IS 15663-3 (2006): Design and installation of natural gas pipelines - Code of Practice : Part 3 Pre-commissioning and commissioning of pipelines [CED 7: Structural Engineering and structural sections]

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भारतीय मानक

प्राकृतिक गैस पाईपलाईनों के डिज़ाइन और संस्थापन की रीति संहिता

भाग 3 पाईपलाईनों की पूर्व-कमीशनिंग और कमीशनिंग

Indian Standard

DESIGN AND INSTALLATION OF NATURAL GAS PIPELINES — CODE OF PRACTICE

PART 3 PRE-COMMISSIONING AND COMMISSIONING OF PIPELINES

ICS 75.200

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 3

FOREWORD

This Indian Standard (Part 3) 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 2 Laying of pipelines in crossings

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

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 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 3 PRE-COMMISSIONING AND COMMISSIONING OF PIPELINES

1 SCOPE

This standard (Part 3) covers the minimum requirements for pre-commissioning and commissioning of natural gas pipeline, including pre-commissioning activities such as pre-commissioning checks, flushing, dewatering, swabbing, magnetic cleaning/electronic geometry pigging (EGP), drying, inertisation, gas-in and commissioning, stabilization and 72 h run.

2 REFERENCE

The standard given below contains provision which through reference in this text, constitutes provision of this standard. At the time of publication, the edition indicated was 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 edition of the standard indicated below:

IS No.	*Title*
15663 (Part 1) : 2006	Design and installation of natural gas pipelines — Code of practice : Part 1 Laying of pipelines

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 15663 (Part 1) shall apply.

4 GENERAL

Procedures shall be established for pre-commissioning and commissioning activities. These shall consider the characteristics of the gas being conveyed, the need to isolate the pipeline from other facilities and the transfer of the pipeline for operation. The procedures and devices shall be such that nothing, that is, incompatible with the gas being conveyed or with the materials in the pipeline components is introduced into the pipeline system. Pre-commissioning shall be commenced only on completion of all activities related to the pipeline construction which includes hydrostatic testing, complete backfilling, installation of field instruments/equipments and suitable cathodic protection system.

The commissioning of the pipelines shall essentially consist of the following operations:

a) pre-commissioning checks;
b) swabbing;
c) inertisation; and
d) commissioning.

5 PRE-COMMISSIONING

5.1 Pre-commissioning shall include the following:

a) De-watering of residual water of the pipeline;
b) Flushing and dry air blowing of above ground piping at dispatch and receiving stations, sectionalizing valve stations, intermediate pigging stations and hook-up point;
c) Swabbing of pipeline;
d) Low pressure leak check (with air) for the above ground section of the pipelines; and
e) Preparation of pre-commissioning procedures for all activities related to pre-commissioning.

5.2 Pre-commissioning Procedure

5.2.1 *Pre-commissioning Checks*

Pre-commissioning checks shall be carried out for the pipeline system up to first isolation valve to ascertain that the pipeline system has been mechanically completed in all respects. These checks shall cover the main pipeline including distribution network system, dispatch and receipt stations, intermediate pigging stations, sectionalizing valve stations and the hook up points. The pre-commissioning checks shall include the following:

a) *Checking of pipe cover* — Cover check over pipeline for every 500 m with suitable instruments (like pipe current measurement, PCM; etc) shall be carried out.
b) *System checks* — The entire facilities shall be checked against drawings/documents and other design specifications. Any observation requiring correction/corrective action shall be recorded and complied with.
c) *Checking of field instruments/equipments* — All the field instruments like actuated valves, control valves, shut down valves, transmitters, solenoid valves, shut down switches, alarms,

etc, shall be checked physically and also for their intended application. It will also include checking of different meters, gauges, actuated valves, control valves, shut down valves, etc.

d) *Pipeline survey* — This shall be performed to confirm that proper fittings/supports, cathodic protection system, route markers, warning signs, fencing around sectionalzing valve stations, crash barriers, etc, have been installed along the pipeline and crossings.

