मानकः पथप्रदर्शकः

COMPENDIUM OF INDIAN STANDARDS ON

GAS METERS

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Foreword

This compendium gives a consolidated list all the Indian Standards published on Gas Metering in a single document. These standards are the collective expertise of scientists, engineers, industry stakeholders, and regulatory authorities who have collaborated under the aegis of BIS to establish comprehensive guidelines for gas metering equipment. It encompasses a wide range of metering technologies, including diaphragm, Coriolis, rotary piston, ultrasonic, orifice plate, turbine, and thermal mass flow meters. Similar Compendiums for Indian Standards on Length Measurement and Weights Measurement are also available.

Gas Meters

Gas meters are specialized devices designed to measure the quantity of gas flowing through a pipeline or consumed by a user, typically expressed in terms of volume (cubic meters or cubic feet) or mass (kilograms or pounds). They play a critical role in residential, commercial, and industrial applications for purposes such as **billing, process control, energy management**, and **safety monitoring**.

Modern gas meters often integrate digital electronics, telemetry, and smart grid compatibility for real-time monitoring, remote data collection, and enhanced accuracy. Their selection is based on parameters such as gas type, pressure, temperature, required accuracy, installation environment, and regulatory standards.

Types of Gas Meters and Their Applicable Indian Standards

1. **Diaphragm Gas Meter** — Uses flexible chambers that expand and contract to measure gas volume; widely used in residential settings. **[IS 14439 (Part 2)]**
2. **Coriolis Meter** — Measures mass flow directly via tube vibrations influenced by Coriolis forces; highly accurate for industrial applications. **[IS 15672]**
3. **Rotary Piston Meter** – Employs a rotating piston to displace and measure fixed volumes of gas; ideal for residential and light commercial use. **[IS 15673]**
4. **Ultrasonic Meter** — Determines flow rate by measuring the time difference of ultrasonic signals traveling with and against the gas flow. **[IS 15674]**
5. **Orifice Plate Meter** — Uses a pressure drop across a thin plate with an orifice to infer flow rate; simple and cost-effective for high-flow systems. **[IS 15675]**
6. **Turbine Meter** — Measures volumetric flow by detecting the rotational speed of a turbine placed in the gas stream. **[IS 15676]**
7. **Thermal Mass Flow Meter** — Calculates mass flow based on heat transfer from a heated element to the flowing gas; suitable for low-flow gas measurements. **[Doc No: PGD 26 (24427)]**

Additional Applicable Indian Standards

In addition to the above specific standards, the following general standards are also relevant to gas metering:

- **IS 14439 (Part 1) : Legal Metrology — Gas Volume Meters : Part 1 General Requirements**
- **IS 15677 : Metering of Natural Gas — Code of Practice**

1. Diaphragm Gas Meters [IS 14439 (Part 2) : 1998 (Reaffirmed in 2019)]

Scope: IS 14439 (Part 2) covers diaphragm gas meters, which are positive displacement meters that measure gas flow using flexible chambers. These meters are primarily designed for measuring the volume of natural gas and other gaseous fuels in domestic and light commercial applications.

Key Aspects:

- **Flexible Chambers:** Gas flow is measured using the movement of diaphragms that displace a known volume of gas per cycle.
- **Working Range:** Defines standard flow limits (Q_{min} to Q_{max}) and supports lower Q_{min} values matching specified fractions.
- **Cyclic Volume:** Deviation from nominal cyclic volume must not exceed ±5%.
- **Error Limits:**
  - Q_{min} to 0.1 Q_{max} : ±3% (initial), -6% to +3% (in-service)
  - 0.1 Q_{max} to Q_{max} : ±1.5% (initial), ±2% (in-service)
- **Test Element:** Meets tight standard deviation for repeatability/accuracy.
- **Pressure Absorption:** Within limits (e.g., 200–220 kg/cm² for G 0.6 to G 6).
- **Pattern Approval:** Tests for accuracy, temperature, durability (2000 hours).
- **Verification:** Initial and periodic (every 10 years) for accuracy.

2. Coriolis Meter [IS 15672 : 2006]

Scope: IS 15672 provides guidance on the selection, installation, calibration, performance, and operation of Coriolis meters for the measurement of mass flow, density, and volume flow of fluids, including natural gas. Though primarily intended for mass flow measurement, Coriolis meters also support density and temperature readings, from which volume flow and other derived parameters can be calculated.

