



Industrial and commercial gas-fired appliances



This Australian Standard® was prepared by Committee AG-011, Industrial and Commercial Gas-Fired Appliances. It was approved on behalf of the Council of Standards Australia on 8 October 2018.

This Standard was published on 25 October 2018.

The following are represented on Committee AG-011:

- Australian Petroleum Production and Exploration Association
 - Energy Networks Association
 - Engineers Australia
 - Gas Appliance Manufacturers Association of Australia
 - Gas Energy Australia
 - Gas Technical Regulators Committee
 - Master Plumbers and Mechanical Services Association of Australia
-

This Standard was issued in draft form for comment as DR AS 3814:2017.

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

Keeping Standards up-to-date

Australian Standards® are living documents that reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued.

Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments that may have been published since the Standard was published.

Detailed information about Australian Standards, drafts, amendments and new projects can be found by visiting **www.standards.org.au**

Standards Australia welcomes suggestions for improvements, and encourages readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at **mail@standards.org.au**, or write to Standards Australia, GPO Box 476, Sydney, NSW 2001.

Australian Standard®

Industrial and commercial gas-fired appliances

Originated as AG 501—1984.
Previous edition AS 3814:2015.
Sixth edition AS 3814:2018.

COPYRIGHT

© Standards Australia Limited

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968.

Published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001, Australia

ISBN 978 1 76072 207 4

PREFACE

This Standard was prepared by Standards Australia Committee AG-011, Industrial and Commercial Gas-Fired Appliances, to supersede AS 3814:2015, *Industrial and commercial gas-fired appliances*.

The objective of this Standard is to provide uniform minimum requirements for the safe operation of gas-fired industrial appliances and other large appliances used for commercial applications which are not covered by any other Standard.

This Standard does not cover all the requirements for the safety of the process carried out in the appliance. Other statutory and regulatory requirements may be applicable to the appliances or installations, or both, that fall within the scope of this Standard. It is the installer/original equipment manufacturer's responsibility to ensure that appliances and installations conform with these requirements.

This Standard should not be regarded as a design specification or as an instruction manual—it has been prepared with consideration for gas rules and regulations now in force. In its preparation, primary consideration has been given to—

- (a) the prevention of injury to persons; and
- (b) the prevention of fire and explosion hazards associated with fuel use and processes, particularly where they could lead to a risk of injury of persons.

Additionally, consideration has been given to—

- (i) the prevention of damage to property;
- (ii) continuity of satisfactory operation of appliances and equipment;
- (iii) the provision of satisfactory permanent access for service; and
- (iv) relevant international and overseas standards.

This Standard has also been revised to remove ambiguities and to place the responsibility for safety of gas-fired industrial appliances, and other large appliances used for industrial and commercial applications firmly on the original equipment manufacturer (OEM). To this end, the OEM has been given a wide definition in this revision.

The main features of this revision are the following:

- (A) A number of editorial and reference errors in the previous edition of this Standard have been corrected and further notes added to several clauses to help provide guidance to users of this Standard.
- (B) As a result of industry comment, Clause 2.27 on programmable electronic systems (PES) has again been revised to better align with AS 61508 (series) (the related application Standard), AS IEC 61511 (series) and AS 62061.
- (C) The robust nature of gas engines has been reflected in the further revision of Clause 5.8.
- (D) The requirements for hazard and risk assessment have been expanded in line with international practice, including a new informative Appendix K as well as a list of significant hazards covered by this Standard in new informative Appendix M.
- (E) The informative Appendix N on the guidance for verifying that an appliance meets the safety requirements and/or measures in accordance with this Standard has been updated.

- (F) A new informative Appendix O on fitness for purpose has been added to provide guidance on establishing an equivalent level of safety to this Standard. This has been achieved where an appliance or installation has not been specifically constructed to the requirements of this Standard. This also includes legacy appliances or installations that originally conformed with the standards of the day and may now need to be reassessed to determine that they are still fit for purpose.
- (G) A new informative Appendix P on biogas applications has been added for guidance on the application of this Standard to biogas installations.

NOTE: Appendix P is expected to become part of Section 5 of this Standard in the next revision, once industry has applied it and provided the necessary peer review regarding its suitability.

The user should be aware that technical regulators in many jurisdictions in Australia deem this Standard as a 'prescribed or preferred Standard', to which conformity is mandatory.

Notes have been integrated into the text of this Standard. They provide additional information and guidance intended to assist the understanding or use of this Standard. The notes do not contain requirements or any information considered indispensable for the use of this Standard.

The term 'informative' has been used in this Standard to define the application of the appendices to which it applies. An 'informative' appendix is only for information and guidance.

CONTENTS

	<i>Page</i>
FOREWORD.....	6
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE.....	7
1.2 APPLICATION	8
1.3 REFERENCED DOCUMENTS.....	10
1.4 DEFINITIONS.....	13
SECTION 2 REQUIREMENTS FOR DESIGN AND CONSTRUCTION	
2.1 GENERAL REQUIREMENTS.....	26
2.2 CONTROLS, BURNER AND SAFETY DEVICE ACCESS.....	28
2.3 BURNER FLAME VISIBILITY.....	28
2.4 TEMPERATURES OF SURFACES AND COMPONENTS	29
2.5 RESTRICTION ON ELECTRICAL CONNECTIONS.....	30
2.6 ACCESSIBILITY OF MANUAL CONTROLS.....	30
2.7 ACCESS FOR MAINTENANCE	30
2.8 MATERIALS.....	30
2.9 GAS PIPEWORK AND VALVE TRAINS.....	31
2.10 GAS PRESSURE REGULATION.....	34
2.11 GAS OVER-PRESSURE PROTECTION.....	35
2.12 GAS LOW-PRESSURE PROTECTION.....	37
2.13 GAS PRESSURE TEST POINTS	37
2.14 GAS FILTER.....	37
2.15 SAFETY SHUT OFF SYSTEMS	38
2.16 COMBUSTION AIR SUPPLY—GENERAL REQUIREMENTS	46
2.17 COMBUSTION AIR FOR ATMOSPHERIC BURNERS.....	47
2.18 FORCED AND INDUCED DRAUGHT BURNERS.....	47
2.19 DAMPERS	48
2.20 APPLIANCE PRE-PURGING.....	49
2.21 PROCESS CONTROLS	52
2.22 IGNITION SYSTEMS.....	53
2.23 PILOT BURNERS.....	53
2.24 MAIN BURNERS.....	54
2.25 FLAME SAFEGUARD SYSTEMS.....	55
2.26 BLEED LINES	58
2.27 APPLIANCE/BURNER CONTROLS AND SAFETY INSTRUMENTED SYSTEMS	59
2.28 GAS/AIR RATIO CONTROL	63
SECTION 3 OPERATION	
3.1 APPLIANCE OPERATION DETAILS	67
3.2 IGNITION	67
3.3 MAIN BURNERS.....	69
3.4 INTERLOCKS AND LIMIT DEVICES	70
3.5 OPERATION SEQUENCES	72
3.6 COMBUSTION CONDITIONS	73
3.7 COMMISSIONING	74

SECTION 4 MARKINGS AND INSTRUCTIONS

4.1	MARKINGS.....	75
4.2	INSTRUCTIONS.....	76

SECTION 5 SPECIAL APPLICATION REQUIREMENTS

5.1	GENERAL.....	77
5.2	HIGH INPUT GAS-FIRED APPLIANCES.....	77
5.3	AIR-GAS MIXING MACHINES AND MIXING BLOWERS	78
5.4	SPECIAL ATMOSPHERES AND ATMOSPHERE GENERATORS	80
5.5	PROCESS AFTER-BURNERS	82
5.6	STEAM AND HOT WATER BOILERS	83
5.7	DIRECT-FIRED AIR HEATERS AND CURTAINS	84
5.8	STATIONARY GAS ENGINES AND TURBINES	85
5.9	INCINERATORS AND CREMATORS	96
5.10	ROTARY PROCESS EQUIPMENT AND OVENS—DIRECT-FIRED	97
5.11	SMOKE OVENS—DIRECT-FIRED.....	99
5.12	WATER HEATERS.....	100
5.13	MULTI-FUEL FIRING SYSTEMS	101

