# ZG 200-2

2020-10-01

Technical specification of OFI CERT for

# Flexible pre-insulated pipe systems for district heating networks with bonded thermoplastic reinforced service pipes

General requirements and tests
for the label OFI CERT

Allgemeine Anforderungen und Prüfungen
für die Zuerkennung des Zeichens OFI CERT

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This technical specification is constantly reviewed by OFI CERT and its‘ stakeholders.
Written remarks and improvements are appreciated.

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# 1 Scope

This technical specification covers flexible pre-insulated pipe systems for district heating networks with bonded thermoplastic reinforced service pipes (TRSP) with a maximum operating temperature up to 115 °C, a maximum operating pressures up to 16 bar and a minimum service life-time of 30 years. The flexible pre-insulated pipe systems covered by this technical specification consists of:

- TRSP out of a PE-Xa inner layer with an additional thermoplastic layer reinforced by high strength aramide yarns, with or without a barrier layer;
- Insulation layer out of PUR;
- Outer casing out of PE;

# 2 Abbreviations

AT Audit Test

BRT Batch Release Test

DN Nominal diameter of the service pipe

LTHP Long term hydrostatic pressure

LPL 97.5 % lower prediction limit

MOP Maximum operating pressure in bar

PE Polyethylene

PE-Xa Peroxide cross linked polyethylene

PUR Polyurethane

PVT Process Verification Test

TRSP Thermoplastic reinforced service pipes

TT Type Test

$T_D$ Design temperature

$T_{max}$ Maximum design temperature

$T_{mal}$ Malfunction temperature

# 3 Classification

## 3.1 Service classes

In Table 1 the service classes with different temperature-time profiles of pipes application are defined. Other temperature-time profiles can be applied in accordance with Annex A.

**Table 1:** Temperature-time profiles of service classes (to be continued next page)

| Service classes | $T_D$ | | $T_{max}$ | | $T_{mal}$ | |
|---|---|---|---|---|---|---|
| | °C | years | °C | years | °C | hours |
| Class A (according EN 15632-2) | 80 | 29 | 90 | 1 | 95 | 100 |
| Class B | 90 | 29 | 100 | 1 | 105 | 100 |
| (elevated temperature in district heating networks of Central Europe) [1)] | 85<br>90<br>95 | 15<br>10<br>4 | 100 | 1 | 105 | 100 |

| Service classes | $T_D$ | | $T_{max}$ | | $T_{mal}$ | |
|---|---|---|---|---|---|---|
| | °C | years | °C | years | °C | hours |
| Class C (elevated temperature in district heating networks of Northern Europe) [1)] | 95 | 29 | 105 | 1 | 120 | 100 |
| | 80<br>95<br>105 | 18<br>7<br>4 | 115 | 1 | 120 | 100 |
| Class D (elevated temperature in district heating networks of Eastern Europe) [1)] | 100 | 29 | 110 | 1 | 120 | 100 |
| | 20<br>95<br>100<br>105<br>110 | 20<br>16<br>10<br>3,5<br>0,3 | 115 | 0,2 | 120 | 100 |

[1)] The constant temperature-time profile needs to be qualified based on test results. In such a case the variable temperature-time profile can be used in addition.

### 3.2 Maximum operating pressure (MOP)

TRSP systems according to this specification are designed for MOP 6, 8, 10, 12 or MOP 16.

Each type of TRSP system shall be qualified by means of the regression procedure based on EN ISO 9080 and hydrostatic pressure test results in accordance with EN ISO 1167-1 and -2 conducted with water as the pressurizing fluid.

The type of TRSP is a dimension range of products having the same principle design, a winding angle of the yarn within ± 1° and the same grades of thermoplastics and reinforcing materials and the number of reinforcing layers.

The qualification pressure tests shall be done on at least one dimension per TRSP type. The maximum test temperature shall be greater than or equal to $T_{max}$. The regression test results shall be used to determine the regression-line gradient and the equation of the time-temperature dependence of LPL for LTHP using the statistical procedure described in EN ISO 9080.

The MOP for the particular service class is calculated from the equation of the time-temperature dependence of LPL for LTHP using Miner's rule according to EN ISO 13760 with taking into account the overall service (design) coefficients C given in Table 2.

