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IS 15663-2 (2006): Design and installation of natural gas pipelines - Code of Practice, Part 2: Laying of pipelines in crossings [CED 7: Structural Engineering and structural sections]



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भारतीय मानक  
प्राकृतिक गैस पाईपलाईनों के डिज़ाइन और  
संस्थापन की रीति संहिता

भाग 2 कटानों पर पाईपलाईनों को बड़ा करना

*Indian Standard*

DESIGN AND INSTALLATION OF NATURAL GAS  
PIPELINES — CODE OF PRACTICE

PART 2 LAYING OF PIPELINES IN CROSSINGS

ICS 75.200

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**BUREAU OF INDIAN STANDARDS**  
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NEW DELHI 110002

## FOREWORD

This Indian Standard (Part 2) was adopted by the Bureau of Indian Standards, after the draft finalized by the Structural Engineering and Structural Sections Sectional Committee had been approved by the Civil Engineering Division Council.

Natural gas has been utilized in the country for many years. With increased exploration efforts and enhanced production, utilization of natural gas has also increased. Natural gas is considered to be much more environment friendly and is therefore being preferred as an alternate fuel. Natural gas is envisaged to be an emerging fuel in the country and is slated to cater to a major portion of the country's energy requirement. The utilization of natural gas is, however, largely dependent on an efficient transmission and distribution network through pipeline systems; connecting gas sources, gas production plants, process plants, storage facilities, to the users/consumers spread across long distances. Towards this objective of its efficient usage, there is a focus on development of pipeline infrastructure through extensive pipeline networks for transmission and distribution of natural gas in the country.

Considering the above, a need was felt to develop a standard that prescribes the requirements necessary for the safe design and installation of such pipelines and its testing and commissioning. The recommended actions set out in the standard are intended to protect the public life as well as the environment from possible hazards in transportation of the gas. The recommendations are applicable to conditions that are normally encountered and additional design considerations may be necessary where unusual conditions are encountered. The standard is published in three parts. The other parts in this series are:

Part 1     Laying of pipelines

Part 3     Pre-commissioning and commissioning of pipelines

The standards keep in view the practices in the country in the field and the safety considerations and guidelines of the Oil Industry Safety Directorate in the following:

OISD-STD-141     Design and construction requirement of cross country hydrocarbon pipelines

OISD-STD-118     Layout of oil and gas installations

OISD-STD-117     Fire protection facilities for petroleum depots, terminal and pipeline installations

Assistance have also been derived from the following international standards:

ISO 13623     Petroleum and natural gas industries — Pipeline transportation systems

ASME B 31.8     Gas transmission and distribution piping systems

API RP 1102     Steel pipelines crossings railroads and highways

API RP 1104     Welding of pipelines and related facilities

## Indian Standard

# DESIGN AND INSTALLATION OF NATURAL GAS PIPELINES — CODE OF PRACTICE

## PART 2 LAYING OF PIPELINES IN CROSSINGS

### 1 SCOPE

This standard (Part 2) covers the minimum requirements for design, installation and testing of pipelines of steel, crossing roads, railways, water courses and other buried services.

### 2 REFERENCES

The standards given below contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>Standard</i>	<i>Title</i>
IS 15663 (Part 1) : 2006	Design and installation of natural gas pipelines — Code of practice: Part 1 Laying of pipelines
API RP 1102 : 1993	Recommended practice for steel pipelines crossings railroads and highways

### 3 TERMINOLOGY

**3.1** For the purpose of this standard the following definitions in addition to those given in IS 15663 (Part 1) shall apply.

**3.1.1 Carrier Pipe** — A steel pipe for transporting natural gas.

**3.1.2 Cased Pipeline/Cased Pipe** — A carrier pipe inside a casing that crosses a rail or road/highway or water course.

**3.1.3 Casing** — A conduit through which the carrier pipe may be placed.

**3.1.4 Casing Insulator** — Insulator spacers fitted on carrier pipe so as to provide electrical insulation of cathodically protected carrier pipe and casing pipe. Also termed as spacers.

**3.1.5 Casing End Seal** — Sealing provided at junction of casing pipe and carrier pipe on both ends of crossings to avoid ingress of water, dust, etc.