APPENDICES

A	TYPICAL INFORMATION AND TECHNICAL DATA	102
B	TYPICAL PROCEDURE FOR THE APPROVAL OF INDUSTRIAL AND COMMERCIAL APPLIANCES.....	107
C	TYPICAL VALVE TRAIN ARRANGEMENTS.....	108
D	FLAME SAFEGUARD SELECTION	116
E	PRO-FORMA LETTER TO THE GAS TECHNICAL REGULATOR FROM A CONTRACTOR/COMPANY CERTIFYING THE TESTS CONDUCTED ON THE PES	118
F	GAS/AIR RATIO CONTROL PROGRAMMABLE ELECTRONIC SYSTEMS....	119
G	MAINTENANCE AND CHECKS OF SAFETY DEVICES.....	123
H	TYPICAL OPERATING SEQUENCE FOR AN AUTOMATIC FORCED OR INDUCED DRAUGHT BURNER WITH INTERRUPTED PILOT.....	129
I	TYPICAL COMMISSIONING PROCEDURE.....	132
J	TYPICAL FIELD CHECKLIST	135
K	GUIDANCE ON THE RISK ASSESSMENT FOR A TYPE B APPLIANCE AND ITS INSTALLATION	145
L	PROGRAMMABLE ELECTRONIC SYSTEM DESIGN AND REVIEW CHECKLIST EXAMPLES.....	159
M	LIST OF SIGNIFICANT HAZARDS.....	164
N	VERIFICATION OF SAFETY REQUIREMENTS AND/OR MEASURES.....	177
O	FITNESS FOR PURPOSE ASSESSMENT	188
P	BIOGAS FLARES AND TREATMENT SYSTEMS.....	195

FOREWORD

Explosions are the main hazard on the firing side of the equipment covered by this Standard, the basic cause being ignition of a combustible mixture in the combustion chamber or associated ductwork. The magnitude and intensity of the explosion will depend on both the quantity of combustibles present and the proportion of air with which the combustibles are mixed.

Explosions could be the result of one or more of the following:

- (a) Improper design of equipment or control systems.
- (b) Equipment or control system malfunction, including valve leakage.
- (c) Interruption and restoration of gas or air supply causing loss of flame followed by delayed ignition of the resultant accumulation of a combustible mixture.
- (d) Flame failure on a burner and subsequent ignition of the resultant accumulation of a combustible mixture.

The presence of a well-trained, reliable and competent operator provides a major contribution to safety.

STANDARDS AUSTRALIA

Australian Standard Industrial and commercial gas-fired appliances

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

1.1.1 General

This Standard sets out the minimum requirements for the design, construction and safe operation of Type B appliances that use any gas, or gases as a gaseous fuel in any combination or with other fuels to produce flame, heat, light, power or special atmosphere.

Construction requirements given relate only to matters affecting gas-firing systems or to any interconnection between the gas-firing system and the safety requirements of the appliance.

NOTES:

- 1 Refer to AS 1375 for additional information regarding safety principles for industrial appliances.
- 2 Where an Australian design standard exists for an appliance and is not called up in this Standard, the original equipment manufacturer (OEM) should ensure that the design is in accordance with that standard before installing (if there is no other relevant authority).
- 3 Refer to AS/NZS 5601.1 for installation requirements for appliances covered by this Standard.

1.1.2 Appliance exclusions

The following appliances are excluded from this Standard:

- (a) Manually operated Bunsen type burners.
- (b) Simple atmospheric burners and simple forced draught burners not exceeding 1 GJ/h that are not fitted into a combustion chamber and burn in an open, well-ventilated space under the control of an operator.
NOTE: Refer to AS 1668.2 and AS/NZS 5601.1 for guidance on determining if a space is well ventilated.
- (c) Petroleum, petrochemical and natural gas industries flares and associated ignition systems for general refinery and petrochemical service in accordance with ISO 25457 and ISO 23251.
- (d) Petroleum and natural gas industries pressure-relieving and depressurizing systems in accordance with ISO 23251.
- (e) Engines other than stationary engines.
- (f) Refrigeration systems that utilize gas as a refrigerant.
- (g) Any vaporizing liquid fuel burners (refer to AS 1375).

NOTE: For regulatory requirements for excluded appliances and burners, see Clause 1.2.1.

1.2 APPLICATION

1.2.1 General

The requirements of this Standard shall be used in conjunction with, but do not take precedence over, the requirements of the technical regulator. The technical regulator determines the extent of application of this Standard.

This Standard applies to—

- (a) the appliance;
- (b) the component parts of the appliance whether supplied with the appliance or separately; and
- (c) Type B appliance regulatory acceptance commenced after its publication date.

NOTES:

- 1 'Commenced', for the purpose of this Clause, means the point at which Type B acceptance has begun.
- 2 Appliances should be in accordance with requirements of all authorities before being placed into service (e.g. electrical, water, environmental, occupational health and safety).
- 3 Bio gas installations and associated flares may not be under the jurisdiction of a technical regulator. See Appendix P for guidance where conformity with minimum standards is required.

1.2.2 Appliance installation

Before an appliance is connected to a gas supply, a submission containing this Standard and technical data specified by the technical regulator may be required by the technical regulator, in accordance with the administrative procedures and regulations of the technical regulator.

NOTE: Typical data and procedural requirements are given in Appendices A and B.

1.2.3 Conformance

The requirements of this Standard shall be used in conjunction with, but do not take precedence over, statutory regulations which apply in any area. Where no requirement is given, good practice or a requirement from a relevant standard is to apply. In a matter of uncertainty, advice should be sought.

In the event of a conflict between this Standard and other standards, this Standard shall take precedence.

Application of this Standard should be viewed only as a starting point in the control of risks. It shall not be assumed that a design that meets this Standard is without risk. This is because this Standard does not deal with all the matters relevant to hazard identification, risk assessment and risk control for the gas installation and any associated plant in question. Appropriate judgement needs to be exercised in such circumstances.

Alternative national and international standards may provide more appropriate safety outcomes in certain specific circumstances and be deemed to conform with this Standard. This is provided the OEM or installer has written evidence showing the level of risk for the activity or thing to which the safety requirement applies is equal to or less than the level of risk that would be achieved by conforming with the requirements of this Standard. This written evidence shall demonstrate that the fundamental safety requirements of this Standard have been satisfied or exceeded. An OEM's or installer's report detailing this evidence and clearly identifying and recording departures from this Standard should be provided as part of the gas installation documentation.

1.2.4 New and alternative materials and methods

Any design, operation and construction methods, not prescribed in this Standard, shall—

- (a) not necessarily be excluded from use if they are not specifically referred to; and
- (b) not be interpreted by this Standard to prevent the use of materials, methods of design or construction not specially referred to herein, provided that the intent of this Standard is conformed with.

1.2.5 Unusual installations

Certain gas installations or portions of installations that are unusual due to particular circumstances, methods or process requirements may not be covered in detail by this Standard. Details of such unusual gas installations or portions of them could be required to be reviewed in conjunction with the technical regulator.

NOTES:

- 1 An example of an unusual installation due to particular circumstances are the variations involving biogas treatment systems and associated flares resulting from the various sources of biogas from landfill, digesters and sewerage lagoons.
- 2 See Appendix P for additional guidance for these types of installations.

1.2.6 Modification or relocation of an appliance

Where an appliance is modified or relocated, it should be upgraded to meet the requirements of this Standard current at the time of the modification or relocation, and may need to be resubmitted to the technical regulator.

NOTE: Clause 1.4.83 defines 'modification'. Guidance on the assessment of fitness for purpose of legacy appliances and existing appliances that are relocated or modified and the extent of the upgrading to this Standard needed is given in Clauses 1.2.3 and 1.2.7 as well as in Appendix O. Legacy appliances are existing appliances that no longer conform with the requirements of this Standard and whose safety is being reviewed at the request of a technical regulator or as a result of an owner or operator review.

1.2.7 Non-conformance with requirements in this Standard

Any new, novel or alternative materials, designs, methods of assembly and procedures, which do not conform with a specific requirement of this Standard, or are not mentioned in it but give equivalent results to those specified, are not necessarily prohibited.

