Technical Report

ISO/TR 7035-2

Design and asset management of DIP for water application —

Part 2: Design, installation and operation

Conception et gestion des actifs des tuyaux en fonte ductile pour l'alimentation en eau potable —

Partie 2: Conception, installation et exploitation

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Contents

Foreword

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This document was prepared by Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 2, *Cast iron pipes, fittings and their joints*.

A list of all parts in the ISO/TR 7035 series can be found on the ISO website.

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.

Introduction

According to the World Health Organization, since 2010, the majority of the world's population lives in cities. By 2030, six out of every 10 people will live in cities and, by 2050, this proportion will have increased to seven out of 10 people. The water and wastewater infrastructure of distribution and collection pipes may have between 5 000 km and 10 000 km of underground piping for water distribution, and a similar network for wastewater collection, for a city of 100 000 to 500 000 people.

In introducing the practices or known acknowledges of this document due regard has been taken of the possibility to use ductile iron pipe easily and quickly, as well as the importance of a reliable and safe supply of water for human consumption and the purpose of trade, industry, agriculture and fire-fighting.

Renovation and repair of pipelines is usually complicated, administratively and technically. In many cases damage and service interruptions are created to other infrastructure networks (not knowing where these services run). Along with deterioration of roads and sidewalks the perceived image of the city worsens, increasing the great list of indirect costs, which is why the long lasting and reliable pipelines like ductile iron pipes (offering the best cost-effectiveness results), when taken all performances are into account by the asset management tools, explained in ISO/TR 7035-1.

Design and asset management of DIP for water application —

Part 2: Design, installation and operation

1 Scope

The objective of this document is to assist conceptors, engineering offices, water companies or project owners in the design, installation and operation of the ductile iron pipeline systems for water supply:

— introduce practices for design, installation and operation of new ductile iron pipe water supply systems, rehabilitation or renovation;

— refers to existing standards that specify products' design, installation and site testing, materials and coatings.

This document gives efficient support to ISO/TR 7035-1 which indicates chapters here for readers' reference.

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 2531, *Ductile iron pipes, fittings, accessories and their joints for water applications*

ISO 16631, *Ductile iron pipes, fittings, accessories and their joints compatible with plastic (PVC or PE) piping systems, for water applications and for plastic pipeline connections, repair and replacement*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2531 and ISO 16631, and the following 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
local main
water main which connects *principal main(s)* (3.2) with service pipes

3.2
principal main
water main serving as a principal distributor within the supply area, normally without direct consumer connections

3.3
service pipe
water pipe which supplies water from the *local main* (3.1) to the consumer

3.4
water distribution system
part of the water supply system comprising pipelines, service reservoirs, pumping stations and other assets by which water is distributed to the consumers

Note 1 to entry: Note to entry 1: It begins at the outlet from the water treatment works (or source, if there is no treatment) and ends at the point of connection to the consumer's installation.

3.5
carrier pipe
pipe inside a *casing* (3.6), which carries a product such as a gas or liquid

3.6
casing
metal pipe (as well as concrete pipe) used to protect the *carrier pipe* (3.5)

4 General

Due to its excellent characteristics, the designs and the applications of ductile iron pipe networks for potable water purpose are quite simple. High mechanical performance (i.e., the robustness) of ductile iron pipe systems allows energy saving from the reduced mechanisation required during the installation (no specialized equipment or on-site welding). Similarly, the need for the imported material for bed and surround is avoided or minimized, with the subsequent saving associated with the unnecessary use of natural resources and transport costs. Ductile iron pipes do not have the factor of time-dependent material creep deformation expressed as apparent stiffness as polymeric material pipes do.

Design processes normally start with the design/service objectives, which are related to the characteristics of the water supply systems in order to meet the targets outlined in Clause 5 and the defined levels of service (see ISO/TR 7035 -1) over the range of operating conditions, having regards to all relevant economic considerations and environment and ecology consideration.

5 Practices to set targets for water supplying system

5.1 Water quality

5.1.1 Materials

Almost all the countries or areas have their rules to make all parts of water supply systems in contact with potable water to be designed and constructed by using components and materials which meet the national or area stands and regulations, such that there is no unacceptable deterioration on water quality. If that's not existing, a practical method is to refer to WHO's rules.

5.1.2 Prevention of back flow

Potable water supply systems are normally designed, equipped and installed to prevent the back flow. The air valves and washouts (with their operation and location) are usually used to avoid water entering the systems. In circumstances of particularly high risk of unacceptable deterioration of water quality, non-return valves would not be an effective method to prevent the back flow.

5.1.3 Stagnation

Potable water supply systems are principally designed installed and operated to minimize water stagnation (zones or points) which would lead to unacceptable deterioration of water quality.

The following arrangements are the main points or locations leading to stagnation:

— main with dead ends;

— branch with dead ends;

— spurs serving hydrants;

— un-isolated pipes laid in advance of development;

— sections with permanently low flow rates;

— enhanced pipe diameters required for fire-fighting or other non-permanent purposes.

In practice, facilities (for example, the level invert tees) are usually provided for main flushing.

5.1.4 Cross-connection with other systems

The interconnection of potable water supply systems is possible when the chemical and physical properties are compatible for blending and there is no unacceptable deterioration of water quality. Normally the potable water supply systems do not directly connect with the systems containing non-potable water, except a plan for the blending.

Closed valves or non-return valves, except for air valves, washout and hydrant, normally do not constitute an effective means of separation for the purpose of the design.