**3.1.6 Limits of Crossing** — Specified width of crossing

(rail/road/water course, etc) which shall be designated as crossings and crossing design may require increased wall thickness/increased burial cover/anti-buoyancy measures and/or installation of carrier pipe inside casing pipe.

**3.1.7 Casing Vent** — Vent pipe installed at one end of casing pipe (at high point) to vent-off the gases from the annulus between casing and carrier pipe.

**3.1.8 Casing Drain** — Drain pipe installed at one end of casing pipe (at low point) to drain out the water from the annulus between casing and carrier pipe.

**3.1.9 Open Cut Crossings** — Method of installation of pipeline across a crossing, which involves making a trench across the facility to be crossed, using open cut trench method (by stopping/diverting the traffic).

**3.1.10 Trenchless Crossings** — Method of installation of pipeline across a crossing, which involves inserting the carrier/casing pipe across the facility to be crossed without open excavation of trench. The casing/carrier pipe may be inserted using jacking, boring, micro-tunnelling, drilling, horizontal directional drilling, etc. The traffic is not stopped during crossing installation.

### 4 PROVISIONS FOR SAFETY

**4.1** Work on crossings of railway, roads/highways, water courses or buried services shall be taken up with the prior approval from authorities having jurisdiction of the facility to be crossed and after making adequate arrangement for safeguarding the railways, roads, water courses, canals, buried services, etc.

**4.2** As appropriate, guards should be posted, warning signs installed, lights/flares placed, temporary walkways, fences and barricades provided and maintained in order to ensure public safety and safety in operation.

**4.3** Highways, main roads, railways and their verges and banks of water courses shall not be used for loading, unloading or stacking of materials and/or equipments. For secondary roads such loading/unloading may be permitted with the prior approval from concerned authority. The movement of vehicles, equipments, materials and personnel across a highway

shall be in strict compliance with the requirements of the concerned authorities. Precautionary measures shall be adopted like posting flag persons to direct traffic and equipment movement and protecting the highway from surface or structural damages. Highway shall be kept free of dirt, muck, debris or other unsafe conditions.

## 5 TYPES OF CROSSING

Crossings can be open cut crossings or trenchless crossings, executed by open cut method or trenchless method, respectively. Crossings can be uncased or cased, taking into consideration the stresses imposed on the pipelines as well as the potential difficulties associated with protecting the pipelines from corrosion. In a cased crossing, the carrier pipe is placed through a casing to cross beneath a highway/road, railway, water course, etc.

## 6 COVER

The cover requirements for pipelines for railway crossings, highway/road crossings, water course crossings or other crossings shall be in accordance with those specified in IS 15663 (Part 1).

## 7 DESIGN

The pipelines shall be designed to ensure safe operation and the stresses affecting the pipeline shall be accounted for, including circumferential, longitudinal and bending stresses. Unless otherwise stated in this standard, for specific design calculations for railway and road crossings the appropriate provisions in API RP 1102 shall apply.

### 7.1 Loads

The pipes (carrier pipes in the case of cased crossings) shall be designed for both internal load from pressurization and external loads from earth and live loads from rail and road traffic, hydrostatic loads for water courses and seismic loads, as applicable. An impact factor shall be applied to the live loads.

Other loads as a result of temperature fluctuations caused by changes in season; longitudinal tension from end effects; fluctuation associated with pipeline operating conditions; ground deformations; etc, shall also be taken into consideration as appropriate.

#### 7.1.1 External Loads

##### 7.1.1.1 Earth loads and hydrostatic loads

Earth load resulting from the weight of the overlying soil, that is, conveyed to the top of the pipe shall be considered. In the case of water courses, earth load as well as hydrostatic load shall be considered.

#### 7.1.1.2 Live load

In the case of railway crossings, the crossing is assumed to be oriented at  $90^\circ$  with respect to the railway. It is also assumed that the pipeline is subjected to load from a single train as would be applied on either track. For simultaneous loadings on both tracks, stress factors for cyclic longitudinal and cyclic circumferential stresses shall be applied.

For highway/road crossings it is assumed that the pipeline is oriented at  $90^\circ$  to the highway/road. It is also assumed that the pipeline is subjected to loads from two vehicles travelling in adjacent lanes, such that there are two sets of tandem axels or single axle in line with each other.