Such non-conformance can conform with the safety requirement without conforming with the requirements of this Standard if the designer has written evidence showing that the level of risk for the activity or thing to which the safety requirement applies is equal to or less than the level of risk that would be achieved by conforming with the requirements of this Standard.

Clause 2.1.1.2 shall apply to the evaluation of the non-conformance.

NOTES:

- 1 The written evidence should be expected to include a HAZOP, or a risk assessment or a layer of protection analysis verifying an equivalent or better level of safety, i.e. an equal or lower level of risk.
- 2 Where a safety instrumented system is involved, a safety integrity level analysis would be expected to verify an equivalent or better level of safety, i.e. an equal or lower level of risk.
- 3 The written evidence and analysis would be expected to utilize, as relevant standards such as AS 61508 (series), AS IEC 61511 (series), AS 62061, AS/NZS ISO 31000, ISO/IEC 31010, AS IEC 61882, ISO 12100 or AS IEC 61160.
- 4 For advice concerning equivalent suitability, contact Standards Australia at <https://www.standards.org.au/contact>, however specific approval remains the prerogative of the technical regulator. See Appendix O for fitness for purpose assessment guidance.

1.3 REFERENCED DOCUMENTS

The following documents are referenced in this Standard:

AS

1271	Safety valves, other valves, liquid level gauges, and other fittings for boilers and unfired pressure vessels
1357	Valves primarily for use in heated water systems
1357.1	Part 1: Protection valves
1357.2	Part 2: Control valves
1375	Industrial fuel-fired appliances
1668	The use of ventilation and airconditioning in buildings
1668.2	Part 2: Mechanical ventilation in buildings
2593	Boilers—Safety management and supervision systems
2885	Pipelines—Gas and liquid petroleum
2885.1	Part 1: Design and construction
4041	Pressure piping
4564	Specification for general purpose natural gas
4617	Manual shut off gas valves
4618	Gas appliance regulators
4620	Thermoelectric flame safeguards
4624	Combination controls for gas
4625	Electronic flame safeguards and flame detectors
4629	Automatic shut off valves and vent valves
4630	Leakage detection systems
4631	Limited flexibility connectors for gas
4670	Commercial propane and commercial butane for heating purposes
4732	LP Gas fuel systems for marine engines
4983	Gas fuel systems for forklifts and industrial engines
61508	Functional safety of electrical/electronic/programmable electronic safety-related systems
61508.1	Part 1: General requirements
61508.2	Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
61508.5	Part 5: Examples of methods for the determination of safety integrity levels
62061	Safety of machinery—Functional safety of safety-related electrical, electronic and programmable electronic control systems
AS/NZS	
1425	LP Gas for fuel systems for vehicle engines
1596	The storage and handling of LP Gas
1869	Hose and hose assemblies for liquefied petroleum gases (LP Gas), natural gas and town gas
3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)

AS/NZS	
4024	Safety of machinery
4024.1401	Part 1401: Ergonomic principles—Design principles—Terminology and general principles
4114	Spray painting booths, designated spray painting areas and paint mixing rooms (series)
5601	Gas installations
5601.1	Part 1: General installations
60079	Explosive atmospheres
60079.10.1	Part 10.1: Classification of areas—Explosive gas atmospheres (IEC 60079-10-1, Ed.1.0 (2008) MOD)
AS IEC	
61160	Design review
61511	Functional safety—Safety instrumented systems for the process industry sector
61511.1	Part 1: Framework, definitions, systems, hardware and software requirements
61511.3	Part 3: Guidance for the determination of the required safety integrity levels
61882	Hazard and operability studies (HAZOP studies)—Application guide
62601	Industrial networks—Wireless communication network and communication profiles—WIA-PA
AS ISO	
21789	Gas turbine applications—Safety
AS/NZS ISO	
31000	Risk management—Principles and guidelines
ISO	
8528	Reciprocating internal combustion engine driven alternating current generating sets
8528-4	Part 4: Controlgear and switchgear
9001	Quality management systems—Requirements
10380	Pipework—Corrugated metal hoses and hose assemblies
12100	Safety of machinery—General principles for design—Risk assessment and risk reduction
13577	Industrial furnace and associated processing equipment—Safety
13577-4	Part 4: Protective systems
13849	Safety of machinery—Safety-related parts of control systems
13849-1	Part 1: General principles for design
19372	Microturbines applications—Safety
23251	Petroleum, petrochemical and natural gas industries—Pressure-relieving and depressuring systems
23551	Safety and control devices for gas burners and gas-burning appliances—Particular requirements
23551-1	Part 1: Automatic and semi-automatic valves
25457	Petroleum, petrochemical and natural gas industries—Flare details for general refinery and petrochemical service

ISO/IEC 31010	Risk management—Risk assessment techniques
BS 6501 6501-1	Metal hose assemblies Part 1-1: Guidance on the construction and use of corrugated hose assemblies
ANSI B11.TR3	Risk assessment and risk reduction—A guide to estimate, evaluate and reduce risks associated with machine tools
CSA B149.6-15 Z21.21/CSA 6.5	Code for digester gas, landfill gas, and biogas generation and utilization Automatic valves for gas appliances
ANSI UL 1998 2200 6200	Software in programmable components Stationary engine generator assemblies Controls for stationary engine driven assemblies
API RP 556	Instrumentation and control systems for fired heaters and steam generators
STD 560	Fired heaters for general refinery service
ASTM F1120-87	Standard specification for circular metallic bellows type expansion joints for piping applications
EN 161 298 1643 12067 12067-2	Automatic Shut-Off Valves For Gas Burners And Gas Appliances Automatic Burner Control Systems For Burners And Appliances Burning Gaseous Or Liquid Fuels Safety and control devices for gas burners and gas burning appliances—Valve proving systems for automatic shut-off valves Gas/air ratio controls for gas burners and gas burning appliances Part 2: Electronic types
IGEM SR/15 Edition 5	Integrity of safety-related systems in the gas industry NOTE: Refer to Section 3, Tolerable risk and safety-integrity criteria
SR/23	Venting of Natural Gas
SR/25 Edition 2	Hazardous area classification of Natural Gas installations
UP/9 Edition 2	Application of Natural Gas and fuel oil systems to gas turbines and supplementary and auxiliary fired burners
ISA TR84.00.05	Guidance on the Identification of Safety Instrumented Functions (SIF) in Burner Management Systems (BMS)
EI EI 15 3rd edition	Model code of safe practice Part 15: Area classification for installations handling flammable fluids

ABS	
3303.0	Causes of death, Australia
HSE	
NS-TAST-GD-005 Rev. 6	ONR Guide: Guidance on the demonstration of ALARP (As Low As Reasonably Practicable)
NIOSH	
IC 9458	Programmable Electronic Mining Systems: Best Practice Recommendations (In Nine Parts)
UK HSE report	Reducing risks, protecting people—HSE’s decision-making process
NFPA	
85	Boiler and Combustion Systems Hazards Code
86	Standard for Ovens and Furnaces
87	Recommended Practice for Fluid Heaters
UL	
429	Electrically Operated Valves
Safe Work Australia	
Fatal occupational injuries—How does Australia compare internationally?	

1.4 DEFINITIONS

For the purpose of this Standard, the following definitions apply.

1.4.1 Accessible

Access gained without hazard or undue difficulty for inspection, repair, renewal or operational purposes.

1.4.2 Air curtain

A direct-fired air heater that discharges a curtain of air across an opening direct to outside.

1.4.3 Air-gas mixing machine

Any combination of proportioning control devices, blowers or compressors that supply mixtures of gas and air to burners where control or safety devices, or both, are installed between the mixing device and burner.

1.4.4 Appliance

An assembly, other than a vehicle refuelling appliance (VRA), part of which uses gas to produce flame, heat, light, power or special atmosphere and includes the following:

- (a) *Type A appliance* An appliance for which a certification scheme exists and/or is prescribed in legislation.
- (b) *Type B appliance* An appliance, with gas consumption in excess of 10 MJ/h, for which a certification scheme does not exist.

NOTE: A Type A appliance when used in an industrial/commercial application for which it was not intended is considered to be part of a Type B appliance. An example of this is a certified direct-fired space heater used as the heating/ventilating device in a spray/bake paint booth.

