



Inspection of Gas Meters in Use

A trend analysis from the years 2017 and 2023

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ABOUT MARCOGAZ

Founded in 1968, MARCOGAZ represents 29 member organisations from 20 countries. Its mission encompasses monitoring and policy advisory activities related to the European technical regulation, standardisation and certification with respect to safety and integrity of gas systems and equipment, rational use of energy as well as environment, health and safety issues. It is registered in Brussels under number BE0877 785 464.

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1. Trends in inspections of gas meters in use

The majority of the contributing distribution grid operators trust the small meters they buy. Usually, the first inspection of a small meter is performed after 10 to 20 operational years. The inspection procedure has not changed since the survey of 2017.

In Italy, domestic gas meters (e.g., G4 and G6) are generally replaced by the network distributor around 15 years after installation because the legal metrology validity of the meter's certification expires after that period (D.M. 93/2017), and regulators such as ARERA require modernization of the meter fleet under regulatory directives..

Only in The Netherlands the meters are inspected one year after installation and then every five years. The goal of this inspection scheme is to identify erroneous meters in large populations of smart meters, as soon as possible. The five – yearly inspection has been agreed upon with the metrology regulator, while the inspection after one year is voluntary.

All participants are subjected to national directions or rules for the inspection of meters. The statistical approach for the sampling procedure in most cases is based on international standards. If not, a country – specific sampling procedure has been defined.

Although international statistical methods are used, the parameters that define the strictness of the control were not returned in the questionnaire. Only the accepted quality limit (AQL) of 6,5 from the Netherlands was reported by the author. This was also the case in the previous survey of 2017.

The generally applied sampling procedure is the inspection by *attributes*, which returns an answer that either rejects or approves a population of meters. The Netherlands use the inspection by *variables* which also returns the gaussian distribution of the meter error. This extra information is used to calculate a trend that predicts the development of the meter error.

Larger meters are inspected more frequently than domestic meters on more measuring points. This is the same as in the previous survey of 2017.

The Belgian TSO, the only transmission network operator that participated in the survey, does not use statistics but checks every meter every year on six measuring points.

In Spain, the inspection frequency for turbine meters is based on the annual energy consumption of the user and decreases with increasing annual consumption.

2. Introduction

The members of the MARCOGAZ decided to conduct a survey on quality of inspection of meters in use following an internal similar survey from 2017. The goal is to investigate changes in the approach of quality control of gas meters.

Eleven network operators from eight member states provided information. The total number of gas meters operated by the organizations that contributed to this survey is approximately 65 million.

3. Number of meters

A chart of the number of meters (in millions) is shown in the figure below.

