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شرکت ملی گاز ایران
مدیریت پژوهش و فناوری
امور تدوین استانداردها

IGS

مشخصات فنی

سیستم های اندازه گیری جریان گاز طبیعی

Natural Gas Flow Measuring Systems



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ابلاغ مصوبه هیأت مدیره

مدیر محترم پژوهش و فناوری

باسلام،

به استحضار می‌رساند در جلسه ۱۷۹۶ مورخ ۱۳۹۷/۷/۸ هیأت مدیره،
نامه شماره گ/۸۳۰۵۷/۰۰۰/۹ مورخ ۱۳۹۷/۷/۳ آن مدیریت درمورد تصویب نهایی استانداردها
به شرح زیر:

۱- مشخصات فنی خرید سیستم های اندازه گیری جریان گاز طبیعی

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۳- مشخصات فنی سامانه فعال قطع خودکار گاز در ایستگاه های تقلیل فشار / تغذیه شهری
در مقابل زلزله

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FOREWORD:

This standard is intended to be mainly used by NIGC and contractors, and has been prepared based on interpretation of recognized standards, technical documents, knowledge, backgrounds and experiences in natural gas industry at national and international levels. Iranian Gas Standards (IGS) are prepared, reviewed and amended by technical standard committees within NIGC Standardization division and submitted to the NIGC's "STANDARDS COUNCIL" for approval. IGS Standards are subject to revision, amendment or withdrawal, if required. Thus the latest edition of IGS shall be checked/inquired by NIGC employees and contractors. This standard must not be modified or altered by NIGC employees or its contractors. Any deviation from normative references and / or well-known manufacturer's specifications must be reported to Standardization division. The technical standard committee welcomes comments and feedbacks about this standard, and may revise this document accordingly based on the received feedbacks.

GENERAL DEFINITIONS:

Throughout this standard the following definitions, where applicable, should be followed:

- 1- "STANDARDIZATION DIV." is organized to deal with all aspects of industry standards in NIGC. Therefore, all enquiries for clarification or amendments are requested to be directed to mentioned division.
- 2- "COMPANY": refers to National Iranian Gas Company (NIGC).
- 3- "SUPPLIER": refers to a firm who will supply the service, equipment or material to NIGC whether as the prime producer or manufacturer or a trading firm.
- 4- "SHALL ": is used where a provision is mandatory.
- 5- "SHOULD": is used where a provision is advised only.
- 6- "MAY": is used where a provision is completely discretionary.

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1. Scope

This Standard specifies functional requirements for the design, construction, testing, commissioning/ decommissioning, with suitable documented provisions for gas volume measuring systems used for custody transfer.

This Standard is applicable for Natural gas According to IGS – M – CH – 033 and not applicable for sour gases.

All parties involved shall exchange all appropriate information to ensure effective design, installation, commissioning ,testing and operation of the measuring system.

2.References

- 2.1.BS EN 1776:2015-Gas infrastructure — Gas measuring systems — Functional requirements
- 2.2.OIML R 140:2007- Measuring systems for gaseous fuel
- 2.3 EN 12186, Gas infrastructure — Gas pressure regulating stations for transmission and distribution —Functional requirements
- 2.4 .EN 12405-1, Gas meters — Conversion devices — Part 1: Volume conversion
- 2.5. IGS-M-IN-104(1)-Multipath Ultrasonic Transit-Time Gas Flow Meter
- 2.6. IGS-M-IN-106(0)-Gas Meters, Gas Volume Electronic Conversion Device(PTZ)
- 2.7. IGS-M-IN-102(2)-Turbine Meters
- 2.8. IPS-G-IN-230-General Standard For Analyzers
- 2.9. IPS-E-IN-230-Engineering Standard For Analytical Instruments
- 2.10.IPS-M-IN-110-Material And Equipment Standard For Pressure Instruments
- 2.11.IGS-C-IN-100(1)- Location of Installation of Devices for Measuring the Quantities of Natural Gas.

3.Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Accuracy of Measurement

Closeness of the agreement between the result of a measurement and a true value of the measured

3.2 Additional Components

elements or devices, required to ensure correct measurement or intended to facilitate the measuring operations, or which could in anyway affect the measurement

Additional components can be

- a) filter;
- b) flow conditioning device;
- c) branch or by-pass line;
- d) valves;
- e) pressure reduction devices located upstream or downstream of the meter;
- f) sampling systems;
- g) piping.

3.3 Authorized Person

person who is appointed to fulfill a given task on gas measuring systems

3.4 Availability

probability, at any time, that the measuring system, or a measuring instrument forming a part of the measuring system, is functioning according to specifications

3.5 Base Conditions

specified conditions to which the measured quantities of gas are converted

Note 1 to entry: Operating and base conditions relate to the volume of gas to be measured or indicated only and should not be confused with “rated operating conditions” and “reference conditions” which refer to influence quantities.