1.4.5 Approved

Acceptable to the technical regulator and meeting the requirements of the nominated Standard or Standards referenced in the clause.

1.4.6 As low as reasonably practicable (ALARP)

ALARP means the cost of further risk reduction measures is grossly disproportionate to the benefit gained from the reduced risk that would result.

1.4.7 Atmospheric burner

See 'Burner'.

1.4.8 Authorized installer

A person appointed, licensed, authorized or otherwise permitted to carry out gas fitting work.

1.4.9 Auto-ignition temperature (AIT)

The lowest temperature at which the rate of self-heating of a gas/air mixture exceeds the rate of heat loss to the surroundings, thus causing the mixture to ignite.

1.4.10 Automatic burner

See 'Burner'.

1.4.11 Automatic ignition

The lighting of gas at a burner without a manual operation whenever gas flows from the burner.

1.4.12 Basic control system

A system which responds to input signals from the process, its associated equipment, other programmable systems or an operator, and generates output signals causing the process and its associated equipment to operate in the desired manner, but which does not perform any safety instrumented functions with a claimed SIL ≥ 1 .

1.4.13 Bleed line

A small diameter pipe or tube that conveys gas to a safe place from a gas component that discharges small rates of gas as part of its normal operation.

1.4.14 Burner

For the purpose of this Standard, the following applies:

- (a) *Atmospheric burner* A system where all of the air for combustion is produced by the inspirating effect of the gas or the natural draught in the combustion chamber or a combination of the two without mechanical assistance.
- (b) *Automatic burner* A system that, on starting, follows a self-acting sequence that has been manually or automatically initiated, to provide gas and ignition to the burner without any intermediate manual operation.
- (c) *Forced draught burner* A system where all of the air, oxygen or a mixture of the two used for combustion is provided under pressure.
- (d) *Induced draught burner* A system where all or part of the air for combustion is introduced by providing suction in the combustion chamber by mechanical means.
- (e) *Multi-fuel alternative burner* A multi-fuel burner that can use only one fuel at a time.
- (f) *Multi-fuel burner* A burner that can use more than one fuel.
- (g) *Multi-fuel simultaneous burner* A multi-fuel burner that can use more than one fuel at a time.
- (h) *Part automatic burner* A burner system that includes any self-acting operation.

1.4.15 Burner management system

The field devices, final control elements and the logic system, dedicated to combustion safety and operator assistance in the starting, running and stopping of fuel burning equipment and for preventing incorrect operation of and damage to fuel burning equipment.

NOTES:

- 1 A burner management system includes a flame safeguard system.
- 2 Fuel burning equipment is the burner(s) and its associated fuel valve train(s) and combustion air supply equipment.
- 3 Burner management systems can be expected to contain one or more functions with a SIL ≥ 1 . In terms of AS IEC 61511 (series), a BMS is a safety instrumented system (SIS).

1.4.16 Burner off cycle

For the purpose of this Standard either of the following applies:

- (a) A normal cessation of operation occurring when a predetermined operation condition is reached and the operation of the burner to provide the application of heat is no longer required. The equipment is placed into a safe stand-by condition ready to restart on demand.
- (b) A shutdown to a safe standby condition in response to an incorrect condition signal, resulting from a fault that it is unlikely to be hazardous or is likely to be self-rectifying, so that normal restarting is permissible when the fault has cleared.

1.4.17 Burner unit

A number of burners, fed from the same manifold, controlled together, having one supervised ignition source and performing as a single burner.

1.4.18 Certified/certification

Assessed by a certifying body and having a certificate number to demonstrate conformity with a relevant Standard or other acceptable safety criteria.

1.4.19 Certifying body

A body that provides assurance of conformity of appliances and components with relevant Standards and other accepted safety criteria, and is acceptable to the technical regulator or is listed as a notified body for the Gas Appliances Directive or Machinery Directive in the European Union.

1.4.20 Closed position indicator switch

A switch which indicates 'closed' when the valve is within 1 mm of the closed position, or has reduced the flow to 10% or less of the equivalent fully open flow for a given pressure differential.

1.4.21 Combination gas control

An assembly of two or more different control functions in a single body.

1.4.22 Combustion products

Constituents resulting from the combustion of a fuel with air, oxygen or mixture of the two, including the inerts associated with the fuel and the air but excluding any other diluent or contaminant.

1.4.23 Common flue

See 'Flue'.

1.4.24 Competent person

A person or body who through training, qualification or practical experience or a combination of these and understanding of the equipment and processes is able to verify conformity with this Standard.

1.4.25 Critical time

The time required to build up a pocket or concentration of unignited gas of such quantity and proportions that, if ignited, the pressure of the resultant explosion could equal the permissible safe internal pressure of the appliance.

1.4.26 Cross lighting

Lighting of one burner from another either directly or by means of an intermediate flame.

1.4.27 Damper

An adjustable device for controlling—

- (a) air flow in a forced or induced draught air system;
- (b) the flow of flue products in a flue system;
- (c) the recirculation of air, flue gases or process gases; or
- (d) the flow of any other fluids.

1.4.28 Direct-fired air heater

An appliance for heating a forced air stream where the combustion products are released with the heated air.

1.4.29 Direct-fired oven

An oven in which the combustion products flow through the oven compartment.

1.4.30 Double block and vent

See 'Safety shut off system, double block and vent'.

1.4.31 Draught diverter

A device, without moving parts, fitted in the flue of an appliance for isolating the combustion system from the effects of pressure changes in the secondary flue.

1.4.32 Electronic flame safeguard

A flame safeguard utilizing electronic components to perform its function.

1.4.33 Excess air

Air in excess of that required for complete combustion that is mixed unchanged with the combustion products, in the combustion chamber.

1.4.34 Fail-safe

A feature that ensures absence or malfunction of any critical control or safety component, system, signal or function will not result in an unsafe condition.

1.4.35 Flame abnormality

A flame condition that results in flame lift, floating, light back, appreciable yellow tipping, carbon deposition or objectionable odour.

1.4.36 Flame detector

A device that is sensitive to flame properties and initiates a signal when flame is detected.

1.4.37 Flame establishment period

The period that begins when the fuel valve is energized and ends when the flame safeguard system is first required to supervise that flame.

1.4.38 Flame failure response time

The time taken for the flame safeguard to detect loss of flame and de-energize the safety shut off valve.

1.4.39 Flame lift

Separation of a flame from a burner port, while continuing to burn with its base some distance from the port.

1.4.40 Flame proving period

The supervised period immediately following the flame establishment period and before any further operation other than shutdown is permitted.

1.4.41 Flame safeguard

A safety device that automatically cuts off the gas supply if the actuating flame is extinguished.

1.4.42 Flame safeguard system

A system consisting of a flame detector(s) plus associated circuitry, integral components, valves and interlocks, the function of which is to shut off the fuel supply to the burner(s) in the event of ignition failure or flame failure.

1.4.43 Flare

A device used for burning excess gas venting from the gas or process system, as follows:

- (a) *Enclosed type* A flare for burning excess gas from the gas or process system when the flame is completely contained within the combustion chamber or stack.
- (b) *Open type* A flare for burning excess gas from the gas or process system when the flame is not completely contained within the combustion chamber or stack.

1.4.44 Flue

A material or duct through which combustion products are discharged, including any draught diverter, slip joint and associated duct, barometric device, fan or other components in the duct and includes the following:

- (a) *Balanced flue* A natural draught flue system in which the combustion products are discharged at the same height and atmospheric pressure as the combustion air inlet of a room-sealed appliance.
- (b) *Common flue* A flue system designed to carry combustion products from two or more appliances.
- (c) *Natural draught flue* A flue in which the draught is provided by the buoyancy effect of the hot gases in it.
- (d) *Open flue* A flue system containing a draught diverter or canopy.
- (e) *Power flue* A flue system in which the combustion products are removed from the gas appliance by a fan in the flue.
- (f) *Primary flue* The portion of the flue which extends from the outlet of the appliance combustion chamber or heat exchanger to the inlet of the draught diverter.
- (g) *Secondary flue* The portion of the flue that extends from the outlet of the draught diverter to the flue terminal.

- (h) *Slip joint* A join in the flue (usually close to the appliance) that can be dismantled to facilitate the disconnection of the appliance from the flue.
- (i) *Twin wall flue* A type of flue in which the inner flue conduit is encased by an outer casing of specific dimensions which acts as an insulator.

