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Plastics piping systems used for the rehabilitation of pipelines — Classification and overview of strategic and operational activities

Systèmes de canalisation en plastique destinés à la réhabilitation des réseaux enterrés — Classification et vue d'ensemble des activités stratégiques et opérationnelles

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 138 *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 8, *Rehabilitation of pipeline systems*.

This third edition cancels and replaces the second edition (ISO 11295:2017), which has been technically revised, to now sequentially cover all steps in process of design of pipeline rehabilitation.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This edition includes the following significant changes with respect to the previous edition:

— Title is renewed from "*Classification and information on design and applications of plastics piping systems used for renovation and replacement*" to "*Plastics piping systems used for the rehabilitation of pipelines — Classification and overview of strategic and operational activities*";

— Clause 5 is new and describes the whole process of pipeline rehabilitation with references to the other clauses for further details;

— Clause 6 is new and deals with the strategic activities to possibly come to the decision to rehabilitate; parts of the content of the former Clause 8 are included;

— Clause 7 is a contraction of the former Clauses 5, 6 and 7, with largely unchanged content;

— Clause 8 is new and handles further strategic activities needed to specify the rehabilitation project; parts of the content of the former Clauses 8 and 9 are included;

— Clause 9 still covers installation aspects but is revised and content on acceptance control is included now.

Introduction

Pipeline systems are continuously required to satisfy physical, chemical, biochemical and biological demands. These demands depend on planning, material, construction, type and period of use.

When pipeline systems become operational, they constitute a valuable asset to the network owner, requiring adequate management. For general guidelines and requirement on asset management, ISO 55000[28], ISO 55001[29] and ISO 55002[30] are applicable.

For pipeline systems in particular, proper pipeline system management has to be put in place, including monitoring the performance of the pipeline system.

For the specific case of pipelines for water supply and wastewater collection, detailed information on the overall management of the networks is provided by ISO 24516-1[25] and ISO 24516-3[26].

In case a malfunctioning of a pipeline system is recognized, reactive measures initially focus on improving regular maintenance procedures, including cleaning. In case of deterioration or other serious defects, more stringent measures to rehabilitate the pipeline become necessary.

Rehabilitation is carried out when there is a need to restore or upgrade the performance of a pipeline system. Rehabilitation can consist of repair, renovation or replacement. In recent years, the rehabilitation of pipeline systems has become increasingly important and will continue to be so.

This document provides information on the design process when considering rehabilitation of an existing pipeline, in order of sequence:

a) investigation and assessment of the deficiencies of current performance of the existing pipeline;

b) determination of viable options, based on performance criteria and process-related factors;

c) specification of the selected type of technique and the required pipe material;

d) the installation;

e) testing the performance.

The techniques used for the renovation and trenchless replacement of existing pipelines are classified in technique families and the typical characteristics of each is described in general terms.

Plastics piping systems used for the rehabilitation of pipelines — Classification and overview of strategic and operational activities

1 Scope

This document sets out the steps of the overall process of pipeline rehabilitation, comprising:

— Information on strategic activities:

  a) Investigation and condition assessment of the existing pipeline;

  b) Pipeline rehabilitation planning;

  c) Project specification.

— Information on and requirements for operational activities:

  d) Application of techniques;

  e) Documentation of the design and application process.

Definitions, classification and description of families of renovation and trenchless replacement techniques are provided, including their areas of application such as underground drainage and sewerage networks and underground water and gas supply networks.

NOTE 1 The following aspects are not covered by the scope of this document:

— new construction provided as network extension;

— calculation methods to determine, for each viable technique, the characteristics of lining or replacement pipe material needed to secure the desired performance of the rehabilitated pipeline;

— techniques for local repair.

NOTE 2 It is the responsibility of the designer to choose and design the renovation or trenchless replacement pipeline system.

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.

ISO 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1043-1 and the following apply.

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

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

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

3.1 General

3.1.1
assessment
process, or result of this process, comparing a specified subject matter to relevant references

3.1.2
design working life
assumed period for which a structure or part of it is to be used for its intended purpose with anticipated repair and maintenance but without renovation or replacement being necessary

3.1.3
hazard
biological, chemical, physical or radiological agent in, or condition of water, with the potential to cause harm to public health

Note 1 to entry: Condition includes quantity.