#### 7.1.1.3 Installation load

Installation loads, depending on the method of construction, shall be considered for trenchless installations.

### 7.1.2 Internal Load

The pipeline is subjected to internal pressure from the gas being transported. The maximum allowable operating pressure or the maximum operating pressure shall be used in designing the pipelines.

### 7.1.3 Environmental Loads

Loads arising from winds and earthquake shall be considered.

## 7.2 Stresses

### 7.2.1 Stresses Due to External Loads

External loads shall produce circumferential, longitudinal, and bending stresses. It is assumed that external loads act across a  $90^\circ$  arc centered on the pipe crown and resisted by a vertical reaction distributed across  $90^\circ$  arc centered on pipe invert. The loads shall be assumed to be acting at  $90^\circ$  to the axis of the bend. Stresses arising from installation loads, based on the method of construction in the case of trenchless installation, shall also be considered.

#### 7.2.1.1 Stresses due to earth load and hydrostatic loads

Circumferential stresses at pipeline invert caused by earth load shall be determined. In the case of water courses stresses from the hydrostatic load shall be considered in addition to the above.

#### 7.2.1.2 Stresses due to live loads

##### 7.2.1.2.1 Surface live loads

The live load from railway traffic and live load from highway/road traffic shall be considered in accordance with 7.1.1.2. The requirements of API RP 1102 shall

be applicable. Based on construction methods adopted, additional consequential loads shall be considered where applicable.

### 7.2.2 Stresses Due to Internal Loads

The circumferential and longitudinal stresses due to internal pressure shall be evaluated.

### 7.2.3 Check for Allowable Stresses

**7.2.3.1** The pipeline shall be checked for allowable stresses in accordance with the appropriate provisions in API RP 1102 for railway and road crossings; and in accordance with that specified in IS 15663 (Part 1) for other crossings.

**7.2.3.2** The combined stress shall be evaluated from the circumferential, longitudinal and radial stresses. The pipeline shall be checked against yielding, in accordance with the criteria defined in IS 15663 (Part 1).

**7.2.3.3** The pipelines shall also be checked for fatigue, considering appropriate fatigue endurance limits for both girth welds and longitudinal welds in accordance with the provisions in API RP 1102 for railway and road crossings.

## 8 REQUIREMENTS OF CASINGS

### 8.1 Minimum Internal Diameter

The internal diameter of casing pipes shall be large enough to facilitate the installation of the carrier pipe and to provide adequate insulation for maintenance of the surface protection coatings and prevent transmission of external loads from the casing to the carrier pipes. Casing pipes shall be at least two nominal pipe sizes larger than carrier pipes.

### 8.2 Wall Thickness of Casing Pipes

The minimum nominal wall thickness of steel casing pipes should be as specified in API RP 1102 or as specified by the authority of the rail/road/water course/facility being crossed, whichever is more.

### 8.3 Installation of Casings

**8.3.1** Casing pipes and vent pipes shall be at least 1.2 m away (vertically) from aerial electrical wires and shall be suitably insulated from under ground conduits carrying electric wires on railway land.

#### 8.3.2 Casing Seals

The casing should be fitted with end seals at both ends to reduce the intrusion of water and fines from the surrounding soil. It should be recognized that a water-tight seal is not possible under field conditions and some infiltration of water should be anticipated. The ends shall be plugged using compatible anti-corrosion

material at both ends having a minimum slope of 1 : 2 and shall be covered with neoprene rubber sheet of a minimum thickness of 2 mm.

### 8.3.3 Casing Vents

One or two vent pipes shall be installed at the highest point of the casing pipes. The vent pipe shall be at a distance of at least 0.5 m from the end of the casing pipe. These pipes should not be less than 50 mm in diameter and should be welded to the casing and should project through the ground surface at right-of-way line or fence line. A hole through the casing of not less than half that of the vent pipe diameter must be made prior to welding of the vent pipe over it.

The vent pipe should extend not less than 1.2 m above ground surface. The top of the vent pipe should be fitted with suitable weather caps.

### 8.3.4 Insulators

Insulators electrically isolate the carrier pipe from the casing by providing a circular enclosure that prevents direct contact between the two. The insulator should be designed to promote minimal bearing pressure between the insulator and carrier coating. The insulator material shall be such that the insulation measured between casing and carrier should be minimum 1 MΩ.