1.4.45 Flue gases

Combustion products plus all diluents and contaminants.

NOTE: These include, where applicable, excess air, dilution air, process air, and waste products from the process.

1.4.46 Flue system

The passage through which flue gases are conveyed from an appliance to a discharge point including draught diverter, barometric device, fan or similar part.

1.4.47 Flue terminal

The point at which flue gases discharge from a flue.

1.4.48 Flued appliance

See 'Open flued appliance'.

1.4.49 Flueless appliance

See 'Indoor flueless appliance'.

1.4.50 Forced draught burner

See 'Burner'.

1.4.51 Forced or induced draught combustion system

A combustion system where all or part of the air for combustion is provided by a fan or other mechanical device which is an integral part of the combustion system.

1.4.52 Gas

A combustible fuel that is a gas at normal temperature and pressure that could be any one of, but is not limited to, the following:

- (a) *Natural gas (NG)* A hydrocarbon gas consisting mainly of methane.
- (b) *Simulated natural gas (SNG)* A gas comprising a mixture of LP gas and air, in the approximate proportions of 55% LP gas and 45% air for commercial propane.
- (c) *Tempered liquefied petroleum gas (TLP)* A gas comprising a mixture of LP gas and air, in the approximate proportions of 27% LP gas and 73% air for commercial propane.
- (d) *Liquefied petroleum gas (LP gas)* A gas composed predominantly of any of the following hydrocarbons, or any combination of them in the vapour phase; propane, propene (propylene), butane and butene (butylene).
- (e) *Biogas* A mixture of primarily methane and carbon dioxide produced by bacterial degradation of organic matter and used as a fuel.

NOTES:

- 1 This includes landfill gas and sewage gas.
- 2 Its constituents are considered flammable, corrosive and potentially toxic.

1.4.53 Gas/air ratio control

A system which simultaneously controls the flow of gas and air to a burner(s).

1.4.54 Gas consumption

The rate of energy consumed by an appliance under specific conditions and expressed in multipliers of joules per hour, e.g. megajoules per hour (MJ/h) or gigajoules per hour (GJ/h).

1.4.55 Gas engine

A gas engine is a reciprocating or rotating internal combustion engine and not a burner.

NOTES:

- 1 Clauses referring to burners are not applicable to gas engines.
- 2 For the purposes of this Standard, a gas engine would include the following types:
 - (a) *Bi-fuel gas engine* An engine that can operate on gas and an optional fuel (e.g. another gas, petrol or diesel).
 - (b) *Dual-fuel gas engine* An engine that can operate as part gas and part optional fuel (e.g. diesel) or the alternative fuel (diesel only).
 - (c) *Mono-fuel gas engine* An engine that can operate on gas only.

1.4.56 Gas pressure regulator

A device that automatically regulates the outlet pressure of the gas passing through it to a predetermined value.

1.4.57 Gas tight

Meets the leak testing requirements of the relevant standards.

1.4.58 Gas turbine purge credit

A condition where all combustibles in the purge volume have been removed by a prior purge cycle, and all fuel safety shut off systems are checked during and prior to an immediate start without purge to be leak tight during the stand-by period.

1.4.59 Hazard

A potential source of danger or harm that exposes people to physical injury, death or damage to their health.

NOTE: For appliances and associated equipment, this includes significant damage and adverse effects to equipment or its surroundings.

1.4.60 Hazardous condition

A condition that may cause physical injury, death or impairment to health to people, with and without significant damage or adverse effects to an appliance and its associated equipment or its surroundings.

1.4.61 High gas pressure detector

A sensing device that is actuated when pressure rises above a pre-set value.

1.4.62 Hose

Flexible tube or pipe of multiple layer construction.

1.4.63 Hose assembly

Flexible hose complete with end couplings.

1.4.64 Hot water boiler

Any vessel wherein water is intended to be heated to a temperature exceeding 99°C by the application of heat from the combustion products to the vessel without the generation of steam.

1.4.65 Ignition temperature

The lowest temperature at which heat is generated by combustion faster than heat is lost to the surroundings, and combustion therefore becomes self-propagating.

1.4.66 In service

An appliance connected to the gas supply irrespective of the on or off status of the isolation valve.

1.4.67 Indoor flueless appliance

An indoor appliance designed to discharge its combustion products into the same room or space in which it is installed.

1.4.68 Induced draught burner

See 'Burner'.

1.4.69 Injector

A device that causes air to mix with a stream of gas. In the case of an aerated burner it incorporates an orifice discharging gas into the mixing tube or throat.

1.4.70 Interlock

A device or function that ensures that the operation of items of equipment is dependent upon the fulfilment of predetermined conditions by other items of equipment.

1.4.71 Intermittent pilot

A pilot that is automatically ignited each time the burner is started, and which is automatically extinguished with the main burner.

1.4.72 Interrupted pilot

A pilot that is automatically ignited each time the burner is started, and which is automatically extinguished at the end of the main flame establishment period.

1.4.73 Leakage detection system

A means of checking that the safety shut off valves and the vent valves, where fitted, of a safety shut off system are gas tight (also referred to as a valve proving system).

1.4.74 Light back

Transfer of the flame from burner port(s) into the body of the burner or back to the injector.

1.4.75 Limit device

A device that is actuated by the approach to a hazardous condition in an appliance due to abnormal conditions, and when actuated causes the gas supply to all burners to shut off with lockout.

NOTE: This includes a functional unit of hardware (including final elements and sensors) or software, or both, capable of accomplishing the specified purpose of implementing the physical action necessary to achieve a safe state.

1.4.76 Lockout

A safety shutdown condition of the control system that requires a manual reset in order to restart.

1.4.77 Lower explosive limit (LEL)

The lowest percentage of gas in a mixture of gas and air in which combustion can be self-sustaining at standard temperature (15°C) and pressure (101.325 kPa absolute) conditions.

1.4.78 Low-gas-pressure detector

A sensing device that is actuated when the gas pressure falls below a pre-set value.

1.4.79 Manual ignition

The lighting of gas at a burner by a manual operation whenever gas flows from the burner.

1.4.80 Manual reset

Reset of an appliance by an operator.

1.4.81 Mixing blower

A motor-driven blower, the suction side of which is supplied with a mixture of air and gas from an appropriate proportioning device, which supplies a burner(s) in the immediate vicinity of the blower and has no control and/or safety device between the blower and burner.

1.4.82 Mixing tube

That part of an atmospheric burner in which the air and gas are mixed.

1.4.83 Modification

An alteration that changes the safety integrity of the existing system or takes the gas appliance out of its original certification criteria. This may include—

- (a) gas valve train equipment;
- (b) combustion/purge air system;
- (c) flame safeguard system; and
- (d) burner management system.

NOTE: Like for like exchange of components does not change the original certification criteria.

1.4.84 Multi-fuel alternative burner

See 'Burner'.

1.4.85 Multi-fuel burner

See 'Burner'.

1.4.86 Multi-fuel simultaneous burner

See 'Burner'.

1.4.87 Natural draught

The flow produced by the tendency of warmed gases to rise.

1.4.88 Natural draught burner

See Item (e) under 'Burner'.

1.4.89 Natural draught flue

See 'Flue'.

1.4.90 No-flow

A flow condition suitably below the normal proven air flow device setting that provides a reliable and repeatable no-flow or low-flow signal from the flow device.

1.4.91 Nominal gas consumption

The appliance gas consumption, in megajoules per hour (MJ/h), stated in specifications, data plates, instructions and general communications.

1.4.92 Non-return valve

A device designed to operate automatically to prevent reversal of flow in a pipe.

1.4.93 Open flued appliance

An indoor appliance designed to be connected to an open flue system, its combustion air being drawn from the room or space in which it is installed.

1.4.94 Open position indicator switch

A switch that indicates 'open' when the valve is within 10% of the fully open position.

1.4.95 Operating pressure

The gas pressure that the consumer piping or the appliance is or will be subjected to under normal operating conditions.

1.4.96 Original equipment manufacturer (OEM)

The person or company having design responsibility for the Type B appliance, its sub-systems or parts of it.

