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**Fuel oil flow meters—Measuring
instruments used in transaction or
certification—Part 1: Fuel dispensers
for motor vehicles**

ICS 17.040.30; 75.200

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law.

This Standard has been made based on **OIML R117:1995** *Measuring systems for liquids other than water* for the purpose of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

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Fuel oil flow meters—Measuring instruments used in transaction or certification—Part 1: Fuel dispensers for motor vehicles

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **OIML R117** *Measuring systems for liquids other than water* published in 1995 with some modifications of the technical contents.

This Standard is established for the purpose of specifying the technical requirements and test methods regarding the construction and the performance of fuel dispensers for motor vehicles, among the requirements for the specific measuring instruments specified by the Measurement Law, and the compliance with this Standard does not necessarily mean that the fuel dispenser has been accepted in the verification as specified by the Measurement Law. It is also not permissible to give the products a marking as specified by Article 19 of the Industrial Standardization Law, which indicates compliance with this Standard.

The portions with continuous sidelines or dotted underlines are the matters in which the contents of the original International Standard have been modified. A list of modifications with explanations is given in Annex E (informative).

1 Scope This Standard specifies those measuring systems (fuel dispensers for motor vehicles) which have a mechanism for filling fuel tanks or other containers of motor vehicles, small boats, small airplanes, etc. with fuel oils⁽¹⁾ (petrol, kerosene, light fuel oil or heavy fuel oil, etc.) and which are installed in fuel delivery sites⁽²⁾ to be used for transaction or certification. This Standard does not apply to systems which measure fuel oils having viscosity exceeding 0.1 Pa·s and temperature under -20 °C or above 50 °C.

Notes ⁽¹⁾ A wide range of fuel oils such as petrol, kerosene and diesel fuel.

⁽²⁾ Fuel delivery sites mean a wide range of sites including general purpose delivery sites as specified by the Fire Service Law and are not limited to petrol stations. Specifically, fuel dispensers such as those for selling kerosene which are installed in such places as rice retailing stores are included.

NOTE : The International Standard corresponding to this Standard is as follows.

In addition, the symbols which denote the degree of correspondence in the contents between **JIS** and the relevant International Standard are IDT (identical), MOD (modified) and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

OIML R117:1995 *Measuring systems for liquids other than water* (MOD)

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS K 2249 Crude petroleum and petroleum products—Determination of density and petroleum measurement tables based on a reference temperature (15 °C)

JIS Z 8103 Glossary of terms used in measurement

3 Terms and definitions For the purpose of this Standard, the terms and definitions given in **JIS Z 8103** and the following apply.

3.1 meter

an instrument intended to measure continuously, memorize and display the volume of fuel oil passing through the measurement transducer at metering conditions

NOTE : A meter includes at least a measurement transducer, a calculator (including adjustment or correction devices if present) and a volume indicating mechanism.

3.2 measurement transducer

a part of the meter which transforms the flow or the volume of the fuel oil to be measured into signals which are passed to the calculator

It may be autonomous or use an external power source.

NOTE : For the purposes of this Standard, the measurement transducer includes the flow or volume sensor.

3.3 calculator

a part of the meter that receives the output signals from the transducer(s) and, possibly, from associated measuring instruments, transforms them and, if appropriate, stores in memory the results until they are used

In addition, the calculator may be capable of communicating both ways with peripheral equipment.

3.4 indicating mechanism

a part of the meter which indicates or displays continuously the measurement results

3.5 ancillary device

a device intended to perform a particular function, directly involved in elaborating, transmitting or displaying measurement results

Main ancillary devices are:

- pre-setting device
- adjustment device
- associated measuring instruments
- correction device
- conversion device
- zero setting device
- price indicating device
- printing device

- memory device
- self-service device

3.6 additional device

a part or a device, other than an ancillary device, required to ensure correct measurement or intended to facilitate the measuring operations, or which could in any way affect the measurement

Main additional devices are:

- air separator,
- filter, pump,
- device used for the transfer point,
- branches or bypasses,
- valves, hoses.

