,0 ± 0,1)	—	5
Secondary containment Type CP1 and CS1	(1,5 ± 0,03)	—	5
Secondary containment Type CP2 and CS2	(5,0 ± 0,1)	—	5

[a] All pressures are gauge pressures.

7.1.4 Combined tests

For thesakeof efficiencyconditioning testsmaybecombined. Forexample, the samplesmaybesubjected to the crush, impact and puncture tests in accordance with 7.2.4, 7.2.6 and 7.2.7 respectively before being tested in accordance with 7.1.3. However, if they then fail the test in accordance with 7.1.3 they shall be deemedtohavefailedallthreeconditioningtests,unlesstheycanbeshowntohavepassedoneoranother of the tests separately.

7.1.5 Procedure for retesting

Where one or more failures are noted, the retest protocol in Table 5 shall be adopted.

Table 5 — Retest protocol

Number of failures	Action
0	Product passes the test
1	Retest with 3 new samples If any one of the new samples fails, the product fails the test
2 or 3	Product fails the test

7.1.6 Test fuels

The test fuels % by volume shall be:

Test Fuel 1: 41,5 % toluene
41,5 % iso-octane
15 % methanol
2,0 % iso-butyl alcohol

Test Fuel 2: 41,5 % toluene
41,5 % iso-octane
17 % methyl tertiary butyl ether (MTBE)

Test Fuel 3: 7,5 % toluene
7,5 % iso-octane
85 % ethanol (in accordance with EN 15376)

Test Fuel 4: bio-diesel B-100 (in accordance with EN 14214 or EN 15940)

7.2 Test methods

7.2.1 Hydrostatic pressure

7.2.1.1 50 °C test

This test is applicable to all pipes and fittings (connected together as one or more assemblies). At least one section of pipe of each diameter shall have a free length of 375 mm.

Fill each assembly with water and place it in a water environment held at a constant temperature of (50,0 ± 2,0) °C for a minimum of 1 h.

Increase the internal pressure at a steady rate to the lower test pressure specified in Table 1 for the application concerned, over a period of between 30 s and 120 s. Hold the lower test pressure for not less than 5 min. Check for leakage.

7.2.1.2 23 °C test

This test is applicable to all pipes and fittings (connected together as one or more assemblies). At least one section of pipe of each diameter shall have a free length of 375 mm.

Fill each assembly with water and place it in an air or liquid environment held at a constant temperature of (23 ± 2) °C for a minimum of 1 h.

Increase the internal pressure at a steady rate to the lower test pressure specified in Table 1 for the application concerned, over a period of between 30 s and 120 s. Hold the lower test pressure for not less than 5 min. Check for leakage. If leakage is apparent, take suitable corrective action. If no leakage is apparent, increase the pressure at a steady rate until it reaches the higher test pressure specified in Table 1, in a period of not less than 15 s. Hold the higher test pressure for not less than 1 min. Check for leakage.

If desired, the pressure may then be increased until failure occurs.

7.2.1.3 Burst test

This test is applicable to integral primary/secondary system fittings without continuous 360° separation between the primary containment and secondary containment CP1 and CP2.

Fill the primary section of each assembly with water and place it in an air environment held at a constant temperature of (23 ± 2) °C for a minimum of 1 h.

Increase the internal pressure at a steady rate of (10 ± 1) bar/min until the fitting bursts or reaches the maximum pressure of 50 bar.

Following the primary burst test, there shall be no leakage of water from the primary system to the outside environment.

7.2.2 Vacuum test

This test is applicable to pipework and fittings for vacuum suction.

The test method EN ISO 13056 applies with the following test conditions:

— Test Temperature: (23 ± 2) °C;

— Test Pressure: (−0,9 ± 0,05) bar ((0,1 ± 0,05) bar absolute);

— Test Duration: 30 min;

— Preconditioning: ≥ 16 h at (23 ± 2) °C.

Monitor the internal pressure during the test. Inspect the exterior and, after disassembly, the interior of the sample for signs of collapse.

7.2.3 Cyclic pressure test

This test applies to pipework and fittings for positive pressure.

The test method EN ISO 19892 applies with the following test conditions:

— Preconditioning: ≥ 1 h with pipe filled with water at temperature of (21,5 ± 3,5) °C;

— Test temperature: (21,5 ± 3,5) °C;

— Test pressure: cycling between 1,0 bar and 4,0 bar above ambient pressure;

— Number of cycles: $1{,}5 \times 10^6$;

— Cycle rate: between 20 and 25 cycles per minute.

