

## Gas Safety Controls (Domestic)

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Gas work as defined in the Gas Safety (Installation and Use) Regulations 1998 must only be performed by a competent individual.

These notes form part of the domestic ACS core domestic natural gas safety training programme from RAD Training Midlands. They cover the underpinning knowledge requirements for safety controls. An up-to-date version is available from [www.radmidlands.co.uk](http://www.radmidlands.co.uk)

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## General information

For any safety control a gas engineer should:

- be able to identify it by sight
- know its purpose
- know the situations that cause it to operate
- understand how it works
- be able to test its effectiveness
- be able to rectify or replace it when necessary

The wide variety of designs can make identification difficult.

Checking the operation of safety controls is a legal requirement every time gas work is done on an appliance. A gas engineer should be able to identify any damage or corrosion such as heat damage on a thermocouple tip or a split capillary tube.

Knowing when controls should activate is the key to testing them: the engineer simulates the associated fault conditions, checking that the control responds correctly.

It is illegal to modify or bypass any appliance safety control.

Some of the controls assessed under ACS are obsolete but are still found in many older gas installations.

## Flame supervision devices (FSD)

**Alternative names:** flame failure device (FFD)

FSD is a general term for any device designed to stop gas going to the burner if the flame is extinguished. This is to prevent a dangerous build up of gas within the appliance, its chimney or the room.

Causes of flame failure include chimney downdraught, temporary interruption of the gas supply, gas under-pressure, liquid overspill on cooker hotplates or the draught from an oven door being opened and closed.

There are many types of FSD utilising different technologies such as thermoelectric valves, flame conductance, flame rectification, ultraviolet sensing devices and liquid expansion valves.

FSDs are found on all modern gas appliances. Cooker hotplates may not have FSD on each burner. If a hotplate is to be used in a multi-occupancy building every burner must have its own FSD.

When the FSD activates it should stop (or reduce to safe levels) gas flow to the burner until it is reset manually.

## Thermostats

**Alternative name:** stat

A thermostat is a device which regulates the appliance to the user's temperature requirements. Overheat thermostats shut down appliances at certain safety threshold temperatures.

Several different technologies are used in thermostats including thermal expansion (in rod thermostats), bimetallic strips and liquid expansion.

## Thermoelectric valve

Flame supervision device

**Alternative names:** thermocouple

### Operation

The tip of the thermocouple, when heated directly by a flame, creates an electrical current which flows down the wire to the thermoelectric valve. Inside the valve the electric current passes through a coil. This generates the magnetic field needed to hold open a spring-loaded gas valve.

If the flame goes out the thermocouple cools, the electricity and magnetism disappear and the valve springs shut, stopping gas flow to the burner.

Note that the thermocouple does not generate enough energy to open the valve from the closed position; this must be done by manually holding in the valve until the thermocouple tip heats up.

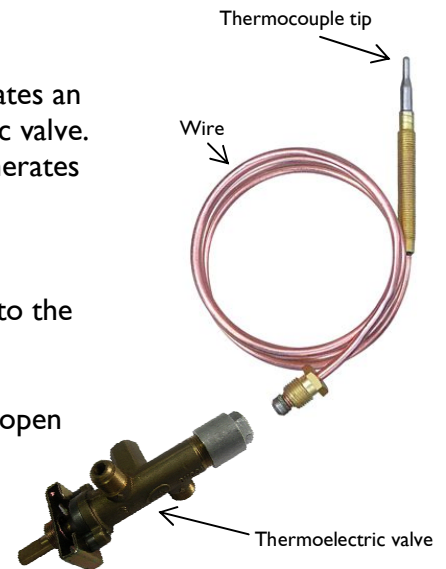
### Test

Attach a manometer to a suitable pressure test point after the valve. Run the appliance for 5 minutes. Interrupt the gas supply to the appliance so the burner goes out and start timing. Ensure the valve clicks out within the acceptable time limit. Reinststate the gas supply and observe the manometer to ensure no gas flows past the valve.

On many gas appliances the maximum time for valve closure is 60 seconds. Manufacturers may specify a different time. If it takes longer than the maximum, or if gas continues to flow, the thermoelectric valve is faulty.

If it takes less than 10 seconds then the thermocouple may be near to failing. Inspect the thermocouple tip, wire and connections carefully for signs of corrosion or damage.