Key Aspects:

- **Measurement Principle**: Uses the **Coriolis Effect**—measuring the force exerted on oscillating tubes by flowing fluid to determine mass flow.
- **Primary & Secondary Devices**:
  - *Flow Sensor*: Contains oscillating tubes and sensing mechanisms.
  - *Transmitter*: Drives the tubes, processes signals, and calculates flow parameters.

- **Multi-Parameter Measurement**: Simultaneously measures mass flow, density, temperature, and calculates volume flow.
- **High Accuracy and Zero Adjustment**: Critical for accuracy, especially in fluctuating conditions or after installation.
- **field-adjustable** for specific fluids and conditions.

3. Rotary Piston Meter [IS 15673 : 2006]

Scope: IS 15673 specifies the requirements for the construction, working ranges, pressure tapping methods, and permissible error limits for rotary piston gas meters. These meters are designed to measure the volume of natural gas supplied through pipelines, especially at the user's end for accurate billing and flow monitoring.

Key Aspects:

- **Measurement Principle**: Uses rotating impellers (pistons) inside a measuring chamber. The number of rotations is proportional to the volume of gas.
- **Pressure Tapping**: Static pressure tapping must be provided at both inlet and outlet for pressure measurement and absorption.
- **Construction**: Includes options for internal reverse flow prevention and volume-to-standard-volume conversion.
- **Permissible Errors**:
  - *Initial verification*: Tight tolerances for accuracy (e.g., ±1.5% or better).
  - *In-service limits*: Slightly relaxed but still stringent.
- **Durability Testing**: Includes requirements for 1000 hours of operation at maximum flow to assess long-term performance.

4. Ultrasonic Meter [IS 15674 : 2006]

Scope: IS 15674 specifies requirements for ultrasonic transit-time flow meters used for the custody transfer measurement of natural gas, particularly those using multipath measurement technology. These meters are suitable for operation in gas temperature ranges from –10°C to +55°C and require at least two acoustic paths for precise volumetric flowrate measurement.

Key Aspects:

- **Measurement Principle**: Ultrasonic meters measure gas flow by comparing the **transit time** of sound waves traveling with and against the gas flow. The difference in transit times is used to calculate flow velocity and, subsequently, volume.
- Multipath Configuration, Bi-Directional Capability and No Moving Parts.

- **Installation requirement**: Performance affected by **upstream piping configurations** and flow disturbances.
- **Advanced Diagnostics**: Includes monitoring of sound speed, path-specific velocities, flow profile symmetry, and acoustic signal quality.
- **Integration and Configuration**: Comes with electronic modules and software for real-time flow calculation, configuration, and data logging.

5. Orifice Plate Meter [IS 15675 : 2006]

Scope: IS 15675 provides the geometry, installation, and operating conditions for orifice plate meters, used to determine the flow rate of fluids, including natural gas, in pipelines running full. It applies specifically to subsonic, single-phase, steady flow conditions using flange pressure tappings. It is intended for custody transfer and bulk flow measurement where reliable and standardized differential pressure measurement is essential.

Key Aspects:

- **Measurement Principle**: Based on **differential pressure** created across an orifice plate inserted in a pipe. The pressure drop correlates with the flow rate.
- **Applicability**:
  - Pipe sizes between **60 mm and 1000 mm**
  - Reynolds number **above 5000**
  - **Subsonic, single-phase flow** only
- **Components & Configuration**:
  - **Orifice Plate**: Precisely machined to specific dimensions and surface roughness
  - **Flange Tappings**: Located upstream and downstream to measure differential pressure
  - **Meter Tube**: Straight section of pipe ensuring accurate flow profile
- **Calculation Basis**: Flow rate is computed using established formulas incorporating orifice diameter, pressure differential, fluid density, and discharge coefficient (from ISO 5167-1).
- **Uncertainty Management**: Requires proper installation, material quality, and pressure/temperature compensation.

6. Turbine Meter [IS 15676 : 2006]

Scope: IS 15676 specifies the dimensions, construction, performance, calibration, and output characteristics of turbine meters used for the measurement of gas flow, especially for custody transfer applications. It also includes installation conditions, pressure and leakage

testing, and informative annexes related to use, field checks, and potential perturbations.

