Moreover, after a delivery, measuring systems shall not be capable of being reset to zero and authorized until measurement data are memorized or printed out.

***6. Metrological control***

When a test is conducted, the expanded uncertainty of the determination of errors on indications of volume or mass shall be less than one-fifth of the maximum permissible error applicable for that test on pattern approval and one-third of the maximum permissible error applicable for that test on other verifications.

*(1) Pattern approval*

(i) General

Measuring systems subject to legal metrology control shall be subject to pattern approval. In addition, the constituent elements of a measuring system, mainly those listed below, and the sub-systems which include several of these elements, may be subject to separate pattern approval:

- meter,
- transducer,
- gas separator,
- gas extractor,
- special gas extractor,
- electronic calculator (including the indicating device),
- conversion device,
- ancillary devices providing or memorizing measurements results,
- pre-setting device,
- densitometer,
- temperature sensor.

The constituent elements of a measuring system shall comply with the relevant requirements even when they have not been subject to separate pattern approval (except, of course, in the case of ancillary devices that are exempted from the controls).

Unless otherwise specified in this Recommendation, a measuring system should fulfil the requirements without adjustment of the system or of its devices during the course of the tests. If an adjustment is carried out, this condition shall still be considered as valid.

(ii) Documentation

(a) The application for pattern approval of a measuring system or of a constituent element of a measuring system shall include the following documents :—

- a description giving the technical characteristics and the principle of operation,
- a drawing or photograph,
- a list of the components with a description of their constituent materials when this has a metrological influence,
- an assembly drawing with identification of different components,
- for measuring systems, the references of the approval certificate of the constituent elements, if any,
- for measuring systems and meters fitted with correction devices, a description of how the correction parameters are determined,
- a drawing showing the location of seals and verification marks,
- a drawing of regulatory markings.

(b) In addition, the application for pattern approval of an electronic measuring system shall include—

- a functional description of the various electronic devices,
- a flow diagram of the logic, showing the functions of the electronic devices,
- any document or evidence which shows that the design and construction of the electronic measuring system comply with the requirements of this specification in particular paragraph 4(3).

(c) The applicant shall provide the body responsible for the evaluation with an instrument representative of the final pattern.

Other specimens of the pattern may be considered necessary by the body responsible for the pattern evaluation to estimate the reproducibility of the measurements.

(iii) Pattern approval certificate

The following information shall appear on the pattern approval certificate :—

- name and address of the recipient of the approval certificate,
- name and address of the manufacturer, if it is not the recipient,
- type and/or commercial designation,
- principal metrological and technical characteristics,
- pattern approval mark,
- period of validity,
- environmental classification, if applicable,
- information on the location of marks for pattern approval, initial verification and sealing (e.g. picture or drawing),
- list of documents accompanying the pattern approval certificate,
- specific remarks.

When applicable, the version of the metrological part of the evaluated software shall be indicated in the pattern approval certificate or in its annexes.

(iv) Modification of an approved pattern

(a) The recipient of the pattern approval shall inform the body responsible for the approval of any modification or addition which concerns an approved pattern.

(b) Modifications and additions shall be subject to a supplementary pattern approval when they influence, or are likely to influence, the measurement results or the instrument's regulatory conditions of use.

The body having approved the initial pattern shall decide to which extent the examinations and tests described below shall be carried out on the modified pattern in relation with the nature of the modification.

(c) When the body having approved the initial pattern judges that the modifications or additions are not likely to influence the measurement results, this body allows the modified instruments to be presented for initial verification without granting a supplementary pattern approval.

A new or supplementary pattern approval must be issued whenever the modified pattern no longer fulfils the provisions of the initial pattern approval.

(v) Pattern approval of a meter or of a measurement transducer

(a) A pattern approval may be given for a complete meter; it may also be given for the measurement transducer only when this is intended to be connected to different types of calculators.

The following examinations and tests shall be carried out on the meter alone or on the measurement transducer when it is the subject of a separate application for pattern approval. They may also be carried out on the whole measuring system.

Tests are normally carried out on the complete meter, fitted with an indicating device, with all the ancillary devices and with the correction device, if any. However, the meter subject to testing need not be fitted with its ancillary devices when the latter are not likely to influence the accuracy of the meter and when they have been verified separately (for example : electronic printing device). The measurement transducer may also be tested alone provided that the computing and indicating device has been subject to a separate pattern approval. If this measurement transducer is intended to be connected to a calculator fitted with a correction device, the correction algorithm as described by the manufacturer must be applied to the output signal of the transducer to determine its errors.

(b) Accuracy tests

(c) The errors of the meter shall be determined at a minimum of six

flowrates which are distributed over the measuring range at regular intervals. At each flowrate the errors shall be determined at least three times, independently. Each error shall not be greater than the maximum permissible error (in absolute value). In addition, for quantities equal to or greater than five times the minimum measured quantity, the repeatability requirement in paragraph 3(1)(ii)(b) applies.

(d) Tests should be carried out at the limits of the field of operation, i.e. at the limits of pressure, temperature and viscosity. However, pressure tests are not necessary when the technology of the meter is such that it is possible to calculate the influence of pressure and to show that it is negligible (for example: meter with pressure-balanced measuring chambers).

***Note*** : It is often unnecessary to carry out tests with liquids having a temperature which differs from the ambient temperature when the meter is intended to measure liquids having a temperature between – 10°C and +50°C.

(e) The following tests shall also be carried out:—

- accuracy test at minimum measured quantity,
- determination of the periodic variation, if appropriate,
- tests with flow disturbances, if appropriate.

For tests with flow disturbances, the applicable maximum permissible errors are those fixed in paragraph 2(5) for the measuring system and not those fixed in paragraph 3(1)(ii) for the meter.

(f) When preliminary verification of the meter is planned to be carried out with a liquid which differs from the liquid the meter is intended to measure, comparative tests with these two liquids shall also be carried out to determine the maximum permissible errors on preliminary verification. It may be necessary to have several specimen of the pattern available.

*Example* : It is necessary to make a distinction between a pattern of a meter intended to measure several products (in the same measuring system) and a pattern of a meter of which different copies may be used for measuring different products (in different measuring systems), each copy being intended to measure a given product only.

For example, meter A may be intended to measure butane and propane alternatively, whereas meter B is intended to measure either butane or propane. Both meters will be subject to accuracy tests with butane and with propane at the time of pattern approval. For meter A, the error curves for propane and for butane shall both be within the maximum permissible errors as specified in paragraph 3(1)(ii).

For meter B, the error curves for butane on the one hand, and for propane on the other hand, shall satisfy the maximum permissible errors; unlike meter A, however, these error curves may be determined using different copies of the meter, or alternatively on the same copy whose adjustment (or correction parameters) has been modified between the test with butane and the test with propane.

Copies of meter A will bear the mention of butane and propane on their data plate and they may also be used to measure mixtures of butane and propane in any proportion.

Copies of meter B will bear either the mention "butane" or the mention "propane" and shall be used for measuring the corresponding product exclusively.

The preliminary verification of pattern A copies may be carried out with either butane or propane, indifferently (with, if appropriate, a reduction of the maximum permissible errors range).

In general, the preliminary verification of pattern B copies will be carried out with the liquid intended to be measured; however, it may be carried out with the other liquid provided that the maximum permissible errors have been shifted. The value of shifting shall be determined at the time of pattern evaluation by evaluating the deviation between the error curves determined with butane and with propane, on the same meter, without modification of the adjustment. The deviations shall be reproducible from one copy of the meter to another. To check this, it is necessary to carry out accuracy tests on several instruments.

(g) Endurance tests

Endurance tests should be carried out at the maximum flowrate of the meter using the liquid the meter is intended to measure or a liquid with similar characteristics. When the meter is intended to measure different liquids, the test should be carried out with the liquid that provides the most severe conditions.

An accuracy test shall precede the endurance tests.

In principle the duration of the endurance test shall be 100 hours in one or several periods. In specific cases (e.g. new technologies, new alloys, new liquids) the duration may be increased up to 200 hours.