**Rectification:** replace defective parts



## Interrupted thermoelectric valve

Flame supervision device and overheat shut off

**Alternative name:** interrupter

### Operation

This works in the same way as the thermoelectric valve but, in addition, the thermocouple lead is 'interrupted' electrically by a connection to an overheat thermostat (or other safety device). If the thermostat reaches cut out temperature (or the safety device operates) it will open the circuit, stopping the electric current reaching the valve and shutting down the appliance.



**Test:** as for thermoelectric valve

**Correction of faults:** replace defective parts

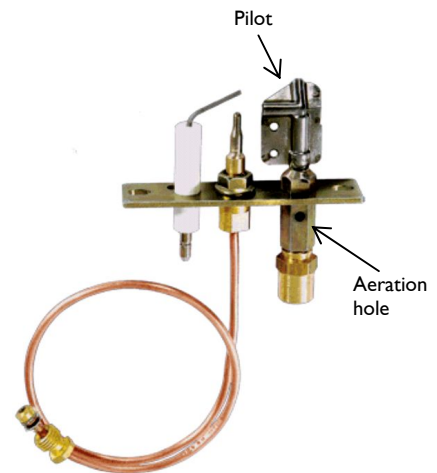
## Vitiation sensing device

**Alternative names:** Oxy-Pilot; Oxy-Safe; precision pilot; atmospheric sensing device, atmosphere sensing device (ASD)

**Function:** to shut down an appliance if there is a build up of vitiated air (i.e. a lack of combustion oxygen)

### Operation

The pilot flame is precisely directed onto the thermocouple tip. If combustion air becomes vitiated the flame will rise as it 'searches for air', lifting off the tip. The tip will cool and will no longer provide enough current to hold the valve open, thus shutting down the appliance. The pilot is aerated by a small hole which draws air in to mix with the gas.



### Test

Test as for a *thermoelectric valve*. There is no means of simulating the activation conditions (i.e. creating a build up of vitiated air) outside a test laboratory. Some engineers temporarily block the aeration hole but this is not an accepted method of testing.

If pilot flame is yellow the aeration hole may be blocked. However, it may be that the vitiation sensing device is operating correctly and is detecting vitiated air. This would be an Immediately Dangerous situation.

**Correction of faults:** unblock aeration hole or replace complete unit.

## Zero regulator

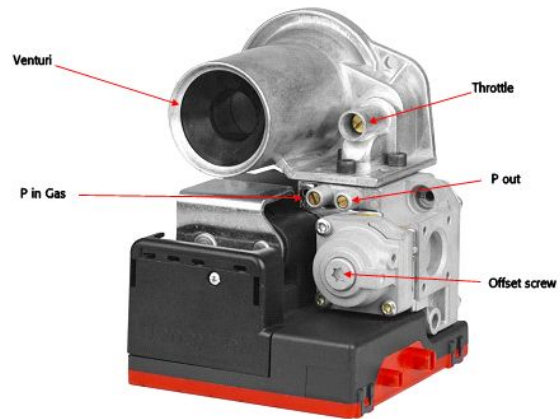
**Alternative names:** zero governor, air / gas ratio valve, air / gas valve, 1:1 valve

### Function

Used mainly in high-efficiency condensing boilers to maintain gas and air flow to the burner in the correct proportions for high combustion efficiency.

### Operation

The appliance circuit board controls the combustion air flow rate by varying the fan speed. The air / gas ratio valve then reduces the gas pressure to equal the air pressure (i.e. a relative 'zero' gas pressure). The gasways to the burner are sized to produce an air / gas mixture of very high combustion efficiency.



### Commissioning

The introduction of this type of valve brings new complexities to the gas engineer's work. Each manufacturer has its own procedures for commissioning appliances with air / gas ratio valves. Adjustments must not be attempted without careful adherence to the specific appliance manufacturer's instructions.

Typically, setting and adjustments are made using a combustion analyser rather than a manometer. A small change in setting may produce a large change in combustion products including carbon monoxide levels.

Air / gas ratio valves have two adjustment parameters, adding further to the level of complexity involved in correctly setting them. Some manufacturers seal one or both adjustment screws to prevent alteration. These seals must not be broken.

### Test

Test according to manufacturer's instructions. Manufacturers may provide a test mode in which the boiler temporarily operates under certain conditions (e.g. at maximum rate) for combustion analysis.

**Correction of faults:** if manufacturer's instructions permit, adjust. If not, contact the manufacturer for specific guidance.