3.7 measuring system

a system which comprises the meter itself and all the ancillary devices and additional devices (see figure 1)

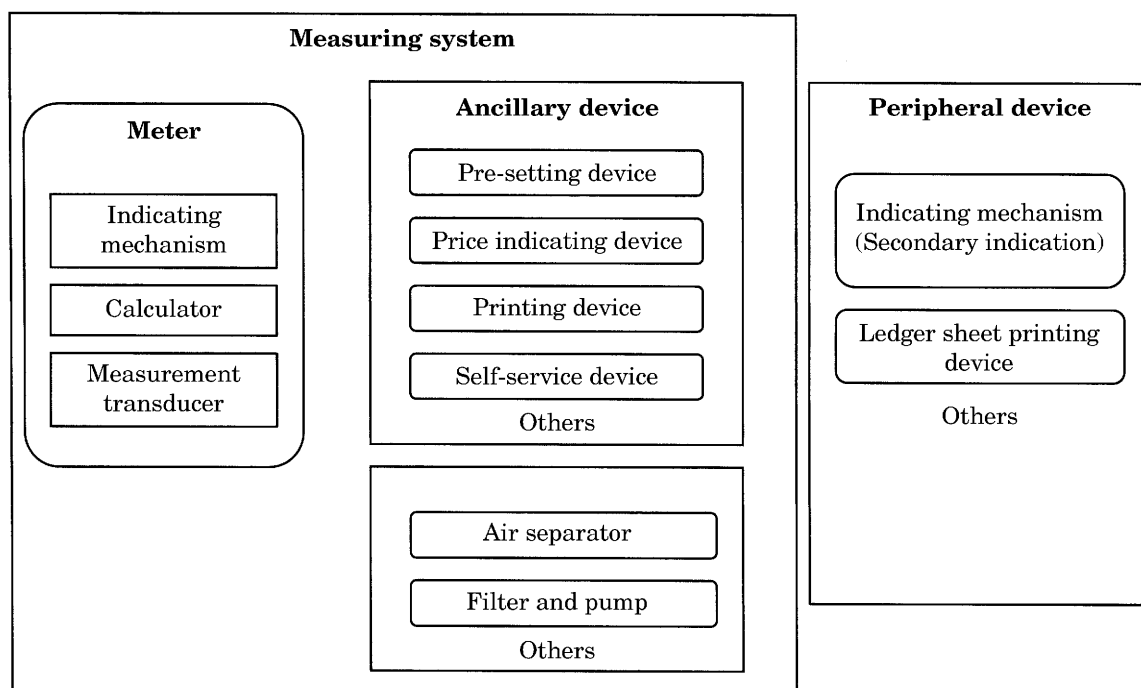


Figure 1 Fuel dispensers for motor vehicles

3.8 pre-setting device

a device which permits the selection of the quantity to be measured and which automatically stops the flow of the fuel oil at the end of the measurement of the selected quantity

NOTE : The pre-set quantity may be the volume, the mass or the related price to pay.

3.9 adjustment device

a device incorporated in the meter, that only allows shifting of the error curve generally parallel to itself, with a view to bringing errors within the maximum permissible errors (see figure 2)

3.10 associated measuring instruments

instruments connected to the calculator, the correction device or the conversion device, for measuring certain quantities which are characteristic of the fuel oil, with a view to making a correction and/or a conversion

3.11 correction device

a device connected to or incorporated in the meter for automatically correcting the volume at metering conditions, by taking into account the flowrate and/or the characteristics of the fuel oil to be measured (viscosity, temperature, pressure ...) and the pre-established calibration curves

The characteristics of the fuel oil may either be measured using associated measuring instruments, or stored in a memory in the instrument.

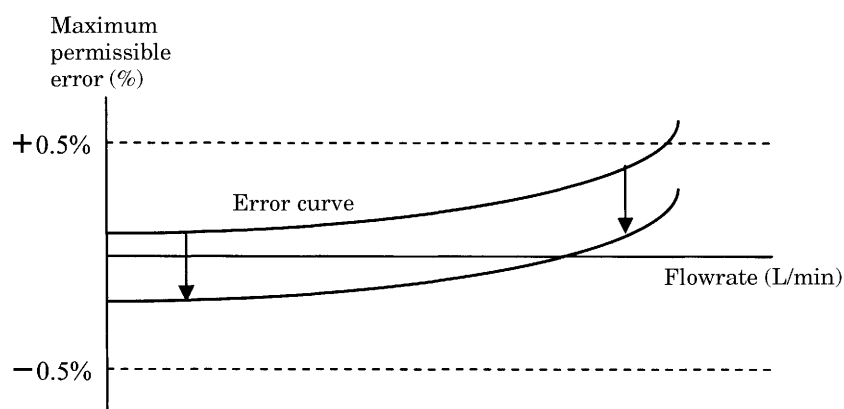


Figure 2 Example of adjustment device

3.12 conversion device

a device which automatically converts the volume measured at metering conditions into a volume at base conditions, by taking account of the characteristics of the fuel oil (temperature, pressure, density, relative density ...) measured using associated measuring instruments, or stored in a memory