The test shall be carried out at a flow rate between $0.8 \times Q_{max}$ and $Q_{max}$.

As far as possible, the meter is subjected to the endurance test on a test bench. However, it is accepted that the meter be temporarily mounted in a measuring system in normal operation, in which case it is necessary that the nominal operating flowrate of the measuring system is more than $0.8 \times Q_{max}$.

After the endurance test, the meter is again subject to a new accuracy test. The deviations between the errors determined before and after the endurance test shall remain within the limits specified in paragraph 3(1)(ii)(c) without any changes of the adjustment or corrections.

(vi) Pattern approval of a gas elimination device

As a rule, tests shall be carried out to prove that the air or gas eliminating devices satisfy the requirements in paragraph 2 (10)(viii) or 2(10)(ix).

It is however acceptable that tests are not carried out at flowrates greater than 100 $m^3/h$ and that the air separating devices are approved by analogy with devices of the same design, having smaller dimensions.

Annexure B describes tests which should be carried out on these devices. The tests are given as examples only.

(vii) Pattern approval of an electronic calculator

When an electronic calculator is submitted to separate pattern approval, pattern approval tests are conducted on the calculator alone, simulating different inputs with appropriate standards.

(a) Accuracy tests include an accuracy test on the indications of measurement results (volume at metering conditions or price to pay). For this purpose, the error obtained on the indication of the result is calculated considering the true value is the one calculated taking into account the value of the simulated quantities applied to inputs of the calculator and using standard methods for calculation. The maximum permissible errors are those fixed in paragraph 2(8).

(b) When the calculator carries out calculations for a conversion device, tests specified in paragraph 6(1)(vii)(a) are performed for the calculation of volume at base conditions or mass.

Accuracy tests also include an accuracy test on the measurement of each characteristic quantity of the liquid. For this purpose, the error obtained on the indication of each of these characteristic quantities these indications are mandatory considering paragraph 3(7)(vii) is calculated by considering the true value as that provided by the standard connected to the inputs of the calculator and which simulates the corresponding associated measuring instrument. For each of

these quantities, the maximum permissible errors fixed in paragraph 2(7)(iii) shall be applied.

It is then necessary to perform a test to check the presence and operation of checking facilities relevant to associated measuring instruments mentioned in paragraph 4(3)(vi).

(c) Examinations and tests described in 6(1)(xi) for electronic instruments shall be performed.

(viii) Pattern approval of a conversion device

(a) General case

It is necessary to verify whether the conversion device connected to all its associated measuring instruments complies with provisions in 2(7)(i). For that purpose, the volume at metering conditions which is converted is supposed to be without any error.

It may also be verified that the provisions in paragraph 2(7)(vi) [and paragraph 2(7)(v) if applicable] are fulfilled.

In the case of an electronic conversion device, the tests and examination described in paragraph 6(1)(ix) shall be performed.

(b) Electronic conversion device

Instead of the procedure in paragraph 6(1)(viii)(a), it is also possible—

- to verify separately the accuracy of associated measuring instruments [see paragraph 2(7)(ii)],
- to verify that the provisions in paragraph 6(1)(vii)(b) are fulfilled, and
- to perform examinations and tests described in paragraph 6(1)(xi).

(ix) Pattern approval of an ancillary device

(a) When an ancillary device that provides primary indications is intended to be approved separately, its indications shall be compared with those provided by an indicating device that has already been approved and which has the same scale interval, or a smaller one.

The results shall satisfy the provisions in paragraph 2(9)(v).

As far as possible, the necessary conditions for compatibility with other devices of a measuring system are stated in the pattern approval certificate.

(b) Electronic devices may be approval separately when they are used for the transmission of primary indications or other information necessary for their determination, e.g. a device which concentrates information from two or more calculators and transmits it to a single printing device.

When at least one of the signals of this information is analogue, the device shall be tested in association with another device whose maximum permissible errors are provided by this Recommendation.

When all the signals of this information are digital, the above provision may be applied; however, when the inputs and outputs of the device are available, the device can be tested separately, in which case it shall introduce no error; only errors due to the testing method may be found out.

In both cases and as far as possible, the necessary conditions for compatibility with other devices of a measuring system are stated in the pattern approval certificate.

(x) Pattern approval of a measuring system

The pattern approval of a measuring system consists of verifying that the constituent elements of the system, which have not been subject to separate pattern approvals, satisfy the applicable requirements, and that these constituent elements are compatible with one another.

Tests for carrying out the pattern approval of a measuring system shall therefore be determined on the basis of the pattern approvals already granted for the constituent elements of the system.

When none of the constituent elements has been subject to separate pattern approval, all the tests provided for in paragraph

6(1)(v), 6(1)(vi) and 6(1)(vii) (in particular) shall be performed on the complete measuring system. On the contrary, when the various constituent elements are all approved separately, it is possible to replace pattern approval based on tests by pattern approval of drawings.

It is also appropriate to reduce the pattern evaluation program when the measuring system includes constituent elements identical to those which equip another measuring system that has already been approved, and when the operating conditions of these elements are identical. For example, it is not necessary to perform the expansion test of a hose in a fuel dispenser when the hose in this measuring system is identical to the hose equipping another measuring system already approved with the same minimum measured quantity.

***Note*** : It is advisable that constituent elements be subject to separate pattern approval when they are intended to equip several patterns of measuring systems. This is particularly advisable when the various measuring systems have different manufacturers and when the bodies in charge of pattern approval are different.

(xi) Pattern approval of an electronic device

In addition to the examinations or tests described in the preceding paragraphs, an electronic measuring system or an electronic constituent element of this system shall been subject to the following tests and examinations:—

(a) Design inspection

This examination of documents aims at verifying that the design of electronic devices and their checking facilities comply with the provisions of this specification, clause 4 in particular.

It includes—

(a) an examination of the mode of construction and of the electronic sub-systems and components used, to verify their appropriateness for their intended use,

(b) consideration of faults likely to occur, to verify that in all considered cases these devices comply with the provisions of paragraph 4(3),

(c) verification of the presence and effectiveness of the test device(s) for the checking facilities.

(b) Performance tests

These tests aim at verifying that the measuring system complies with the provisions of paragraph 4(1)(i) with regard to influence quantities. These tests are specified in Annexure A.

(a) Performance under the effect of influence factors:

When subjected to the effect of influence factors as provided for in Annexure A, the equipment shall continue to operate correctly and the errors shall not exceed the applicable maximum permissible errors.

(b) Performance under the effect of disturbances:

When subjected to external disturbances as provided for in Annexure A, the equipment shall either continue to operate correctly or detect and indicate the presence of any significant faults. Significant faults shall not occur on non-interruptible measuring systems.

(c) Equipment under test (EUT)

Tests are carried out on the complete measuring system where size and configuration permit, except where otherwise specified in Annexure A.

Where tests are not carried out on a complete system, they shall be carried out on a sub-system comprising at least the following devices:—

- measuring transducer,
- calculator,
- indicating device,
- power supply device,
- correction device, if appropriate.

This sub-system shall be included in a simulation set-up

representative of the normal operation of the measuring system. For example, the movement of the liquid may be simulated by an appropriate device.

The calculator shall be in its final housing.

In all cases, peripheral equipment may be tested separately.

*(2) Initial verification*

(i) General

Initial verification of a measuring system is carried out in a single stage when the system can be transported without dismantling and when it is verified under the intended conditions of use; in all other cases, it is carried out in two stages.

The first stage concerns at least the measurement transducer, alone or fitted with associated ancillary devices, or possibly included in a sub-system. Tests of the first stage may be carried out on a test bench, possibly in the factory of the manufacturer, or on the installed measuring system. At this stage, the metrological examinations may be carried out with different liquids than those which the system is intended to measure.

The first stage also concerns the calculator and the density sensor. If necessary, the measurement transducer and the calculator can be verified separately.