e) *Communication system* — Communication systems shall be checked for adequacy to ensure uninterrupted communication.

f) *Electrical distribution system* — Electrical instrumentation system shall be checked to ensure an uninterrupted power supply during startup and normal pipeline operation. Earth resistance of all earth pits and equipments, towers, lightning arresters, etc, shall also be carried out. Electrical fixtures shall be checked for their compliance to the area classification requirements for such purpose.

g) *Checking of instruments control and interlocks* — This check shall be carried out to ensure that instrument controls and interlocks are functional as per the normal operating conditions.

h) *Utilities* — Utilities like power, UPS, water, air, instrument air conditioning, etc, shall be checked.

j) *Alarm systems* — Setting off alarms and its functioning shall be ensured.

k) *Safety* — Identification of possible emergencies and preparedness for its mitigation shall be checked.

Any other checks as considered necessary shall also be carried out.

5.2.2 *Swabbing*

5.2.2.1 *Swabbing operation*

The swabbing operation shall be done subsequent to dewatering operation for removal of residual water in the pipeline prior to final drying, inertisation and commissioning of the pipeline system. This is done by driving number of suitably designed absorbant pigs propelled by oil free compressed dry air. For the purpose of swabbing, air compressors of required capacity, after-coolers and driers should be deployed.

5.2.2.2 *Acceptance criteria*

Swabbing operation shall be considered to be complete when there is no free water left in the pipeline as indicated by increase in weight of less than 10 percent of the original weight (prior to launching) of the last retrieved pig or when pigs are received in touch dry condition.

5.2.3 *Low Pressure Leak Check for Above Ground Piping*

5.2.3.1 The above the ground piping sections of the pipeline system shall be checked for leaks at flange points of piping and equipment, instrument impulse tubing points, etc. This shall be done by pressurizing the piping system/equipment with dry compressed air (for this purpose, oil free air compressors shall be used) and testing by means of soap solution/suitable digital gauge for leaks.

5.2.3.2 *Acceptance criteria*

The leak check operation shall be considered to have been completed when the piping system/ equipment is free of leaks when tested at a pressure of 6.0 kg/cm^2.

6 COMMISSIONING

6.1 General

Commissioning of a pipeline shall be considered to be complete when the line has been charged with product natural gas at the operating pressure and the entire system has been operated at operating parameters for a minimum period of 72 h with all instruments, controls and interlocks working at normal operating conditions.

Commissioning shall include magnetic cleaning, EGP, drying, inertisation, gas-in, stabilization and 72 h run.

6.2 Commissioning Procedure

6.2.1 *Magnetic Cleaning*

In order to ensure that the pipeline is free from metallic debris, the magnetic cleaning shall be carried out using a train of bi-directional brush magnetic pigs after the completion of swabbing and tie in. The operation shall be carried out using super dry air. A detailed procedure and the sequence of the operations shall be prepared before starting the operation.

6.2.1.1 *Acceptance criteria*

The magnetic cleaning of the section will be acceptable if the total ferrous debris collected is less than 5 kg/ 100 km in the last pig.

6.2.2 *Electronic Geometry Pigging (EGP)*

Calliper survey shall be carried out using super dry air

after the swabbing and magnetic cleaning operations from the pig launcher to the pig receiver.

6.2.2.1 *Pig tracking*

The movement of any type of pig put into the pipeline during magnetic cleaning and electronic geometry pigging shall be monitored along the pipeline length from launcher to receiver trap.

6.2.2.2 *Electronic geometry pig runs*

The electronic geometry pig should be capable of recording the entire length of each segment that is, from the launcher to receiver, in one single run and therefore its electronic recorder system should have the requisite data storage capacity. The measurement shall cover the entire (360°) of internal pipe wall circumference using properly oriented and sufficient quantity of sensors. The tool shall be capable of identifying and locating the following features:

a) individual girth weld;
b) dent, ovality, buckles or any other out of roundness;
c) change in pipeline internal diameter and difference of thickness; and
d) valves.