NOTES:

- 1 This may be the manufacturer or packager of the Type B appliance, its sub-systems or parts of it.
- 2 The OEM includes a manufacturer that produces a Type B appliance from components usually bought from other manufacturers or their agents and includes manufacturers of major sub-systems of a Type B appliance (e.g. the burner management system).
- 3 The OEM also includes importers and suppliers of Type B appliances, agents of the OEM, manufacturers that modify an existing Type B appliance or contractors who install a Type B appliance whose OEM has ceased to exist.

1.4.97 Over-pressure protection system

A system preventing the pressure in piping or in an appliance from exceeding a predetermined value.

1.4.98 Over-temperature cut-out device

A manual reset or non-resetting device that functions to shut off the gas supply to a burner or burners, so as to prevent temperature from exceeding a predetermined level.

1.4.99 Part automatic burner

See 'Burner'.

1.4.100 Permanent pilot

A pilot that is intended to be permanently alight while the appliance is in service and that is controlled independently of the main burner.

1.4.101 Pilot

A permanently located burner independent of the main burner, small in relation to it, and arranged to provide ignition for the main burner.

1.4.102 Position indicator switch

A switch that is activated when a particular position is reached.

1.4.103 Position-proving system

A means of checking that the safety shut off valves and vent valves of a safety shut off system are in the correct position.

1.4.104 Process after-burner

A gas-fired appliance used specifically for the incineration of exhaust gases containing combustible gases or dust in concentrations below the lower explosive limit.

1.4.105 Programmable electronic system (PES)

A system based on one or more central processing units (CPUs), connected to sensors and actuators, for the purpose of control, protection or monitoring.

1.4.106 Programming flame safeguard

A flame safeguard that automatically sequences at least two burner functions such as ignition spark and gas valve.

1.4.107 Proof-of-closure switch

A switch fitted to a safety shut off valve that is only activated after the valve is closed and incorporates over-travel of the valve past the position where the valve is just closed.

1.4.108 Protected pilot

A pilot that is fitted with a flame safeguard.

1.4.109 Purge (or purging)

With respect to an appliance means the removal of combustibles.

1.4.110 Purge volume

This volume includes the combustion chamber, and all areas where combustion products and combustible vapours, dusts or gases could accumulate in the appliance or process, up to the vertical connection of a flue or chimney that discharges directly to the atmosphere.

1.4.111 Rated working pressure

The maximum allowable inlet pressure specified by the OEM.

1.4.112 Regulator

See 'Gas pressure regulator'.

1.4.113 Relief device

A safety device designed to forestall the development of a dangerous condition by preventing pressure, temperature or vacuum build-up.

1.4.114 Risk

Effect of uncertainty on objects.

[SOURCE: ISO 31000:2018]

NOTES:

- 1 An effect is a deviation for the expected. It can be positive, negative or both, and can address, create or result in opportunities and threats.
- 2 Objectives can have different aspects and categories, and can be applied at different levels.
- 3 Risk is usually expressed in terms of *risk sources* (3.4), *potential events* (3.5), their *consequences* (3.6) and their *likelihood* (3.7).

1.4.115 Safety function

A function to be implemented by a safety-related system or other risk reduction measures that is intended to achieve or maintain a safe state for the Type B appliance in respect of a specific hazardous condition.

1.4.116 Safety integrity

The probability of a safety-related system satisfactorily performing the required safety functions under the stated conditions within a stated time period.

1.4.117 Safety integrity level (SIL)

One of three possible discrete integrity levels (SIL 1, SIL 2, SIL 3) defined by quantitative or qualitative methods.

NOTES:

- 1 SIL 3 has the highest level of safety integrity for gas appliances, refer to the relevant parts of AS 61508 (series), AS IEC 61511 (series) and AS IEC 62601.
- 2 It is possible to use several lower safety integrity level systems to satisfy the need for a higher level function (e.g. using a SIL 2 and a SIL 1 system together to satisfy the need for a SIL 3 function).
- 3 SIL 4 is not considered in this Standard, as it is not relevant to the risk reduction requirements normally associated with industrial and commercial gas-fired appliances. For requirements applicable to SIL 4, refer to AS 61508.1 and AS 61508.2.

1.4.118 Safety control system

A system used to implement one or more safety functions. A safety control system is composed of any combination of sensor(s), logic solver(s) and final element(s).

NOTES:

- 1 A safety control system may or may not include software. Further details are provided in AS 61508 (series), AS IEC 61511 (series) and AS 62061.
- 2 AS 61508 (series) refers to safety control systems as safety-related systems. AS IEC 61511 (series) refers to safety control systems as safety instrumented systems (SIS). AS 62061 refers to safety control systems as safety-related electrical, electronic and programmable electronic control systems (SRECS).

1.4.119 Safe start check

A check of a flame safeguard system that will prevent an ignition attempt from occurring if the system is in the flame proved condition before any gas valves are energized as part of an ignition attempt.

1.4.120 Safety shutdown

The action of shutting off all gas and ignition energy by means of a safety control such that restart cannot be accomplished without a full start cycle.

1.4.121 Safety shut off system

An arrangement of valves and associated control systems that shuts off the supply of gas, when required, using a device that senses an unsafe condition.

1.4.122 Safety shut off system, double block and vent

A safety shut off system that incorporates two safety shut off valves in series, with the space between the two valves automatically vented. These valves are interlocked so that when the safety shut off valves are closed, the vent valve is open and vice versa.

1.4.123 Safety shut off system, triple block and double vent valve arrangement

A safety shut off system that incorporates three safety shut off valves in series, with an automatic Class 1 vent valve provided between each of these safety shut off valves.

1.4.124 Safety shut off valve

An automatic shut off valve that is in accordance with the requirements of AS 4629 and is used to shut off gas supply to an appliance when a signal is generated indicating the approach of an unsafe condition.

1.4.125 Set pressure

The mean pressure at which a device will actuate at a specific adjustment.

1.4.126 Spit back

The explosion of the gas/air mixture inside the inlet manifold of an engine.

NOTE: Also referred to as 'backfire'.

1.4.127 Start gas

The gas flowing at a pilot burner, or when no pilot burner is fitted, at a main burner, during the flame establishment period for initial ignition.

1.4.128 Steam boiler

Any vessel in which steam is intended to be generated at a pressure above that of the atmosphere by the application of heat from the combustion products to the vessel.

1.4.129 Stoichiometric combustion

The theoretical combustion of fuel in air such that no combustible agent or residual oxygen remains in the combustion products.

1.4.130 Supervised burner

A burner fitted with a flame safeguard system.

1.4.131 Supervised pilot

See 'Protected pilot'.

1.4.132 Technical regulator

The government-appointed person, body or authority that has jurisdiction over gas safety legislation (or other entity authorized by that person, body or authority).

1.4.133 Temperature limit device

A device that automatically causes the gas supply to be interrupted when the temperature at the control point reaches a predetermined limit.

1.4.134 Test firing valve

A manual shut off valve that can be used for turning a burner on or off in order to test it for satisfactory ignition, and flame stability.

1.4.135 Thermostat

A device that automatically maintains a predetermined temperature in an appliance.

1.4.136 Valve

A device for the purpose of controlling or shutting off flow.

1.4.137 Valve train

A combination of valves, regulators, pipe pieces and unions that form an integrated system for flow or pressure control and safe operation of a burner.

1.4.138 Vent line

A pipe that is connected to a gas pressure regulator, relief valve or a double block and vent safety shut off system, and will convey gas to a safe location.

1.4.139 Vent valve, double block and vent safety shut off system

A valve in the vent line of a double block and vent safety shut off system that automatically opens when de-energized and automatically closes when energized.

1.4.140 Water heater

An appliance for the supply of water at a temperature not exceeding 99°C.

SECTION 2 REQUIREMENTS FOR DESIGN AND CONSTRUCTION

2.1 GENERAL REQUIREMENTS

2.1.1 Appliance design

2.1.1.1 *General*

Appliance design shall be in accordance with the requirements of AS 1375 in regard to the overall safety of the process.

A risk assessment shall be conducted on the appliance and its associated installation to ensure that it is provided with safety measures in accordance with both AS 1375 and this Standard. The scope of this analysis will depend on the size, nature and complexity of the installation.