The second stage concerns the measuring system in actual working condition. It is carried out at the place of installation under operating conditions and with the intended liquid of use. However, the second stage may be carried out in a place chosen by the verification body when the measuring system can be transported without dismantling and when the tests can be performed under the operating conditions intended for the measuring system.

Initial verification of electronic systems shall include a procedure for verifying the presence and correct operation of checking facilities by the use of test devices as specified in paragraph 4(3).

(ii) Tests

(a) When initial verification takes place in two stages, the first stage shall include—

- an examination for conformity of the meter, including the associated ancillary devices (conformity with the respective patterns),
- a metrological examination of the meter, including the associated ancillary devices.

The second stage shall include—

- an examination for conformity of the measuring system, including the meter and the ancillary and additional devices,
- a metrological examination of the measuring system; if possible, this examination is carried out within the limits of operating conditions for the system,
- an operational test of the gas elimination device, where appropriate, with no need to verify that the maximum errors applicable to this device and specified in 2.10 are met,
- an inspection of the adjustment of the prescribed pressure maintaining devices where appropriate,
- when necessary, a test of the variations of the internal volume of the hoses in full hose measuring systems, e.g. in the case of a hose reel, an operational test of the control valve preventing the emptying of the hose during non-operating periods, for full hose measuring systems,
- a determination of the residual quantities in empty hose measuring systems.

(b) When initial verification takes place in one stage, all tests in paragraph 6(2)(ii)(a) shall be performed.

*(3) Subsequent verification*

(i) Subsequent verification of a measuring system may be identical to initial verification.

(ii) The preliminary examination of the meter should only be repeated if the protective marks on the measuring element of the meter have been damaged. This examination may be replaced by a test of the measuring system if the conditions for the preliminary examination are met and if the measuring system can undergo testing with a volume of liquid corresponding to the minimum measured quantity. For the determination of the error curve, at least 60% of the maximum flowrate should be reached.

(iii) The ancillary devices shall be considered as having been subjected to the preliminary examination if the protective marks are not damaged. It is sufficient to carry out a reduced number of measurements during the simplified examination of the ancillary devices.

## ANNEXURE A.

PERFORMANCE TEST FOR ELECTRONIC MEASURING SYSTEMS.

(*Mandatory*).

### 1. General

This Annexure defines the program of performance tests intended to verify that electronic measuring systems may perform and function as intended in a specified environment and under specified conditions. Each test indicates, where appropriate, the reference conditions for determining the intrinsic error.

These tests supplement any other prescribed test.

When the effect of one influence quantity is being evaluated, all other influence quantities are to be held relatively constant, at values close to reference conditions.

### 2. Severity levels

For each performance test, typical test conditions are indicated: they correspond to the climatic and mechanical environment conditions to which measuring systems are usually exposed.

Measuring systems are divided into three classes according to climatic and mechanical environmental conditions:

- Class B for fixed instruments installed in a building,
- Class C for fixed instruments installed outdoors,
- Class I for mobile instruments, in particular measuring systems on trucks.

However, the applicant for pattern approval may indicate specific environmental conditions in the documentation supplied to the metrology service, based on the intended use of the instrument. In this case, the metrology service carries out performance tests at severity levels corresponding to these environmental conditions. If pattern approval is granted, the data plate shall indicate the corresponding limits of use. Manufacturers shall inform potential users of the conditions of use for which the instrument is approved. The metrology service shall verify that the conditions of use are met.

### 3. Reference conditions

| | |
|---|---|
| Ambient temperature | : 20°C ± 5°C |
| Relative humidity | : 60% ± 15% |
| Atmospheric pressure | : 86 kPa to 106 kPa |
| Power voltage | : Nominal voltage ($V_{nom}$) |
| Power frequency | : Nominal frequency ($F_{nom}$) |

During each test, the temperature and relative humidity shall not vary by more than 5°C or 10% respectively within the reference range.

### 4. Performance tests

The following tests can be carried out in any order:—

| *Test* | *Nature of the influence quantity* | *Severity level for the class* | | |
|---|---|---|---|---|
| | | *B* | *C* | *I* |
| 1. Dry heat | Influence factor | 2 | 3 | 3 |
| 2. Cold | Influence factor | 2 | 3 | 3 |
| 3. Damp heat, cyclic | Influence factor | 1 | 2 | 2 |
| 4. Vibration (sinusoidal) | Influence factor | -- | -- | 3 |
| 5. Power voltage variation | Influence factor | 1 | 1 | 1 |
| 6. Short time power reductions | Disturbance | 1a & 1b | 1a & 1b | 1a & 1b |
| 7. Bursts | Disturbance | 2 | 2 | 2 |
| 8. Electrostatic discharge | Disturbance | 1 | 1 | 1 |
| 9. Electromagnetic susceptibility | Disturbance | 2, 5, 7 | 2, 5, 7 | 2, 5, 7 |
| 10. Disturbances on d.c. voltage powered equipment | | | | |

The above tests involve the electronic part of the measuring system or its devices.

The following rules shall be taken into consideration for these tests:—

(i) Tests volumes

Some influence quantities should have a constant effect on measurement results and not a proportional effect related to the measured volume. The value of the significant fault is related to the measured volume; therefore, in order to be able to compare results obtained in different laboratories, it is necessary to perform a test on a volume corresponding to that delivered in one minute at the maximum flowrate, but not less than the minimum measured quantity. Some tests, however, may require more than one minute, in which case they shall be carried out in the shortest possible time.

(ii) Influence of the liquid temperature

Temperature tests concern the ambient temperature and not the temperature of the liquid used. It is therefore advisable to use a simulation test method so that the temperature of the liquid does not influence the test results.

*(1) Dry heat*

| | |
|---|---|
| Test method: | Dry heat (non-condensing) |
| Object of the test: | To verify compliance with the provisions in paragraph 4(1)(i) under conditions of high temperature. |
| Test procedure in brief: | The test consists of exposure of the EUT to a temperature of 55°C (classes C or I) or 40°C (class B) under "free air" conditions for a 2-hour period after the EUT has reached temperature stability. The EUT shall be tested at least one flowrate (or simulated flowrate):<br>· at the reference temperature of 20°C following conditioning,<br>· at the temperature of 55°C or 40°C, 2 hours after temperature stabilization,<br>· after recovery of the EUT at the reference temperature of 20°C. |
| Test severities: | (1) Temperature : severity level 2: 40°C<br>severity level 3: 55°C<br>(2) Duration : 2 hours |
| Number of test Cycles: | One cycle |
| Maximum allowable variations: | All functions shall operate as designed.<br>All errors shall be within the maximum permissible errors. |

*(2) Cold*

| | |
|---|---|
| Test method: | Cold |
| Object of the test: | To verify compliance with the provisions in paragraph 4(1)(i) under conditions of low temperature. |
| Test procedure in brief: | The test consists of exposure of EUT to a temperature of–25°C (classes C or I) or –10°C (class B) under "free air" conditions for a 2-hour period after the EUT has reached temperature stability. The EUT shall be tested at least one flowrate (or simulated flow rate):<br>· at the reference temperature of 20°C following conditioning,<br>· at a temperature of -25°C or -10°C, 2 hours after temperature stabilization,<br>· after recovery of the EUT at the reference temperature of 20°C. |
| Test severities: | (1) Temperature : severity level 2: -10°C<br>severity level 3: -25°C<br>(2) Duration : 2 hours |
| Number of test cycles: | One cycle |
| Maximum allowable variations: | All functions shall operate as designed.<br>All errors shall be within the maximum permissible errors. |

*(3) Damp heat, cyclic*

| | |
|---|---|
| Test method: | Damp heat, cyclic (condensing) |
| Object of the test: | To verify compliance with the provisions in 4.1.1 under conditions of high humidity when combined with cyclic temperature changes. |
| Test procedure in brief: | The test consists of exposure |

of the EUT to cyclic temperature variations between, 25°C and the upper temperature of 55°C (class C or I) or 40°C (class B), maintaining the relative humidity above 95% during the temperature changes and during the phases at low temperature, and at 93% at the upper temperature phases. Condensation should occur on the EUT during the temperature rise. Standard stabilizing period before and recovery after the cyclic exposure are indicated in IEC Publication 68-2-30. The power supply is not on when the influence factor is applied.