Check the samples for leaks.

7.2.4 Crush test

7.2.4.1 Applicability

This test applies to all pipework and fittings. Both 7.2.4.2 and 7.2.4.3 apply.

7.2.4.2 High temperature crush tests

Condition the samples in air at (50 ± 2) °C for not less than 16 h. Remove them from this environment and test them within 5 min.

Measure the outside diameter of the pipe. Place the centre point of each pipe and each fitting, in turn, between two flat plates 150 mm × 150 mm in size, with rounded edges. Apply a compressive force of (2 000 ± 20) N with a ramp rate of (10 ± 1) mm · min^{-1} for (60 ± 5) s. Measure the outside diameter of the pipe and each fitting at 5 min ± 15 s after release of the compressive force.

Inspect the samples for signs of cracking.

Then test the samples in accordance with 7.1.3.

7.2.4.3 Low temperature crush test

Perform the same tests as 7.2.4.2 but condition the samples at (−40 ± 2) °C for Temperature Class T1 or (−20 ± 2) °C for Temperature Class T2. Remove the samples from this environment and test them within 5 min.

7.2.5 Bend radius test

7.2.5.1 Choice of method

This test applies to all pipes and straight couplers. The samples shall consist of sections of pipe at least 1,4 m long or, if a straight coupler is included, two lengths each 0,7 m longconnected bya straight coupler at the centre.

Either Method 7.2.5A or Method 7.2.5B shall be applied. Method 7.2.5A is preferred. Where the force required to bend the specimen is too great to be applied manually apply Method 7.2.5B.

If theproducthasa natural bend thesamplesshall be bent to the specified radiusinthedirectionopposite to the natural bend.

7.2.5.2 Method 7.2.5A

Condition the samples in air at (−40 ± 2) °C for Temperature Class T1 or (−20 ± 2) °C for Temperature Class T2. Remove the samples from this environment and test them within 5 min. Bend each sample round a former to a radius of curvature equal to the smallest radius stated in the installation manual for a minimum of 10 s.

7.2.5.3 Method 7.2.5B

Condition the samples in air at (−40 ± 2) °C for Temperature Class T1 or (−20 ± 2) °C for Temperature Class T2. Remove the samples from this environment and test them within 5 min. Place the sample on two supports a minimum of 1 m apart and apply a deflection at its centre using a mechanical testing machine. The value of this deflection shall be calculated to produce the minimum bend radius at the centre of the span in accordance with the formula $y = L^2/12R$, where L is the distance between the supports, R the required bend radius and y the deflection to be applied. Maintain this deflection for a minimum of 10 s.

7.2.5.4 Evaluation

After testing to Method 7.2.5A or Method 7.2.5B inspect the samples for signs of damage or cracking.

Then the samples shall be tested in accordance with 7.1.3.

7.2.6 Impact test

This test applies to all pipework and fittings.

Condition the samples in air at (−40 ± 2) °C for Temperature Class T1 or (−20 ± 2) °C for Temperature Class T2. Remove the samples from this environment and test them within 5 min. Place the samples on a flat surface or in a 'V' block directly supporting the pipe or fitting below the point of impact and at the same temperature. Impact each pipe at its centre point, and each fitting, with a (50 ± 1) mm diameter hemispherical striker weighing (0,5 ± 0,03) kg, dropped from a height of (1,8 ± 0,05) m.

Inspect the samples for signs of cracking.

Then the samples shall be tested in accordance with 7.1.3.

7.2.7 Puncture resistance

7.2.7.1 Applicability

This test applies to all pipes. Both 7.2.7.2 and 7.2.7.3 apply.

7.2.7.2 Ambient temperature puncture test

Condition the samples in air at (23 ± 2) °C for not less than 16 h. Place each sample on a rigid surface and apply a (500 ± 10) N load by means of a loading tip perpendicular to the outer surface for not less than 10 s. The loading tip shall be rectangular, with dimensions of (6,35 ± 0,1) mm × (2,00 ± 0,1) mm, with edges rounded to a radius of (0,5 ± 0,1) mm. Apply the load at two points, (100 ± 10) mm apart, approximately in the centre of the sample, once with the longest length of the tip in line with the pipe direction, once with the longest length of the tip at 90° to the pipe direction. Alternative orientations are acceptable provided that they relate to the structure of the pipe wall.