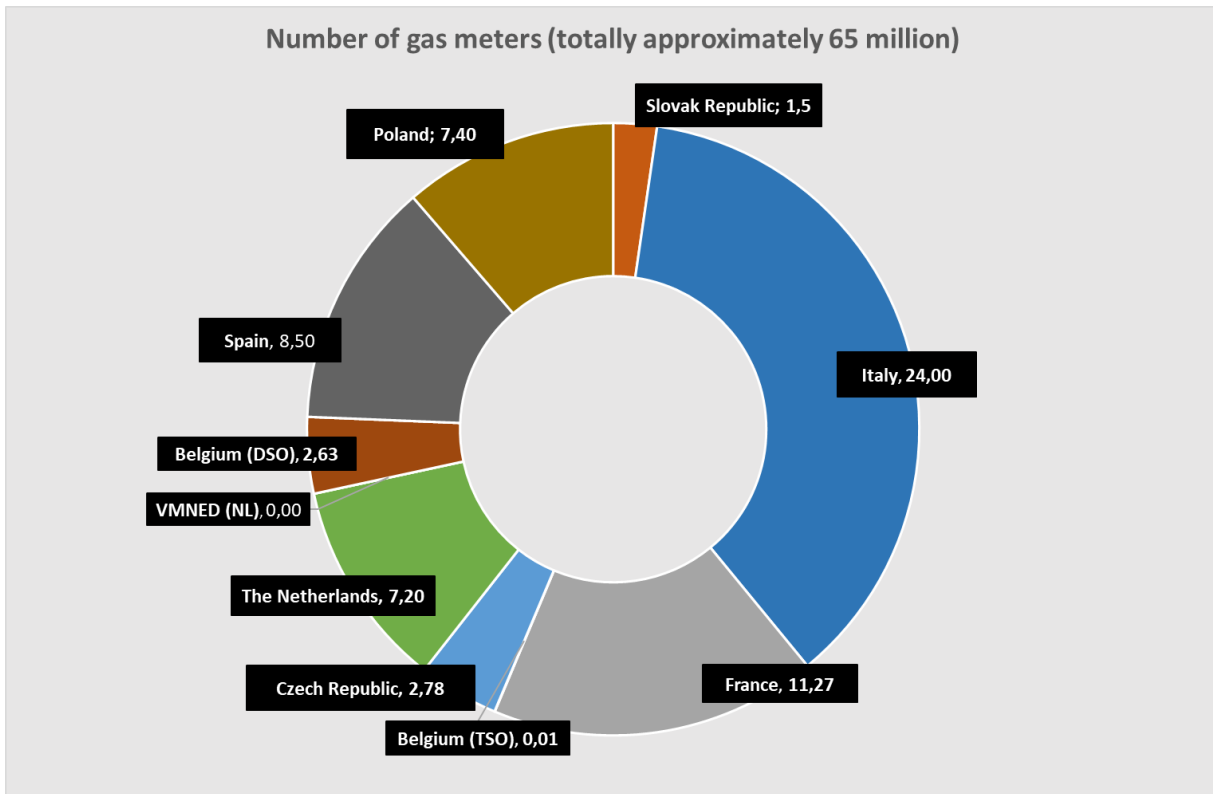


Figure 1 - Number of meters within the participating organizations and countries

The number of meters operated by the Belgian TSO (0,01) is low compared to other network operators. The reason is that it is a transmission network operator.

VMNED is the association of service providers for gas meters above G25 in The Netherlands but is not a member of Marcogaz. The publicly available Dutch regulation for inspection of these meters was used as source for the survey. The number of meters operated by the members of the Dutch association VMNED (zero) was not available.

The data from Italy refers to the total number of gas meters installed on the Italian gas distribution network.

4. Inspection procedure

The inspection procedure for gas meters is shown in Table 1 for the type of meter and the meter capacity (G-code).

Two examples for Table 1:

- 15;5 means operation of the meter for 15 years at the first inspection and an extension of the life with 5 years after a positive result of the inspection.
- 15;0 means mandatory replacement after 15 years.

The capacity of the meters is indicated by the G-code. G-codes of gas meters are explained in chapter 13.

Organization	Diaphragm meter	Ultrasonic meter	Rotary meter	Turbine meter	Separate Volume convertor	Other* meter technology
Slovak Republic	15; 5.					
Italy	≤G6: 15; 0. ≥G10: 16;16	≤G6: 15; 0. ≥ G10: 8;8	10; 10.		Depending on the type ***	≤G6: 15; 0. ≥ G10: 8;8
France	G4-G6: 20;0. ≥G10: 15;0.		5		1	
Belgium (TSO)		All meters yearly inspected. Automatic replacement after 6 to 10 years at border stations; 15 to 30 years at other stations				
Czech Republic	≤G6: 10; 5.	All meters inspected every 5 years				
The Netherlands	compulsory: every 5 years. Voluntary: one year after installation					
VMNED** Netherlands			compulsory: every 5 years	100% Inspection every 5 years, 5 years extension	compulsory: every 3 years.	
Belgium (DSO)	10; 5.					
Spain	G4- G16:20;0. ≥G25: 10; 5.		6; 3.	4; 2.	4, 2, 1 or half a year.****	
Poland	G1,6-G4: 10; 10.					

Table 1 - Meter service life at the first inspection and extension after positive result of sampling, and meter types with full inspection

*Other technologies mentioned are thermal mass flow meters and Coriolis meters

**VMNED is the association of Dutch service providers that measure gas in Dutch networks using rotary and turbine meters. The source for data in this report is their publicly available regulation, agreed with the Dutch Metrology Regulator. VMNED is not a member of Marcogaz.

*** Depending on the type:

Every 2 years (conversion devices type 2 - EN 12405-1)

Every 4 years (conversion devices type 1 - EN 12405-1)

Every 8 years (conversion devices Integrated into the meter and with the same EC certification approval of the meter)

**** With increase of the annual gas consumption in GWh, the inspection interval decreases.

The data from Italy refers to foreseen replacement of gas meters $\leq G6$ by smart meters, not by law but due to the end of metrological validity and the end of tariff life. Regarding gas meters $\geq G10$ the obligations established in the legislation in force in Italy, which requires that each gas meter $\geq G10$ and each conversion device must be periodically inspected.

