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EAST AFRICAN STANDARD

Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 5: Fitness purpose of the system

EAST AFRICAN COMMUNITY

First Edition 2010

Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in East Africa. It is envisaged that through harmonized standardization, trade barriers which are encountered when goods and services are exchanged within the Community will be removed.

In order to meet the above objectives, the EAC Partner States have enacted an East African Standardization, Quality Assurance, Metrology and Test Act, 2006 (EAC SQMT Act, 2006) to make provisions for ensuring standardization, quality assurance, metrology and testing of products produced or originating in a third country and traded in the Community in order to facilitate industrial development and trade as well as helping to protect the health and safety of society and the environment in the Community.

East African Standards are formulated in accordance with the procedures established by the East African Standards Committee. The East African Standards Committee is established under the provisions of Article 4 of the EAC SQMT Act, 2006. The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

Article 15(1) of the EAC SQMT Act, 2006 provides that "Within six months of the declaration of an East African Standard, the Partner States shall adopt, without deviation from the approved text of the standard, the East African Standard as a national standard and withdraw any existing national standard with similar scope and purpose".

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

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Introduction

In the preparation of this East African Standard, the following source was consulted extensively:

ISO 4427-5:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 5: Fitness for purpose of the system*

Assistance derived from this source and others inadvertently not mentioned is hereby acknowledged.

INTERNATIONAL STANDARD

ISO 4427-5

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Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply —

Part 5: Fitness for purpose of the system

Systèmes de canalisations en plastique — Tubes et raccords en polyéthylène (PE) destinés à l'alimentation en eau —

Partie 5: Aptitude à l'emploi du système

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 4427-5 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*.

ISO 4427 consists of the following parts, under the general title *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply*:

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

— *Part 5: Fitness for purpose of the system*

Introduction

ISO 4427, the system standard, specifies the requirements for a piping system and its components when made from polyethylene (PE). The piping system is intended to be used for water supply intended for human consumption, including the conveyance of raw water prior to treatment and that of water for general purposes.

In respect of potential adverse effects on the quality of water intended for human consumption caused by the products covered by ISO 4427:

a) ISO 4427 provides no information as to whether the products may be used without restriction;

b) existing national regulations concerning the use and/or the characteristics of these products are in force.

Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply —

Part 5: Fitness for purpose of the system

1 Scope

This part of ISO 4427 specifies the characteristics of the fitness for purpose of assembled piping systems made from polyethylene (PE) intended for the conveyance of water for human consumption, including raw water prior to treatment and water for general purposes.

It also specifies the test parameters for the test methods to which it refers.

In conjunction with the other parts of ISO 4427, it is applicable to PE pipes, fittings, valves, their joints and to joints with components of other materials, intended to be used under the following conditions:

a) a maximum operating pressure (MOP) up to and including 25 bar[1)];

b) an operating temperature of 20 °C as the reference temperature.

NOTE 1 For applications operating at constant temperatures greater than 20 °C and up to 40 °C, see ISO 4427-1:2007, Annex A.

NOTE 2 ISO 4427 covers a range of maximum operating pressures and gives requirements concerning colours and additives. It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and any relevant national guidance or regulations and installation practices or codes.

2 Normative references

The following referenced documents are indispensable for the application 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.

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

ISO 3458, *Assembled joints between fittings and polyethylene (PE) pressure pipes — Test of leakproofness under internal pressure*

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

ISO 3459, *Polyethylene (PE) pressure pipes — Joints assembled with mechanical fittings — Internal under-pressure test method and requirement*

ISO 3501, *Assembled joints between fittings and polyethylene (PE) pressure pipes — Test of resistance to pull-out*

ISO 3503, *Assembled joints between fittings and polyethylene (PE) pressure pipes — Test of leakproofness under internal pressure when subjected to bending*

ISO 4427-1:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 1: General*

ISO 4427-3, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 3: Fittings*

ISO 11413:1996, *Plastics pipes and fittings — Preparation of test piece assemblies between a polyethylene (PE) pipe and an electrofusion fitting*

ISO 11414:1996, *Plastics pipes and fittings — Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by butt fusion*

ISO 13953, *Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*

ISO 13954, *Plastics pipes and fittings — Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm*

ISO 13955, *Plastics pipes and fittings — Crushing decohesion test for polyethylene (PE) electrofusion assemblies*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in ISO 4427-1 and the following terms and definitions apply.

3.1
electrofusion joint
joint between a PE socket or saddle electrofusion fitting and pipe or fitting with spigotted ends, made by heating the electrofusion fittings by the Joule effect of the heating element incorporated at their jointing surfaces, causing the material adjacent to them to melt and the pipe and fitting surfaces to fuse

3.2
butt fusion joint
joint made by heating the planed ends of matching surfaces by holding them against a flat heating plate until the PE material reaches fusion temperature, quickly removing the heating plate and pushing the two softened ends against one another

3.3
saddle fusion joint
joint made by heating the curved surface of a saddle and the outside surface of a pipe by holding them against a heated tool until the PE material reaches fusion temperature, quickly removing the heated tool and pushing the two softened surfaces against each other

3.4
mechanical joint
joint made by assembling a PE pipe to another PE pipe, or any other element of the piping system that generally includes a compression part, to provide for pressure integrity, leaktightness and resistance to end loads

NOTE 1 A support sleeve inserted into the pipe bore can be used to provide a permanent support for the PE pipe to prevent creep in the pipe wall under radial compressive forces.

NOTE 2 Metallic parts of these fittings can be assembled to metallic pipes by jointing threads, compression joints, or welded or flanged connections including PE flanges. The fitting can allow either a dismountable or permanently assembled joint.

3.5
fusion compatibility
ability of two similar or dissimilar polyethylene (PE) materials to be fused together to form a joint which conforms to the performance requirements of this part of ISO 4427

4 Fitness for purpose of the system

4.1 General

This clause details the preparation of test assemblies and the tests required to verify the fusion process under normal and extreme conditions and compatibility; 4.5 gives details of tests on mechanical fittings.

4.2 Preparation of assemblies for testing

4.2.1 General

The following subclauses specify the methods for preparing test assemblies, taking into account the extremes of pipe/fitting manufacturing tolerances, field assembly, equipment tolerances, ambient temperature variations during installation and, where appropriate, sealing and component material and tolerances.

Test pieces for pressure testing shall be closed with pressure-tight, end-load-bearing caps, plugs or flanges, which shall be provided with connections for the entry of water and release of air.

If failures that call for a redesign of the fitting are detected during testing according to this part of ISO 4427, retesting according to ISO 4427-3 automatically becomes necessary.

4.2.2 Grouping

For testing purposes, the size groups for pipes and fittings shall be in accordance with Table 1.

Table 1 — Size groups for pipes and fittings

Size group	1	2	3	4
Nominal outside diameter, d_n	$\geqslant$ 16 and $<$ 75	$\geqslant$ 75 and $<$ 250	$\geqslant$ 250 and $<$ 710	$\geqslant$ 710

4.2.3 Fitting types

This part of ISO 4427 is applicable to the following fitting types:

a) fittings with spigot ends;

b) electrofusion socket fittings;

c) electrofusion saddle fittings;

d) mechanical fittings.

4.3 Electrofusion joints

4.3.1 Assemblies with pipes and components having different MRS and SDR

a) Preparation

When applicable, the assemblies shall be prepared in accordance with Table 2, using pipe and components having a different MRS (minimum required strength) and SDR (standard dimension ratio), in accordance ISO 11413:1996, Table C.1, condition 1.

Table 2 — Sampling scheme

Electrofusion fitting	Pipe or component					
	PE 63		PE 80		PE 100	
	SDR max.	SDR min.	SDR max.	SDR min.	SDR max.	SDR min.
PE 63	X			X		X
PE 80	X		X			X
PE 100	X		X			X

b) Test pieces

The smallest diameter from each size group plus the largest diameter from the manufacturer's own product range per product type (see Table 1) shall be taken as the test pieces.

c) Requirement

The assembly shall be in accordance with the requirement specified in Table 3 for the characteristic *cohesive resistance* for electrofusion socket fittings or for electrofusion saddle fittings, as applicable.

4.3.2 Assemblies under extreme conditions

a) Preparation

The assemblies shall be prepared using pipe having the same MRS and SDR as the fitting, in accordance with ISO 11413:1996, Table C.1, conditions 2 and 3, using the minimum and maximum permitted ambient temperatures for joint assembly, T_{min} and T_{max}, as recommended by the fittings manufacturer and given in his technical file.

If accepted by the purchaser, the minimum and maximum energy conditions 2 and 3 may be replaced by a nominal energy at a given ambient temperature at which a joint is made, T_a, as defined by the fitting manufacturer in his technical file (see ISO 11413:1996, 3.4).

For straight, equal electrofusion socket fittings (couplers), test joints on selected diameters out of the product range, which shall be prepared with a gap of $0{,}05 d_n$ between the pipe end and the maximum theoretical depth of penetration of the fitting where, for diameters greater than 225 mm, the adjoining pipes shall be arranged to provide the maximum angular deflection possible for the fitting, limited to 1,5°. Saddle fittings shall be fused to the test pipe while pressurized with water to the maximum rated pressure. The pipe shall be cut immediately after the manufacturer's prescribed cooling time has elapsed.

NOTE Joints with electrofusion saddle fittings will need to be prepared taking into account national safety regulations.

b) Test pieces

One diameter from each size group, including the smallest and largest diameter from the manufacturer's own range per product type (see Table 1), shall be taken as test pieces.

c) Requirement

The assembly shall be in accordance with the requirement specified in Table 3 for the characteristic *cohesive resistance* for electrofusion socket fittings or for electrofusion saddle fittings, as applicable.

4.4 Butt fusion joints

4.4.1 Assemblies between components of different MRS

The following is to be carried out if requested by the purchaser or end user.

a) Preparation

The assemblies shall be prepared using pipe and/or fittings with spigot ends of the same SDR and having different MRS, in accordance with ISO 11414, and under normal conditions at 23 °C.

b) Test piece

One diameter from the manufacturer's own product range per product type shall be taken as the test piece.

c) Requirement

The assembly shall be in accordance with the requirement specified in Table 3 for the characteristic *tensile strength* for butt fusion joints.