5.2 Design life

Design life follows the requests and needs from the end users or authorities. For ductile iron pipes(buried) a service life of 100 years is commonly recognized in usual conditions because of the excellent mechanical properties and good internally and externally anti-corrosion solutions. Normally the design life of ductile iron pipeline systems is at least 50 years or is based on local national building codes.

Some components such as pumps and certain metering and control equipment are usually replaced earlier based on the replace time from national regulations.

5.3 Demand for water

5.3.1 General

The total demand of water depends on the elements the pipe systems service for. That includes volume for resident, factories & plants, municipal use, firefighting. The leakage volume of the pipelines is practically taken into account also, that depends on the experienced data of leakage ratio.

5.3.2 Water demand estimate

The demand for water depends very much on local circumstances. The real measurement of consumption makes the estimate results accurate.

In the absence of detail flow measurements or historical data the average daily of demand is practically obtained by estimating the domestic consumption per person per day (the per capita allowance) and multiplying it by the number of persons to be supplied. Some local criteria (such as GB 50013) give quota data helping designing jobs.

Where no better information exists, the overall allowance is usually taken as being between 150 and 250 l per person per day depending on social and climate conditions excluding specific industrial demands. In some areas consumption is up to 450 l per person per day.

The demand normally covers other use e.g., street cleaning and supplies to premises such as schools and hospitals which, added to the per capita allowance, give the overall allowance.

Regarding the peak flow factors, where water use is estimated on an average day basis, suitable factors are usually applied to give estimates of the expected demand in the peak week, peak day or hour. If no better information available, the multiplying factor for the peak day usually varies from 1,5 for populations above

10 000, to over two times (the average day demand) for population below2 000. The peak hour rate in any day ranges from twice the average hour rate in that day for over 10 000 people to more than 5 times the average for less than 2 000. Where consumer storage is provided, the peak hour flow factors is usually significantly lower than those experienced data above.

5.3.3 Water for fire-fighting

The potential demand for water for fire-fighting purposes to be provided by the water supply system is very large in relation with rules from authorities. In these circumstances the authorities responsible for fire-fighting usually incline to seek alternative sources of emergency supply.

5.4 System security

System security of water supply systems usually includes prevention of acts of vandalism, terrorism or other unlawful activity.

In general, the underground system will be secure, particular attention is given to above-ground pipework. Special designs are normally given to pumping station, service reservoirs and other above-gourd structures, to deter unauthorized entry or interference with operation systems, as well as the possibility of contamination of potable water. Security fencing and monitoring systems are the practical ways for the places where risks are higher.

6 Design

6.1 Hydraulic design

6.1.1 Sizing

Mains and service ductile iron pipes are principally sized to meet the maximum specified flow rate having regard to the defined levels of service. Normally the capacity and flow requirements of the various system components depends much on the interaction of main, service reservoirs, pumping installations, optimum hydraulic and economic parameters like pumping cost and asset depreciation. In general, it is the local mains and principal mains used for direct supply which offer the capacity of sustaining peak flow rates or a subdivision thereof. Mains that supply reservoir is possible not to meet fully peak flow rates. National rules usually give the maximum and minimum flow rates. ISO 23991 also gives the experienced data.

In determining the capacity of a reservoir, a practical method is to take the balance between supply and demand into account. In addition, other aspects are usually considered as following (not limited):

— estimated time to repair bust main upstream;

— effect of pump or power failure;

— existence of alternative sources of supply;

— single or duplicate supply mains to storage;

— degree of telemetry monitoring;

— ratio of peak hour to average flow rate;

— demands with respect to water for industrial supplies, fire-fighting or other special circumstances.

6.1.2 Mains

6.1.2.1 General

Hydraulic calculations are the common jobs for designers to demonstrate that the system will

— satisfy the estimated demand,

— operate at acceptable velocity, and

— operate within the required pressure range.

The designed diameters to satisfy the flow requirements for the hydraulic gradient are calculated by widely known calculation methods as follow in this clause.

The inner diameter of the pipe has a major influence on the pressure loss and therefor on the pumping energy consumptions. The greater internal diameter of the ductile iron pipe in comparison to the equivalent nominal diameter provides better economic results.

6.1.2.2 Head loss

It's widely known that the total head loss of a pipeline is as following (Formula 1):

$$H_t = H_f + H_l \quad (1)$$

where

H_t is the total head loss, in meters;

H_f is the friction head loss, in meters;

H_l is the local head loss, in meters.

The H_f is calculated by different methods known as Hazen-William's formula, Darcy-Wisbach formula and Chezy formula. These formulae are well known by designers globally, and ISO 23991 gives some of them.

6.1.2.3 Local head loss

Local head loss mainly occurs at bends, tees, valves and other service connections, as well as the irregularities in the ductile iron pipeline profile. It is usually taken into account in two ways:

— using experimental results which demonstrate the head losses are approximately proportional to the square of flow velocity, as the Formula 2 shows. Coefficients are available for various types of fittings;

— using an 'equivalent length' of straight pipe to give the same loss of head as the fittings. Some local criteria define k the hydraulic roughness to be 0,1 mm as a reasonable value for distribution mains instead of being 0,03 for straight ductile iron pipelines.

$$H_\mathrm{l} = \Sigma\xi \times \frac{V^2}{2g} \quad (2)$$

Where

H_l is the local head loss in metres;

ξ is the coefficient for local head loss, which depends on the shape of fittings, flowing direction;

V is the flow velocity in metres per second;

g is the gravity acceleration in metres per square second.