## Flame rectification

Flame supervision device

### Operation

Flames contain freely-moving charged particles called ions which allows them to conduct an electric current. This can be used to detect flame failure. The circuit board passes a current through the flame using two electrodes (or 'ionisation probes'). If the flame is extinguished the circuit board will detect that current flow has stopped. It may then try to re-ignite the flame at the burner. If this does not work after a set time (e.g. 30 seconds), the circuit board can shut down the appliance completely so that it will have to be manually reset.



### Note

Flame rectification has superseded the earlier flame conductance systems which would incorrectly regard a short circuit or soot between the electrodes as the presence of a flame.

In flame rectification systems the two electrodes are of very different sizes. This favours current flow in one direction (i.e. rectification of AC to DC). Any short circuit or soot on the burner will conduct current both ways equally (i.e. it will remain AC) and the circuit board will be able to tell that something is wrong and shut down the appliance.

### Test

While the appliance is running interrupt the gas supply briefly. The appliance should immediately begin the re-ignition sequence and thereafter continue to operate as normal. Turn off the gas supply again, this time leaving it off. After failing to re-ignite the gas the appliance should shut down.

**Correction of faults:** replace defective parts

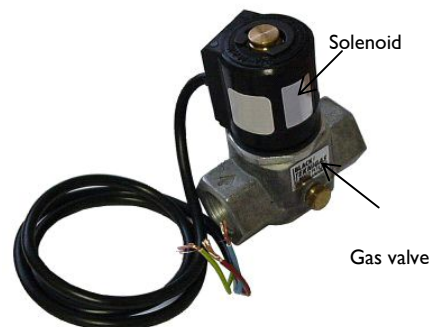
## Solenoid valve

### Operation

Mains electricity, when passed through a tightly coiled wire, generates a magnetic field that can be used to open or close a gas valve.

**Test:** check that the solenoid valve controls gas flow.

**Correction of faults:** replace



## Liquid expansion valve

Flame supervision device, temperature control, overheat protection

### Operation

A phial (bulb) contains a substance which, when heated, expands through the capillary tube. At the other end of the tube a protrusion is pushed out which can control other devices. The expandable substance may be a volatile alcohol or water. Mercury is no longer used.



### Functions

1. Flame supervision device - typically found in gas ovens. The phial is positioned in the burner flame. While the flame is present the liquid expansion device holds the burner's gas valve open. If the flame is extinguished the fluid cools and contracts back into the phial, closing the gas valve.
2. Temperature control (see also *electrical thermostat*) - typically found in gas ovens. The phial is positioned to determine oven temperature. As the oven heats up the fluid inside the phial expands, eventually closing the gasway in the oven gas tap. The tap contains a 'bypass' (usually a small screw with a hole through its body) which always allows a small amount of gas to flow to keep the burner lit and to maintain oven temperature.

### Test

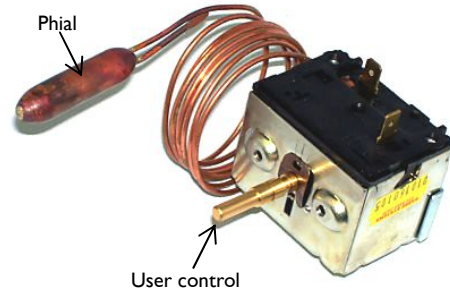
1. Flame supervision device - check that the burner starts off on low flame and, after about 15 seconds, comes to full flame. Leave the oven running for 5 minutes. Turn off the oven and after 60 seconds re-light. The flame should have returned to a low level.
2. Temperature control - ensure that the oven flame falls to the bypass rate (low flame) when the desired temperature is reached. If the burner goes out the bypass may be blocked and must be cleaned by non-invasive methods (e.g. with warm water or compressed air).

**Correction of faults:** if the capillary tube is kinked liquid will not pass through and the valve will not operate. If the phial or tube split the fluid will escape. There is no way to repair these valves so replacement is necessary.

## Electrical thermostat

### Operation

This is a basic form of temperature control. It does not modulate (i.e. vary the heat output of the burner). Instead, it merely turns the burner on while heat is required and off as long as the desired temperature is reached.



A temperature sensing device such as a liquid expansion phial (see *liquid expansion valve*) or a bimetallic strip activates an electrical switch to a solenoid valve controlling gas flow to the burner.

When heat is required the switch is closed. The current flow to the solenoid opens the gas to the burner which is ignited by the pilot. When the desired temperature is reached the switch opens, de-energising the solenoid and turning off the burner.

The desired temperature can be set by the user control.