The quotient of the volume at base conditions to the volume at metering conditions is referred to as "conversion factor".

3.13 metering conditions

the conditions of the fuel oil of which the volume is to be measured, at the point of measurement

3.14 base conditions

the specified conditions to which the measured volume of fuel oil is converted

NOTE : The values chosen as base conditions should preferably be 15 °C and 101 325 Pa.

3.15 transfer point

a point at which the fuel oil defined as being delivered or received.

3.16 air separator

a device used for continuously separating, and removing, any air or gases contained in the fuel oil

3.17 blend measuring system

a fuel dispenser providing mixtures of various grades of gasoline (multigrade-dispenser) or mixtures of gasoline and lubricating oil (gasoline-oil-dispenser) through a single nozzle

3.18 suspension type measuring system

measuring system for supplying fuel oils to motor vehicles by installing hose reels mainly in the ceiling of a fuel delivery site

3.19 measuring system for small boat and small airplane

measuring system for supplying fuel oils mainly to small boats and small airplanes

3.20 self-service device

a specific device that is part of a self-service arrangement and which allows one or more measuring systems to perform in this self-service arrangement

3.21 attended service mode

an operating mode of a self-service arrangement in which the supplier is present and controls the authorization for the delivery

3.22 pre-payment

a type of payment requiring payment for a quantity of fuel oil before the delivery commences

3.23 post-payment

a type of payment requiring payment for the delivered quantity after the delivery but before the customer leaves the site of the delivery

3.24 peripheral device

a device which is not used for transactions with customers or for certification such as a device for printing business forms used in accounting work, and which is connected to the measuring system

3.25 primary indication

an indication (displayed, printed or memorized) which is subject to legal metrology control

NOTE : Indications other than primary indications are commonly referred to as secondary indications.

3.26 testing liquid

liquid having the viscosity equivalent to that of a fuel oil of the fuel oil type as indicated on the fuel dispensers for motor vehicles (hereinafter referred to as "indicated fuel oil")

3.27 intrinsic error

ratio of the measurement value of the measuring system used under the reference conditions minus the true value to its true value

3.28 maximum permissible error

intrinsic error tolerance in verification

3.29 minimum measured quantity of a measuring system

the smallest volume of fuel oil for which the measurement is metrologically acceptable for that system

3.30 minimum specified volume deviation

the absolute value of the maximum permissible error for the minimum measured quantity of a measuring system

3.31 minimum specified price deviation

the price to pay corresponding to the minimum specified volume deviation

3.32 repeatability error

the difference between the largest and the smallest results of successive measurements of the same quantity carried out under the same conditions

3.33 initial intrinsic error

the intrinsic error of a measuring system as determined prior to all performance tests

3.34 fault

the difference between the error of the measuring system used under reference conditions and the error of the measuring system used under influence of disturbance

3.35 significant fault

a fault the magnitude of which is greater than the larger of these two values:

- one fifth of the magnitude of the maximum permissible error for the measured volume,
- the minimum specified volume deviation

The following are not considered to be significant faults:

- transitory faults being momentary variations in the indication, which cannot be interpreted, memorized or transmitted as a measurement result,
- faults implying the impossibility of performing any measurement.

3.36 influence quantity

a quantity which is not the subject of the measurement but which influences the value of the measurand or the indication of the measuring system

3.37 influence factor

an influence quantity having a value within the rated operating conditions of the measuring system, as specified in this Standard

3.38 disturbance

an influence quantity having a value within the limits specified hereafter in this Standard, but outside the specified rated operating conditions of the measuring system

NOTE : An influence quantity is a disturbance if for that influence quantity the rated operating conditions are not specified.