Then the samples shall be tested in accordance with 7.1.3.

7.2.7.3 Low temperature puncture test

Perform the same tests as 7.2.7.2 but condition the samples at (−40 ± 2) °C for Temperature Class T1 and (−20 ± 2) °C for Temperature Class T2. Remove the samples from this environment and test them within 5 min.

7.2.8 Fuel compatibility test

7.2.8.1 Principal test

This test applies to all pipes and fittings.

For all pipes and fittings place the samples in a container and immerse them in Test Fuel 2 in accordance with 7.1.6 with both their inner and outer surfaces exposed to the fuel. Allow an air gap for expansion of the fuel. Seal the container. Ensure that the end-closures used for pressure testing are sufficiently resistant to fuels.

Place the samples or containers in an environment maintained at (50 ± 2) °C for a period of $30\ {}^{+2}_{0}$ days.

Condition an unexposed sample at the same temperature and duration as stated above. After ageing, cool the container to ambient temperature, remove the fuel and examine thesamplesinternallyand externally by eye without magnification for signs of damage or swelling, for example of seals, which could impair correct functioning of the pipework.

Then test the samples in accordance with 7.1.3, except that the samples shall be kept in an environment maintained at a constant temperature of (23 ± 2) °C for (2 ± 1) h [i.e. with a maximum limit of 3 h] before testing. In addition, on completion of the tests following conditioning (7.1.3), for pipes with a multi-layer construction, perform either test in accordance with 7.2.8.2.2 or 7.2.8.2.3.

Manufacturers may choose to conduct additional testing, e.g. with specific alcohols, aromatics and ethers, as appropriate, to provide additional confidence in their pipework. This testing shall be recorded in the technical file.

7.2.8.2 Peel test

7.2.8.2.1General

When two or more layers are part of a multilayer construction, it shall be defined:

Flexible-Flexible layers: when both layers can be bent up to 90° without breaking or cracking.

Flexible-Rigid layers: when only one layer of the multilayer construction can be bent up to 90° or more without braking or cracking.

7.2.8.2.2Peel test A, Flexible-Flexible

This test applies to pipes with a multi-layer construction where the layers are Flexible-Flexible.

Five samples shall be taken from the exposed pipe and five from the unexposed pipe. Each group of five shall be tested in accordance with EN ISO 11339. Testing shall be performed within two days of completion of the fuel compatibility test.

7.2.8.2.3Peel test B, Flexible-Rigid

This test applies to pipes with a multi-layer construction where the layers are Flexible-Rigid.

Five samples shall be taken from the exposed pipe and five from the unexposed pipe. Each group of five shall be tested in accordance with EN 28510-1 and EN ISO 8510-2. Testing shall be performed within two days of the completion of fuel compatibility test.

7.2.9 Fuel permeability test

7.2.9.1 Applicability and general provisions

This test applies to pipes of Types A, CS1, CP1, CS2, CP2. Method 7.2.9A shall normally be applied. Method 7.2.9B can be applied in order to reduce the time of testing. Experience has shown that the rate of mass loss measured using Method 7.2.9B generally exceeds that measured using Method 7.2.9A. In the event of dispute Method 7.2.9A shall be regarded as definitive.

The method chosen shall be applied using four test fuels separately: Test Fuel 1, Test Fuel 2, Test Fuel 3, and Test Fuel 4 (see 7.1.6).

7.2.9.2 Method A

A sample consists of a length of pipe (450 ± 50) mm long. Each pipe end shall be sealed with suitable end-closures for the duration of the test.

Standard end-closures used for pressure testing are unlikely to be suitable. The end-closures used for the permeation test will need to be fitted with FPM, e.g. Viton™ F[1], seals. The test fuels have been specially selected for their volatile nature, so that multiple seals could be required to ensure that loss through the end-closures is negligible.

[1] Viton™ F is the trademark of a product supplied by Viton. This information is given for the convenience of users of this document and does not constitute an endorsement by CEN of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Close the pipe at one end. Fill it with the appropriate test fuel to > 90 % of full volume, allowing a limited air gap for expansion of the fuel. Seal the pipe at the other end. Measure the exposed length of the pipe, *L*, i.e. excluding the length of the end closures either on the inside or the outside of the pipe, and the mean external diameter, *D*.