**Test:** ensure that the heating cycle correctly regulates the appliance to the desired temperature.

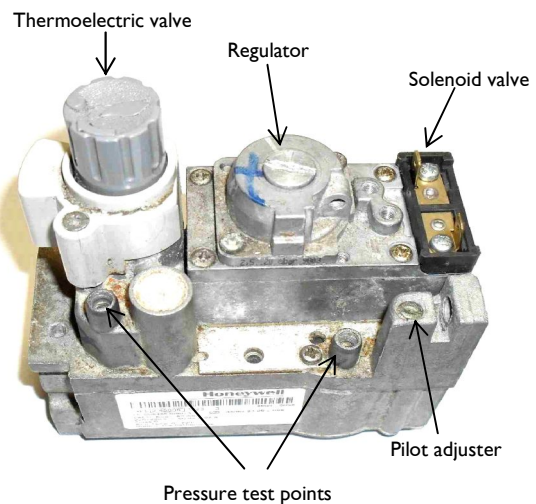
**Correction of faults:** replace defective part

## Multifunction valve

**Function:** to combine the functions of several devices in one unit

**Test:** check each component individually.

**Correction of faults:** replace unit.

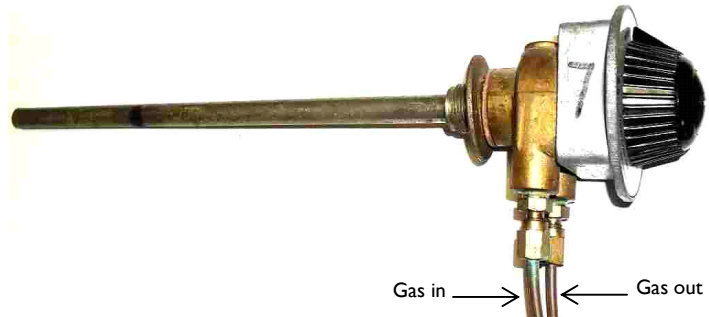


## Mechanical thermostat

**Alternative names:** rod thermostat

### Operation

A solid metal bar is surrounded by a tube of metal with a different thermal expansion rate. When the rod is heated its core pushes out into the gasway, closing it. When the rod cools it contracts and the gasway reopens.



**Note:** This type of thermostat is usually used in conjunction with a relay valve which allows indirect control of a greater flow of gas than the thermostat can pass itself.

**Test:** ensure that the heating cycle correctly regulates the appliance to the desired temperature.

**Correction of faults:** replace unit

## Gas tap

**Function:** manual control of gas flow to a burner

### Operation

Turning the handle rotates a tapered barrel that reveals differently sized openings to let through variable amounts of gas to the burner.



### Test

Check that the tap is stable and not too stiff to turn. Check that the tap does not allow passage of gas when in the off position and that there is no smell of gas.

### Correction of faults

If the tap is stiff or passing gas dismantle it and lightly apply high temperature grease (e.g. Molykote) to the barrel, taking care not to block any hole. Ensure all parts are correctly oriented when reassembling the tap and check that it operates correctly.

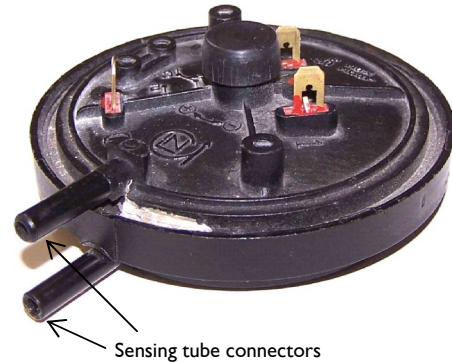
## Fan proving switch

**Alternative names:** pressure switch; fan switch

**Function:** to shut down the appliance if the fan stops working.

### Operation

A fan causes changes in air pressure when it is working. A tube is positioned so as to detect this pressure and is linked to the fan proving switch. The pressure closes the switch, allowing the appliance to operate. If the fan stops working (e.g. through blockage or mechanical failure) the switch opens and shuts off the appliance.



**Note:** a second tube may be connected to another part of the appliance to provide the differential pressure.

### Test

1. In the boiler – remove the pressure sensing tubes from the switch. The boiler should shut down. Any attempt to re-ignite the burner should fail. Replace the tubes and check for correct operation.
2. Outside the boiler – applying air pressure at the tube connections (suction at the negative connection or blowing into the positive connection) should result in an audible click and electrical continuity across the switch connections. Note: it is possible to damage the pressure switch if too much pressure is applied. The maximum operating pressure may be marked on the switch.