The MOP of a already qualified TRSP system with permitted changes in diameter and reinforcement concentration can be recalculated in accordance with Annex B.

**Table 2:** Overall service (design) coefficients

| Temperature, °C | Overall service (design) coefficient, C |
|---|---|
| $T_D$ | 1,5 |
| $T_{max}$ | 1,3 |
| $T_{mal}$ | 1,0 |

## 4 Requirements for TRSP Systems

### 4.1 Material Requirements

The PE-Xa inner layer shall comply with section 4 of EN ISO 15875-2:2003+Amd1:2007. For other thermoplastic materials e.g in additional layers the relevant part of EN ISO, EN or ISO shall be applied.

### 4.2 Appearance

TRSP shall have a smooth inside, outside and end surface. Any cracks, sinks, foreign inclusions, that can be seen without magnification are not allowed.

The outer layer of the TRSP shall evenly cover the surface. Local variances of the outer layer thickness caused by reinforcement yarns as well as a roughness caused by the reinforced layer structure on the surface are acceptable.

The outer layer of the TRSP shall be evenly coloured. The colour shall be specified by the manufacturer.

### 4.3 Construction and Dimensions

A typical construction of a TRSP is shown in Figure 1. The order of layers can differ from the construction shown in Figure 1. The geometrical characteristics shall be measured according to EN ISO 3126. Pipes are produced in straight cuts, in coils or on drums. The manufacturer shall give information related to geometrical characteristics and type of fittings, which can be used in the system, in a technical file.

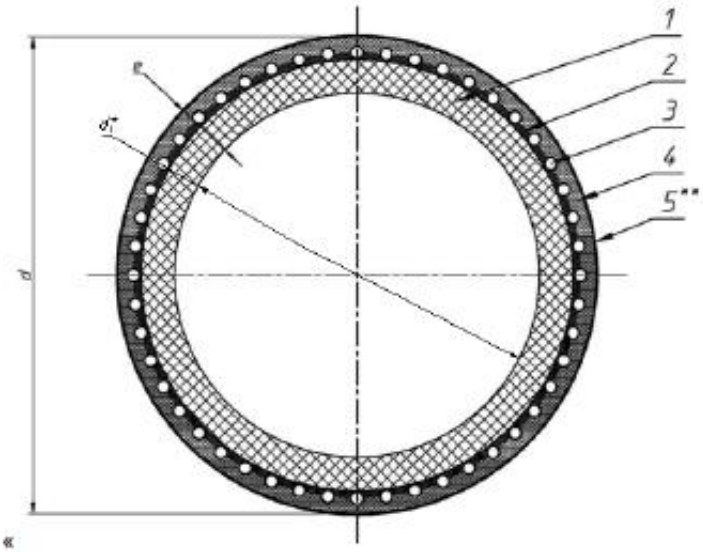


**Fig. 1:** Typical construction of a TRSP
1 - PE-Xa inner layer; 2 – Intermediate layer; 3 – Reinforcement layer;
4 – Outer thermoplastic layer; 5 – Optional barrier layer

### 4.4 Mechanical and Physical Characteristics

The mechanical and physical characteristics are listed in Table 3.

**Table 3:** Mechanical and physical characteristics (to be continued next page)

| Characteristic | Requirement | Test method |
|---|---|---|
| Resistance to internal pressure | Test pressure [1)]<br>Test temperature: $T_{max}$<br>Time: 22 h<br>Endcap: Type a) | EN ISO 1167-1 and -2 |
| | Test pressure [1)]<br>Test temperature: $T_{max}$<br>Time: 165 h<br>Endcap: Type a) | |
| | Test pressure [1)]<br>Test temperature: $T_{max}$<br>Time: 1 000 h<br>Fittings of the system and if they are not available endcap Type a) | |