Test severities: (1) Upper temperature: severity level 1: 40°C severity level 2: 55°C

(2) Humidity : > 93%

(3) Duration: 24 hours

Number of test cycles: Two cycles

Maximum allowable variations : After the application of the influence factor and recovery:

- all functions shall operate as designed, and
- all errors shall be within the maximum permissible errors.

*(4) Vibration*

Test method : Sinusoidal vibration

Object of the test: To verify compliance with the provisions in paragraph 4(1)(i) under conditions of sinusoidal vibration.

This test should normally apply to mobile measuring systems only.

Test procedure in brief: The EUT shall be tested by sweeping the frequency in the specified frequency range, at 1 octave/minute, at the specified acceleration level with a specified number of sweep cycles per axis. The EUT shall be tested in its three, mutually perpendicular main axes, mounted on a rigid fixture by its normal mounting means. It shall normally be mounted so that the gravitational force acts in the same direction as it would in normal use.

The instrument is non-operational when the influence factor is applied.

Test severities: (1) Frequency range: 10-150 Hz

(2) Max. acceleration level : 20 $m.s^{-2}$

Number of test cycles: 20 sweep cycles per axis

Maximum allowable variations: After the application of the influence factor and recovery:

- all functions shall operate as designed and
- all errors shall be within the maximum permissible errors.

*(5) Power voltage variation*

Test method: Variation in a.c. mains power supply (single phase)

Object of the test: To verify compliance with the provisions in paragraph 4(1)(i) under conditions of varying a.c. mains power supply.

Test procedure in brief: The test consists of exposure of the EUT to power voltage variations, while the EUT is operating under normal atmospheric conditions.

Test severities: Main voltage : upper limit : $V_{nom}$ +10%
lower limit : $V_{nom}$ −15%

Number of test cycles: One cycle

Maximum allowable variations: All functions shall operate as designed.

All errors shall be within the maximum permissible errors.

*(6) Short time power reduction*

Test method: Short time interruptions and reductions in mains voltage.

Object of the test: To verify compliance with the provisions in paragraph 4(1)(i) under conditions of short time mains voltage interruptions and reductions.

Test procedure in brief: The test consists of subjecting the EUT to voltage interruptions from nominal voltage to zero voltage for a duration equal to half a cycle

474 GI/11—142

of line frequency, and reductions from nominal voltage to 50% of nominal for a duration equal to one cycle of line frequency. The mains voltage interruptions and reductions shall be repeated ten times with a time interval of at least ten seconds.

Test severities: [illegible] voltage interruption for a period equal to half a cycle. [illegible] voltage reduction for a period equal to one cycle.

Number of test cycles: [illegible] least ten interruptions and ten reductions, each with a minimum of ten seconds between tests.

The interruptions and reductions are repeated throughout the time necessary to perform the whole test; for this reason, more than ten interruptions and reductions may be necessary.

Maximum allowed variations: (a) For interruptible measuring systems, either the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in paragraph 3(12) part-I or the measuring system shall detect and act upon a significant fault, in compliance with paragraph 4(3)(i).

(b) For non-interruptible measuring systems the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in paragraph 3(12) part-I.

*(7) Bursts*

Test method: Electrical bursts

Object of the test: To verify compliance with the provisions in paragraph 4(1)(i) under conditions where electrical bursts are superimposed on the mains voltage.

Test procedure in brief: The test consists of subjecting the EUT to bursts of double exponential waveform transient voltages. Each spike shall have a rise time of 5 ns and a half amplitude duration of 50 ns. The burst length shall be 15 ms, the burst period (repetition time interval) shall be 300 ms. All bursts shall be applied during the same measurement or simulated measurement in symmetrical mode and asymmetrical mode.

Test severities : Amplitude (peak value) 1000 V

Number of test cycles: At least ten positive and ten negative randomly phased bursts shall be applied at [illegible]

[illegible] are applied during [illegible] time necessary to [illegible] the test; to that [illegible] more bursts than indicated above may be necessary.

Maximum allowed variations: For interruptible measuring systems, either the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in paragraph 3(12) part-I or the measuring system shall detect and act upon a significant fault, in compliance with paragraph 4(3)(i).

For non-interruptible measuring systems, the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in paragraph 3(12)

*(8) Electrostatic discharge*

Test method: Electrostatic discharge (ESD)

Object of the test: To verify compliance with the provisions in paragraph 4(1)(i) under conditions of direct and indirect electrostatic discharges.

Test procedure in brief: A capacitor of 150 pF is charged by a suitable DC voltage source. The capacitor is then discharged through the EUT by connecting one terminal to ground (chassis)

and the other via 330 ohms to surfaces which are normally accessible to the operator.

The test includes the paint penetration method, if appropriate. For direct discharges the air discharge shall be used where the contact discharge method cannot be applied.

The [illegible]s: 8 kV for air discharges

6 kV for contact discharges

[illegible] cycles: At each test point, at least ten direct discharges shall be applied at intervals of at least ten seconds between discharges, during the same measurement or simulated measurement. As for indirect discharges, a total of ten discharges shall be applied on the horizontal coupling plane, and a total of ten discharges for the various positions of the vertical coupling plane.

[illegible] [illegible]vable [illegible]iation: (a) For interruptible measuring systems, either the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in paragraph 3(12) of part-I or the measuring system shall detect and act upon a significant fault, in compliance with paragraph 3(3)(i).

(b) For non-interruptible measuring systems, the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in paragraph 3(12) of part-I.

*[illegible]omagnetic susceptibility*

[illegible]chod: Electromagnetic fields (radiated)

[illegible] of the test: To verify compliance with the provisions in paragraph 4(1)(i) under conditions of electromagnetic fields.

[illegible]rocedure in brief: The EUT shall be exposed to electromagnetic field strength as specified by the severity level.

The field strength can be generated in various ways:

- the strip line is used at low frequencies below 30 MHz (or in some cases 150 MHz) for small EUTs;
- the long wire is used at low frequencies (below 30 MHz) for larger EUTs;
- dipole antennas or antennas with circular polarization placed 1 m from the EUT are used at high frequencies.

The specified filed strength shall be established prior to the actual testing (without EUT in the field).

The field shall be generated in two orthogonal polarizations and the frequency range shall be scanned slowly. If antennas with circular polarization i.e. log spiral or helical antennas are used to generate the electromagnetic field, a change in the position of the antenna is not required.

When the test is carried out in a shielded enclosure to comply with international laws prohibiting interference to radio communications, care should be taken to handle reflections from the walls. Anechoic shielding may be necessary.

[illegible] severities:

| [illegible]requency range | 26-500 MHz | 500-1000 MHz |
|---|---|---|
| [illegible]ield strength | 3 V/m | 1 V/m |
| [illegible]Modulation | 80% AM 1kHz sine wave | |

[illegible]imum [illegible]vable [illegible]iation: (a) For interruptible measuring systems, either the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in paragraph 3(12) of part-I or the measuring system shall detect and act upon a significant fault, in

compliance with paragraph 4(3)(i).

(b) For non-interruptible measuring systems, the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in paragraph 3(12) of part-I.

(10) Perturbations on dc voltage powered instruments

Electronic measuring systems supplied with dc voltage shall fulfil the tests in Annexure A 4(1) to Annexure A, paragraph 4(9), with the exception of Annexure A, paragraph 4(5), 4(6) and 4(7) which are to be replaced by the following provisions:—

General provision

For under-voltages or over-voltages all errors shall be within maximum permissible errors when the instrument is still operating.

The under-voltage or over-voltage is applied for a complete measurement or part of a measurement.

Provision applicable to instruments fed by the battery of a vehicle

Tests pulses 1, 2 and 3 of the relevant part of ISO 7637 *Electrical disturbance by conduction and coupling*, Part 1: *Vehicles with nominal 12 V supply voltage*, and Part 2: *Commercial vehicles with nominal 24 V supply voltage*, are applied at the various severity levels specified in this Standard.

Pulses are repeated for as long as necessary to complete the test.

The pattern approval certificate shall indicate, for each type of pulse, the maximum severity level met by the instrument.

## ANNEXURE B

TESTING OF GAS ELIMINATION DEVICES

(*Informative*)

### 1. Testing of a gas elimination device as a unit separate from the measuring system for which it is intended

### (1) General provisions

In order to examine whether the pattern of a gas elimination device complies with the requirements in, paragraph 2(10), a specimen of the pattern must be installed on a suitable test bench equipped with a meter and a conventional proving tank.

***Note***: In tests on gas elimination devices, the proving tank may be replaced by any appropriate standard.

The efficiency of the gas elimination device is determined with reference to the meter error at the same flowrate.

The test bench must, as far as possible, comply with the following provisions:—

(i) The capacity of the proving tank should be at least equal to the greater of the following two values: volume delivered in one minute at maximum flowrate, or 1000 times the scale interval of the meter of the test bench.

(ii) It is recommended that an adjustable non-return valve be installed downstream of the meter in order to prevent back flow of the liquid which has been measured and to obtain the minimum back pressure required for the proper operation of the gas elimination device.

(iii) There should be no reverse gradient in the pipework downstream of the meter so that gas bubbles are allowed to escape in the normal way in order to keep this pipework filled to the same level at the beginning and end of the test.

(iv) The liquid used for the tests should either be the same as that for which the device is intended or should be of a viscosity which is at least equal to that of the liquid for which it is intended.

Tests on gas elimination devices should be carried out for flowrates up to a maximum of 100 $m^3/h$. For higher flowrates, characteristics may be determined by analogy with equipment of the same design and smaller dimensions. "By analogy" means that parameters like Reynolds number, Froude number, etc., are to be taken into account for the gas elimination device.

### (2) Tests on gas separators

The volume of air or gas continuously entering may be measured by a gas meter and isothermally converted to atmospheric pressure on the basis of the indication of a pressure gauge fitted upstream of the gas meter.

A pressure gauge positioned upstream of the meter for liquid makes it possible to determine the lowest pressure at which the gas separator still meets the efficiency requirements.

Before starting a test, the whole apparatus is made to operate at the desired liquid and gas flowrates so that all parts of the apparatus (except the proving tank) fill up under set conditions as regards the entry of air or gas.

The air may be introduced either by injection downstream of the pump or by suction upstream of it (see Figures 1, 2 and 3, which are given as examples).

In the former case, which makes it possible to operate without changing the performance of the pump due to the entry of air, the liquid and gas flows are adjusted by means of control valves. The air or gas is introduced through a tube positioned in the centre of the pipework for the liquid, for example at an elbow.

In the latter case, which reproduces the conditions encountered in reality (pressure reduction by suction), the pump must be set to the maximum flowrate of the separator. If the pump has too great a flowrate, it must be possible to regulate it with a speed reducer. The pump should preferably be of the volumetric type but it may also be of the centrifugal type if the supply tank feeds the pump by gravity. The pressure reduction must then be regulated by a valve positioned upstream of the pump, and the air inlet must be equipped with a non-return valve which prevents any leakage at the movement of switching off.

**(3) Test on gas extractors**

An example of test bench is shown in Figure 4.

It includes a container for creating a pocket of air to be removed with a volume equal to the minimum measured quantity of the gas extractor (the minimum measured quantity of the system being not yet specified). When the test is carried out with a proving tank having such a great capacity that the maximum permissible error cannot be evaluated correctly on the basis of a single operation of the gas extractor, the number of operations during the same test shall be multiplied by 2, 3 or 4, to obtain the required accuracy.

**(4) Tests on special gas extractors**

Special gas extractors, mainly used for measuring systems on road tankers, are principally intended to prevent measurement errors which may arise from the complete emptying of one compartment. They must also separate and continuously remove introduced air, although to a lesser degree than a gas separator.

In the case of separate approval, they should be tested on a test bench which corresponds in principle to Figure 5.

This test bench is similar to that in Figure 1 but it differs in order to reproduce the actual conditions of delivery from road tankers to underground tanks, as is the case when service stations are supplied with petrol, and domestic fuel oil deliveries are made. Thus, the supply tank is located above the special gas extractor and the meter, i.e. at a level corresponding to that of road tanker, and the proving tank is approximately 4 m below the meter.

In order to determine the additional error arising from the complete emptying of a road tanker, which may be caused by the air drawn in at the end of the delivery by the formation of a vortex, the supply tank is filled with a volume of liquid equivalent to that of the proving tank. The liquid is then emptied through the meter into the proving tank without operating the shut-off valve.

For delivery by gravity, pipework is used which bypasses the pump.

Due to the existence of the automatic shut-off valve in the hydraulic circuit connected to the gas extractor, the pocket of air to be evacuated (described in Annexure-B, paragraph 1(3)) may be created by emptying the pipework between the tank and the gas extractor.

Furthermore, given that a special elimination device should also perform the function of a separator for a small percentage of air introduced continuously it is necessary to carry out this test in a manner comparable to the tests described for separators in Annexure-B, 1(2), with air being either injected into the supply pipework or drawn in upstream of the pump by creating an entry of air and partly closing the valve of the supply tank.

2. **Tests on gas elimination devices forming part of a measuring system during pattern approval**

The tests are carried out with a proving tank of the capacity specified in Annexure B, paragraph 1(1) or any appropriate standard.

(1) Tests on a gas separator

This examination particularly applies to patterns of separators included in measuring systems which can be mass produced and transported without dismantling, such as petrol pump fed by their own supply pumps.

The essential part of the test bench (Figure 6) is the measuring system itself (in this case, the fuel dispenser).

In accordance with conditions encountered in actual use, the liquid is drawn up from a

tank on a lower level than the meter. The air is drawn in by suction through a special inlet equipped with a control valve. The air can be measured by a gas meter. However, it is not necessary to use a gas meter if the separator is capable of separating and eliminating the air introduced in any proportion, as provided in, paragraph 2(10)(viii).

The requirements in, paragraph 2(10)(i) and 2(10)(viii) should be complied with under test conditions such that the maximum flowrate of the measuring system is reached when no air enters.

(2) Tests on a gas extractor and a special gas extractor

The measuring system comprising the gas elimination device must be constructed so that the tests can be carried out as described in Annexure B, Paragraph 1(3) or 1(4).

**3. Tests on gas elimination devices forming part of a measuring system during verification**

The gas elimination devices are tested without it being necessary to verify that the maximum permissible errors for the individual units are complied with.

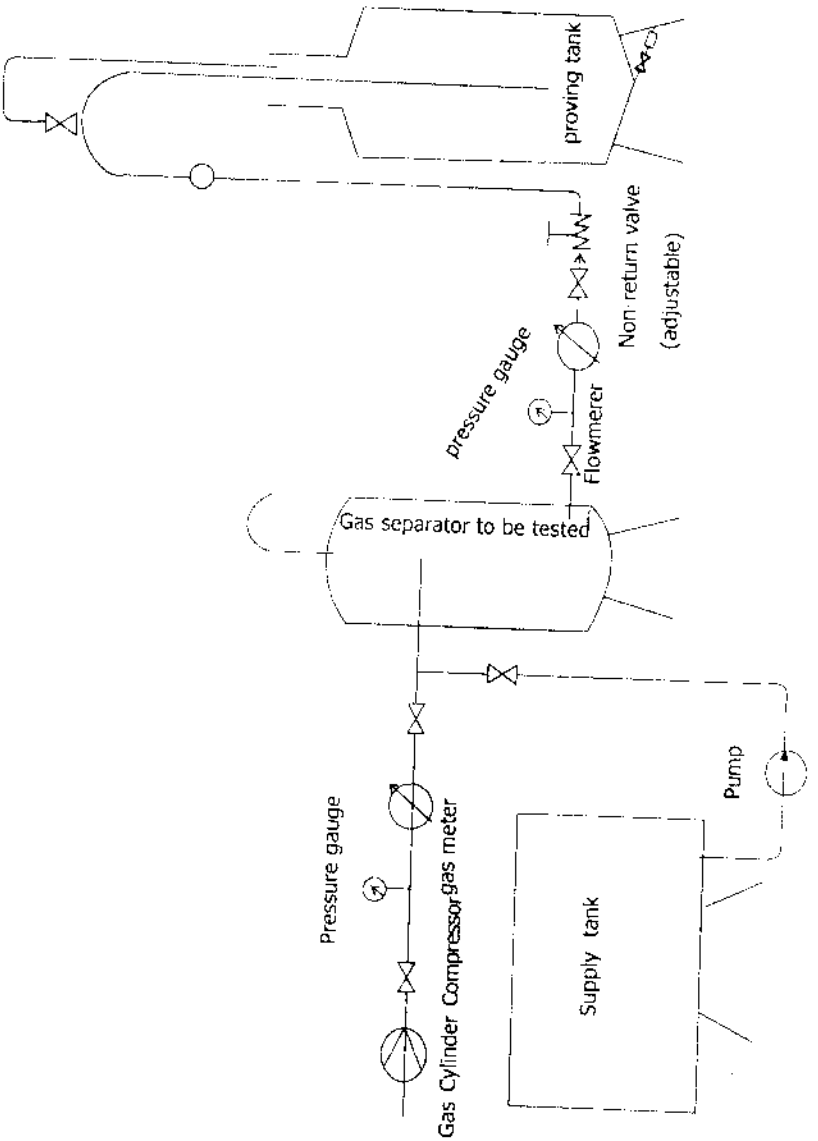


**FIGURE-1**

**TEST BENCH FOR GAS SEPARATORS**

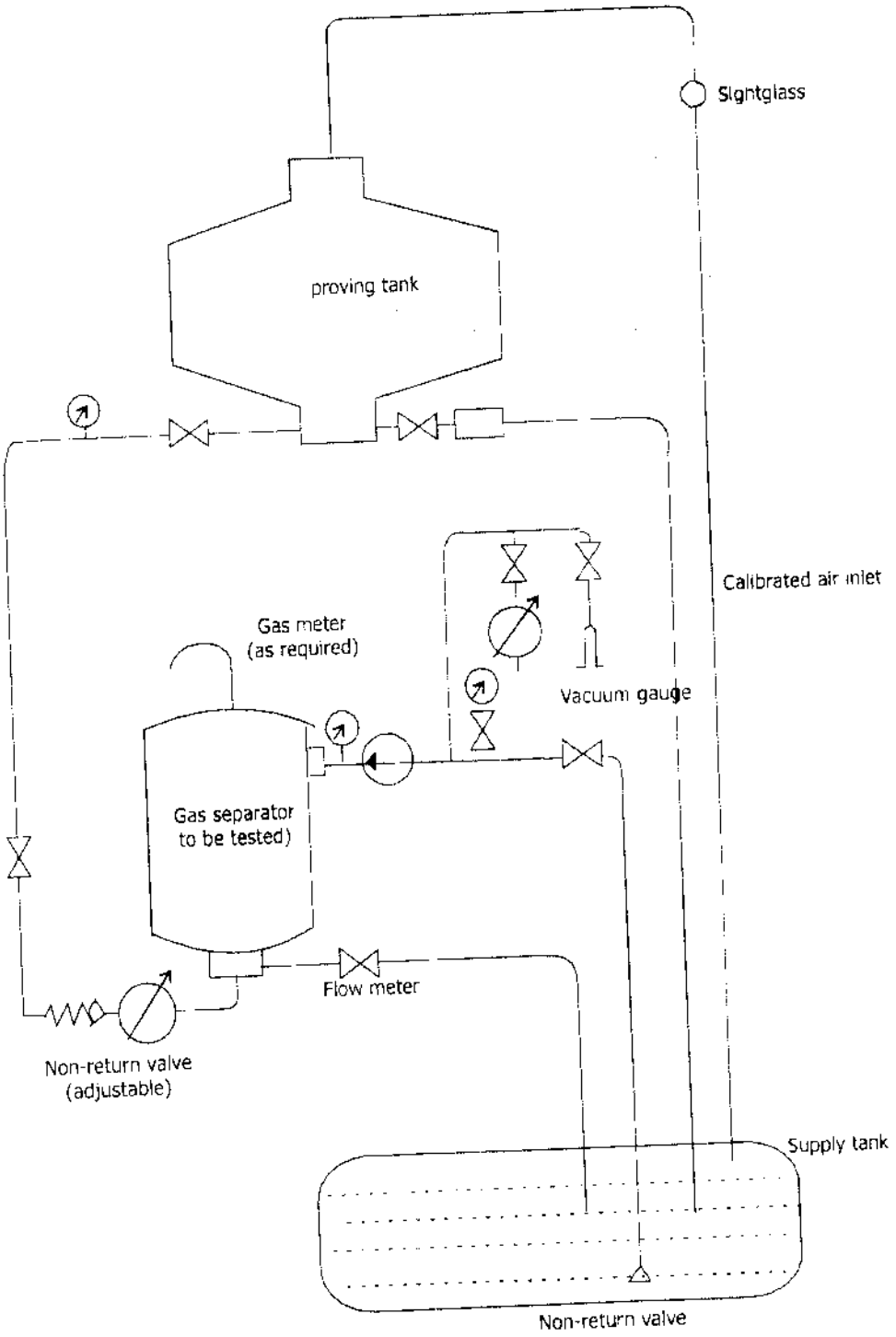


**FIGURE-2**

**TEST BENCH FOR GAS SEPARATORS**

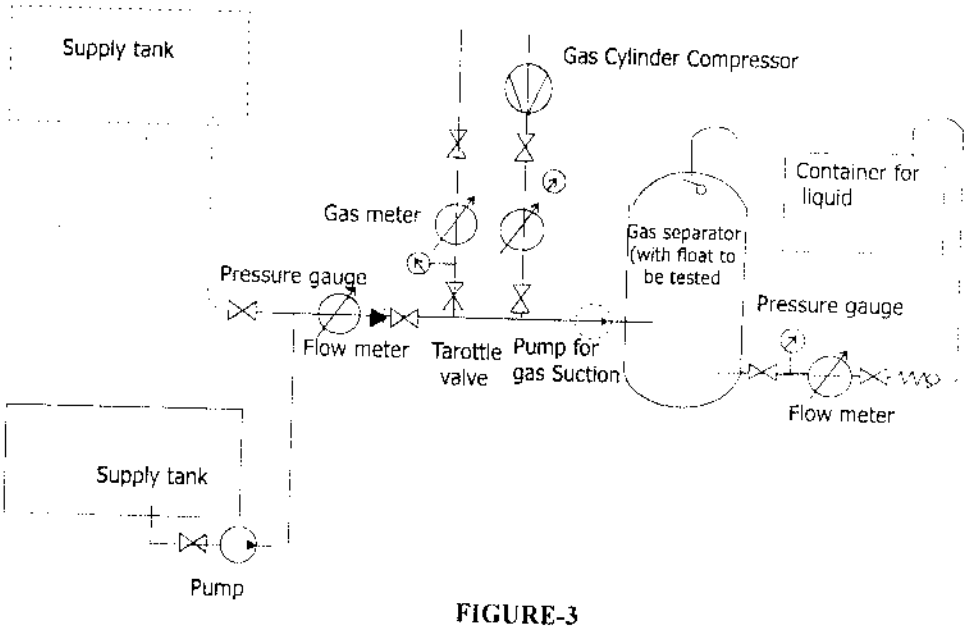


**FIGURE-3**
TEST BENCH FOR GAS SEPARATORS
..... with gas injection
..... with gas suction

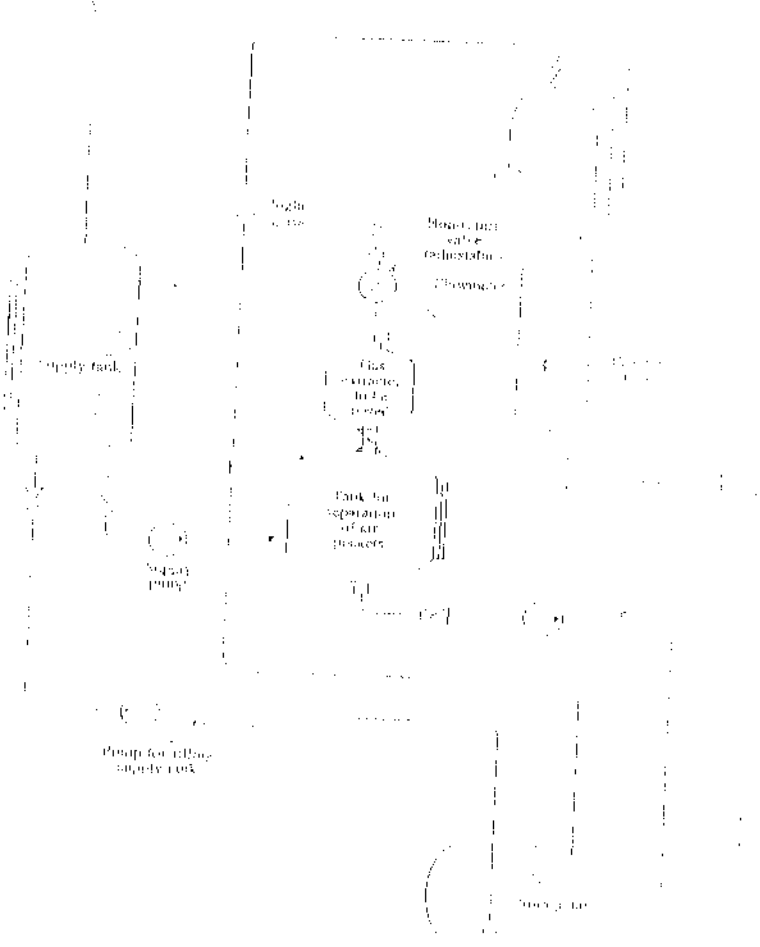

**FIGURE-4**
TEST BENCH FOR SPECIAL GAS EXTRACTORS

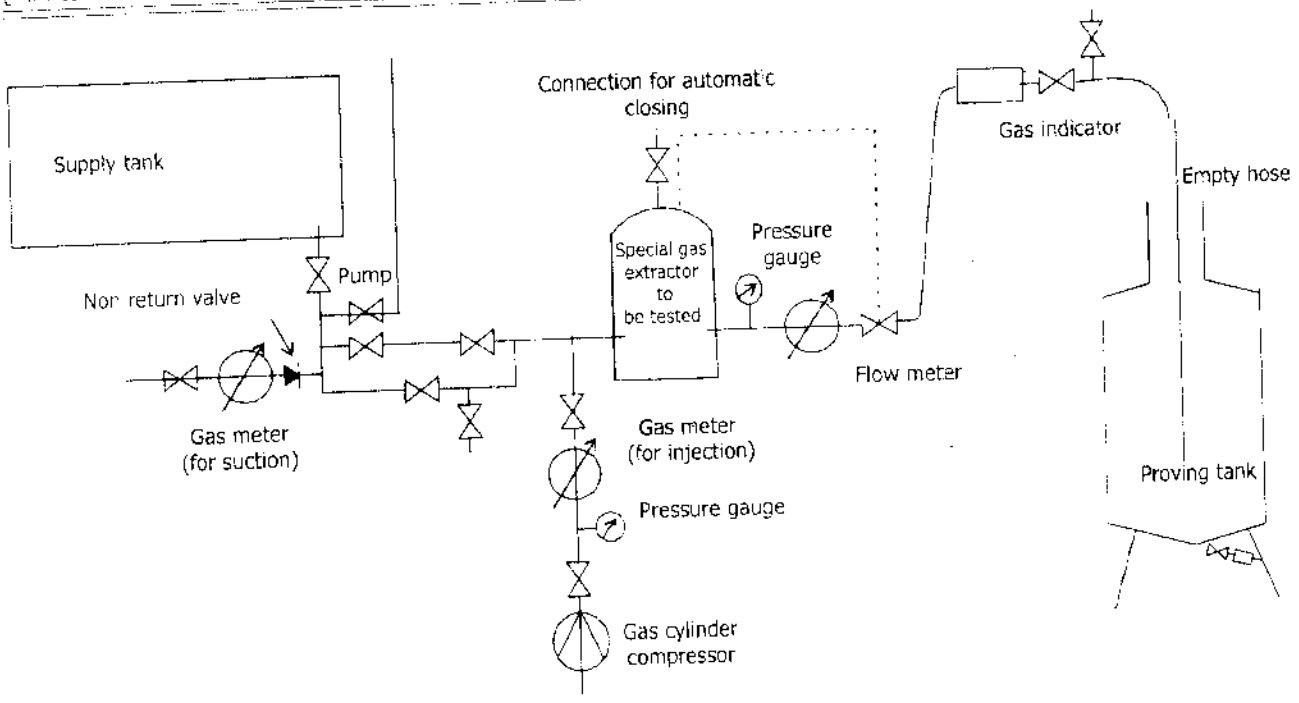


**FIGURE-5 : Test bench for special gas extractors**

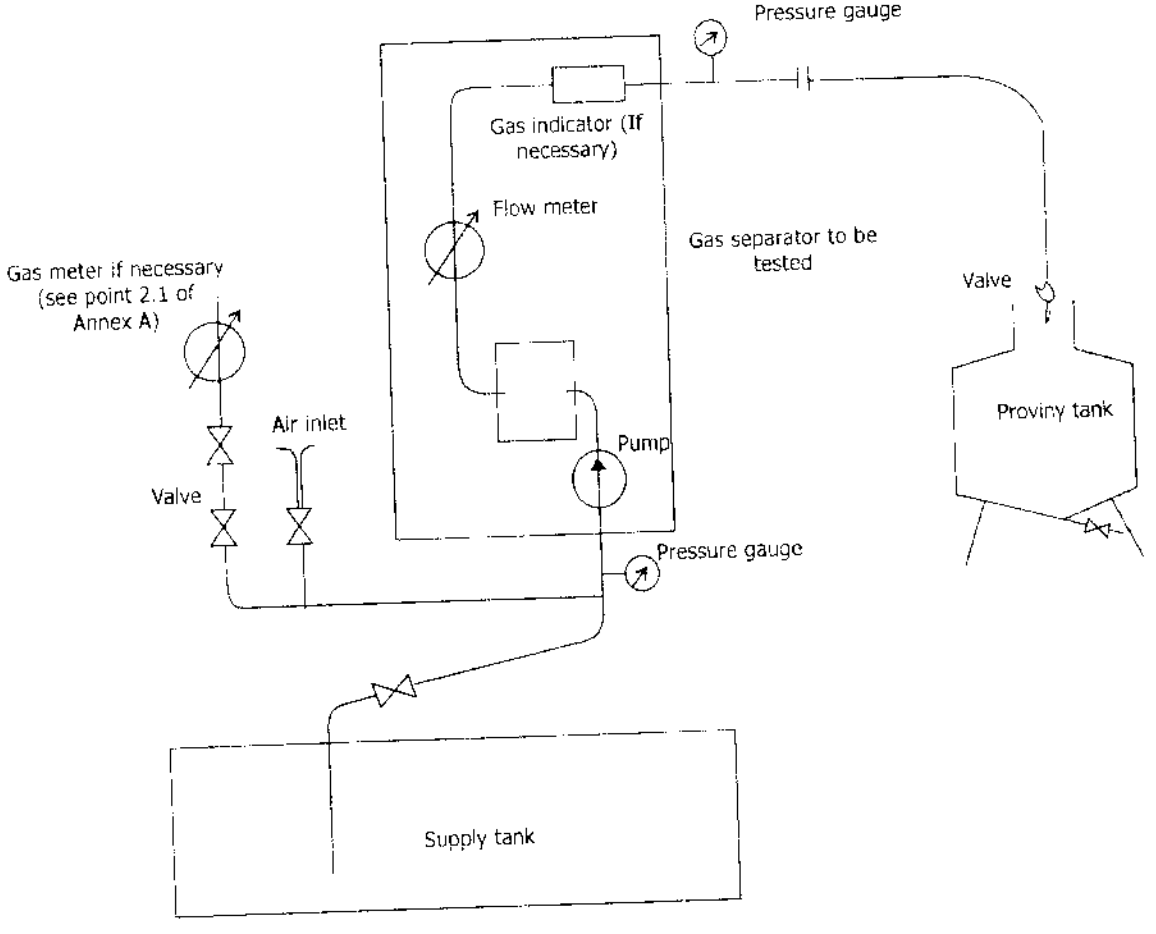


**FIGURE-6**
**TESTING FACILITY FOR GAS SEPARATORS IN FUEL DISPENSERS**

474 GI/11—144

## PART V

## VOLUMETRIC CONTAINER TYPE LIQUID MEASURING DEVICE

### 1. General

The volumetric container type liquid measuring device consists of a bucket, a float and a dip stick suitably graduated to indicate the volume of liquid at different heights in the bucket. The device is generally used for measuring the quantity of milk at milk purchasing centres.

### 2. Nominal capacities

(a) The unit of volume shall be the cubic decimetre or litre; or the cubic centimetre (cm) or millilitre.

(b) The volumetric container type liquid measuring device may be one of the following capacities :

5 $dm^3$, 10 $dm^3$, 20 $dm^3$ and 50 $dm^3$

(c) The value of the smallest graduation on the dipstick shall be of the form of 1 x 10n, 2 x 10n or 5 x 10n where 'n' represents a whole number, positive or negative or is equal to zero.

### 3. General requirements

(a) The bucket shall be made of suitable metal or alloy. The metal or alloy used shall be thermally stable, shall resist deformation, shall not have an unduly high coefficient of cubical expansion, and shall not affect the liquid being measured in any way or be injurious to health. Some of the materials considered suitable are :

(i) mild steel,

(ii) stainless steel,

(iii) brass sheet,

(iv) copper sheet,

(v) aluminium alloy.

(b) The wall thickness of the bucket shall be so selected that the bucket will not get dented in normal use or become unusable after a few years in service.

(c) The bucket shall be free from surface defects and indentation. External and internal surfaces of the bucket made of mild steel, copper sheet and brass sheet shall be well tinned or tin plated.

(d) All seams shall be filled and smoothened to prevent the entrapment of air or liquid.

(e) The bucket shall be provided with a well formed and proportionate spout to facilitate pouring of liquid.

(f) The bucket shall be cylindrical in form. The bottom of the bucket shall be slightly concave to prevent change of shape due to the weight of the liquid. The maximum depth of the concavity shall not be more than 20 mm.

(g) The bottom of the bucket shall be reinforced with angle strip of thickness not less than 5 mm.

(h) The upper edge of the bucket shall be reinforced round the circumference with a reinforcing band having a thickness not less than 5 mm.

(i) The bucket shall be provided with a suitable handle on the side opposite the spout.

(j) The top of the bucket shall be provided with a cross band across the diameter. The band shall have groove of appropriate size and centrally located for inserting the dip stick.

(k) The float shall be suitably fabricated so as to be free from holes, pockets, dents or crevices. A dip stick shall be firmly welded on the upper centre of the float. The dip stick together with the float shall be so constructed that the device so formed maintains verticality in all positions.

(l) The dip stick shall have a rectangular cross-section of minimum dimensions 20mm x 10mm. The graduations shall be made by engraving or other means on both sides of the vertical surface.

(m) The dip stick shall be graduated at suitable intervals throughout the nominal capacity of the measure.

(n) The graduation lines on the dip stick shall be clear straight, perpendicular to the axis of the stick and of uniform thickness not exceeding 1 mm.

(o) The dip stick shall be identified with the bucket by a number of identifications, which shall be clearly legible and indelible.

### 4. Marking

The following inscriptions shall be clearly and indelibly marked at a conspicuous place on the bucket or on a special plate securely attached to the bucket :—

(a) nominal capacity,

(b) manufacturer's name or trade mark,

(c) the words "for edible liquids".

**5. Sealing**

A suitable plate or other device shall be provided to receive the stamp or seal of the verification authority.