Key Aspects:

- **Measurement Principle**: A turbine rotor spins due to the dynamic force of gas flow. The rotational speed is proportional to the gas volume passing through, enabling volumetric flow measurement.
- **Design Features**:
  - **Rotor Assembly**: Key rotating part that responds to gas velocity.
  - **Stators and Housings**: Direct the flow uniformly to improve accuracy.
  - **Mechanical or Electronic Counters**: For reading gas volume.
- **Flow Range and Accuracy**:
  - High accuracy over a **designated flow range**.
  - **±1**% permissible error over most flow ranges; tighter tolerances possible with calibration.
- **Calibration**: Each meter must be individually calibrated and supplied with calibration data including flow rate, temperature, pressure, and test conditions.
- **Installation Requirements**: Includes straightening vanes and minimum upstream/downstream lengths to reduce turbulence and maintain accuracy.
- **Materials and Safety**: Components must withstand specified pressures, temperatures, and fluid properties. Electrical safety compliance is required for hazardous environments (e.g., IS 2148 for flameproof enclosures).

7. Thermal Mass Flow Meter [PGD 26 (24437)]

Scope: This standard covers battery-powered Class 1.5 capillary thermal mass flow gas meters for measuring 2nd/3rd family gases (per IS 15127). Using heat transfer to measure gas flow, they provide volume at base conditions, suitable for low-pressure (≤ 0.5 bar) environments, flow rates up to 40 m^3/h, and indoor/outdoor use under vibration, condensation, and electromagnetic disturbances.

Key Aspects:

- **Measurement Principle**: Uses heat transfer via a thermal sensor to directly measure gas flow rate. Despite the term "mass" in the principle, output is typically in volume at base conditions.
- **Flow Range**: G1.6 to G40, turndown ratio ≥150:1.
- **Permissible Errors**:
  - ±3.5% for lower flow range (Q_{min} to Q_t)
  - ±2.0% for higher flow range (Q_t to Q_{max})
- **Design Features**:
  - Operates at –10°C to 55°C; stores at –20°C to 70°C.

    - Resists humidity, pressure, gas disturbances; includes reverse flow prevention, diagnostics, non-volatile memory.
- **Construction**: Leak-tight, vibration-resistant, electromagnetic-compatible, robust (IP67, corrosion-resistant, flame-retardant).

Additional Indian Standards

IS 14439 (Part 1) : 1997 (Reaffirmed in 2024) Gas Volume Meters : Part 1 General Requirements.

Scope:

IS 14439 (Part 1) specifies general requirements for gas volume meters, including diaphragm, rotary piston, turbine, and electronic meters. It covers definitions, construction, performance, markings, permissible errors, and guidelines for pattern approval and verification. Specific meter types are detailed in subsequent parts.

Key Aspects:

- **Types Covered**: Positive displacement (e.g., diaphragm, rotary piston) and inferential types (e.g., turbine).
- **Construction**: Gas-tight, corrosion-resistant casing; tamper-proof; withstands normal operating conditions.
- **Indicating Devices**: Mechanical or electronic readouts in cubic meters; may include volume conversion to base conditions.
- **Test Element**: Supports calibration via dials or pulse generators.
- **Electronic Requirements**: Resists electromagnetic interference, temperature, humidity; includes diagnostics and memory retention.

IS 15677 : 2006 Metering of Natural Gas - Code of Practice

Scope:

This standard outlines specifications, design, installation, operation, and maintenance of gas metering systems for custody transfer of natural gas (gaseous phase, –10°C to +55°C). It covers orifice, turbine, ultrasonic, rotary piston, and Coriolis meters.

Key Aspects:

- **Meter Types:** Orifice, turbine, ultrasonic (multipath), rotary piston, Coriolis.
- **System Design:** Requires steady, swirl-free flow; straight pipe lengths; clean, dry gas.
- **Meter Selection & Calibration:** Based on flow rate, pressure, uncertainty; calibration traceable to standards.
- **Installation Guidelines**: Avoid pulsations/turbulence; include filtration, structural support, safety features (venting, grounding).
- **Secondary Instrumentation**: Use of pressure/temperature sensors, gas chromatographs, and flow computers.
- **Safety Aspects**: Addresses electrical safety, hazardous zones, earthing, explosion protection.