3.1.4
pipeline system
interconnecting pipe network for the conveyance of fluids

[SOURCE: EN ISO 11298-1:2018-07, 3.1.1]

3.1.5
rehabilitation
measures for restoring or upgrading the performance of existing pipeline systems, including renovation (3.1.6), *repair* (3.1.7) and *replacement* (3.1.8)

3.1.6
renovation
work incorporating all or part of the original fabric of the pipeline, by means of which its current performance is improved

3.1.7
repair
rectification of local damage

3.1.8
replacement
construction of a new pipeline, on or off the line of an existing pipeline, where the function of the new pipeline system incorporates that of the old

3.1.9
network extension
new construction off the line of a pipeline or a network with the aim to expand the total capacity of the network

3.1.10
trenchless replacement
replacement (3.1.8) without opening trenches other than small excavations to provide access for the particular technique

3.1.11
maintenance
routine work undertaken to ensure the continuing performance of a pipeline system(3.1.4)

3.1.12
independent pressure pipe liner
liner (3.2.3) capable on its own of resisting without failure all applicable internal loads throughout its design life

3.1.13
interactive pressure pipe liner
liner (3.2.3) which relies on the existing pipeline for radial support in order to resist without failure all applicable internal loads throughout its design life

3.1.14
fully structural renovation
use of an *independent pressure pipe liner* (3.1.12) or a non-pressure pipe liner which is capable of resisting all external loads and all externally induced post-lining deformations irrespective of the condition of the existing pipeline

3.1.15
semi-structural renovation
use of an *interactive pressure pipe liner* (3.1.13) which is capable of long-term hole and gap spanning at operational pressure or use of an *independent pressure pipe liner* (3.1.12) which is not capable of resisting all external loads

3.1.16
flow diversion
temporary isolation of the section of pipeline to be rehabilitated by the use of a temporary bypass or other means

3.2 Techniques

3.2.1
technique family

grouping of *renovation* (3.1.6) or *trenchless replacement* (3.1.10) techniques which are considered to have common characteristics for standardization purposes

3.2.2
lining pipe
pipe inserted for *renovation* (3.1.6) purposes

3.2.3
liner
lining pipe (3.2.2) after installation

3.2.4
lining system
lining pipe (3.2.2) and all relevant fittings inserted into an existing pipeline for the purposes of *renovation* (3.1.6)

3.2.5
lining with continuous pipes
lining with pipe made continuous prior to insertion, where the diameter of the *lining pipe* (3.2.2) remains unchanged

3.2.6
lining with close-fit pipes
lining with a continuous pipe (3.2.5) for which the cross-section is reduced to facilitate installation and reverted after installation to provide a close fit to the existing pipe

3.2.7
lining with cured-in-place pipes
lining with a flexible tube impregnated with a thermosetting resin, which produces a pipe after resin cure

3.2.8
lining with discrete pipes
lining with short lengths of pipe which are jointed to form a continuous pipe one by one during insertion

3.2.9
lining with adhesive-backed hoses
lining with a reinforced hose which relies on an adhesive bond to the host pipe to provide resistance to collapse

3.2.10
lining with spirally-wound pipes
lining with a profiled strip, spirally wound to form a continuous pipe after installation

3.2.11
lining with sprayed polymeric materials
lining with a sprayed two-part polymeric resin material that forms a continuous pipe after resin cure

3.2.12
lining with inserted hoses
lining with a reinforced hose which is either permanently shaped or re-rounded after installation by the application of an internal pressure

3.2.13
lining with a rigidly anchored plastics inner layer
lining with a single rigid annulus of structural cementitious grout formed between a plastics layer and the host pipe, where the plastics layer is permanently anchored in the grout

3.2.14
lining with pipe segments
lining with prefabricated segments bonded to the existing pipe, which either have longitudinal joints and cover the whole of the pipe circumference, or cover only part of circumference

3.2.15
pipe bursting
on-the-line *replacement* (3.1.8) method in which an existing pipe is broken by longitudinal splitting or brittle fracture, using a mechanically applied force from within, where the pipe fragments are forced into the surrounding ground and a new pipe of the same, smaller or larger diameter, is simultaneously pulled in

3.2.16
pipe removal
on-the-line *replacement* (3.1.8) method, in which the existing pipe is removed by *pipe eating* (3.2.17) or *pipe extraction* (3.2.18) and a new pipe is installed

3.2.17
pipe eating
type of *pipe removal* (3.2.16), where the existing pipe is progressively broken up and removed along with an annulus of the ground immediately surrounding the existing pipe

3.2.18
pipe extraction
type of *pipe removal* (3.2.16), where the existing pipe is extracted by pulling or pushing and replaced with a new one, either simultaneously or as a separate step