3.39 rated operating conditions

conditions of use, giving the range of values of influence quantities for which the metrological characteristics are intended to be within the maximum permissible errors

3.40 reference conditions

a set of specified values of influence factors fixed to ensure valid intercomparison of results of measurements

3.41 performance test

a test intended to verify whether the measuring system under test (EUT) is capable of accomplishing its intended functions

3.42 endurance test

a test intended to verify whether the meter or the measuring system is able to maintain its performance characteristics over a period of use

3.43 electronic device

a device employing electronic sub-assemblies and performing a specific function

Electronic devices are usually manufactured as separate units and are capable of being tested independently.

NOTE : Electronic devices, as defined above, may be complete measuring systems or part of measuring systems, in particular such as those mentioned in **3.1** through **3.5**.

3.44 electronic sub-assembly

a part of an electronic device, employing electronic components and having a recognizable function of its own

3.45 power supply device

a device which provides the electronic devices with the required electrical energy, using one or several sources of a.c. or d.c.

3.46 measured value

value of a quantity of the object state as indicated by a measuring system

3.47 scale mark

numeral, point, line or other symbol to indicate a measured value or related value

3.48 scale interval

difference between the quantities of the object state indicated by each of the two adjacent scale marks

3.49 verification

verification as specified by the Measurement Law

Information : The Measurement Law specifies that those who carry out verification shall be prefectural governors, designated verification organizations, National Institute of Advanced Industrial Science and Technology or Japan Electric Meters Inspection Corporation according to the types of specific measuring instrument.

3.50 use tolerance

tolerance for intrinsic errors at an inspection during use

3.51 control mark

mark for showing a pass of verification or compliance with requirements

4 General requirements

4.1 Constituents of a measuring system The smallest possible measuring system includes:

- a meter,
- a transfer point,
- a hydraulic circuit.

The measuring system may be provided with other ancillary and additional devices.

If several meters are intended for a single measuring operation, the meters are considered to form a single measuring system.

If several meters intended for separate measuring operations have common elements (calculator, filter, air separator, conversion devices, etc.) each meter is considered to form, with the common elements, a measuring system.

4.2 Ancillary devices

4.2.1 When these ancillary devices are relevant to transactions with customers or certification, they shall meet the requirements of this Standard.

4.2.2 When ancillary devices are not relevant to transactions with customers or certification, they may be nonconforming to the requirements of this Standard. However, in this case, one shall verify that these devices do not affect the correct operation of the measuring system.

In addition, these devices shall bear a legend which is clearly visible to the user to indicate that they are used for purposes other than transactions or certification when they display a measurement result visible to the user.

4.3 Field of operation

4.3.1 The field of operation of a measuring system is determined by the following characteristics:

- minimum measured quantity,
- measuring range limited by the minimum flowrate, $Q_{\min}$, and the maximum flowrate, $Q_{\max}$,
- maximum pressure of the fuel oil, $P_{\max}$,
- minimum pressure of the fuel oil, $P_{\min}$,
- nature of the fuel oil(s) to be measured and the limits of kinematic or dynamic viscosity when an indication of the nature of the fuel oil alone is not sufficient to characterize their viscosity,
- maximum temperature of the fuel oil, $T_{\max}$,
- minimum temperature of the fuel oil, $T_{\min}$,
- severity level (see 9.2).

4.3.2 The minimum measured quantity of a measuring system shall have the form 1×10^n , 2×10^n or 5×10^n authorized units of volume, where n is a positive or negative whole number, or zero.

The minimum measured quantity shall satisfy the conditions of use of the measuring system; except in exceptional cases, the measuring system shall not be used for measuring quantities less than this minimum measured quantity.

The minimum measured quantity of a measuring system shall be not less than the largest minimum measured quantity of any one of its constituent elements [meter(s), etc.]. However, for air separators this provision does not need to be fulfilled if it is demonstrated (including tests) that it is not necessary.

4.3.3 The minimum measured quantity of a measuring system with a maximum flowrate of 60 L/min or less shall not exceed 5 L.

4.3.4 The measuring range shall satisfy the conditions of use of the measuring system; the latter shall be designed so that the flowrate is between the minimum flowrate and the maximum flowrate, except at the beginning and at the end of the measurement or during interruptions.

The measuring range of a measuring system shall be within the measuring range of each of its elements.