### 8.3.5 Casing Drain

Drain pipe shall be installed with casing pipes. The drain pipe shall not be less than 50 mm in diameter and shall be welded to the casing and shall project through the ground surface at right-of-way line or fence line. Tapping for drain line shall be taken from bottom of casing. A hole of not less than half that of the drain pipe diameter shall be made prior to welding of the drain pipe to casing pipe. The drain pipe shall extend not less than 1.2 m above ground surface and top shall be fitted with suitable weather cap.

### 8.3.6 Protection of Casing Vent and Casing Drain

Portion of vent and drain off pipes which are under ground or which may be under water shall be coated with approved quality corrosion resistant tape/coating. Portion above ground water level shall be painted with approved paint after application of primer.

## 9 INSTALLATION

### 9.1 General

Angle of intersection (alignment of pipeline) between pipeline and the roads, railway and water course crossing shall be in accordance with the requirements specified in IS 15663 (Part 1). The number of warning signs shall be one for crossing of less than 15 m width and two for crossing above 15 m width. Pipeline string



welded for the crossing shall be hydrostatically pre tested *ex-situ*, prior to joint coating whenever:

- a) river crossing/water course crossing pipes are to be continuously concrete weight coated (to be tested prior to concrete coating);
- b) a crossing is installed in casing pipe; and
- c) pre-testing is insisted upon by the authorities having jurisdiction over the utility crossed.

**9.2** Crossings can be installed by open cut methods or by trenchless methods.

**9.2.1** For open cut method, the requirements of pipeline installation as specified in IS 15663 (Part 1) shall apply, unless otherwise stated in this standard.

**9.2.2** Trenchless method shall be by horizontal directional drilling or horizontal auger boring or pipe ramming or thrust boring methods.

**9.2.2.1** Horizontal directional drilling (HDD) is a steerable method for the installation of pipes in a shallow arc using a surface launched drilling rig. In particular, the term applies to large scale crossings in which a fluid filled pilot bore is drilled without rotating the drill string, and this is then enlarged by a washover pipe and back reamer to the size required for the product pipe. Depending on the diameter of the product pipe, multiple enlargements may be required. The excavation is performed by the mechanical action of a fluid assisted cutting head.

Prior to undertaking horizontal directional drilling operations the geotechnical and hydrological data shall be available for deciding on appropriate drilling rig and accessories required.

The pipe in horizontal directional drilling operation may be exposed to significant abrasion during pullback. Therefore, a coating to provide a corrosion barrier as well as an abrasion barrier is required. The coating shall be bonded well to the pipe and have a hard smooth surface to resist soil stresses and reduce friction.

The designed profile of the pipe string shall ensure that the requirements of pipeline cover as specified in IS 15663 (Part 1) are satisfied. It is desirable to have an entry penetration angle between 10° and 12° and an exit angle between 5° and 12°. However, the final profile and the design load for the safe operation of horizontal directional drilling shall be approved by the owner.

Pipe rollers, skates or other protective devices shall be used to prevent damage to the pipe, eliminate ground drag, reduce pulling force, and reduce the stress on the pipe and joints. The drilling fluid in the annular region outside of the pipe shall not be removed after installation, and remain in place to provide support for the pipe and neighbouring soil.

During construction, continuous monitoring and plotting of pilot drill progress shall be undertaken to ensure compliance with the proposed installation alignment and allow for appropriate course corrections to be undertaken.

**9.2.2.2** Horizontal auger boring involves the forming of a bore from a drive pit, by means of a rotating cutting head, and installing a steel pipe that serves as a casing for carriers. It is a multi-stage process consisting of constructing a temporary horizontal jacking platform and a starting alignment track in a drive pit at a desired elevation. The casing pipe is then jacked along the starting alignment track with simultaneous excavation of the soil being accomplished by a rotating cutting head in the leading edge of the casing pipe's annular space. The soil is transported back to the entrance pit by a helically-wound auger rotating inside the casing pipe. This method typically provides limited tracking and steering as well as limited support to the excavation face; unless a modified auger boring machine is used.