3.2.19
horizontal directional drilling
off-the-line *trenchless replacement* (3.1.10) method in which a pilot bore is drilled using a steerable drilling head connected to flexible rods and then the bore is enlarged by reamers up to the diameter required for the pipe or pipes subsequently pulled/pushed into place

3.2.20
impact moling
off-the-line *trenchless replacement* (3.1.10) method in which pipes are pulled in behind a pneumatic powered soil displacement hammer

3.2.21
pipe jacking
off-the-line *trenchless replacement* (3.1.10) method in which pipes are pushed through the ground, and the soil inside removed either manually, mechanically or using a slurry system

3.2.22
auger boring
type of *pipe jacking* (3.2.21), where the bore is excavated by a rotating cutting head attached to an auger which continuously removes the spoil, and the pipeline is pushed independently from the auger

3.2.23
microtunnelling
type of *pipe jacking* (3.2.21) where pipes are pushed behind a steerable, small scale tunnelling machine, remotely controlled from the surface

3.2.24
grout system
cement-based grout including any fillers, reinforcement or other additives or admixtures, in specified proportions

3.3 Service conditions

3.3.1
internal pressure resistance
ability to withstand internal fluid pressurization

3.3.2
allowable operating pressure
PFA
maximum hydrostatic pressure that a component is capable of withstanding continuously in service.

Note 1 to entry: It is expressed in bars [1].

4 Abbreviated terms

For the purposes of this document, the abbreviated terms given in ISO 1043-1 and the following apply.

CCTV	closed circuit television
HDD	horizontal directional drilling
EP	epoxy resin
GRP	glass-reinforced thermosetting plastics
PE	polyethylene
PP	polypropylene
PRC	polyester resin concrete
PUR	polyurethane
PVC-U	unplasticized poly(vinyl chloride)
UP	unsaturated polyester resin
VE	vinyl ester resin

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

5 Pipeline rehabilitation process

A pipeline rehabilitation process involves taking several sequential steps from the assessment of the performance condition to its set requirements, via the selection of the appropriate technique of rehabilitation to the actual rehabilitation work.

This document provides information and requirements for each of the steps:

1	Investigation of functional performance of the existing pipeline	Clause 6
2	Condition assessment of performance against set requirements	
3	Measures to control risks / pipeline rehabilitation	
4	Pre-selection of suitable types of rehabilitation techniques	Clause 7
5	Project specification	Clause 8
6	Selection of technique / installer	
7	Application of rehabilitation technique	Clause 9
8	Acceptance control	
9	Documentation of the rehabilitation process	Clause 10

A substantial part of this document (Clause 7) is dedicated to the Classification of techniques for pipeline rehabilitation, both renovation and trenchless replacement, by means of technique families. Typical characteristics and process related factors are provided for each technique family.

NOTE 1 Guidance on the whole process of integrated management of drains and sewers is presented in EN 752[41].

6 Investigation and condition assessment of the existing pipeline

6.1 Performance criteria

6.1.1 General

For every pipeline system certain objectives apply, depending on their intended functionality.

These are the basis for the performance requirements of a pipeline system. The pipeline system objectives, that impact on the performance requirements of the individual pipeline, shall be identified.

For drinking water distribution networks and wastewater collection networks, detailed guidance and requirements is provided by ISO 24516-1[25] and ISO 24516-3[26] respectively. The items detailed below specifically relate to the rehabilitation process of the pipeline systems in these networks, as well as in gas supply networks.

Pipeline system objectives include at least the following:

— Health and safety;

— Environmental protection;

— Sustainable operation.

Health and safety encompasses (depending on the function of the pipeline):

— Provision of access to safe and good quality drinking water;

— Preventing spread of disease by safe disposal of wastewater;

— Meeting user's needs and expectations;

— Minimizing occupational health and safety risks;

— Maintaining pipeline system integrity.

Environmental protection includes:

— Preventing pollution and minimize generating pollutants;

— Minimizing energy consumption;

— Avoiding nuisance in construction, operation and maintenance.

Sustainable operation includes:

— Providing service over many years - economic, social, environmental;

— Monitoring the quality of water (sampling, surveillance, maintenance);

— Minimizing mains failures and leakages.

The objectives shall be transformed to performance requirements and the resulting design criteria that ensure functionality of the pipeline system, such as: structural integrity, design working life, water tightness, prevention of pollution, sustainability, maintenance of flow.

Objectives can be split into the following categories:

— Hydraulic requirements;

— Structural requirements;

— Environmental requirements;

— Operational requirements.