4.4.2 Assemblies under extreme conditions

The following is to be carried out if requested by the purchaser or end user.

a) Preparation

The assemblies shall be prepared using pipe and/or fittings with spigot ends having the same MRS and SDR in accordance with ISO 11414:1996, Table B.1, under the minimum and maximum conditions specified therein, and including the misalignment requirements given in ISO 11414:1996, Clause 6, item a).

b) Test piece

One diameter from the manufacturer's own product range per product type shall be taken as the test piece.

c) Requirements

The assembly shall be in accordance with the requirements specified in Table 3 for the characteristics *hydrostatic strength* (165 h at 80 °C) and *tensile strength* for butt fusion joints.

4.5 Mechanical jointing

a) Preparation

PE pipes of different MRS and SDR for jointing by mechanical fittings shall be prepared and assembled in accordance with the manufacturer's instructions.

b) Test piece

One fitting per diameter from product types from the manufacturer's own product range shall be taken as the test piece.

c) Requirements

The assemblies shall be in accordance with the requirements specified in Table 3 for mechanical joints.

4.6 Conditioning

Except where otherwise specified in the applicable test method according to Table 3, the test pieces shall be conditioned at (23 ± 2) °C before testing.

Table 3 — Characteristics for fitness for purpose of the system

Characteristic	Requirement	Test parameters		Test method
Electrofusion/butt fusion joints				
Hydrostatic strength at 80 °C	No failure of any test piece during test period	End caps	Type A [a]	ISO 1167-1 ISO 1167-3
		Number of test pieces [b]	See Clause 4	
		Conditioning period	According to ISO 1167-1	
		Type of test	Water-in-water	
		Test temperature	80 °C	
		Test period	165 h [d]	
		Circumferential (hoop) stress for: [c]		
		PE 40	2,5 MPa	
		PE 63	3,5 MPa	
		PE 80	4,5 MPa	
		PE 100	5,4 MPa	
Tensile strength	Test to failure: Ductile — Pass Brittle — Fail	Test temperature	23 °C	ISO 13953
		Number of test pieces [b]	See Clause 4	
Cohesive resistance for electrofusion socket fittings	Length of initiation rupture $\leqslant L_2/3$ in brittle failure	Test temperature	23 °C	ISO 13954 or ISO 13955
		Number of test pieces [b]	See Clause 4	
Cohesive resistance for electrofusion saddle fittings	Length of initiation rupture $\leqslant L_2/3$ in brittle failure	Test temperature	23 °C	ISO 13955 [f]
		Number of test pieces [b]	See Clause 4	

Table 3 (*continued*)

Characteristic	Requirement	Test parameters		Test method
Mechanical joints [e]				
Leaktightness under internal pressure	No leaks	Test period Test pressure Number of test pieces [b]	1 h 1,5 × PN of pipe 1	ISO 3458
Leaktightness under internal pressure when subjected to bending	No leaks	Test period Test pressure Number of test pieces [b]	1 h 1,5 × PN of pipe 1	ISO 3503
External pressure test	No leaks	Test pressure Test period Test pressure Test period Number of test pieces [b]	Δp_1 = 0,01 MPa 1 h Δp_2 = 0,08 MPa 1 h 1	ISO 3459
Resistance to pull-out under constant longitudinal force	No pull-out or separation of the pipe from the fitting	Test temperature Test period Force	23 °C 1 h According to ISO 3501	ISO 3501

[a] Type B end caps may be used for tests for diameters ⩾ 315 mm.

[b] The number of test pieces given indicates the quantity required to establish a value for the characteristic described in this table.

[c] Stress shall be calculated for the pipes used in the test.

[d] Premature ductile failures are not taken into account; for the retest procedure, see 4.7.

[e] Mechanical joints ⩽ 63 mm; test methods for sizes > 63 mm are under development.

[f] This test method and its requirements may be superseded by an appropriate test standard under development by ISO/TC 138/SC 5.

4.7 Retest in case of failure at 80 °C

A fracture in a brittle mode in less than 165 h shall constitute a failure; however, if a sample in the 165 h test fails in a ductile mode in less than 165 h, a retest shall be performed at a selected lower stress in order to achieve the minimum required time for the selected stress obtained from the line through the recommended stress/time points given in Table 4.

Table 4 — Test parameters for retesting hydrostatic strength at 80 °C

PE 40		PE 63		PE 80		PE 100	
Stress MPa	**Test period** h	**Stress** MPa	**Test period** h	**Stress** MPa	**Test period** h	**Stress** MPa	**Test period** h
2,5	165	3,5	165	4,5	165	5,4	165
2,4	230	3,4	295	4,4	233	5,3	265
2,3	323	3,3	538	4,3	331	5,2	399
2,2	463	3,2	1 000	4,2	474	5,1	629
2,1	675			4,1	685	5,0	1 000
2,0	1 000			4,0	1 000		

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