NOTE: Requirements for the prevention and relief of explosions due to such process hazards as combustible gases, vapours or dusts are given in AS 1375.

2.1.1.2 *Risk assessment requirements*

The risk assessment on the design and the installation of the appliance at its installed location shall—

- (a) be performed by the organization or person in control of the Type B appliance and its installation by using a risk criteria to determine whether the appliance and associated equipment may cause risk of injury or fatality, or collateral damage or other adverse effects to the installation or its surrounds. The risk assessment shall include the known hazardous consequence of an appliance failure, taking into account the location of the appliance and occupancy around it, as well as known consequences such as an appliance explosion or gas leak; and

NOTES:

- 1 See Appendix M for guidance on hazards covered by conforming with this Standard. These should be reviewed to identify if the appliance process or location creates a requirement for additional safety measures for these hazards or additional hazards identified.
 - 2 See Appendix K for further guidance, including risk criteria that may be suitable.
 - 3 A simple qualitative risk assessment to ensure that sufficient mitigation measures to reduce the risk to ALARP may be applicable for low risk installation of Type B appliances with a gas consumption of 20 GJ/h or less. Low risk Type B appliances are generally those that do not have solvents, dusts or other process conditions that present additional hazards. Low risk installations are in locations that ensure low occupancy in the vicinity of the appliance (e.g. low risk installations are roof-top or remote plant rooms, industrial premises or outdoor locations but do not include installations in basements or at schools, hospitals or aged care facilities). Refer to the Building Code of Australia's building classifications for further guidance.
 - 4 Type B appliance OEM and installer should supply information to the organization or person in control of the Type B appliance on the hazards, consequences and level of risks. This should include the levels of residual risks associated with their Type B appliance and installation, where installed to their instructions. This is so that the organization or person in control of the Type B appliance may take additional mitigation action as necessary when assessing the specific site hazards and risks associated with the installation and its operation.
- (b) identify all reasonable risks and reduce them to a tolerable level. Risks in the tolerable region should be identified as controlled and as low as reasonably practicable (ALARP).

NOTES:

- 1 A tolerable level may be defined by both occupational and health legislation and corporate values.
- 2 Refer to AS/NZS ISO 31000 for guidance on both qualitative and quantitative methods.
- 3 Other industry standards and codes could be used for assessments of Type B appliance installations where appropriate.
- 4 Refer to Appendix G of AS 2885.1 for guidance on the demonstration of ALARP and whether the implementation costs are grossly disproportionate to the reduction in or avoidance of risk. Refer also to UK Health and Safety Executive report, '*Reducing risks, protecting people—HSE's decision making process*', at <http://www.hse.gov.uk>.

2.1.1.3 Improper use

Equipment and protective systems shall be designed and integrated into the end product after due analysis of possible operating faults, so as to preclude dangerous situations due to the consequences of improper use.

NOTE: Examples are as follows:

- (a) Tool required to gain entry to the control enclosure.
- (b) Password protected controls.
- (c) Locking devices.
- (d) A work permit system.
- (e) Operating instructions and signage warning against any potential improper use of the equipment.

NOTE: One or more of these may be required after all improper uses have been assessed.

2.1.2 Suitability for application**2.1.2.1 Location**

An appliance and its associated components shall be designed to ensure safe, satisfactory and reliable operation in its intended location.

2.1.2.2 Gas quality

An appliance and its associated components shall be designed with attention to the quality and composition of the gas. It shall be ensured that the fuel gas quality and composition does not adversely affect the integrity and safe operation and combustion process of the appliance. In addition, attention shall be given to the effects of any combustion by-products ensuring they do not pose an unacceptable risk to human health.

2.1.3 Controls and indicating devices

Controls and indicating devices fitted to an appliance shall—

- (a) be able to provide complete and safe control of the appliance; and
- (b) where frequent observation or adjustment is required, be conveniently located.

2.1.4 Design of adjustable devices

An adjustable device that affects an appliance shall be designed so that it—

- (a) can be readily and conveniently adjusted as required;
- (b) is, if important to the safety of the equipment, protected against unauthorized interference;
- (c) is not unduly influenced by temperature change;
- (d) is not susceptible to sticking or seizing under normal operating conditions of use; and
- (e) incorporates a locking or holding arrangement to prevent subsequent movement through accident, vibration or expansion.

The tightening of any such locking device shall not alter any setting.

2.1.5 Appliance to be well constructed

All component parts of an appliance shall be installed in accordance with the OEM's specification and be suitable for the application, well-fitted, and not warped, bent, broken or otherwise damaged.

2.1.6 Appliance parts to be secure against accidental displacement

Every part of an appliance shall be secure against accidental displacement.

2.1.7 Appliance parts to be secure for satisfactory operation

Essential parts of an appliance shall be secured to maintain their position to ensure satisfactory operation of the appliance.

NOTE: This requirement ensures that essential parts of the appliance maintain their relationship during normal operation and after any maintenance (e.g. flame detector in relation to the burner).

2.1.8 Appliance to be free of sharp edges

All parts of an appliance with which a person may come into contact during normal operation, adjustment or servicing shall be free from sharp projections or edges and projecting screw ends.

2.1.9 Appliance supports to be of adequate strength

Appliance supports shall be of adequate strength to withstand the total weight of the appliance in service.

2.1.10 Provision to be made for sampling flue gases

Provision shall be made for obtaining samples of flue gas for analysis.

2.2 CONTROLS, BURNER AND SAFETY DEVICE ACCESS

All controls, burners and safety devices shall be accessible for any of the following:

- (a) Normal operation.
- (b) Normal servicing.
- (c) Functional adjustment.
- (d) Testing.
- (e) Replacement.

NOTE: Manifold assemblies that permit removal of control(s) intact for servicing are considered to meet this requirement. Removal of an access door or panel to a control compartment or appliance enclosure is considered acceptable.

2.3 BURNER FLAME VISIBILITY

2.3.1 Burner flame to be visible to maintenance personnel

It shall be possible for maintenance or adjusting personnel to safely view a burner flame, either by direct sight or by means of a remote viewing device equivalent to direct sight.

NOTES:

- 1 The removal of a panel or part to allow viewing is permissible provided there is no hazard involved and combustion is not significantly affected (see Clause 3.6.1).
- 2 The location of a viewing device in or adjacent to an explosion relief panel, or other similar area designed to relieve pressure or allow the passage of flame, gas or combustion products is not considered to meet this requirement.
- 3 With gas turbines, the use of a screen display or operating parameter indication on a screen display, appropriate to the appliance that is accessible to maintenance personnel, will satisfy this requirement.

2.3.2 Visual indication of burner flame to operator

It shall be possible for an operator to—

- (a) at any time, safely ensure visually that the main or pilot burner is alight; and
NOTE: Reflected glare or indicator lamps could be considered adequate for this purpose.
- (b) where manually operated final burner controls are fitted, have a clear view of the main and pilot flames.

2.4 TEMPERATURES OF SURFACES AND COMPONENTS

Appliance design shall ensure that the surface temperatures of appliance controls intended to be operated shall not present a danger to the user.

NOTE: See Table 2.1.

Where thermal radiation exceeds 5 kW/m² required warning signs shall be used as protection against hot surfaces and heat radiation emission.

NOTE: This radiation can come from visible flames as well as very hot surfaces, e.g. an open flare or when an appliance door or maintenance cover is open.

TABLE 2.1
RECOMMENDED MAXIMUM TEMPERATURES
OF SURFACES AND COMPONENTS

Surface or component	Maximum temperature °C
Adjacent combustible materials, floors, walls and the like	70
Surfaces intended to be handled (e.g. handles, knobs and the like) when made of—	
(a) metals or materials with similar high conductivity;	55
(b) porcelain, vitreous enamel or similar medium conductivity material; or	65
(c) plastic, wood, rubber or similar low conductivity material.	80
Surfaces likely to be accidentally touched, except those that are obviously hot including—	
(a) metals or materials with similar high conductivity;	100
(b) porcelain, vitreous enamel or similar medium conductivity material; or	115
(c) plastic, rubber or similar low conductivity material.	120
Bodies of valves, cocks and the like	Maximum specified by the original equipment manufacturer
Controls and components containing non-metallic bellows, diaphragms and the like (unless specifically designed for higher temperature)	65
Electrical and electronic components	Maximum specified by the original equipment manufacturer
Copper fuel piping	70

NOTES TO TABLE 2.1:

- The above values are based on the temperature limits in the gas appliance Standards. In the gas appliance Standards the limits are given as above ambient values. An ambient of 20°C should be used for comparison purposes.
- The limits specified for knobs, handles, surfaces, etc. are intended to provide a degree of personal protection. It is recognized that equivalent protection could be achieved by the provision of measures such as special protective clothing, gloves, guards. The need for such protection should be indicated by a notice.