4.3.5 The ratio of the maximum flowrate to the minimum flowrate of such systems shall be designed to be 10 or more. However, the minimum flowrate may be 8 L/min if the ratio is 10 or more and the minimum flowrate is less than 8 L/min.

4.3.6 A measuring system shall exclusively be used for measuring the types of fuel oils that are indicated.

The field of operation of a measuring system shall be within the fields of measurement of each of its constituent elements (meters, air separators, etc.).

When two or more meters are mounted in parallel in the same measuring system, the limiting flowrates of the various meters are taken into consideration, especially the sum of the limiting flowrates, to verify if the measuring system meets the provision above.

4.4 Maximum permissible errors and minimum specified volume deviation

4.4.1 Maximum permissible errors The maximum permissible error shall be ± 0.5 %.

4.4.2 Minimum specified volume deviation ($E_{\min}$) The minimum specified volume deviation is given by the formula:

$$E_{\min} = 2 \times V_{\min} \times A \times 1/100$$

where, $V_{\min}$: the minimum measured quantity,

A : maximum permissible error (%); 0.5 (%)

4.5 Conditions to be applied for maximum permissible error and minimum specified volume deviation

Verification of a measuring system intended to measure two or more fuel oils may be carried out with one fuel oil only or with a fuel oil different from the intended fuel oils.

4.6 Conversion devices When conversion device for converting into a volume at base conditions or into a mass (including all its components and associated measuring instruments) is verified separately, for the errors on converted indications due to the conversion device, the maximum permissible error shall be applied.

4.7 Calculators Maximum permissible errors on quantities of fuel oil indications applicable to calculators, when they are tested separately, are equal to one-tenth of the maximum permissible error.

4.8 Indications

4.8.1 The volume indication shall be made in cubic centimetres or millilitres, in cubic decimetres or litres, or in cubic metres. The symbol or the name of the unit shall appear in the immediate vicinity of the indication.

4.8.2 Measuring systems shall be provided with an indicating mechanism giving the volume of fuel oil measured at metering conditions.

Without prejudice to the provisions in **4.8.3**, when a measuring system is fitted with a conversion device, it shall be fitted with a mechanism indicating the volume at base conditions.

Provisions applicable to mechanisms which indicate the volume at metering conditions apply to mechanisms which indicate the volume at base conditions.

4.8.3 The use of the same display for the indications of volume at metering conditions and of volume at base conditions is authorized provided that the nature of the displayed quantity is clear.

4.8.4 A measuring system may have several mechanisms indicating the same quantity. Each shall meet the requirements of this Standard.

4.8.5 For a measuring system which shows the primary indications of the same measurement through several indicating mechanisms, when at least one of the input signals of the measurement value into the indicating mechanisms is analogue, the primary indications provided by various mechanisms shall not deviate one from another by more than the maximum permissible error. When all of the input signals of the measurement values into the several indicating mechanisms are digital, the measurement indications provided by the various indicating mechanisms shall not deviate one from another by more than one scale interval.

4.8.6 Use of the same indicating mechanism for the indications of several measuring systems is authorized provided that one of the following conditions is met:

- it is impossible to use any two of these measuring systems simultaneously,
- the indications relating to a given measuring system are accompanied by a clear identification of that measuring system and the user may obtain the indication corresponding to any of the measuring systems concerned, using a simple command.

4.8.7 A measuring system which has two or more meters shall be equipped with a totalizing indicating mechanism if the sum of the measured values of all the meters is indicated. The totalizing indicating mechanism shall clearly show that the system indicates the summed value. The sum of the measured values of all the meters and the value to be indicated by the totalizing indicating mechanism shall not exceed the minimum specified volume deviation. For a measuring system whose meters have their own indicating mechanisms and which is equipped with a totalizing indicating mechanism, the indication of the totalizing indicating mechanism shall disappear when one of the indicating mechanisms has been returned to zero.

4.9 Elimination of air or gases

4.9.1 General requirements Measuring systems shall be constructed and installed so that during normal operation, neither air intake nor gas release will occur in the fuel oil upstream of the measurement transducer. If there is a risk that this requirement may not be met, the measuring systems shall incorporate an air separator permitting the proper elimination of any air or undissolved gases which may be contained in the fuel oil before it enters the meter.