**Correction of faults:** unblock sensing tubes or replace switch.

## Regulator

**Alternative names:** governor

### Function

1. Meter regulator - to provide a constant gas pressure when gas flow demand changes (e.g. when appliances are switched on or off). It also 'locks up' when no gas is being used to prevent mains gas pressure entering the meter, pipework and appliances.

2. Appliance regulator – to reduce the inlet working pressure to the pressure required at the burner.



**Meter regulator**

### Operation

A spring-loaded diaphragm allows gas to flow at a certain pressure. The pressure can be adjusted by a screw on the top of the regulator.

Meter regulator adjustment screws should be sealed and must only be adjusted by competent persons authorised by the gas transporter (National Grid). Appliance regulators should be adjusted to manufacturer's requirements.

### Test

1. Meter regulators - perform meter standing and working pressure tests. Standing pressure should be below 30 mbar. Working pressure should be 21 mbar (with a tolerance of  $\pm 2$  mbar).

2. Appliance regulators – check burner pressure can be adjusted to the manufacturer's requirements.

### Correction of faults

1. Meter regulators – contact the gas transporter (National Grid).

2. Appliance regulators – replace.

## Medium pressure regulator

**Alternative names:** called a 'MOP' regulator in the Viper book

**Function:** to regulate a medium pressure mains supply (up to 2000 mbar) to 21 mbar.

### Operation (Mesura only)

This type of regulator reduces pressure in two stages: first stage from 2000 mbar to 350 mbar; second stage from 350 mbar to 21 mbar.

Because of the pressures involved the regulator has a safety provision for over-pressure situations. A pressure relief vent fitted with a flame arrestor removes the excess gas when pressure reaches approximately 35 mbar. The vent should be piped to outside air a minimum of 1000 mm from any opening into the building.

In the recommended method of installation there are two control valves: the emergency control valve (ECV) before the regulator and the meter inlet valve (MIV) or 'test valve' between the regulator and meter.

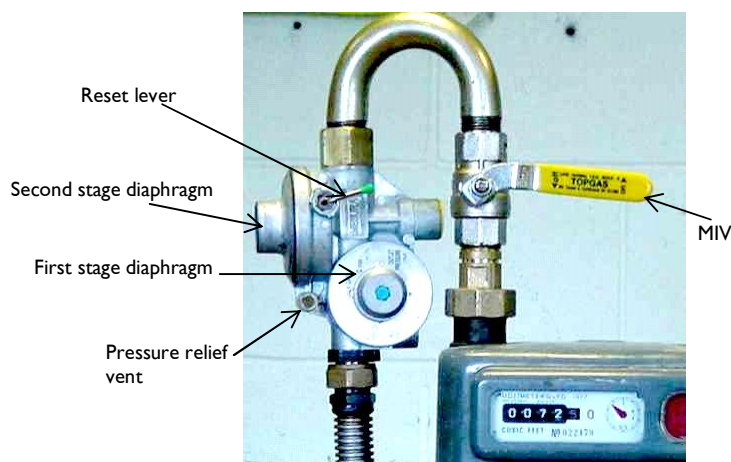
Tightness testing should be performed using the MIV, not the ECV. This is because the safety mechanisms of the regulator may operate and interfere with the results of the test. If there is no MIV then the ECV may be used with modified testing procedures. See IGE/UP/IB and Gas Safe Bulletin 094 for details. Note: to prevent lock up always open these valves slowly.

Under-pressure situations are handled by a lock up mechanism. This can be reset manually with the reset lever.

### Test

Perform meter standing and working pressure tests. Working pressure should be 21 mbar (with a tolerance of  $\pm 2$  mbar).

**Correction of faults:** turn off the gas supply and inform the gas emergency service provider (National Grid).



## Safety shut-off

**Alternative names:** safety cut-off

**Function:** to stop hotplates operating when the lid is down.

### Operation

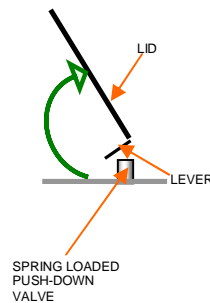
Some models use a lever fitted to the lid that pushes open the gas valve only when the lid is raised (see diagram below). More sophisticated versions physically turn off all hotplate gas taps if the lid is lowered. Some models require a reset button to be pressed before they will allow gas flow after shut off.

### Test

Slowly and carefully lower the lid with one hotplate burner operating at low flame. The burner should go out well before the lid gets close to the flame.

**Correction of faults:** replace defective parts

**Cooker with  
fold-down lid**



**Simple safety shut off  
mechanism**