3.6 Bias

systematic difference between the true value of measured and its determined value

3.7 Traceability

property of the result of a measurement or a value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties

3.8 Competent Person

person who is qualified, trained and experienced to perform activities to gas measuring systems

3.9 Compression Factor Z

ratio of the volume of an arbitrary mass of gas, at a specified pressure and temperature to the volume of the same mass of gas under the same conditions as calculated from the ideal-gas law

Note 1 to entry: The compression factor (Z) indicates the extent to which gas deviates from ideal gas behavior.

3.10 Conversion Device

3.10.1 Conversion Device

device that converts a quantity at metering conditions to a quantity to base conditions or energy

3.10.2 Energy Conversion Device

device which calculates, integrates and displays energy using quantity at base conditions and the calorific value and/or the gas composition

3.10.3 Volume Conversion Device

device that converts the quantity measured at measuring conditions into a quantity at base conditions

3.11 Custody Transfer

change in responsibility for the conveyance of gas, this may or may not involve a change of ownership of the gas

3.12 Documented Provisions

provisions established by the operator of a gas measuring system in order to give confidence that operations are performed according to metrological expectations

3.13 Drift

slow change of a metrological characteristic of a measuring instrument

3.14 Energy Determination

quantitative determination of the amount of energy of a quantity of gas based either on measurement or calculation using measured values or attributed values

3.15 Fail-Safe

characteristic of a device to go to a safe operating condition when a failure occurs

3.16 Gas Measuring Installation

complete set of measuring instruments and additional components assembled to carry out specified measurements

3.17 Gas Measuring Station

measuring station consists of one or more gas measuring installation(s) and includes its housing, compound, the inlet and outlet pipework as far as the isolating valves

Note 1 to entry: Measuring station does not normally apply for gas measuring installation for residential and commercial use, even if there is housing.

3.18 Gas Measuring System

consists of a gas measuring installation, documented provisions and where appropriate a gas measuring station

3.19 Gas Measuring System Operator

natural or legal person who is responsible for the operation and maintenance of the measuring system

Note 1 to entry: The gas measuring system operator is referred to be the operator.

3.20 Gas Meter

instrument designed to measure, memories and display the quantity of gas (volume or mass) that has passed it

3.21 Uncertainty

parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

3.22 Hazardous Area

area in which an explosive or flammable gas atmosphere is or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment

[SOURCE: EN 60079-10-1:2009]

3.23 Housing

cabinet or meter compound external to the building

3.24 Installation Effect

difference in performance of the measuring instrument between the calibration conditions and actual conditions of use

Note 1 to entry: This difference can be caused by different flow conditions due to velocity profile, perturbations, or by different working regimes (pulsation, intermittent flow, alternating flow, vibrations, etc.).

3.25 Maximum Permissible Error (MPE)

extreme absolute value of error permitted by specification

Note 1 to entry: Conformity with an MPE is based on calibration results for individual instruments and on statistical methods for measuring systems.

3.26 Measuring Conditions

conditions of the gas at which the quantity is measured at the point of measurement (temperature and pressure of the measured gas)

3.27 Measuring Instrument

device intended to be used for measurements, alone or in conjunction with supplementary device(s)

EXAMPLE Gas meter, calorific value determination device.

3.28 Metering Temperature

absolute gas temperature to which the indicated quantity of gas is related

3.29 Pressure

3.29.1 Absolute Pressure

pressure of the gas measured with the reference to an absolute vacuum

3.29.2 Gauge Pressure

difference between the absolute pressure of the gas and the atmospheric pressure at the place and time of the measuring

3.29.3 Design Pressure DP

pressure on which design calculations are based

Note 1 to entry: A part of a measuring installation designed for a design pressure DP can comprise components designed for a different maximum allowable pressure PS.

3.29.4 Maximum Incidental Pressure MIP

maximum pressure which a system can experience for a short time, limited by the safety device(s)

3.29.5 Maximum Operating Pressure Mop

maximum pressure at which a system can be operated continuously under normal operating conditions

Note 1 to entry: Normal operating conditions are: no fault in any device or stream.

3.29.6 Metering Pressure (Pm)

absolute pressure at which the volume of gas is measured

3.29.7 Temporary Operating Pressure TOP

pressure at which a system can be operated temporarily under control of the regulating device(s)

3.30 Representative Calorific Value

individual calorific value or a combination of calorific values that is considered to be, according to the constitution of the measuring system, the most appropriate calorific value to be associated with the metered quantity in order to calculate the energy.