The Dutch distribution network operators check a new population of smart meters one year after installation. This is a voluntary check that was introduced when the roll-out of digital (smart) meters started. All Dutch distribution network operators take part voluntarily in this inspection.

The Dutch contributor is the only organization in the survey that inspects meters in use periodically from the beginning of the service of the meter. VMNED inspects samples of meter every five years.

According to the Dutch regulation, a population of gas meters that is deemed outside MPE by the sampling shall be removed from the network before 31st of December of the year following the verdict. The roll-out of smart meters in 2013 introduced large populations of meter. To mitigate the risk of removing a large number of meters all at once, statistical procedures were adapted to collecting information to make predictions on the meter quality.

The Dutch periodical inspection system allows for meters to remain in the network if the error remains within the MPE. This can result in operational life longer than the expected lifetime. The lifetime of meters with new technologies that require batteries, however, is also limited by the depletion of the battery.

5. Measuring points for inspection

The chosen points for inspection of the meters are shown in Table 2. The points are mentioned in terms of the meter capacity Q_{max} .

Organization	Diaphragm meter	Ultrasonic meter	Rotary meter	Turbine meter	Separate Volume convertor	Thermal mass flow meter
Slovak Republic	Q_{max} ; $0,1*Q_{max}$					
Italy	Q_{min} , Q_t , Q_{max} .		Q_{min} , Q_t , Q_{max} .			
France	For $\geq G10$, see \rightarrow		6 measurements including Q_{min} , Q_t , Q_{max} .			
Belgium (TSO)		Between Q_t and Q_{max}				
Czech Republic	OIML*					
The Netherlands	OIML					
VMNED			$(0,05; 0,20; 0,70)*Q_{max}$			
Belgium (DSO)	OIML					
Spain	Q_{min} , Q_t , Q_{max}		Q_{min} , Q_t , $(0,25; 0,4; 0,7; 1)*Q_{max}$			
Poland	Q_{min} , $0,2*Q_{max}$, Q_{max}					

Table 2 - Measuring points for inspection related to Q_{max} of the meter

*OIML: the recommendation from OIML 137 to measure two points at Q_{max} and $0,2*Q_{max}$ is followed [1].

From Table 2 we conclude that:

- The OIML recommendation is followed by a minority of the participants
- Most of the participants check three to six measuring points
- Belgium (TSO) does not check on low flows

The MPE values are not part of this survey since they depend on the class of meter and the regulation they are certified for.

6. Types of meters covered by the inspection

The meters covered by the inspection are shown in Table 3, by measuring principle and meter size (G-code).

Organization	Diaphragm meter	Ultrasonic meter	Rotary meter	Turbine meter	Separate Volume convertor	Thermal mass flow meter
Slovak Republic	G1,6 to G6					
Italy	$\geq G10$ $\leq G6$ randomly				Y	$\geq G10$ $\leq G6$ randomly
France	Y		Y			
Belgium (TSO)		Y				
Czech Republic.	G4, G6	Y				
The Netherlands	G4 to G25	G4, G6				
VMNED			$\geq G40$	$\geq G40$	Y	
Belgium (DSO)	Y					
Spain	Y		Y			
Poland	G1,6 to G4					

Table 3 - Meters covered by the inspection, by measuring principle and capacity. Y affirms the type of meter covered.

The separation between the Dutch DSOs/TSOs and VMNED (The Dutch association of metering service providers) at meter size G25 is visible in Table 3.

The Belgian TSO and VMNED, only operate industrial size meters. Other participants operate a wide variety in the capacity of meters. The Slovak, Czech and Polish DSOs operate small capacity meters.

7. Number of meters installed by capacity

The number of meters in the scope of this survey is shown in Table 4, by capacity.

Organization	Number of meters G4 and G6	Number of meters G4 and G6 nationally		≥G10
Slovak Republic	1,5			
Italy	24,0			
France	11,0			0,27
Belgium (TSO)			0,007	
Czech Republic	2,2	2,7 ¹		0,075
The Netherlands	7,2			
Belgium (DSO)	2,8			0,063
Spain	8,5			
Poland	7,4			

Table 4 - Numbers of meters installed in a country and coverage by the survey (millions)

The total number of meters is 78 million. Being a transmission grid operator, the number of meters of the Belgian TSO is relatively small.