| Characteristic | Requirement | | | | Test method |
|---|---|---|---|---|---|
| Thermal Stability | Test pressure: 0.6 x MOP<br>Test temperature and time depending on service classes: | | | | EN ISO 1167-1 and -2<br>Endcap Type a) |
| | Class A<br>T = 115 °C<br>t = 10 000 h | Class B<br>T = 125 °C<br>t = 8 760 h | Class C<br>T = 125 °C<br>t = 16 000 h | Class D<br>T = 125 °C<br>t = 24 000 h | |
| Degree of cross linking (PE-Xa layer/s) | Min. 70 % | | | | EN ISO 10147 |
| Oxygen tightness of barrier layer [2] | Test temperature: 80 °C<br>Max. 1.80 mg/(m$^2$ d) | | | | ISO 17455 |
| Resistance to thermal cycling of the system | Test pressure: MOP<br>Test temperature: 95 °C<br>Number of cycles: 2 500, no leakage<br>Cycle time: 60 min | | | | EN ISO 19893 |
| Resistance to pressure cycling of the system | Max. test pressure: 1.5 MOP<br>Min. test pressure: 0.5 bar<br>Test temperature: 23 °C<br>Number of cycles: 10 000, no leakage<br>Frequency of cycles: (30±5)/min | | | | EN 12295 |

[1] The test pressure depends on the construction of the type of TRSP and is taken from the evaluation according to EN ISO 9080.

[2] Tests are carried out on special produced sample pipe without reinforcement layer with an outer diameter between 20 mm and 25 mm with the same thickness of the barrier layer as with the TRSP.

### 4.5 Marking

The marking is made on the surface of the TRSP and the casing every meter by means of color printing or another method providing pipe integrity and not decreasing pipe quality. The marking shall at least contain:

- Manufacturer name and/or trade name;
- Dimension;
- Service class
- Maximum operating temperature ($T_{max}$);
- MOP;
- Production date, batch and production line (coded or uncoded);

After certification the manufacturer may use the sign OFI CERT together with the number of the this technical specification (ZG 200-2) on the TRSP and the casing.

### 4.6 Packaging

TRSP in coils or on drums shall be fixed in not less than four positions. Pipe ends shall be protected against the ingress of dirt and water by the use of endcaps.

## 5 Assessment of Conformity

### 5.1 General

The assessment of conformity is done by TT, BRT, PVT and AT. Additionally the requirements in section 5.2 apply to the manufacturer.

## 5.2 Requirements to the Manufacturer of the TRSP and the Flexible Pre-insulated District Heating System

a) The manufacturer(s) shall produce the product in such a way, that a constant high quality level is ensured. Therefore the technical equipment in the production shall be the state of the art. Qualified staff and the testing equipment needed for the assessment of conformity shall be available. The testing equipment shall be calibrated at least once a year, to ensure the correctness of the test results.

b) The quality management system shall be certified according to ISO 9001.

## 5.3 Type Test

### 5.3.1 General

The TT is performed by an accredited inspection and testing body before the certification is established and consists of an initial inspection of the production site and tests on samples, that are taken from there. The inspection shall also confirm the requirements in 5.2.

Between the manufacturer and the inspection and testing body as well as the certification body a certification contract needs to be established.

### 5.3.2 Type Test of the TRSP System

The TT on the TRSP systems is performed according to section 4. One dimension per size group is tested. The size groups are the following.

- Size group 1: Outer diameter of the TRSP up to 90 mm
- Size group 2: Outer diameter of the TRSP above 90 mm

### 5.3.3 Type Test of the Flexible Pre-insulated District Heating System

The TT is performed on one dimension according to Annex D of EN 15632-1:2009+A1:2014 and sections 5.3, 5.4 and 5.5 of EN 15632-2:2010+A1:2014.

## 5.4 Batch Release Test

### 5.4.1 General

Products are accepted and released in batches. The batch is considered as the clearly identifiable cut of pipe of the same type, manufactured on the same production line under the same steady state conditions. The batch size shall not exceed 2 000 m.

If the result of at least one characteristic is not satisfactory, a re-test is conducted on double quantity of samples. If results of re-testing are also not satisfactory, then the batch or a segment of batch is rejected.

### 5.4.2 Batch Release Test of the TRSP

The BRT on the TRSP is performed according to Table 4.

**Table 4:** BRT on TRSP

| Characteristic | Reference | Frequency | Test Piece(s) |
|---|---|---|---|
| Appearance | 4.2 | 1 / 4 h | 1 |
| Construction and dimension | 4.3 | 1 / 4 h | 1 |
| Resistance to internal pressure (22 h or 165 h) | 4.4 | 1 / Batch | 1 |
| Degree of cross-linking | 4.4 | 1 / Batch | 2 |
| Marking and packaging | 4.5, 4.6 | 1 / Batch | 1 |

### 5.4.3 Batch Release Test of the Flexible Pre-insulated District Heating System

The BRT on flexible pre-insulated district heating sytems is specified by the manufacturer in his quality plan.