Repair of defects shall be carried out in accordance with that specified in IS 15663 (Part 1).

6.2.2.3 *Significance of defects*

The following information/performance shall be expected out of the electronic geometry pig inspection:

a) Inspection of entire length of each segment to be completed in one single run; and
b) Tools of a minimum detection level of 2 percent of internal diameter shall be selected. The accuracy of measurement shall be 1 percent of the internal diameter and 2.5 percent of the measured value. The locational accuracy of the axial measurement shall be 0.1 percent from permanent features. The tool shall be capable of negotiating a minimum bend of 3 times the diameter and a 15 percent reduction in internal diameter of the pipe.

6.2.2.4 *Final work report*

Any reporting system shall include but shall not be limited to the following:

a) A detailed report in respect of each pipe segment of running each of the pre-inspection tools such as magnet cleaning pig;
b) Detailed report of the running of the electronic geometry pig including but not limited to the operational and functional details;
c) Detailed description of the type, size and location of individual mechanical defects. The location and orientation of each defect should be suitably listed with reference to permanent pipeline features, girth weld number, relative and absolute distance;
d) A detailed report in respect of each defect for which sizing has to be done, indicating its length, depth and axial location suitably referenced;
e) Preliminary site report for each pipe segment for each running of magnetic cleaning, and electronic geometry pig runs, stating the comments/observations of each run, pig condition, operating parameters, and total time required; and
f) Velocity plot of the electronic geometry pig along the length of the segment.

6.2.3 *Drying*

6.2.3.1 *Requirements*

The pipeline system including the under ground pipelines and the above ground piping at dispatch and receipt stations, sectionalizing valve station, intermediate pigging stations and hook-up/tap-of points need to be dried prior to charging natural gas. Drying is required to prevent internal corrosion of the pipeline over a prolonged period of operation and to meet the supply specification of the product natural gas and also as a means of preservation of the pipeline sections subsequent to the pre-commissioning activities.

The pipeline shall be dried by using super dry air or by any other suitable method (for example, vacuum drying process). A detailed procedure and the duration of the operation shall be prepared and approved before start of drying operation.

6.2.3.2 *Acceptance criteria*

The drying operation shall be complete before proceeding to the next step of inertisation. The drying of the pipeline system shall be considered to have been complete on attaining a water dew point of (–)10°C at atmospheric pressure. The pipeline system shall then be left at a pressure of 2.0 kg/cm^2 with dry air at this dew point after the drying operation and maintained at this pressure and dew point till the commencement of the subsequent commissioning activities of inertisation and gas-in. Alternatively, nitrogen can be purged to break the vacuum for inertisation after attainment of the desired dew point of (–)10°C in the pipeline and a dew point profile test, provided that the

gas-in is carried out immediately after breaking of the vacuum by nitrogen.

6.2.4 *Commissioning Checks*

Commissioning checks including pre-startup safety review prior to start of commissioning activities shall be carried out to achieve a ready for commissioning status for underground pipeline and above ground piping system at dispatch and receipt stations, above ground piping system at intermediate pigging stations, sectionalizing valve stations and hook-up/tap-off points and before pressurized entry of natural gas into the new pipeline facility.

6.2.5 *Inertisation*

The inertisation of the entire pipeline system including under ground pipeline and the above ground piping at dispatch and receipt stations, intermediate pigging stations and hook-up/tap-off points shall be carried out using nitrogen gas.