8. Sampling of meters

All organizations that perform the checks on meters shall be accredited bodies. The sampling of the meters is either based on a national law, or on an international standard:

- ISO-2859-2 statistical testing by *attributes*. [2] Traditional sampling with a rejection of the population when the number of faulty meters in the sample exceeds a defined maximum.
- ISO 3951-1:2022 statistical testing by *variables*. [3] The result is the shape of the normal distribution of a sample and an approximation of the percentage of the population outside MPE. Requirement for this method is a normally distributed sample.

The sampling of meters per contributing organization and the regulations is shown in Table 5.

¹ The largest DSO in Czech Republic operates 2.2 million home diaphragm meters and two other distributors operate an additional 0.5 million, for a total of 2.7 millions operated diaphragm gas meters in the Czech Republic

Organization	Sampling	Test for normal distribution	Test for outliers	When not normally distributed	Regulation	Law
Slovak Republic					MID [4]	Law No.157/2018 Decree No.161/2019
Italy	D.M. 93/2017 UNI 11600				D.M. 93/2017 UNI 11600	Metrology, National
France						
Belgium (TSO)	100% inspection					
Czech Republic					MID	Metrology, National
The Netherlands	Statistical test by variables; AQL=6,5; level II	Lilliefors test [5]	Grubbs' test [6]	Statistical test by attributes	Meter base management	Metrology, National
VMNED					Meter base management	Metrology, National
Belgium (DSO)					A.R. 3/08/2012	Metrology, National
Spain	Statistical test by attributes				ICT 155/2020. NGTS PD01	
Poland	By national law					Polish law - The Weights and Measures Act

Table 5 - The sampling of meters

The statistical sampling by *variables* requires a set of data that is normally distributed. The result of the test is a standard deviation and an average value of the meter deviations. The *Grubbs'* test used in The Netherlands determines the maximum number of outliers in a sample.

The statistical sampling by *attributes* results in an OK/NOK verdict on the meter population.

9. Miscellaneous

Organization	Choice for smart meters	Test location
Slovak DSO	Y	Lab or field
Italian DSOs	Compulsory	
French DSO		
Belgium (TSO)		
Czech DSO		
Dutch DSOs	Y	Lab or field
VMNED		
Belgium DSO	By DSO	Lab
Spanish DSO		
Polish DSO		

Table 6 - Smart (or digital) meters and test locations

10. Participation

MARCOGAZ thanks the organizations that contributed to the survey in 2023 and 2024.

11. References

- [1] Organisation internationale de métrologie légale, "OIML R 137-1 and 2," Organisation Internationale de Métrologie Légale, Paris, France, Amendment 2014.
- [2] International Standard Organization, "ISO 2859-1: Sampling procedures for inspection by attributes - Part 1: sampling schemes (AQL)," ISO, Genève, 1999.
- [3] International Standard Organization, "ISO 3951-1: Sampling procedures for inspection by variables - part1 Single sampling plans," ISO, Genève, 31 12 2022. [Online]. Available: <https://www.iso.org/standard/74706.html>. [Accessed 9 2 2024].
- [4] European Commission, Measuring instruments Directive (MID) Directive 2004/22/EC Directive 2014/32/EU, Brussels: European Commission, 2014.
- [5] Wikipedia, "Lilliefors test," Lilliefors, Hubert W., 1 2 2024. [Online]. Available: https://en.wikipedia.org/wiki/Lilliefors_test. [Accessed 1 2 2024].
- [6] ISO, ISO 5725-2:2019; Accuracy (trueness and precision) of measurement methods and results; Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method, Geneva: International standards organization, 2019.

12. Abbreviations

- OIML Organisation Internationale de Métrologie Légale
- MPE Maximum Permissible Error

13. Gas meter size

The size of a gas meter is mainly characterized by its G-code and the flow of gas through the meter. (See Table 7).

G code	Q_{max} (m ³ /h)
G1,6	2,5
G2,5	4
G4	6
G6	10
G10	16
G16	25
G25	40
G40	65
G65	100
G100	160
G160	250
G250	400
G400	650
G650	1000

Table 7 - The G-code of a gas meter and the meter capacity Q_{max}

The flow Q is a flow of gas in m³/h at the gas pressure in the meter. Between the minimal capacity Q_{min} and the maximal capacity Q_{max} in Table 7, the measuring error of a meter shall comply with a lawful MPE.