### 5.5 Process Verification Test

#### 5.5.1 General

The stability of the production process in a long-term run is verified by PVT. If the result of at least one characteristic is not satisfactory, a re-test is conducted on double quantity of samples. If results of re-testing are also not satisfactory, then the batch or a segment of batch is rejected.

#### 5.5.2 Process Verification Test of the TRSP

The PVT on the TRSP is performed according to Table 5.

**Table 5:** PVT on TRSP

| Characteristic | Reference | Frequency | Test Piece(s) |
|---|---|---|---|
| Resistance to internal pressure (1000 h) | 4.4 | 1 / year on each dimension | 1 |

#### 5.5.3 Process Verification Test of the Flexible Pre-insulated District Heating System

The PVT on flexible pre-insulated district heating sytems is specified by the manufacturer in his quality plan.

### 5.6 Audit Test

#### 5.6.1 General

Regulary based on the certification contract (5.3.1) the AT is performed by an accredited inspection and testing body. The AT consists of an inspection of the production site, the control of the performed BRT and PVT as well as tests on samples, that are taken from the production site. The inspection shall also confirm the requirements in 5.2.

#### 5.6.2 Audit Test of the TRSP

The AT on the TRSP is performed once a year according to Table 6.

**Table 6:** AT on TRSP

| Characteristic | Reference | Frequency | Test Piece(s) |
|---|---|---|---|
| Appearance | 4.2 | 1 dimension per size group | 1 |
| Construction and dimension | 4.3 | | 1 |
| Resistance to internal pressure (22 h) | 4.4 | | 3 |
| Resistance to internal pressure (1000 h) | 4.4 | | 3 |
| Degree of cross linking | 4.4 | | 3 |
| Marking and packaging | 4.5 and 4.6 | | 1 |

#### 5.6.3 Audit Test ot the Flexible Pre-insulated District Heating System

The AT on flexible pre-insulated district heating sytems is performed on one dimension every 3 years according to Annex D of EN 15632-1:2009+A1:2014 and sections 5.3, 5.4 and 5.5 of EN 15632-2:2010+A1:2014.

## 6 Referenced Standards

| | |
|---|---|
| EN 12295 | Plastics piping systems - Thermoplastics pipes and associated fittings for hot and cold water - Test methods for resistance of joints to pressure cycling |
| EN 15632-1 | District heating pipes - Pre-insulated flexible pipe systems - Part 1: Classification, general requirements and test methods |
| EN 15632-2 | District heating pipes - Pre-insulated flexible pipe systems - Part 2: Bonded plastic service pipes - Requirements and test methods |

| | |
|---|---|
| EN ISO 3126 | Plastics piping systems - Plastics components - Determination of dimensions |
| 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 |
| 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 |
| EN ISO 9080 | Plastics piping and ducting systems - Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation |
| EN ISO 10147 | Pipes and fittings made of crosslinked polyethylene (PE-X) - Estimation of the degree of crosslinking by determination of the gel content |
| EN ISO 10508 | Plastics piping systems for hot and cold water installations — Guidance for classification and design |
| EN ISO 13760 | Plastics pipes for the conveyance of fluids under pressure — Miner's rule — Calculation method for cumulative damage |
| EN ISO 15875-2 | District heating pipes - Pre-insulated flexible pipe systems - Part 2: Pipes |
| EN ISO 19893 | Plastics piping systems — Thermoplastics pipes and fittings for hot and cold water — Test method for the resistance of mounted assemblies to temperature cycling |
| ISO 9001 | Quality management systems - Requirements |
| ISO 17455 | Plastics piping systems - Multilayer pipes - Determination of the oxygen permeability of the barrier pipe |

# Annex A - Service Classes of TRSP

(Informative)

This Annex gives information about the service classes given in this specification.