Store the samples in air at (23 ± 2) °C and re-weigh approximately every seven days, using a balance calibrated to a suitable accuracy.

Plot mass loss against time. After the end of an incubation time of 313 days, continue the test for a further seven weeks with at least eight measurement points and fit a regression line. At least six of the points, including those at each end of the linear section, shall deviate from the regression line by no more than ± 0,2 g.

Determine the rate of mass loss of the 'steady-state' period (gradient of the regression line) in $g \cdot d^{-1}$. Calculate the surface area *A*, where $A = \pi \cdot L \cdot D$, in m^2. Divide the rate of mass loss by A to give the permeation rate in $g \cdot m^{-2} \cdot d^{-1}$ for each specimen.

7.2.9.3 Method B. Accelerated fuel permeability test

This method is the same as Method 7.2.9A except that the sealed samples are placed in an environment at (50 ± 2) °C and their mass measured at least twice every seven days. The 'steady-state' period shall last for at least 21 days with at least eight test points. After this has been achieved remove the samples to an environment at (23 ± 2) °C. Then proceed as in Method A of 7.2.9. Calculate and report the rate of mass loss at 23 °C.

7.2.10 Longitudinal swelling

This test applies to pipes of Types A, CP1, CS1, CP2, CS2 and should be performed simultaneously with Method A or B according to 7.2.9.

After filling the pipe with the test fuel make two marks at either end of the pipe such that the line between them is parallel to the axis. Measure the length between the two marks to the nearest 0,1 mm.

Each time the pipe is weighed measure the length between the two marks.

Take the finalmeasurement of length from theend of permeationtest. From thismeasurement determine the elongation as a percentage of the initial length.

7.2.11 Pull-out test

This test applies to pipes and straight connectors for positive pressure and vacuum suction.

A sample consists of either two transition fittings separated by a section of pipe of minimum length 375 mm, or two sections of pipe connected by a straight connector with a transition fitting at each end of the assembly.

A linkage shall be provided such that axial load can be applied to the transition fittings by a mechanical testing machine.

Thelength of eachsampleshallbesufficient to allowthe assemblyto beconnected to amechanical testing machine capable of applying a gradually increasing tensile load and to end-closures suitable for pressure testing.

Condition the samples in air at (23 ± 2) °C for not less than 16 h. Connect them to the mechanical testing machine. Apply a tensile load as follows:

— (4 000 ± 40) N for pipes up to and including 63 mm diameter;

— (7 500 ± 75) N for larger pipes.

Apply the load gradually over a period of (30 ± 10) s, and maintain the full load for not less than 5 min.

The samples shall be inspected for signs of slippage.

Then the samples shall be tested in accordance with 7.1.3.

7.2.12 Fitting pull-out test

This test is applicable to secondary containment CP1 and CP2.

Applyanaxial load to the Primary Sectionof the fitting while restraining the secondary containment part. Axial load should be as shown below:

— (4 000 ± 40) N for primary sizes up to and including 63 mm diameter.

— (7 500 ± 75) N for primary sizes up above 63 mm diameter.

Following application of the load, primary and secondary containment shall be pressure tested independently in accordance with 7.2.1.2 of the document.

8 Markings on pipe and fittings

Pipesshallbepermanentlyandindeliblymarkedwiththeiridentity,traceabilityandintendedapplication as shown in Table 6. Fittings shall be marked in the same way, or supplied with a permanent label containing traceability data.

Table 6 — Marking

Aspects	Mark or symbol
Number of the system standard	EN 14125
Manufacturer's name or trade mark	
External or internal diameter in mm	DN/OD *** or DN/ID ***** mm
Type	Type A or B
Application	PP/VA/VE/VR/FI/CS1/CS2/CP1/CP2 (see NOTE 1)
Temperature Class	T1 or T2
Resistance classification	C, D or I (see NOTE 3)
Manufacturer's information	**.**/******* (see NOTE 2)
NOTE 1 PP: positive delivery VA: vacuum delivery VE: vent pipework VR: vapour recovery pipework FI: fill pipework CS1: See 4.1 CP1: See 4.1 CS2: See 4.1 CP2: See 4.1 NOTE 2 For providing traceability the following details are required: batch or lot number, year, and a name or code for the production site if the manufacturer is producing in different sites, nationally and/or internationally. NOTE 3 C: conductive D: Dissipative	

The marking elements shall be printed or formed directly on the pipe or on the fitting in such a way that after storage, weathering, handling and installation in accordance with the manufacturer's instructions, legibility is maintained during the use of the products. The maximum interval between successive markings on pipe shall be 1 m. Where the size of fitting makes marking impractical the marking shall be made on a sealed package containing the fitting.

Marking shall not initiate cracks or other types of defects which would impair conformity to the requirements of this document.

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

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

9 Manuals

9.1 Product manual

Manufacturers of pipe systems shall make available a manual covering:

— correct applications for pipework and fittings;

— estimated working life;

— static electricity. The manufacturers shall describe necessary precautions how the pipework shall be operated to prevent accumulation of static electricity. The precautions shall consider the requirements in accordance with Annex B and EN ISO 80079-36. Reference shall be made to specific national regulations.

9.2 Installation manuals

Manufacturers shall make available a written manual covering:

— transport, storage and handling;

— static electricity;

The manufacturers shall give guidance on any necessary precautions that their pipework should need to prevent accumulation of static electricity. The precautions shall consider the requirements in accordance with Annex B and EN ISO 80079-36.

— protection against weathering;

— bend radius;

— tools or equipment;

— maintenance;

— safety;

— check list of actions to achieve correct installation;

— installation testing;

— proper back filling.

Consideration should be given to providing the manual in the user's language.

10 Records

The manufacturer shall maintain a technical file containing details of the materials used, the necessary data on their long-term performance, plus any calculations and supporting data necessary to relate this to the design of the pipe, e.g. wall thickness.

Unless otherwise specified, all records shall be maintained for a minimum of 10 years.

Annex A
(informative)

A-deviations

A-deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CEN and/or CENELEC member.

This European Standard does not fall under any Directive/Regulation of the EU.

In the relevant CEN and/or CENELEC countries, these A-deviations are valid instead of the respective provisions of the European Standard until the national situation causing the A-deviation has changed.

Clause	Deviation
5.5.2	**Austria** Verordnung für brennbare Flüssigkeiten Bundesgesetzblatt Nr. 354/1993; § 20 In addition to the requirements of this document, the following is valid in Austria: “The use of products for transport of flammable liquids is restricted to durable and impermeable products in general.” Therefore, the following requirements shall be fulfilled: As stated in EN 14125:2025, Table 2, for delivery pipework for fuel permeability the allowable tolerance is stated in the range of $-0\ g \cdot m^{-2} \cdot d^{-1}$ to $+0{,}2\ g \cdot m^{-2} \cdot d^{-1}$. With respect to this and having in mind the provision mentioned above the following shall be stated: In accordance with Austrian law and in particular with respect to pipes Type A in accordance with 4.1 in EN 14125:2025 in Austria for transport of fuel the use of pipes with permeability $> 0\ g \cdot m^{-2} \cdot d^{-1}$ is forbidden.
5.5.2	**Germany** Gesetz zur Ordnung des Wasserhaushalts (Wasserhaushaltsgesetz — WHG) Ausgabe 07/2009: Paragraph 62 Absatz (1) In addition to the requirements of this document the following is valid in Germany: (1) Anlagenzum Lagern, Abfüllen, Herstellenund Behandelnwassergefährdender Stoffe sowieAnlagenzumVerwendenwassergefährdenderStoffeimBereichdergewerblichen Wirtschaft und im Bereich öffentlicher Einrichtungen müssen so beschaffen sein und so errichtet, unterhalten, betrieben und stillgelegt werden, dass eine nachteilige Veränderung der EigenschaftenvonGewässernnicht zu besorgenist. Das Gleiche gilt für Rohrleitungsanlagen, die 1. den Bereich eines Werksgeländes nicht überschreiten, 2. Zubehör einer Anlage zum Umgang mit wassergefährdenden Stoffen sind oder 3. Anlagen verbinden, die in engem räumlichen und betrieblichen Zusammenhang miteinander stehen. Therefore, the following requirements shall be fulfilled: The underground pipework shall have a permeation of $0\ g \cdot m^{-2} \cdot d^{-1}$. Metallic pipework shall be considered as a pipework with $0\ g \cdot m^{-2} \cdot d^{-1}$.

Clause	**Deviation**
5.5.2	**The Netherlands** Directive Petrol Stations Environmental Control dated 20th January 1994 /Besluit Tankstations Milieubeheer d.d. 20 januari 1994 CPR 9-1:1993 Guideline 9-1 prepared by the Committee for Prevention of Disasters caused by dangerous substances with the title "Liquid petroleum products: underground storage in steel tanks and dispensers for motor fuels" /CPR 9-1:1993 Richtlijn 9-1 van de Commissie Preventie van Rampen door Gevaarlijke Stoffen getiteld "Vloeibare aardolie produkten: ondergrondse opslag in stalen tanks en afleverinstallaties voor motorbrandstof" CPR 9-6:1993 Guideline 9-6 from the Commission for Prevention of Disasters caused by dangerous substances with the title "Liquid petroleum products: storage up to 150 m^3 of flammable fluids with a flash point from 55 to 100 °C in above ground storage tanks" /CPR 9-6:1993 Richtlijn 9-6 van de Commissie Preventie van Rampen door Gevaarlijke Stoffen getiteld "Vloeibare aardolie produkten: opslag tot 150 m^3 van brandbare vloeistoffen met een vlampunt van 55 tot 100 °C in bovengrondse tanks" The above guidelines CPR 9-1 and CPR 9-6 were retitled PGS 28 and PGS 30 "Publication series Dangerous Goods" as per 1st June 2004 with identical status. Based on the above legislation thermoplastic piping systems for the transport of liquid oil products and their vapours shall conform to the requirements of BRL-K552. Specifically, the following requirement shall be fulfilled: The maximum permeation rate of the complete piping system (including fittings, sealing rings, etc.) shall not exceed 150 mg/24 h per length of pipe from tank to pump.

Annex B
(informative)

Static electricity

B.1 General

Fuel handling operations at retail filling stations involve both the delivery of fuel into underground tanks at the station, usually from road tankers, and the dispensing of fuel from the underground tanks into customer's vehicles. Flashfires initiated bystatic electricityhave occurred both whilst delivering fuel into the underground tanks and whilst dispensing gasoline to customer vehicles.

The production of explosive atmospheres during both delivery and dispensing operations depends on the fuel type. Based on the Flash Point of diesel fuel being at least 58 °C, diesel fuel vapours are usually too lean for combustion at ambient temperatures although hot diesel return lines on the vehicle can sometimes produce an explosive atmosphere within the vehicle tank. However, some countries permit diesel fuel to have a significantly lower flash point. In these countries, diesel vapours can produce flammable mixtures at high ambient temperatures.

In contrast, gasoline vapour mixtures are generally too rich for combustion in enclosed spaces such as fueltanksbutcancomeintotheexplosiverangewheremixingwithfreshairispossible(e.g.whenfuelling a vehicle with gasoline there will always be a place near the filler inlet where the mixture strength is at the optimum for ignition, consequently, an electrostatic discharge near the filler inlet could lead to a fire and burn the person filling the vehicle). Ethanol-gasoline mixtures with high concentrations of ethanol can produce explosive atmospheres within closed tanks at standard ambient temperatures although these fuels are less likely to become electrostatically charged because of their high conductivity.

Based on the above, explosive atmospheres can occur in the following situations:

— inside gasoline-ethanol (e.g. E85) tanks or drained pipes;

— inside gasoline pipes when air is drawn in after hoses are disconnected following a delivery;

— around gasoline filler openings during refuelling, outside gasoline or gasoline-ethanol pipes due to leaks or spillage, particularly in enclosed underground "sumps" or "fill boxes" where the underground pipes are connected to tanks or truck hoses. Gasoline and diesel pipes are often housed in the same fill box so it is conceivable for a leak from the gasoline line to produce an explosive atmosphere that could be ignited during diesel loading.

The fuel at filling stations varies from low conductivity hydrocarbons blends without static dissipative additive (SDA) to high conductivity blends of oxygenated bio-components (e.g. ethanol) and hydrocarbons. Even with the low conductivity fuels, the flow rates are sufficiently small to prevent hazardous potentials being generated by the accumulation of charge on the liquid either in the underground storage tanks or in the fuel tanks on customer vehicles.

However, if any of the conductors associated with the operations (e.g. the filler nozzle, pipe couplings, the vehicle being filled, the filler neck, or a person) are electrically isolated, charge accumulation on the isolated item could then give rise to incendive spark discharges. Also, charges accumulating on insulating pipes or other insulating components in the handling system could produce incendive brush discharges. An ignition could occur if any of these discharges occurred in an explosive atmosphere (see above). The precautions listed in B.2 should be taken to avoid electrostatic ignitions in fuel delivery to underground tanks.