**9.2.2.3** Pipe ramming method involves the forming of a bore from a drive pit, by driving a steel casing with an open end using a percussive hammer or pushing device that serves as a casing for carrier pipe. In this process of horizontal ramming of steel pipe involves an open steel pipe string being jacked dynamically with the aid of modified displacement hammer or a horizontal ram from the starting shaft through the subsoil to the target shaft. The soil core entering the pipe is removed continuously, at suitable intervals or after completion of jacking. The soil may be removed by augering, jetting or compressed air. In appropriate ground conditions a closed casing may be used.

**9.2.2.4** In the case of thrust boring, direct boring/jacking of carrier pipes for crossings is allowed in the normal rock free soil having cohesive strata only provided the pipes for boring/jacking are provided with a suitable corrosion coating and adequate protective measures are taken to ensure the integrity of carrier pipe and its coating. A soil investigation to determine the ground water table shall be carried out prior to boring/jacking operation. During the execution of boring the ground water table over the length of boring shall be lowered to at least 0.50 m below the pipeline bottom. In approaches to crossings, unnecessary bending of pipe shall be avoided by deepening of the ditch to match the contour of the ground at such approaches. The bottom of trench and/or pit for at least 12 m at approach at each end of a casing shall be graded and if necessary backfilled with clean sand and compacted sufficiently, so as to provide continuous support to the pipeline and ensure its correct alignment at casing ends during and after backfilling. The bored section shall have a hole diameter as close as

practicable to the outside diameter of the carrier or casing pipe. At the front of the pipe there may be a cutting ring, 12 mm larger than the outside diameter of the pipe or casing. A lubricating pipe can also be used in casing, the nipples of which shall not protrude from the cutting ring. The lubricating pipe shall not be fixed to the pipe or casing. When jacking preferably biologically degradable lubricants shall be used. Removal of soil from the pipeline during jacking operation shall be done mechanically by means of a standard locked auger, which has to be safeguarded against jacking ahead of the pipe. During jacking the progress of the pipe to be jacked and the cutting capacity of the auger shall be mutually adjusted, by regulating the speed of auger, to prevent the road from bulging (rpm too low) or cave-ins (rpm too high). In any case no more soil shall be removed than the volume of the pipe. If the jacking fails, the casing shall not be withdrawn. It shall be filled with sand and plugged at either end.

### 9.3 Road and Railway Crossings

**9.3.1** The installation work of crossings shall include as necessary clearing, grading and trenching to required depth and width, welding of casing (when required) and carrier pipes, coating, lowering-in, backfilling, clean up, restoration work, testing including installation of assemblies, insulators and seals. Prior approval from statutory authorities shall be obtained to lay the pipeline across highway/roads either by open cut method or trenchless methods. Railway crossings shall always be by trenchless methods.

**9.3.2** Before the installation work of crossings is started, the suitable barricades, temporary bridge/by pass work (especially where roads are open cut) with railing should be provided for safety of traffic. Adequate traffic warning signals and/or traffic lights and suitable diversions shall be provided.

**9.3.3** Welding of casing and vent/drain pipe need not be radiographed. Casing pipe must be laid with a single gradient in order to allow for an easy insertion and if necessary at a future date, to allow for the removal or replacement of the pipeline, leaving the casing undisturbed. The assembly of vent pipe units shall be carried out by direct insertion and welding to the ends of the casing pipe before introducing the carrier pipe. Insulators shall be securely fastened to the pipe with all bolts and fixtures firmly tightened. Adequate number of insulators shall be provided. At the end of both sides of the casing, a double set of insulators shall be installed. After installation of the carrier pipe section, the casing and the appurtenances, but prior to making tie-in welds and backfilling, an electrical test shall be conducted to determine the resistance between the casing and the carrier pipe or the carrier pipe and

the soil. These tests shall show at least a resistance of 1 M $\Omega$ . After backfilling and compaction, additional tests shall be conducted to determine if the casing is electrically shorted to the pipe.

**9.3.4** Pipeline at railway crossings shall be provided with casing pipe. The casing pipe shall be at least two nominal pipe sizes larger than the carrier pipe. The rail crossing shall comply with the requirements of railway authorities.

The casing pipe shall generally extend to a distance of 14.0 m beyond the center line of the outermost railway tracks on either side of the tracks or to a distance of 0.6 m beyond the right-of-use limits of the railway authorities on either side, whichever is more.