Each class relates to the field of application with certain temperature-time profile for a design period of 30 years. Class A was taken from the existing standard EN 15632-2, and the other classes of district heating application with elevated operating temperatures for Central, Northern and Eastern Europe were constructed using the principle of ISO 10508 and real data of temperature- time profiles for Eastern Europe) and data of semi-empirical function of the outside temperature between 2000 and 2015 for Central and Western Europe. From this time period profiles of the coldest year for each region were prolonged for a design service life:

**Class A** – District heating application profile with a maximum operating temperature of 95 °C according to EN 15632-2;

**Class B** – District heating application profile with a maximum operating temperature of 100 °C which was constructed for Biomass District heating networks in Central Europe (e.g. Austria, Germany, France) using the data from district heating supply network of Linz, Austria, as a semi-empirical function of the outside temperature;

**Class C** – District heating application profile with a maximum operating temperature of 115 °C which was constructed for the District heating networks in Northern Europe (e.g. Norway, Sweden, Finland) using the data from district heating supply network of Rovaniemi , Finland, as a semi-empirical function of the outside temperature;".

**Class D** – District heating application profile with a maximum operating temperature of 115 °C which was constructed for the Second loop District heating networks (from heat exchanger to end housings) in Eastern Europe (e.g. Russia, Belarus, Ukraine, Baltics) using the real data of Second loop networks in Moscow, Russia.

As an illustration of profiles construction, the data given in Table A.1 for Linz are used.

**Table A.1**: Temperature-time profile from Linz, Austria

| Temperature, °C | Profile of the coldest year (2006), days | Prolonged profile for 30 year service life, years |
|---|---|---|
| 95 to 100 | 6 | 0.5 |
| 90 to 95 | 45 | 3.7 |
| 85 to 90 | 106 | 8.7 |
| 80 to 85 | 201 | 16.5 |
| < 20 | 7 | 0.6 |

The profile of the coldest year was prolonged for 30 years' service life as follows:

a) Days given for a temperature range (5 °C) are all taken as if obtained at the highest temperature;

b) Time for temperature < 20 °C is not taken into account due to very short period of switched off mode;

c) Obtained profile is prolonged to service life;

d) Figures for prolonged time in years are rounded, as follows:

   0.5 year for 100 °C is rounded up to 1 year
   3.7 years for 95 °C is rounded up to 4 years

8.7 years for 90 °C is rounded up to 10 years
Residuary 15 years from 30 year service life is taken for 85 °C

e) Add Malfunction temperature 105 °C which time is not considered as part of the temperature-time profile but is included in the application of Miner’s rule.

These service classes are given as guidance. In countries with extreme weather conditions other classes may be preferred. When the actual temperature profile deviates from the profile given in Table 2 of this specification, the system supplier should provide calculations applying Miner's Rule.

# Annex B – Recalculation Procedure of MOP of a qualified TRSP

(Normative)

This Annex specified the procedure of recalculation of MOP for a qualified TRSP system with permitted changes in diameter and mass of reinforcement to avoid full qualification according to EN ISO 9080.

Due to the fact that the principal load-bearing component of the TRSP is high-strength reinforcing layer the MOP is the function of the yarns concentration in the reinforcement.

To allow for recalculation of the MOP qualified TRSP system with permitted changes in diameter and reinforcement concentration the conformity pressure test shall be done. Test pressure, P2500, must be calculated by scaling the LPL of LTHP of the qualified TRSP, as follows:

$$P_{2500} = P_{2500,LPL} * \frac{D_{QP}}{D_{CP}} * \frac{\rho_{CP}}{\rho_{QP}}$$

where

$P_{2500,LPL}$ is the LPL pressure for 2 500 h time to failure in the qualified TRSP

DQP is the mean reinforcement diameter of the qualified TRSP

DCP is the mean reinforcement diameter of the changed TRSP

ρQP is the mass of reinforcement per unit cylindrical area (at mean reinforcement diameter) in the qualified TRSP

ρCP is the mass of reinforcement per unit cylindrical area (at mean reinforcement diameter) in the changed TRSP

The conformity pressure test requires three test pieces of the changed TRSP to be subjected to a constant pressure test at $P_{2500}$ at the qualification maximum test temperature. The criterion is satisfied if all samples withstand 2 500 h without failure.

The change in TRSP system can be accepted if one dimension per size group pass the Type Test according to section 5.3.2 of this specification. If the result of at least one characteristic during type test is not satisfactory, a re-test is conducted on double quantity of samples. If results of re-testing are also not satisfactory, then the full qualification according to EN ISO 9080 for changed TRSP system shall be done.