6.2.5.1 *Operational requirements*

During the inertisation operation, the dry air left in the pipeline shall be replaced by dry nitrogen before admitting the natural gas into the pipeline for safe commissioning. Depending on the commissioning plan/strategy, sections of the pipeline system shall be taken up for commissioning in steps. It is recommended that nitrogen slugs separated by pigs be used for inertisation of the under ground pipeline. The amount of nitrogen shall depend on the length of the pipeline portion to be taken up for commissioning. In general, the totalized length of the nitrogen slugs must be at least 10 percent of the total length of the pipeline under consideration. The nitrogen in the pig train shall be propelled by natural gas (during commissioning stage of the pipeline). For above ground piping at dispatch and receipt stations, sectionalizing valve stations, intermediate pigging stations and hook-up/tap-off points, the piping shall be purged with nitrogen till the residual content in the pipline is below 1 percent (vol/vol).

Nitrogen used for inertisation purpose of the pipeline and above ground piping shall be of such purity level as to satisfy the acceptance criteria for residual oxygen content as specified in **6.2.5.2**. Nitrogen gas at ambient temperature (not liquid nitrogen) and in compressed, vaporized and gaseous state shall be used as the inertising medium. In case the source of gaseous nitrogen is from liquid nitrogen tankers, then all precautions (including verification of the lowest tolerable temperature of all components in the system under commissioning) should be ensured. Due precautions in working with and in releasing of nitrogen shall be undertaken.

6.2.5.2 *Acceptance criteria*

Inertisation of the pipeline may be accepted if the required quantity of nitrogen with adequate number of batching pigs has been introduced into the pipeline. For above ground piping at dispatch and receipt stations, sectionalizing valve stations, intermediate pigging station and hook-up/tap-off points, the inertisation may be accepted when the residual oxygen content in the piping is below 1 percent (vol/vol).

6.2.6 *Gas-in and Commissioning*

6.2.6.1 *Operational requirements*

During the introduction of natural gas into the pipeline, the gas shall be the motive fluid for driving the last pig of the nitrogen slug train. The pig train speed shall be maintained at 3 to 4 km/h. Maintenance of proper back pressure shall control pig train speed. Venting shall be controlled at the pig-receiving end to achieve the desired dynamics. The desired portion of the pipeline shall be commissioned in this manner. The pipeline system shall subsequently be slowly pressurized up to its operating conditions and high pressure leak checks of the pipeline system at flange points, instrument points, etc, shall be carried out with soap solution at regular intervals during the course of pressurization of the pipeline system. Once the pipeline system is pressurized at its operating conditions, normal gas flow shall be established in the pipeline system.

Commissioning shall also include establishing the process control parameters and turn down as per the design value stipulated. As a part of commissioning, all pipeline monitoring and control equipment shall be fully function tested, especially safety systems such as pig-trap interlocks, pressure and flow monitoring systems, and emergency pipeline shut down systems. Consideration shall also be given to performing a final test of pipeline valves prior to the introduction of natural gas to ensure that they operate correctly.

6.2.6.2 *Acceptance criteria*

The system shall be considered to have been commissioned successfully when the pipeline system including the under ground pipeline and the above ground piping at dispatch and receipt stations, sectionalizing valve stations, intermediate pigging stations and hook-up/tap-of points is charged with natural gas, is free of leaks and have run successfully for a minimum period of 72 h at stable operating conditions and instrumentation/control systems, process utilities and support systems taken on line. The commissioning of pipeline system shall include commissioning of branch lines and associated facilities including auxiliary facilities and above ground piping.

7 DOCUMENTATION

7.1 Commissioning documentation shall include records of the following:

a) Pre-commissioning checks;
b) Residual dewatering and swabbing;
c) Low pressure leak check of above ground piping system with dry compressed air;
d) Documents related to magnetic cleaning and EGP;
e) Inertisation; and
f) Gas-in and commissioning activities (including pressurization of pipeline system, high pressure leak check, establishment of flows and 72 h run).

7.2 All these documents should be prepared covering all aspects of health, safety and environment (HSE), quality assurance and quality control plans.

Bureau of Indian Standards

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Review of Indian Standards

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