**9.3.5** All national highway and state highway crossings shall normally be cased crossing. If permitted by the concerned authorities horizontal directional drilling may also be considered for these crossings. Provision of casing or installation of carrier pipe by direct boring at other locations shall be decided based on type of road crossing and in consultation with roadway authorities as necessary. The casing pipe shall be at least two nominal pipe sizes larger than carrier pipe.

### 9.4 Water Course Crossings

**9.4.1** Crossings across ditches, canals, rivers, streams, etc, shall constitute water course crossings. Applicable conditions of working on, over, under or through water courses shall be ascertained from the concerned authorities and followed. Whenever water courses with moderate flow rate or torrential nature is to be crossed, required geotechnical and hydrological survey shall be carried out before starting the work in order to ascertain the precautions necessary and period appropriate for executing the work. Bends provided in the string for crossings shall be of cold field type.

**9.4.2** Crossing shall be installed by open cut or trenchless method depending upon width, depth, bank slopes, soil type, flow, etc.

**9.4.3** Minimum cover over the pipeline shall be as specified in IS 15663 (Part 1) or as stipulated by the authority having jurisdiction over the water course being crossed, whichever is higher.

**9.4.4** Temporary installations for diversions as may be necessary are to be arranged, to ensure the effective functioning of these water courses crossed. In addition to the above, the terminologies in IS 15663 (Part 1) shall also be applicable.

**9.4.5** Banks and trenches of water course crossings shall be backfilled with soil and shall be thoroughly compacted to prevent soil and bank erosion. Whenever boulders, rock, gravel and other hard objects are

encountered, they shall not be placed directly on the pipe. Sufficient earth, sand or selected and approved backfill material shall be backfilled initially around and over the pipe to provide a protective padding or cushion extending to a minimum thickness of 300 mm around the pipe before backfilling remainder of the trench with excavated or other material. After the trench has been backfilled and during the clean up works, the water course crossing shall be cleaned at least across the whole width of the right-of-use. The excavation shall be backfilled with well compacted solid soil, followed by a minimum 0.25 m thick layer of properly shaped boulders (75 to 150 mm) encased in a net of galvanized iron wire of 3 mm diameter spaced at a maximum distance of 50 mm to be laid over the backfill, compacted and graded such that top of boulder filled mattress coincide with natural ground level. The top of mattress shall be provided with 100 mm thick plain cement concrete of adequate sand cement mixture to avoid exposure of mattress to public. The length of the above protection shall be equal to the bank excavation and damage and extending 2 m on either sides. The width of this protection on the slope shall be determined from 2 m plus the highest water level. No drilling work on embankment shall be permitted.

Wherever there is an evidence of bank erosion and the slope is less than 45°, the banks shall be protected by gabion mattresses. Suitable gabion wall should be provided wherever the slope of bank is more than 45°.

### **9.5 Crossings of Buried Services**

#### **9.5.1** The pipeline under construction may pass above

or below the existing buried facilities such as other pipelines, cables, etc. The minimum clearance required between pipeline and such existing facility shall be 500 mm. Wherever buried services in the right-of-use to be crossed, these shall be safeguarded and precautions as approved by the owner of such services shall be taken. In the case of existing pipeline crossings, the specific requirements of owner/operator of existing pipeline shall generally be followed. Unless specified otherwise, there shall be a minimum clearance of 300 mm between the pipelines.

Interference survey shall be performed to investigate the electrical potential interference developed due to dissimilar potential of pipelines. Adequate measures shall be adopted to pacify the effects of interference.

## **10 TESTING**

**10.1** The section of the pipeline at critical crossings such as railway, national highway, expressways, major canal, major rivers shall be hydrostatically pre-tested as a single string. Unless specified otherwise, the hydraulic test pressure shall be 1.5 times the design pressure but limited to a maximum of 95 percent of the specified minimum yield strength (SMYS) of the line pipe material. For major river crossings, the pipeline shall again be hydrostatically tested for a minimum period of 24 h after backfilling, at similar pressure conditions.

**10.2** Unless otherwise mentioned in this standard, the method of testing shall be in accordance with that specified in IS 15663 (Part 1).

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### Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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### Amendments Issued Since Publication

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