The air separator shall be suitable for the supply conditions and be arranged in such a way that the effect due to the influence of the air or gases on the measuring result does not exceed:

- 0.5 % of the quantity measured for fuel oils of a viscosity not exceeding 1 mPa·s,
- 1.0 % of the quantity measured for fuel oils of a viscosity exceeding 1 mPa·s.

However, it is not necessary for this effect to be less than 1 % of the minimum measured quantity.

The values specified in this clause apply to the air separator when it is subject to separate test.

In this case, they apply to the differences between:

- the meter errors with air intake or with gas, and
- the meter errors without air intake or gas.

4.9.2 An air separator shall be provided when the pressure at the pump inlet may, even momentarily, fall below either the atmospheric pressure or the saturated vapour pressure of the fuel oil.

No air separator is required when the pressure at the pump inlet is always greater than the atmospheric pressure and the saturated vapour pressure of the fuel oil, and if any gaseous formation liable to have a specific effect greater than 1 % of the minimum measured quantity cannot form or enter the upstream pipework of the measurement transducer, whatever be the conditions of use.

An air separator is required when the pressure at the pump inlet is always greater than the atmospheric pressure and the saturated vapour pressure of the fuel oil, but gaseous formation liable to have a specific effect greater than 1 % of the minimum measured quantity can occur.

The air separator shall be installed at the pump outlet or be combined with the pump.

If the air separator is installed below the level of the measurement transducer, a non-return valve fitted, if necessary, with a pressure limiting device shall be incorporated to prevent the pipework between the two components from emptying.

The loss of pressure caused by the flow of fuel oil between the air separator and the measurement transducer shall be as small as possible.

If the pipework upstream of the measurement transducer incorporates several high points, it may be necessary to provide one or more automatic or manual evacuation devices.

4.9.3 When the measuring system is designed as one of the equipment within an integrated pump system or designed for a remote pump, **4.9.1** shall be applied.

In a measuring system having no air separator, the minimum level in the reservoir shall be automatically assured and any leakage shall be able to be monitored.

4.9.4 Viscous fuel oils Since the effectiveness of air separators decreases as the viscosity of the fuel oils increases, these devices may be dispensed with, despite the provision in **4.9.2**, for fuel oils with a dynamic viscosity of more than 20 mPa·s at 20 °C.

In this case, it is necessary to make provisions to prevent entry of air. The pump shall be so arranged that the inlet pressure is always greater than the atmospheric pressure.

If it is not always possible to meet this condition, a device shall be provided to stop the flow fuel oil automatically as soon as the inlet pressure falls below the atmospheric pressure.

These provisions are not necessary if devices are provided which ensure that no air can enter through the joints in the sections of the pipework under reduced pressure and if the measuring system is so arranged that no air or dissolved gases will be released.

4.9.5 Removal of gases The gas removal pipe of an air separator shall not include a manually controlled valve if closure of this valve prevents the operation of an air separator. However, if such a closing element is required for safety reasons, it shall be possible to ensure by means of a sealing device that it remains in the open position, unless closure of the valve automatically prevents further measurement.

4.9.6 General provisions for air separators

4.9.6.1 In principle, the gas separated in an air separator is evacuated automatically. However, the automatic operation is not necessary if a device is provided which automatically either stops or sufficiently reduces the flow of liquid so as to meet the requirements in 4.9.1 when there is a risk of air or gases entering the measurement transducer. In the case of shutdown, no measurement shall be possible unless the air or gases are automatically or manually eliminated.

4.9.6.2 The operational limits of an air separator are as follows:

- the maximum flowrate(s) for one or more specified fuel oils,
- the maximum pressure (with no flow running) and minimum pressure (with fuel oil and without air intake while the pump is running at maximum flowrate) compatible with the correct operation of the air separator,
- the minimum measured quantity for which it is designed.

4.9.7 Special provisions applicable to air separators

4.9.7.1 An air separator fitted in a measuring system shall ensure the elimination of air or gases mixed with the fuel oil to be measured under the following test conditions:

- a) without air or gases the measuring system operates at the maximum flowrate and at the minimum pressure specified for the measuring system,
- b) then air is introduced or gases are created as long as the measuring system operates.

When the air separator is designed to have the maximum flowrate not more than 20 m³/h, the volume ratio of the air or gas to the fuel oil shall be within the following range (the air or gas volume to be used for calculating the ratio shall be measured under the atmospheric pressure):

- Not more than 20 % for fuel oils of a viscosity not more than 1 mPa · s;
- Not more than 10 % for fuel oils of a viscosity exceeding 1 mPa · s.