3.31 Responsible Person

person who is responsible for design, construction, commissioning, operation and maintenance of the measuring installation and/or system

3.23 Sensor

instrument for measuring certain measured which are characteristic of the gas (temperature, pressure, calorific value, etc.)

3.33 Smart Meter

meter with additional functionalities one of which is data communication

3.34 Stability

ability of a measuring system, or a measuring instrument, to perform its functions for a specified period of time.

3.35 Stripped Gas

natural gas from which large amounts of easily liquefiable components have been removed.

4. Safety and environment

Metering systems shall be designed and supplied to operate in a safe manner and takes into account all aspects and rules related to safety, environment, space, location and operation constraints .Special care shall be paid for instance to sampling, venting, degassing, draining...

Safety is a management responsibility which requires that all personnel involved in design, installation, testing, commissioning, the gas measuring system shall be competent and have adequate safety training. The management shall ensure that all areas of responsibility are clearly defined.

Environmental and external conditions like sun, flare... which can generate failure, errors or generate difficulties in operation shall be considered. During normal operation, the gas measuring system shall meet locally established environmental noise levels. The owner / operator of the measuring system shall inform the consumer or the person responsible for the property of any risks associated with the system, e.g. instructions stating the precautions to be taken if the smell of gas persists.

All components of the measuring installation shall be resistant to or protected against external corrosion.

When designing a gas measuring system, safety provisions shall be integrated to ensure its safe access, egress, construction, operation, inspection and located such that risk and nuisance to the environment and its operation are kept within acceptable limits.

The designer of the gas measuring system shall ensure that proper care is taken to prevent noise generated hazards.

The gas pressure installation shall have at least one inlet valve to allow it to be safely isolated and undertake any maintenance. For higher accuracy installations an outlet valve should be fitted.

As part of the design of the system the electrical safety shall be considered. All electrical installations shall comply with the applicable NIGC specifications.

5. Hazardous Area Classification

The possible hazardous area in any housing, station and installation shall be assessed and classified according to API 505.

If a hazardous area is classified at the place of installation, any electrical equipment shall be suitable for the classified zone and be designed, selected and fitted in accordance with API RP 505 and manufacturer`s instructions.

Table1. Minimal design criteria for the constitution of measuring systems

Design Q_{max} at base conditions scm/h	Less than or equal to 160	Greater than 160 to 100,000 ¹		More than 100,000
Accuracy Class	C	B	A	A
High pressure calibration certificate		*	*	*
Standby Meter Run		*	*	*
Z configuration design			* ²	* ²
Local checking system			* ²	* ²
Temperature conversion		*	*	*
Pressure conversion		*	*	*
duplicated pressure and temperature measurements			* ²	*
Z conversion		*	*	*
Online gas composition device (GC)			* ²	* ²
gas composition determination (sampling or computation)		Two times in a Year		
on line analyzer device for dew point and Sulphur components			* ²	* ²
Archiving the metering data in Volume Corrector / flow computer (tables / trends)		*	*	*
Creating and saving the daily and monthly reports		*	*	*
Event & parameter Log in Volume Corrector / flow computer		*	*	*
Alarm system in Volume Corrector /flow computer		*	*	*
Connection to data gathering system (SCADA)		* ³	*	*
Hardware & Software Security in Volume Corrector / flow computer		*	*	*

6. Basic Requirement for Measuring System

The output of the gas measuring system is Volume that is the product of gas volume at standard conditions.

NOTE Several different physical principles are used to determine gas volume flows. The most commonly used techniques are included in this Standard.

Involved parties shall ensure that the method of Volume determination is traceable, reliable and satisfies the measurement requirements such as accuracy, safety as well as economic criteria.

The chosen technique shall be sufficiently accurate to reduce random and systematic

¹ system accuracy class (A or B) shall be specified by N.I.G.C

² Optional only for city gate stations

³ not necessary for measuring system with Q_{max} lower than 10,000 scm/h

errors to such a level that contractual obligations are fulfilled and that can be justified on technical or economic considerations. Based on the accuracy requirements, the designer shall choose the most appropriate class according Table 1- Minimal design criteria for the constitution of measuring systems.

6.1 Components of a measuring system

A meter itself is not a measuring system or a metering module.