B.2 Delivering fuels to underground tanks

B.2.1 Systems with metal pipes

a) All pipe sections should be earthed in a manner that does not risk introducing electrical fault currents into the piping system (e.g. with a suitable isolating resistance).

b) The earthing should be regularly checked.

c) Equipment such as fine filters that could give enhanced fuel charging should be used only if there is enough relaxation time in the conductive pipe.

B.2.2 Systems with plastic pipes

Plastic pipes are increasingly being used for fuel delivery from road tankers to underground tanks, from underground tanks to fuel dispensers, and for vapour recovery lines and vents because they provide improved corrosion resistance and secondary containment.

Two main varieties of plastic pipe system are in use: the so-called "non-conductive" (insulating) pipes and the so-called "conductive" pipes (non-conductive pipes incorporating co-extruded dissipative inner linings). Typical plastic pipe systems use connectors which incorporate metal heating coils (electrofusion couplers, EFCs) to couple and seal pipe lengths and joints. These EFCs could have an installed capacitance of between 5 pF and 30 pF depending on the installation. Plastic pipes normally incorporate a co-extruded inner lining for countering fuel permeation. For pipes that also have a dissipative lining, the dissipative lining is usually the innermost.

Specific risks in these types of systems include:

a) Fuel flow could cause significant charging of low or medium conductivity fuels. Consequently:

   1) For fully insulating ("non-conductive") pipes:

      i. High voltagescould buildup onunburied pipe walls or onassociated non-earthed connectors.

      ii. Dischargescanoccur onthe innersurface of acharged pipe.The fill point where the hose from the lorryis attached is acritical pointinthis respectbecausedischarges toearthedconnectors or couplings or from highly charged to less charged plastic surfaces can cause ignition if air ingress occurs on disconnection.

      iii. The electrostatic fields arising from the build-up of charge on the pipe wall could cause high voltages to arise on nearby conductive EFCs, tools, and other items outside pipes and cause spark discharges to nearby earthed conductive items.

      iv. High electric fields could occur in the walls of buriedpipes leading to possible breakdown and pinholing by electrostatic discharges.

   2) For insulating pipes with dissipative liners (so-called "conductive pipes"):

      i. Charge cannot accumulate if the lining is earthed, and the shielding provided by an earthed lining minimizes the risk of flow-related high voltages on associated conductors such as EFCs.

      ii. However, voltages can build up on any unearthed liner sections or on the connectors associated with them.

b) Charging of external insulating pipe surfaces by rubbing could give brush discharges.

c) Mixing of insulating and conductive pipes in a system could lead to isolated conductive parts. It is acceptable only if all conductive parts are certain to be earthed. Particular attention should be paid to earthing metal flanges, couplings and clips on insulating segments and earthing the lining of the conductive segments.

d) Where pipes are fitted during maintenance of a system, when a flammable atmosphere could be present, specific risks canarise. Both conductive and insulating pipes can charge during handling and give potentially incendive discharges.

   1) For insulating pipes, incendive brush discharges from the outer pipe surface are possible.

   2) For pipes with dissipative liners, the accumulated surface charge could induce high voltage on an erroneously un-earthed liner and this could be the source of shocks to people and incendive discharges.

The voltage build-up on insulating pipes from fuel charging depends on flow speed, fill volume and the length of unburied sections as well as on pipe and fuel properties. The variability of these charging characteristics and the variation of charge dissipation characteristics with age and temperature is still not well understood. Wide safety margins for dissipation should, therefore, be applied until the worst-case charging characteristics are better known.

There is, however, a considerable installed base of pipes and there are only few recorded incidents so existing practices seem to be broadly acceptable with today's fuels. It is, however, unclear whether existing practices would continue to provide adequate safety margins if the increasing use of oxygenated biocomponents in gasoline were to give rise to higher charging.

NOTE There are indications thatat leastsome ethersandesters are prone to higher charging thanhydrocarbon fuels.

In order to prevent excessive electrostatic charge and voltage build-up on the pipe walls, valves and couplings the following precautions are recommended:

e) Insulating plastic pipes:

   1) To avoid pinholing insulating plastic pipes should have anelectrical breakthrough strength across the pipe exceeding 100 kV, measured according to EN 60243-2. A polyethylene layer of at least 4 mm in thickness usually exceeds this breakthrough strength.