Any proportion by volume of air or gases relative to the fuel oil is permitted if the gas separator is designed for a maximum flowrate lower than or equal to 20 m³/h; it is limited to 30 % if the gas separator is designed for a maximum flowrate higher than 20 m³/h.

The percentage is considered only when the meter is running.

Furthermore, when provided, the automatic gas removal device must continue to operate correctly at the maximum pressure fixed for these air separators.

4.10 Transfer point

4.10.1 Measuring systems shall incorporate a transfer point located downstream of the measurement transducer.

4.10.2 Measuring systems shall be of “full hose” systems: the term “hose” includes rigid pipework.

4.10.3 Full hose systems, in the case of delivery equipment, are measuring systems in which the transfer point consists of a closing device located in the delivery line. When the delivery line has a free end, the closing device must be installed as close as possible to this end.

4.11 Complete filling of the measuring system

4.11.1 The measurement transducer and the pipework between the measurement transducer and the transfer point shall be kept full of fuel oil during measurement and during shutdown periods.

4.11.2 A measuring system in which the fuel oil could flow in the opposite direction to that of normal flow when the pump is stopped shall be provided with a non-return valve, fitted with a pressure limiting device if necessary, when reversal of the flow could result in errors greater than the minimum specified volume deviation.

4.11.3 The free end of the hose shall incorporate a device which prevents the draining of the hose during shutdown periods.

When a closing device is installed downstream of this device, the volume of the space between them shall be as small as possible and, in all cases, be less than the minimum specified volume deviation.

4.12 Variations in the internal volume of full hoses For full hoses, the increase in internal volume due to the change from the coiled hose position when not under pressure to the uncoiled hose position when under pressure without any flow of fuel oil, except those specified in 7.2 and 7.3, shall not exceed the minimum specified volume deviation.

4.13 Branches and bypasses No means shall be provided by which any measured fuel oil can be diverted downstream of the measurement transducer. However, two or more delivery outlets may be permanently installed and operated simultaneously or alternately provided so that any diversion of flow to other than the intended receiving receptacle(s) cannot be readily accomplished or is readily apparent.

NOTE : Such means include, for example, physical barriers, visible valves or indications that make it clear which outlets are in operation, and explanatory signs, if necessary.

4.14 Sealing devices and stamping plate

4.14.1 General The seals shall, in all cases, be easily accessible.

Sealing should be provided on all parts of the measuring system which cannot be materially protected in any other way against operations liable to affect the measurement accuracy.

It must be prohibited to change parameters which participate in the determination of the results of measurement (parameters for correction and conversion in particular) by means of sealing devices.

A plate, referred to as the stamping plate, aimed at receiving the control marks, shall be sealed or permanently attached on a support of the measuring system. It may be combined with the data plate of the measuring system.

4.14.2 Electronic sealing devices

4.14.2.1 When access to parameters that participate in the determination of results of measurement is not protected by mechanical sealing devices, the protection shall fulfill the following provisions:

- a) access shall only be allowed to authorized people, e.g. by means of a code (keyword) or of a special device (hard key, etc.); the code shall be changeable;
- b) it shall be possible for at least the last intervention to be memorized; the record shall include the date and a characteristic element identifying the intervention. It shall be possible to memorize more than one intervention, and if deletion of a previous intervention must occur to permit a new record, the oldest record shall be deleted.

4.14.2.2 For measuring systems with parts which may be disconnected one from another by the user and which are interchangeable, the following provisions shall be fulfilled:

- a) it shall not be possible to access parameters that participate in the determination of results of measurements through disconnected points unless the provisions in **4.14.2.1** are fulfilled;
- b) interposing any device which may influence the accuracy shall be prevented by means of electronic and data processing securities or, if not possible, by mechanical means.

4.15 Influence of external devices Meters shall keep normal operation and the measuring function shall be free from any influence when the meters are connected with ancillary devices or peripheral devices not through ancillary devices.

5 Requirements for meters and ancillary devices of a measuring system

5.1 Meter The meter(s) of a measuring system shall meet the following requirements.

5.1.1 Field of operation

5.1.1.1 The field of operation of a meter is determined at least by the following characteristics: