

Module 6

Tightness Testing

Module 6: Tightness Testing

IGE / UP / 1B New Tightness Testing Procedure



Covers pipework up to 35mm and installation volumes of 0.035m³

Module 6: Tightness Testing

Objectives



By the end of Module 6, Tightness Testing and Direct Purging of Small Natural Gas Installations, you should be able to show understanding in the following areas:

- The correct selection and reading of pressure gauges
- The allowed pressure drops for existing installations related to meter size/type, pipe diameter and internal volume (IV) with appliances connected to the gas supply and not isolated including Ultrasonic E6, Diaphragm U6/G4, U16/G10 meters and where no meter is fitted
- The identification of no perceptible movement on the gauge (0.25mbar water gauge and 0.2mbar electronic gauge reading to one decimal place)
- The allowed pressure drop for an existing installation to be tested including emergency control valve, but no meter is installed e.g., flat where the supply is not individually metered.

Module 6: Tightness Testing

Objectives



- Electronic token meter tamper devices and their effect on tightness testing
- The procedures for dealing with an emergency/meter control that is letting by
- The actions to be taken when a smell of gas persists:
 - a) after completion of a satisfactory soundness test
 - b) when the ECV/AECV/MIV is turned off or a leaking installation cannot be repaired
- Tightness testing requirements when carrying out gas work on pipework over 35mm or where total IV exceeds 0.035m^3
- Tightness testing requirements prior to alteration or extension to existing installations
- Acronyms and symbols used within the industry standard used for tightness testing
- Calculating internal volume (IV) and purge volume (PV) exercise for installations with E6, U6 G4 meters connected to 35mm pipework and U16 meters connected to any pipework up to 35mm
- The requirements for purging installations with an $\text{IV} \leq 0.02\text{m}^3$ and those exceeding 0.02m^3
- Additional tests required where the supply Maximum Operating Pressure (MOP) exceeds 75mbar, but a meter inlet valve (MIV) is not fitted.

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Regulations and Standards



The main Regulations and Standard applying to Tightness Testing and Purging of domestic sized natural gas installations are:

- Regulations 22 and 33 - Gas Safety (Installation and Use) Regulations 1998
- IGEM/UP/1B Edition 3 - Tightness testing and direct purging of small Liquefied Petroleum Gas/Air, Natural Gas and Liquefied Petroleum Gas installations.

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When to Test for Tightness



- On completion of new pipework installations
- After alteration to, replacement of, or re-use of, existing installations
- New extensions to existing pipework
- Prior to any work (see Gas Safety (Installation and Use) Regulations (GS(I&U)R) on existing pipework
- Where there is a known or suspected gas leak in installations
- Where there has been a complete loss of pressure for any reason.

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When to Test for Tightness



Tightness testing procedures also apply to installations where:

- Gas appliances are not connected
- Gas appliances are connected but are isolated
- Gas appliances are connected, not isolated, but are turned off at the operating tap(s)
- A meter is installed, and no outlet pipework is connected.

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Direct Purging



Direct purging of installations is required in the following circumstances:

- New installations
- Alteration to, replacement of, or re-use of existing installations
- New extensions to existing installations
- Where there has been a complete loss of installation pressure for any reason
- Where there is the possibility of air being present in an installation
- Where an installation is to be taken out of service temporarily or permanently.

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The Correct Selection and Reading of Pressure Gauges



Pressure Gauges

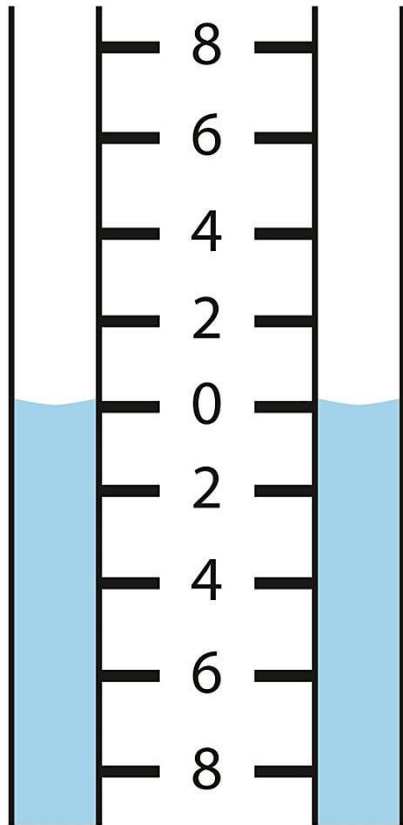
To carry out a tightness test the most important piece of equipment required is some form of pressure gauge.

There are many types of gauge that exist including:

- U gauge - also known as a water gauge or U tube manometer
- Electronic pressure gauges.

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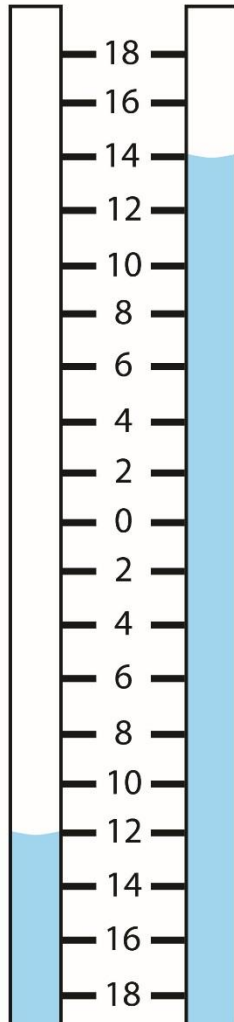
The Correct Selection and Reading of Pressure Gauges



- U tube manometers are generally filled to the zero level using a suitable fluid of specific gravity (SG) = 1, i.e., water
- Any gauge which is filled to the zero level using high specific gravity (SG) fluid is not considered suitable for the purpose of tightness testing
- Most U gauges incorporate dual scales for reading in millibars (mbar) or inches water gauge ("WG)
- Only older appliances refer to working pressures in "WG, so we will use mbar for all work with pressures throughout this module
- Should you wish for any reason to convert millibars to "WG, simply divide by 2.5. E.g., $7.5\text{mbar} \div 2.5 = 3\text{"WG}$

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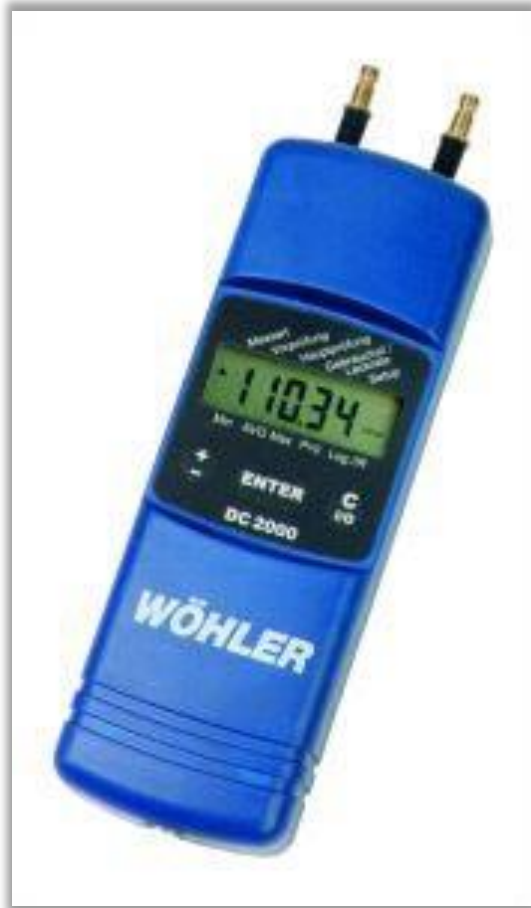
The Correct Selection and Reading of Pressure Gauges



- When reading the gauge, for accuracy, it is essential that the gauge is vertical, as tilting it will give false readings
- Similarly, if the operative's eyes are not level with the meniscus, then the reading can be misinterpreted
- If a reading is taken without zeroing the scale, a true reading can be obtained by reading each column separately, adding the two readings together and then dividing by 2
- For example, if one column reads 12mbar and the other 14mbar then the true reading would be: 13mbar, i.e., $12\text{mbar} + 14\text{mbar} = 26\text{mbar} \div 2 = 13\text{mbar}$

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The Correct Selection and Reading of Pressure Gauges



Electronic Gauges

Electronic pressure gauges are becoming increasingly popular, particularly as they can be used for taking the differential pressure readings that are required on some modern appliances

They are usually capable of reading pressures to one decimal place and as a result can be misleading if an operative is not concentrating, i.e., 1.0mbar could be read as 10mbar.

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The Correct Selection and Reading of Pressure Gauges



Electronic Gauges

IGEM/UP/1B Edition 3 specifies tolerances for equipment used when tightness testing a gas installation. These are:

- Any water gauge shall be capable of being read to an accuracy of 0.5mbar or better
- Any electronic gauge shall be capable of being read to an accuracy of 0.1mbar.

IGEM/UP/1B Edition 3 also declares that any electronic gauge shall be:

- Operated within the manufacturer's specification for ambient temperature
- Be stabilised at the ambient temperature as stated by the manufacturer, prior to the test being carried out
- Be calibrated annually and be intrinsically safe.

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Using the U Gauge



- Check that the gauge is in good condition and that the glass is clean
- Fill the gauge to zero position with clean water; ensure that there are no air bubbles
- The scale may be adjusted slightly to obtain a zero reading
- The gauge must be supported firmly in the vertical position by using either the stand or other method of support
- When using a dual scale gauge ensure the tube is connected to the correct side to make certain the required scale is used, e.g., mbar or inches water gauge
- Admit the gas slowly to prevent a surge in pressure which may blow the gauge water out
- Read the correct level and avoid errors, and ensure the reading is the same on both limbs of the gauge.

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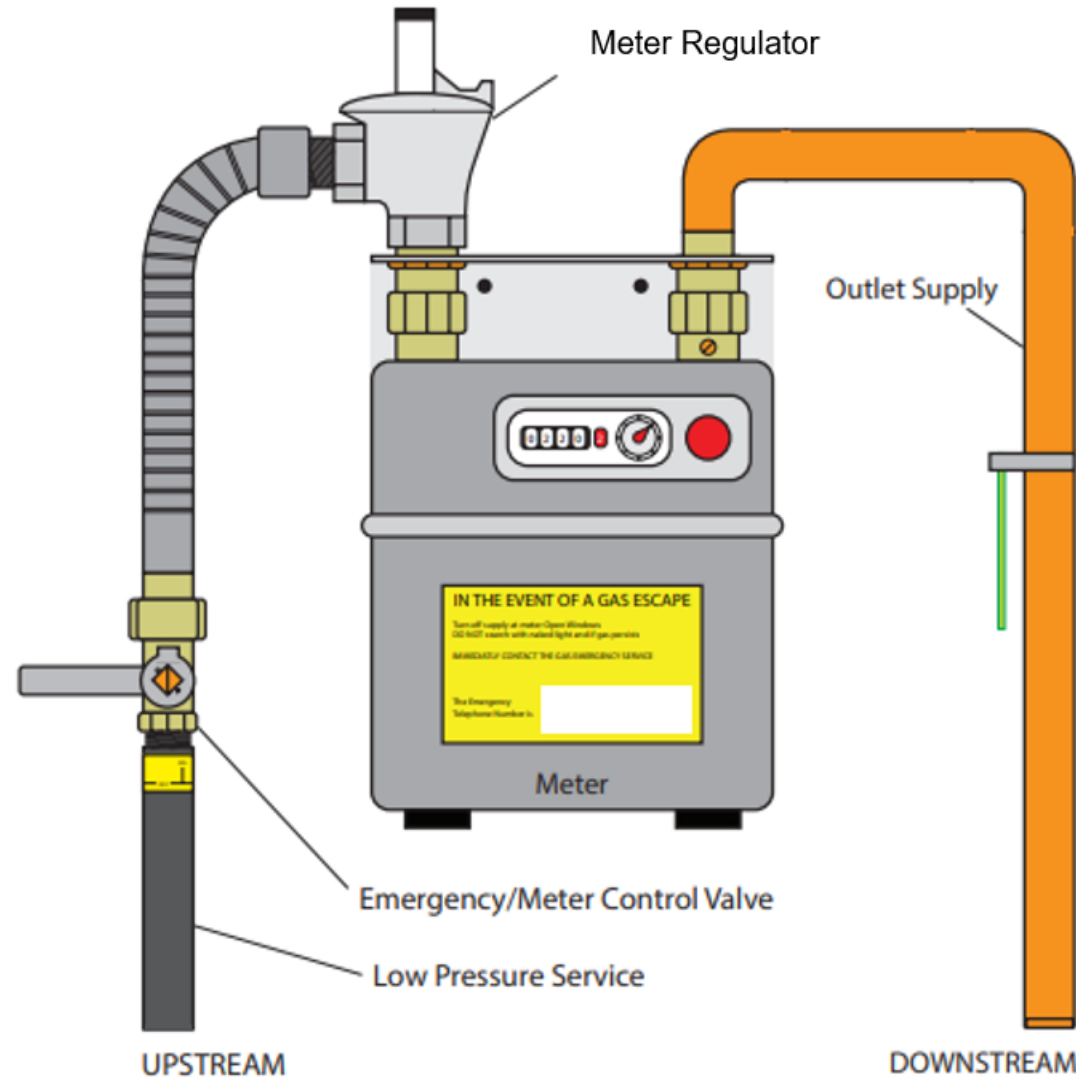
Criteria for Tightness Testing



- New installation pipework with new meter
- New installation pipework - no meter fitted
- Existing installation pipework and existing meter
- Existing installation pipework and new meter
- New extension
- New or existing installation with a gas meter but no outlet pipework connected.

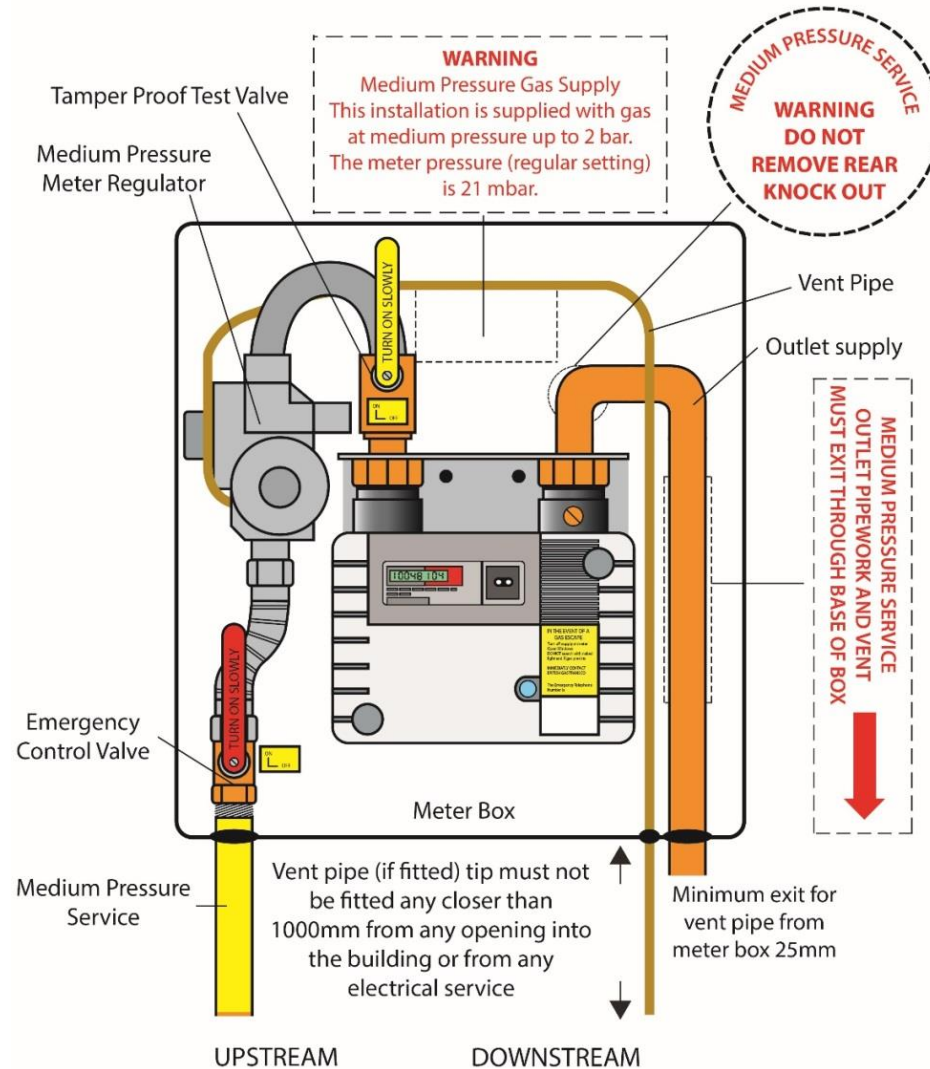
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Criteria for Tightness Testing



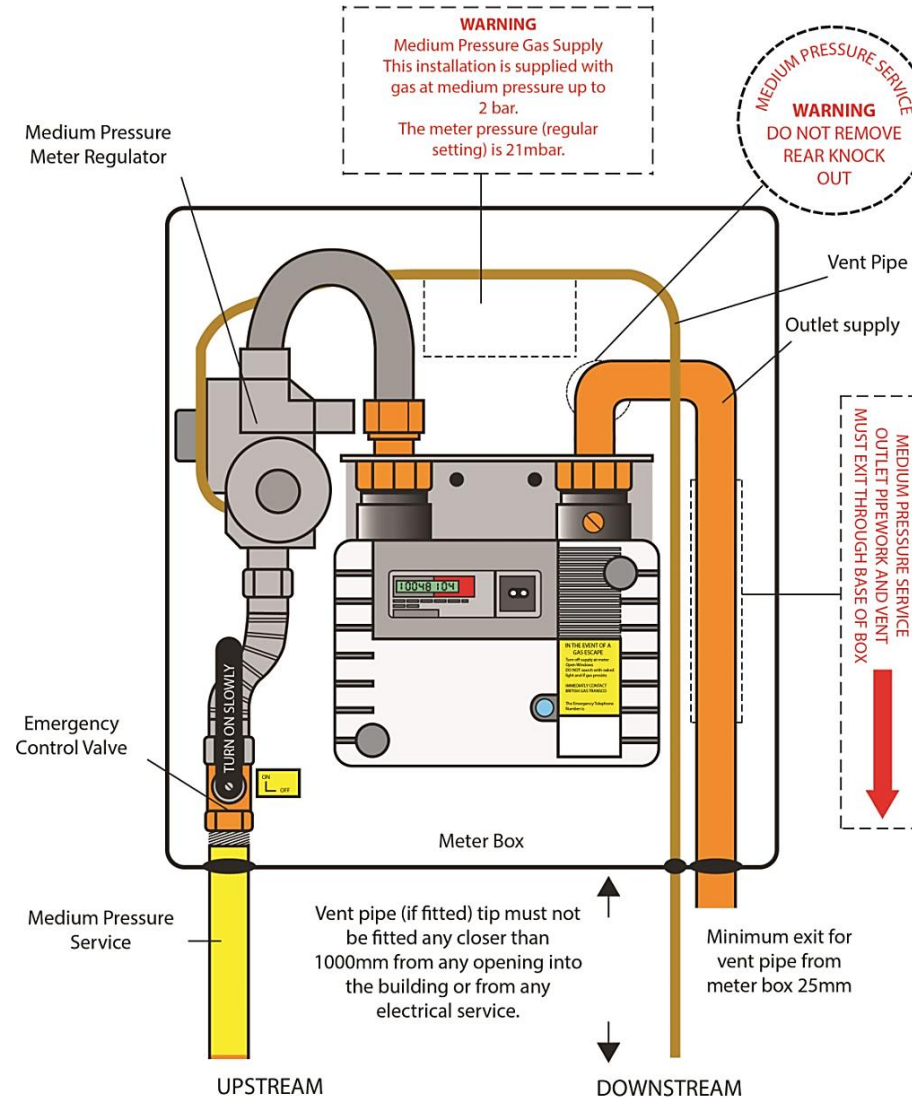
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Criteria for Tightness Testing



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Criteria for Tightness Testing



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Perceptible Movement



- For “new” installations and for all “let by tests”, the pass criteria is “no perceptible movement” during the test period

Note: A movement of 0.25mbar or less on a fluid (water) gauge is considered to be “not perceptible”. Therefore, if the gauge is seen to move, it can be inferred that the pressure within the installation has altered by more than 0.25mbar.

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Perceptible Movement - Existing Installation Pass Criteria



Type of Installation		
Meter Designation	Pipework Diameter	Maximum Permissible Pressure Drop
No Meter	≤ 28mm	8mbar
AECV only (e.g. flat)	> 28mm ≤ 35mm	4mbar
Ultrasonic ≤ 6m ³ h ⁻¹ (e.g. E6)	≤ 28mm	8mbar
	> 28mm ≤ 35mm	4mbar
Diaphragm ≤ 6m ³ h ⁻¹ (e.g. U6, G4)	≤ 28mm	4mbar
	> 28mm ≤ 35mm	2.5mbar
Diaphragm > 6m ³ h ⁻¹ ≤ 16m ³ h ⁻¹ (e.g. U16, G10)	≤ 35mm	1mbar
Key: ≤ less than or equal to > greater than		

Existing Installations Pass Criteria

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Leak Detector Fluid (LDF)



- The standard defines one action for all types of installation regardless of supply pressure or regulator
- That is, if the tightness test includes the section of pipework between the meter control valve (MCV) and the primary meter regulator, all joints in that section shall be tested at operating pressure, i.e., at the supply pressure, using a suitable leak detection fluid (LDF) or gas detector

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Installations with Electronic Token Meters



- You may encounter token or electronic card (Quantum) meters where the customer pays for their gas as they use it
- With these meters it is essential that you make sure that there is sufficient credit in the meter to allow gas to pass for you to carry out the tightness tests and purging
- An additional difficulty with a Quantum meter is that it is a very sophisticated meter that is designed to prevent fraud and theft of gas
- If the Quantum meter is knocked or tilted, it has a mechanism that will “lock off” the flow of gas until it has been reset by an engineer from the National Gas Emergency Service.

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Emergency Actions



These actions are intended to prevent the situation deteriorating and then improve the situation:

- Turn off the gas supply
- Extinguish all naked flames
- Do not operate any electrical switches or equipment
- Ventilate the property by opening windows and doors
- Report the problem to the National Gas Emergency Service Call Centre
- Ensure there is access to the property when the Emergency Service engineer arrives.

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Let-by Test of the ECV



When using gas as the test medium, carry out a let-by test of the isolation valve (the ECV or, for supply MOP > 75mbar, the MIV) as follows:

- Adjust the pressure to between 7 and 10mbar by slowly opening the isolation valve
- Turn off the gas supply by closing the isolation valve

If, over the next one minute period, there is a perceptible movement (rise) of the gauge, the means of isolation from the pressurised source may be leaking (letting-by), in which case the isolation valve shall be checked for let-by by disconnecting its outlet union and applying LDF to the valve barrel or ball.

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Tightness Testing Procedures



These procedures apply to any section of pipework, including meters, having all of the following:

- Maximum operating pressure at the outlet of the Emergency Control Valve not exceeding 2 bar
- An operating pressure at the outlet of a primary meter of 21mbar (nominal)
- A nominal bore of not greater than 35mm (DN 32, R1¼)
- A maximum rated capacity through the primary meter of not exceeding 16m³/h
- A maximum installation volume (IV), including any meter and its fittings, of not exceeding 0.035m³.

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Tightness Testing New Installations



- Open the means of isolation of any appliance(s) and ensure the control taps and any pilot burner supplies are turned off
- On a cooker with a fold down lid, lift the lid to the fully open position to ensure that any safety shut-off valve on the gas supply is in the open position.

Connect the pressure gauge to:

- A suitable pressure test point if the installation is connected to a gas supply or;
- Where a gas meter is not fitted, a branch of a test T-piece which is valved on the other branch for air to be pumped into the installation.

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Tightness Testing New Installations



When using gas as the test medium, carry out a let-by test of the closed isolation valve (the ECV or, for supply MOP > 75mbar, the MIV) as follows:

- Adjust the pressure to between 7 and 10mbar by slowly opening the isolation valve
- Close the isolation valve
- If, over the next one-minute period, there is no perceptible movement (rise) of the gauge, the installation shall be deemed to have passed the let by test
- Adjust the pressure to between 20 and 21mbar by slowly opening the isolation valve if pressurising using NG or pressurise the system via the test T-piece if using air
- Should the pressure exceed 23mbar it is necessary to drop the pressure back to between 7 and 10mbar before raising the pressure to between 20 and 21mbar. This is to avoid regulator lock-up during the tightness test

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Tightness Testing New Installations



- Turn off the gas or air supply
- Allow one minute for temperature stabilisation, then, if necessary, re-adjust the pressure to between 20 and 21mbar
- Check for any perceptible movement (fall) of the gauge over the next two-minute period. If there is no perceptible movement on the gauge and there is no smell of gas, the installation shall be deemed to have passed the test
- Otherwise, the installation shall be deemed to have failed the test
- If the installation fails the test, trace and repair the leak(s) and re-test the installation.

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Tightness Testing New Installations



- If the leak(s) cannot be traced and repaired, the installation must be made safe by disconnecting appliance(s) or isolating the installation, as appropriate, and sealing all open ends with appropriate fittings
- Upon completion of the test, remove the pressure gauge and re-seal the test point/test T-piece connection
- Where connected to a gas supply, slowly turn on the gas supply
- Test the pressure test point, ECV outlet connection, regulator connections and where appropriate, the MIV connections, with LDF
- Purge installation
- Record the test results and, where appropriate, inform the responsible person.

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Tightness Testing Existing Installations



- Open the means of isolation of any appliance(s) and ensure the control taps and any pilot burner supplies are turned off
- On a cooker with a fold down lid, lift the lid to the fully open position to ensure that any safety shut-off valve on the gas supply is in the open position
- Turn off the gas supply at the appropriate isolation valve i.e. for Maximum Operating Pressure of up to 75mbar, the Emergency Control Valve and, for Maximum Operating Pressure greater than 75mbar, the Meter Inlet Valve (in which case ensure that the Emergency Control Valve is open)
- Connect the pressure gauge to a suitable pressure test point on the installation.

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Tightness Testing Existing Installations



Carry out a let-by test of the closed isolation valve as follows:

- Adjust the pressure to between 7 and 10mbar by slowly opening the isolation valve
- For MOP greater than 75mbar, ensure the regulator is activated
- Close the isolation valve.
- If, over the next one-minute period, there is no perceptible movement (rise) of the gauge, the installation shall be deemed to have passed the let by test

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Tightness Testing Existing Installations



- Adjust the pressure to between 20 and 21mbar by slowly opening the isolation valve.
- Should the pressure exceed 23mbar it is necessary to drop the pressure back to between 7 and 10mbar before raising the pressure to between 20 and 21mbar. This is to avoid regulator lock-up during the tightness test
- Turn off the gas supply
- Allow one minute for temperature stabilisation then, if necessary, re-adjust the pressure to between 20 and 21mbar
- Check for any pressure drop over the next two minute period.

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Tightness Testing Existing Installations



- Where no appliance is connected, there shall be no perceptible pressure movement (fall) on the gauge over the two minute period and there shall be no smell of gas
- If there is no perceptible movement on the gauge and there is no smell of gas, the installation shall be deemed to have passed the test
- If the installation fails the test, trace and repair the leak(s) and re-test the installation. If the leak(s) cannot be traced and repaired, the installation must be made safe by disconnecting appliances or installation.

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Tightness Testing Existing Installations



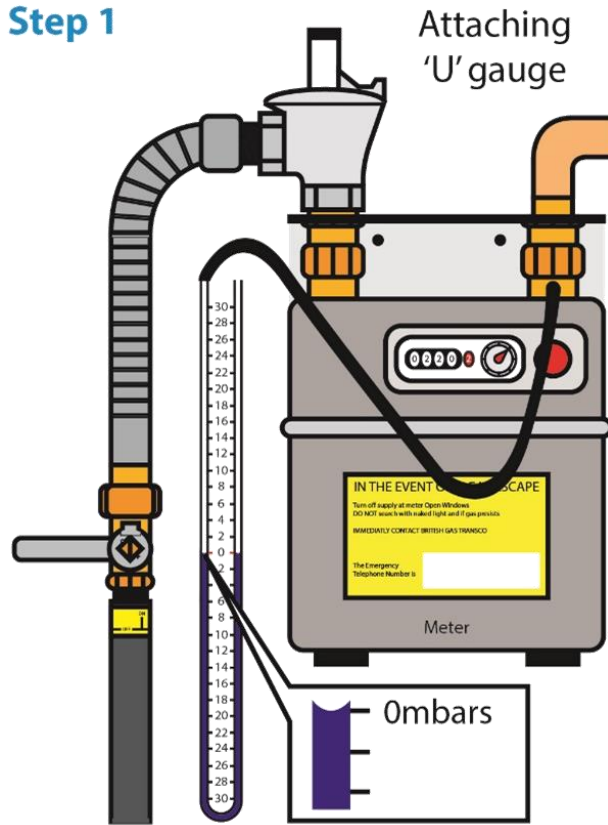
- Upon completion of the test, remove the pressure gauge and re-seal the test point
- Slowly turn on the gas supply
- Test the pressure test point, ECV outlet connection, regulator connections and, where appropriate, the MIV connections with LDF or a gas detector. If required at this stage, purge the installation
- Record the test, results and, where appropriate, inform the responsible person.

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Tightness Testing Requirements Prior to Alteration or Extension to Existing Installations

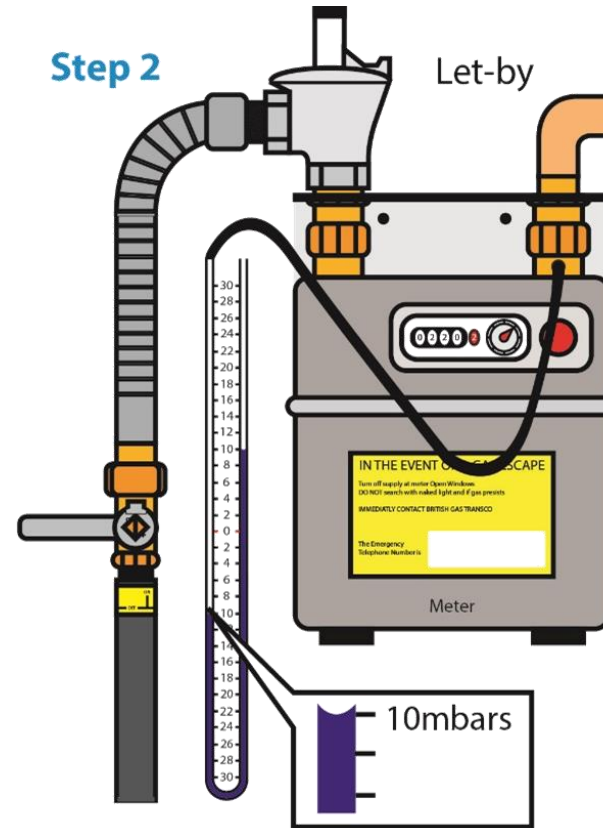


Step 1



Turn off gas at emergency/meter control valve and attach a zeroed 'U' gauge to the meter test point.

Step 2



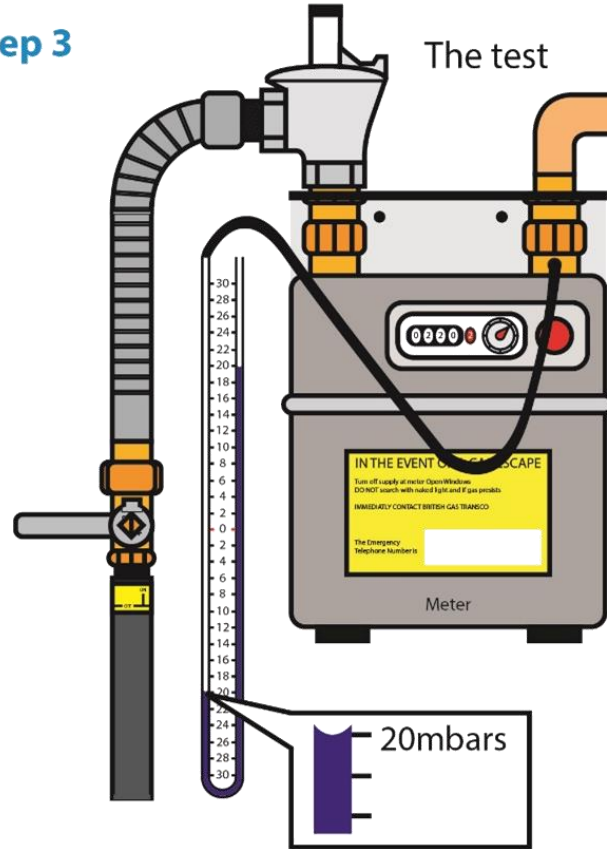
Check all appliances are off including pilot lights. Adjust the pressure to between 7 and 10mbar and turn off emergency/meter control. After one minute check for any increase in pressure.

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Tightness Testing Requirements Prior to Alteration or Extension to Existing Installations



Step 3



Following a satisfactory let-by test raise pressure to between 20 and 21mbar. Turn off meter/emergency control and allow one minute for temperature to stabilise. Observe the gauge after a further two minutes. Ensure any hotplate lids are in the upright position.

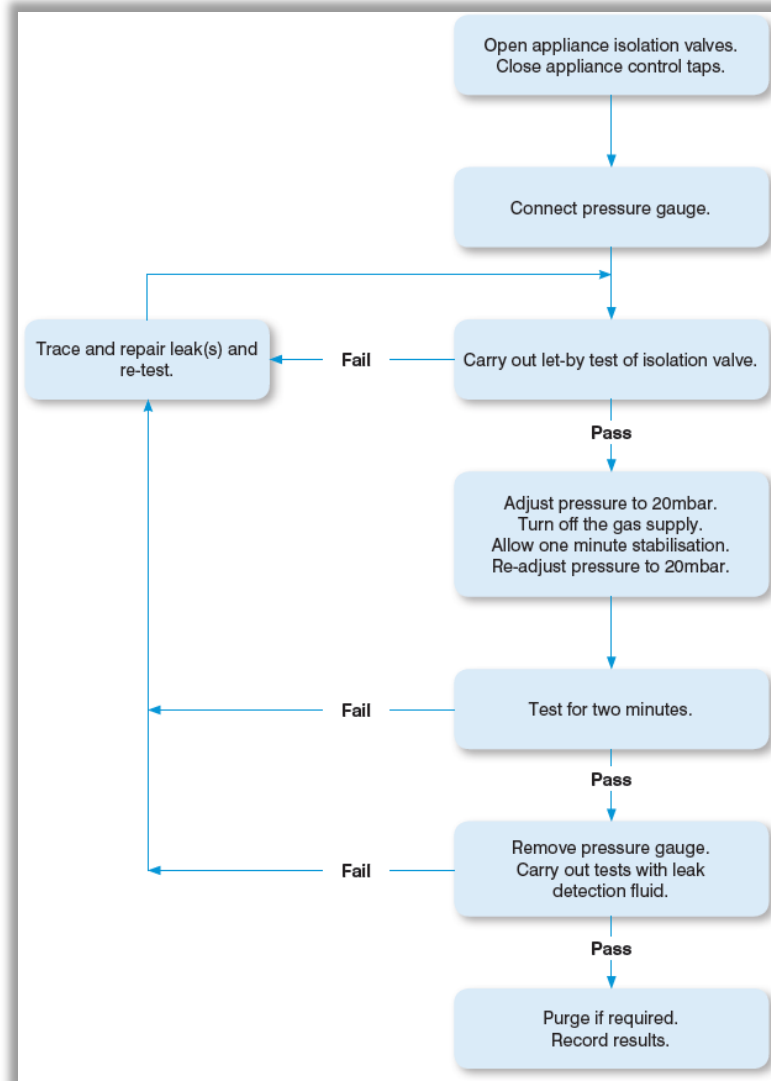
Step 4 & 5



Check results of test and on satisfactory completion of the test, remove gauge and with the meter/emergency control in ON position, test with leak detection fluid, the connections, between the meter/emergency control and the meter inlet connection and the meter test point.

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Flow Diagram for Tightness Testing New and Existing Installations



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Additional Tests Required Where the Supply MOP Exceeds 75mbar, but a Meter Inlet Valve (MIV) is not Fitted



Carry out a let-by test of the ECV as follows:

- Turn off the gas at the ECV and adjust the pressure in the installation to between 7 and 10mbar
- Operate the UPSO or excess flow valve reset mechanism to balance the pressures either side of the regulator and then allow it to re-shut
- If when operating the UPSO or excess flow valve the release of the trapped pressure causes the pressure in the installation to rise above 10mbar then re-adjust the pressure to between 7 and 10mbar
- Check for any perceptible movement (rise) of the gauge reading over the next one minute period.

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Additional Tests Required Where the Supply MOP Exceeds 75mbar, but a Meter Inlet Valve (MIV) is not Fitted



Carry out a let-by test on the regulator as follows:

- Allow any release mechanism on the regulator to return to its off position
- Open the ECV
- Following the successful completion of let-by tests, close the ECV and release any pressure from the system and re-seal
- Open the ECV and slowly raise the pressure in the installation to between 18 and 19mbar (re-set the UPSO mechanism)
- Turn off the gas supply
- Allow one minute for temperature stabilisation.

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Additional Tests Required Where the Supply MOP Exceeds 75mbar, but a Meter Inlet Valve (MIV) is not Fitted



- Check for any pressure drop over the next two minute period and that the pressure drop over this period does not exceed the values given in slide 19 and that there is no smell of gas
- Upon completion of the test, remove the pressure gauge and re-seal the test point/test T-piece connection
- Where connected to a gas supply, slowly turn on the gas supply. Test the pressure test point, ECV outlet connection, regulator connections and, where appropriate, the MIV connections, with LDF. If required at this stage, purge in accordance with the procedures described earlier in this module
- If the installation fails the test, trace and repair the leak(s) and re-test the installation. If the leak(s) cannot be traced and repaired, make the installation safe
- Record the test results and, where appropriate, inform the responsible person.

Module 6: Tightness Testing

Direct Purging to Fuel Gas



Whenever a gas supply is commissioned or re-commissioned after being turned off, any air in the installation must be purged.

A tightness test of pipework must be carried out immediately prior to any purge admitting fuel gas.

Every new and modified installation must be purged after passing the tightness test when being connected to a gas supply.

Module 6: Tightness Testing

Installation Volume and Purge Volume



Type of Installation		Purge Volume (PV)
Meter Designation	Pipework Diameter	
U6, G4, E6	$\leq 28\text{mm}$	0.01m ³ (0.35ft ³)
U6, G4, E6, U16, G10	$> 28\text{mm} \leq 35\text{mm}$	1.5 IV
Key: \leq less than or equal to		$>$ greater than

Purge Volume

Module 6: Tightness Testing

Purging Procedures



The following procedure shall be carried out:

- a) Within the vicinity of the purge point prevent inadvertent operation of any electrical switch or appliance, extinguish all potential sources of ignition and open windows, doors etc.
- b) Ensure all appliances are turned off and advise the responsible person for the premises of the intent to purge and that there may be a smell of gas
- c) Slowly turn on the gas supply and note the position of the test dial or test drum on diaphragm meters or the meter reading on ultrasonic meters
- d) Select the appropriate purge activity based on the installation volume.

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Installation Volumes $\leq 0.02\text{m}^3$



From a suitable purge point on the installation either turn on a burner control tap on an appliance with an open burner or loosen the appropriate fitting sealing the gas way.

If purging by opening a burner control tap, it is permissible to hold a source of ignition adjacent to the burner head or to continually operate the appliance's ignition system to attempt to ignite the purged gas/air mixture.

Module 6: Tightness Testing

Installation Volumes $> 0.02\text{m}^3 \leq 0.035\text{m}^3$



From a suitable purge point on the installation turn on a burner control tap on an appliance with an open burner.

The purge gas mixture shall be ignited at the burner as soon as possible, by holding a source of ignition adjacent to the burner head or by continually operating the appliances ignition system.

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Purging Procedures



- e) Return to the meter and note the volume of gas that has passed
- f) Continue steps (c) and (e) until the correct PV has been passed (see slide 42)
- g) Unless appliance burners are lit during purging, avoid exceeding the PV to minimise the amount of un-ignited gas that is released
- h) Ensure every branch of pipework is purged
- i) Establish a stable flame picture at each appliance.

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Estimation of the Installation Volume (IV) and the Purge Volume (PV)



Take note of the relevant dimensions of all components including any:

- Meter
- Pipe
- Fitting, including any regulator, bend, tee, etc.
- Inaccessible section of pipework.

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Calculating the IV



The total IV (IV_t) (m^3) is calculated using the following formula:

$$\text{Total installation volume } (IV_t) = \text{Meter volume } (IV_m) + \text{Pipe volume } (IV_p) + \text{Fittings volume } (IV_f)$$

Meter Designation	IV_m (m^3)
E6	0.0024
U6, G4	0.008
U16, G10	0.025

Meter Volumes

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Pipe Volume (IV_p)



Material & Nominal Size of Pipe		Vol of 1m Length of Pipe
(mm)	(in)	(m ³)
Steel/Stainless Steel/ CSST		
15	½	0.00024
20	¾	0.00046
25	1	0.00064
32	1¼	0.0011
Copper		
15		0.00014
22		0.00032
28		0.00054
35		0.00084
PE SDR 11		
20		0.00019
25		0.00033
32		0.00053

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Calculating the PV



Fittings Volume

To calculate additional volume for fittings, valves, pressure vessels, accumulators etc. (IV_f) add 10% of the IV_p .

Multiply the IV_p by 0.01.

Having calculated the IV_t , the purge volume (PV) can be calculated by multiplying the IV_t by 1.5.

Example

A U6 diaphragm meter has an installation containing 1m of 35mm copper tube, 8m of 28mm copper tube and 9m of 22mm copper tube. (see next slide)

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Calculating the PV



Installation Item		Volume m ³
Meter volume (IV_m)		$IV_m = 0.008$
Pipework (IV_p)		
1m - 35mm copper		$1 \times 0.00084 = 0.00084$
8m - 28mm copper		$8 \times 0.00054 = 0.00432$
9m - 22mm copper		$9 \times 0.00032 = 0.00288$
		$IV_p = 0.00804$
Fittings (IV_f)		
$IV_p \times 0.1$	0.00804×0.1	$IV_f = 0.000804$
Total volume		
$IV_m + IV_p + IV_f$		$IV_t = 0.017$
Purge Volume (PV)		
$IV_t \times 1.5$		$PV = 0.026$