   2) Unburied EFCs should be either long-lasting and reliably earthed or sealed using airtight seals.

   3) All other conductive parts of pipes or joints should be earthed.

   4) The earthing of all conductive and dissipative items should be regularly checked.

   5) Unburied fully insulating plastic pipe sections should be kept as short as practicable.

   6) Fuel flow rates should be limited to < 2,8 m/s.

      The possible future introduction of bio-components can change the charging behaviour of fuel.

   7) The earthing of the majority of each pipe by burial contributes significantly to the safe operation of the system. Consequently, following installation or repair, liquid should not be admitted into a pipe until all sections that are intended to be buried are confirmed to be fully covered with earth.

   8) Equipment such as fine filters that could give enhanced fuel charging should be used only with careful assessment of the likely hazards.

9) The fill point where the truck hose is attached should use a safety connection valve, preferably an interlocked system, that does not allow air to enter the system and mix with the fuel vapours, e.g. a valve that is closed before disconnecting hose and pipe.

10) The exposure of pipes and joints in sumps where flammable vapours could accumulate should be minimized.

11) People should avoid brushing against external pipe surfaces where a flammable vapour can be present.

12) During system maintenance, care should be taken to avoid introducing a highly charged pipe into a flammable atmosphere.

f) Plastic pipes with dissipative linings:

1) The linings should be earthed. An earthed, dissipative liner prevents internal discharges and screens external conductors from flow charging.

2) Earthing should be achieved by a suitable arrangement of dissipative internal couplings linking to external grounding points.

3) The earthing of all conductive and dissipative items should be regularly checked.

4) Equipment such as fine filters that should give enhanced fuel charging should be used only with careful assessment of the likely hazards.

5) During system maintenance, care should be taken to avoid introducing a highly charged pipe into a flammable atmosphere. Dissipative liners should be grounded before the pipe is introduced into a flammable atmosphere and the ground connection should be maintained during the fitting process, until the liner is reliably grounded via the installed system.

People should avoid brushing against external pipe surfaces where a flammable vapour can be present.

Annex C
(informative)

Environmental aspects

C.1 Materials should be selected to optimize product durability and lifetime. Rare or hazardous materials should be avoided.

C.2 Consideration should be made to reduce the CO_2 footprint by using bio-based materials, and to the selection of materials which can then be subsequently recycled.

C.3 The possibility of marking components to aid to their sorting for disposal/recycling at end of life should also be reviewed.

C.4 Packaging design should consider using recycled materials, and materials that need little energy for their manufacture, and should minimize waste.

C.5 Packaging design should consider subsequent re-use and recycling.

C.6 The size and weight of packaging should be minimized whilst protecting the products to minimize waste through damage.

C.7 Test fluids should be used and disposed of in accordance with local regulations.

For the environmental checklist see Table C.1.

Table C.1 — Environmental checklist

Environmental Issue	**Stages of the life cycle**										**All stages**
	Acquisition		**Production**		**Use**			**End-of-Life**			
	Raw materials and energy	**Pre-manu-factured materials and components**	**Production**	**Packaging**	**Use**	**Main-tenance and repair**	**Use of additional products**	**Reuse/Material and Energy Recovery**	**Incineration without energy recovery**	**Final disposal**	**Transportation**
Inputs											
Materials	C.1, C.2	C.1, C.2		C.5				C.2, C.3, C.5	C.2, C.3, C.5	C.2, C.3, C.5	
Water											
Energy				C.4							C.6
Land											
Outputs											
Emissions to air			C.7								
Discharges to water											
Discharges to soil											
Waste			C.7							C.2, C.3, C.5, C.6	
Noise, vibration, radiation, heat											

Environmental Issue	Stages of the life cycle										All stages
	Acquisition		Production		Use			End-of-Life			
	Raw materials and energy	Pre-manu-factured materials and components	Production	Packaging	Use	Main-tenance and repair	Use of additional products	Reuse/Material and Energy Recovery	Incineration without energy recovery	Final disposal	Transportation
Other relevant aspects											
Risk to the environment from accidents or unintended use											
Customer information											

NOTE The stage of packaging refers to the primary packaging of the manufactured product. Secondary or tertiary packaging for transportation, occurring at some or all stages of the life cycle, is included in the stage of transportation.

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