## PART VI
## CLINICAL THERMOMETER
## PART A
## CLINICAL THERMOMETER—SOLID STEM TYPE

*Scope* : This part specifies the requirements and methods of tests for solid stem type mercury in glass clinical thermometers having a maximum indicating device.

**1. Terminology**

For the purpose of this standard the definitions given in IS 2627—1979 Glossary of terms relating to liquid-in-glass thermometers (first Revision) as revised from time to time in addition to the following, shall apply.

**2. Types**

The thermometers shall be of the solid stem mercury-in-glass type.

**3. Temperature Scale**

The thermometers shall be graduated in degrees Celsius (°C) and shall have a range from 35° to 42°C or 35° to 43°C.

**4. Testing**

Thermometers shall be tested for total vertical immersion.

**5. Requirements**

(1) *Patterns*—There shall be two patterns of bulb, namely, oral and rectal as follows:—

(a) Oral—for thermometers for use in mouth and

(b) Rectal—for thermometers for use in rectum

***Note*** 1: Oral thermometers may also be used in armpit or groin.

***Note*** 2: Rectal thermometers may also be used in the mouth, armpit or groin after proper disinfection. Rectal thermometers if used orally, may however give slightly lower reading.

(2) *Materials*

(i) *Glass tubing*—The thermometers shall be made from glass tubing conforming to IS 4529—1968 Specification for glass tubes for medical thermometers.

(ii) *Bulb*—The thermometer bulb shall be made from a type of glass which assures that the depression of zero, determined in accordance with the procedure given in Appendix D, does not exceed 0.07°C. The glass shall be identified visible and indelible, either by the glass manufacturer or by the manufacturer of the thermometer.

(iii) The types of glass used for the maximum device, capillary tube, and bulbs shall meet the following requirements:—

When the glass is analyzed according to the requirements of IS 2303 (Part I/Section 1), the quantity of alkali passed into solution for 1g of glass must correspond to not more than 263.5g of $Na_2O$.

(iv) *Thermometric liquid* — The thermometric liquid shall be pure, dry mercury.

(3) *Construction*

(i) The stem shall be in alignment with the bulb.

(a) The free end of the stem shall be finished smooth, preferably hemispherical in shape, as shown in Figure 1.

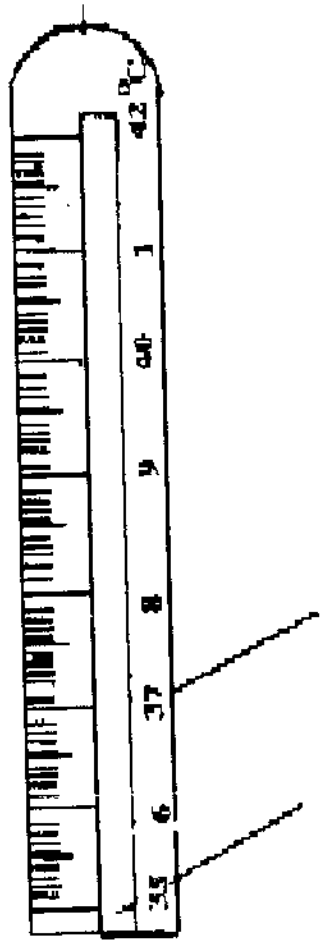


**FIGURE 1 STEM OF CLINICAL THERMOMETER**