A measuring system may include elements of the following non exhaustive list:

- meter(s) or metering module;
- checking facilities;
- metrological seals;
- conversion devices; (* if applicable)
- Gas composition determining device; (* if applicable)
- memory or printing device and automatic chronological recorder; (* according to national regulation)
- switching equipment to select the appropriate number of meter lines corresponding to the real load of the station and used to ensure that any meter in service is measuring flows between its Q_{min} and Q_{max} ; (*)
- gas sampling extraction and conditioning system; (* if applicable)
- provision for the calibration of the gas composition determining device including calibration standards; (* if applicable)
- isolating valves; (**)
- additional piping and fittings; (**)
- filter and separator; (**)
- gas pre-heating equipment; (**)
- equipment to reduce the noise level; (**)
- flow and pressure control equipment for the station or the metering line; (**)
- equipment to prevent the formation of hydrates and ice; (**)
- equipment to absorb vibrations and pulsations; (**)
- flow profile conditioning device; (**)
- other components; (**)
- Documented provisions and quality assurance systems. (***)

* is always part of the measuring system when present

** is part of the measuring system when there is a risk it influences the performance of the measuring system

*** is part of the measuring system when necessary to ensure the integrity and/or the correct operation of the measuring system.

If several meters and/or flow measuring devices are intended for a single measurement operation, these meters are considered to be included in the same metering module or measuring system.

If several meters and/or flow measuring devices intended for separate measuring

operations (different contracts) do have elements in common (calculator, filters, conversion device, etc.), each meter and/or flow measuring device is considered to make up, together with the common elements, one metering module or measuring system.

7. Accuracy classes

7.1 Type of Accuracy Classes

Measuring systems are classified into three accuracy classes: A, B, C.

7.2 Maximum permissible errors (mpes) for measuring systems

The maximum permissible relative errors, positive or negative, for measuring systems are specified in Table 1. These values are applicable for type approval and for initial verification.(see OIML 140 Part 6.2)

TABLE 2-mpes for measuring systems

Maximum permissible errors on determining:	Accuracy class A	Accuracy class B	Accuracy class C
Energy(if applicable)	$\pm 1.0 \%$	$\pm 2.0 \%$	$\pm 3.0 \%$
Converted volume	$\pm 0.9 \%$	$\pm 1.5 \%$	$\pm 2.0 \%$

The maximum permissible errors, positive or negative, for modules (parts or functions as stated in Table 3) are specified in Table 3. These values are applicable at type approval and at initial verification.

Table 3 - mpes for modules

Maximum permissible errors on:	Accuracy class A	Accuracy class B	Accuracy class C
Measuring volume at metering conditions	$\pm 0.70 \%$	$\pm 1.20 \%$	$\pm 1.50 \%$
Representative calorific value determination	$\pm 0.60 \%$	$\pm 1.25 \%$	$\pm 2.00 \%$

Moreover, when conformity to Table 2 cannot be verified directly, the conformity of the measuring system is assessed by calculation. By convention and where applicable, the global maximum permissible error of a measuring system is equal to the square root of the sum of the squares of the maximum permissible errors of the following modules (see Annex C OIML140 for an example):

- metering module (measuring the quantity at metering conditions);
- converting this quantity into volume at base conditions

Table 4 mpes for associated measuring instruments other than gas composition device

Maximum permissible errors on:	Accuracy class A	Accuracy class B	Accuracy class C
Temperature	$\pm 0.5\text{ }^{\circ}\text{C}$	$\pm 0.5\text{ }^{\circ}\text{C}$	$\pm 1\text{ }^{\circ}\text{C}$
Pressure	$\pm 0.2\text{ }\%$	$\pm 0.5\text{ }\%$	$\pm 1\text{ }\%$
Density	$\pm 0.35\text{ }\%$	$\pm 0.7\text{ }\%$	$\pm 1\text{ }\%$
Compressibility factor	$\pm 0.3\text{ }\%$	$\pm 0.3\text{ }\%$	$\pm 0.5\text{ }\%$

For Temperature, pressure, density and compressibility factor, the maximum permissible errors on the calculation of each characteristic quantity of the gas, positive or negative, are equal to one fifth of the relevant value specified in Table 4.

7.3 Other metrological performances of a gas composition device

Requirements from 7.3.1 through 7.3.6 and 7.3.9 apply to all types of gas composition devices. In addition, the provisions in 7.3.7 and 7.3.8 give additional requirements for specific types of gas composition devices.

7.3.1 General requirement

The complete gas composition device (not only the electronic part) shall fulfill the general requirements specified in part 13.

7.3.2 Repeatability

The repeatability error of gas composition device, as defined below, shall be smaller than or equal to one fifth of the magnitude of the mpe that would be applicable to the mean value of the measurement results.

Repeatability error :

For the purpose of this Recommendation: difference between the largest and the smallest results of successive measurements of a same quantity carried out under the same conditions.

7.3.3 Adjustment interval and drift

The drift at the end of the adjustment interval shall be smaller than or equal to half of the magnitude of the mpe. The adjustment interval and the adjustment procedure shall be specified by the manufacturer.

For gas composition device fitted with an automatic internal adjustment means, the means shall not be likely to drift and either the adjustment shall be performed automatically at the end of the adjustment interval or a warning calling for adjustment shall be generated automatically at the end of the adjustment interval.