NOTE 1 In ISO 24512[24] 'performance requirements' are recommended to be clearly defined in objective, verifiable 'Performance Indicators (PIs)', allowing for a clear comparison with the targeted objectives.

NOTE 2 In EN 752[41], 'performance requirements' are for the status quo. When any predicted changes in time are taken into account, they become 'design criteria'.

6.1.2 Hydraulic requirements

The following hydraulic requirements shall be considered:

a) sufficient capacity, allowing for foreseeable increases in flow over the design working life of the pipeline system;

b) ensuring operation of the pipeline system to be safe, and economically efficient;

c) water tightness in accordance with national or local testing requirements;

d) in the case of water supply pipelines, additional requirements apply:

   — The effects on water quality shall satisfy the requirements of national legislation;

   — Sufficient pressure, flow rate and continuity of supply;

   — Prevention of back flow (via valves and wash outs);

   — Minimize stagnation to avoid possible deterioration of water quality;

   — Requirements for firefighting (hydrants) to follow requirements of national legislation;

   — Prevention of contamination at pumping stations.

e) in the case of non-pressure drainage and sewerage networks,

— The hydraulic capacity shall limit surcharge and flooding to national prescribed levels.

6.1.3 Structural requirements

The following shall apply:

a) Structural integrity over the design working life of the pipeline system;

The pipeline system shall be able to withstand the loads without defects which can:

— Lead to risk of loss of structural integrity;

— Impair the function of the pipeline system.

6.1.4 Environmental requirement

The following shall apply:

a) Protection of groundwater;

b) Sustainable use of products and the potential re-use of recycling;

c) Minimize the use of energy over the design working life of the pipeline system;

d) Prevention of odours and toxic, explosive and corrosive gases.

6.1.5 Operational requirements

The following shall apply:

a) Trouble-free operation of the pipeline system, without interruptions of service;

b) Minimize the risk of failures: collapses (non-pressure pipelines) or bursts (pressure pipelines);

c) Maintenance to be carried out safely and without risks to the health of personnel;

d) Adequate access and working space;

e) Prevention of noise and vibration;

f) Not endangering adjacent structures and utility services.

6.2 Investigation of performance

6.2.1 General

Prior to the actual investigation, the following basic information about the existing pipeline shall be collected:

a) location;

b) pipe material;

c) actual internal diameter or other non-circular section dimensions;

d) wall thickness (especially in the case of pressure pipelines where interactive lining considered);

e) fluid transported;

f) accessibility and section lengths between access points;

g) frequency and location of any lateral connections, branches and/or valves;

h) depth of cover;

i) height of ground water table (both mean long term and peak short term);

j) flow quantity;

k) failure and repair records;

l) historical operating pressure regimes;

m) traffic or other surface loads;

n) proximity of adjacent buried services and structures.

NOTE 1 Some of this information can be ascertained from records and plans.

If available, following additional information shall be acquired additionally:

— Year of installation;

— Pipe class (e.g. crushing strength, stiffness or pressure class);

— Joint type;

— Bedding and backfill of the original construction.

Methods for determining the condition of the existing pipeline affecting functional performance differ in some respects for non-pressure and pressure applications and as a function of material, section size and shape.

In the case of non-pressure pipelines, the initial investigation shall be done by visual inspection in the form of a CCTV survey and/or profiling equipment and/or by man-entry, and should be recorded systematically such that the exact location of each feature, condition and defect is known and an assessment of its severity can be made.

In the case of pressure pipelines, the initial investigation shall be done by non-flow-interrupting techniques, such as via sonar/acoustic sensors, tracer gas leak detection and ground penetrating radar measurements, in a second step possibly to be followed by a CCTV survey.

In both cases, further investigation shall be done by checking exposed pipe sections and/or by extraction and evaluation of pipe samples.

NOTE 2 Where a substantial pipeline network shall be investigated, priorities shall be assigned, using the already available information. Those pipelines with the likely most serious problems, or those where the cost of investigation are best justified, then shall be investigated first.

Prior to inspection, in particular in the case of non-pressure drainage and sewerage networks, the pipelines should be cleaned thoroughly (removing sediments etc.).

NOTE 3 Further information on the investigation and assessment of and other service activities relating to drinking water and waste water and management of these utilities, is given in ISO 24510[22], ISO 24511[23], ISO 24512[24], ISO 24516-1[25] and 24516-3[26] and additionally, just for waste water networks by EN 752[41] and EN 13508-1[36]. Further information on the inspection and leak survey of gas pipeline systems is provided by EN 12007-1[34] and EN 12007-4[35].