2.5 RESTRICTION ON ELECTRICAL CONNECTIONS

2.5.1 Ease of connection

Electrical components or assemblies that may be required to be removed from an appliance shall not be connected by permanent or soldered joints, except in the case of extra-low voltage circuits.

NOTE: 'Extra-low voltage' means not exceeding 50 V a.c. and 120 V d.c. as defined by AS/NZS 3000.

2.5.2 Limit on cross-connection

Electrical plug/socket connectors to the start gas valves and the main gas valves shall not be interchangeable.

NOTE: The use of a wiring loom or arrangement that does not allow interchange without significant modification will satisfy this Clause.

2.6 ACCESSIBILITY OF MANUAL CONTROLS

Any ladder or step that may be needed to reach manual operating controls on an appliance shall be a permanent fixture.

2.7 ACCESS FOR MAINTENANCE

Adequate space should be provided around any appliance (or its enclosure) and its control equipment, to allow access for maintenance and repair.

2.8 MATERIALS

2.8.1 Materials to be adequate for their intended application

To ensure safe operation, materials used for the construction of an appliance shall be—

- (a) strong enough for their intended application;
- (b) sufficiently resistant to heat; and
- (c) sufficiently resistant to corrosion.

2.8.2 Restriction on use of zinc-base die-castings

Zinc-base die-casting alloys shall not be used where—

- (a) failure could result in leakage or ignition of gas;
- (b) temperatures may exceed 90°C; or
- (c) the alloy is in contact with water.

2.8.3 Materials to be suitable for gas

Materials in contact with gas shall be suitable for use with the gas for which the equipment has been designed.

NOTE: For corrosive gases such as biogas, OEM recommendations should be sought on the suitability for use with such gases of the appliance, gas treatment components, valve train components, pipe, pipe fittings and burners, as many components are not suitable for corrosive gases such as biogas.

2.9 GAS PIPEWORK AND VALVE TRAINS

2.9.1 Gas pipework

Pipework on an appliance shall be—

- (a) up to and including 200 kPa in accordance with the requirements for pipe and pipe fittings (excluding pressure test points, flexible hoses and flexible connections) in AS/NZS 5601.1;
- (b) over 200 kPa in accordance with the requirements for pipe and pipe fittings in AS 4041 and Section 2 of AS/NZS 5601.1; and
- (c) gas tight at operating pressure when assembled.

NOTES:

- 1 Refer to Clause 4.2 and Table 4.1 of AS/NZS 5601.1, for pipe and pipe fitting details. Refer also to Section 2 of AS/NZS 5601.1 for appliance pipework, including pipe fittings up to 200 kPa.
- 2 Pressure test points are covered separately in Clause 2.13.
- 3 Pipework may require testing to higher pressures to meet the requirements of AS/NZS 5601.1 or AS 4041. It could be necessary to isolate specific sections of the pipework, valves and, or components to undergo this test due to their pressure rating.
- 4 See Appendix C for typical valve train arrangements.

2.9.2 Flexible hose and connection requirements

A flexible hose or connection for use in a valve train or as part of an appliance shall—

- (a) be as short as practicable for the specific valve train or appliance requirements, in accordance with the appliance OEM's specification;
- (b) be of adequate diameter for the maximum expected gas flow rates, including transient short term flows;
- (c) be designed and constructed and installed to withstand all normal operating conditions;
- (d) not to be installed where it may be subject to damage;
- (e) be inspected, maintained and replaced according to the OEM's specifications;
- (f) be in conformance to, or be in accordance with, one of the following standards where applicable:
 - (i) AS/NZS 1869.
 - (ii) AS 4631.
 - (iii) ASTM F1120-87.
 - (iv) BS 6501-1.
 - (v) ISO 10380.
 - (vi) ISO 3821,
- (g) if a quick release coupling is used, be provided with protection against the continuous release of gas due to inadvertent disconnection, e.g. self-sealing connections, a low gas pressure switch, or other suitable means be fitted.

NOTES:

- 1 Normal operating conditions may include the expected changes in pressures, temperatures, bending radius, strain, vibrations, frequency and number of cycles.
- 2 See Clause 5.8.4 for specific requirements related to gas supply flexible connections installed to a gas engine or gas turbine.

2.9.3 Enclosure for a valve train

An enclosure for a valve train shall be ventilated to ensure safe operating temperature and conditions for valve train components. An enclosure for a valve train shall be so constructed that the available dilution ensures that the foreseeable gas leakage is not dangerous.

NOTES:

- 1 Assessment of foreseeable gas leakage may be done utilizing guides such as AS/NZS 60079.10.1, EI 15 and IGEM/SR/25 Edition 2.
- 2 AS/NZS 5601.1 may be used for additional guidance.

2.9.4 Pressure rating of valve train components

2.9.4.1 *Upstream of and including appliance gas pressure regulator*

Piping and valve train components upstream of, and including, the appliance gas pressure regulator shall have a rated working pressure not less than—

- (a) the inlet pressure to the next upstream regulator; or
- (b) the setting of any over-pressure protection system fitted to the next upstream regulator.

2.9.4.2 *Downstream of appliance gas pressure regulator*

Piping and valve train components downstream of the appliance gas pressure regulator shall have a minimum rated working pressure not less than the inlet pressure of the appliance regulator, unless an over-pressure protection in accordance with Clause 2.11 is fitted.

2.9.5 Requirements where pressurized air, oxygen or a stand-by gas is to be used

Where pressurized air, oxygen or a stand-by gas is to be used in conjunction with a gas valve train or burner, a suitable protective device(s) shall be installed in the piping as close as possible to and upstream of the point of interconnection of any gas and air, oxygen or stand-by gas lines, so as to prevent cross-contamination.

NOTE: Suitable protective devices include the following:

- (a) A check valve preferably fitted with a soft seat of non-metallic material that is compatible with gas.
- (b) A three-way valve that completely closes one outlet before opening the other.
- (c) A reverse-flow detector that controls a positive shut off valve.
- (d) A device, which mixes gas and combustion air and incorporates a double-diaphragm zero regulator, used in conjunction with a proportional mixing device, where the air or oxygen supply pressure does not exceed 7 kPa.

2.9.6 Multi-position manual control valves

Manual control valves having more than one operating position shall have the function of each position clearly indicated.

2.9.7 Design of valve handles, dials and pointers

Valve handles, movable dials and pointers shall be designed so that they—

- (a) are not capable of being incorrectly assembled;
- (b) are securely attached to their spindles; and
- (c) do not contain loose parts that could become detached when the valve handle, dial or pointer is removed.

2.9.8 Appliance isolating valve

2.9.8.1 *Appliance isolating valve to be fitted*

A quarter-turn manual shut off valve shall be fitted to isolate all gas to the appliance.

2.9.8.2 *Requirements for appliance isolating valve*

The appliance isolating valve shall conform with all of the following:

- (a) Be in accordance with the Type 1 requirements of AS 4617 and subject to Item (b). For valves requiring excessive physical force to operate, an alternative means to a single-action type lever may be used, provided it has position indication. For valves outside the scope of AS 4617, the safety requirements shall be in accordance with that relevant Standard at least at an equivalent level and the valve shall be approved. A declaration by the OEM of the valve, together with documentation which supports the fitness for purpose of the valves for the application, is acceptable as evidence of conformity.

NOTES:

- 1 Refer to AS/NZS 4024.1401 for guidance on the physical strength for the hand-operation of equipment.
 - 2 See Appendix O for guidance on fitness for purpose assessment.
- (b) Be capable of being connected to the inlet piping such that, when the outlet piping is disconnected from it, the valve will remain securely attached to the inlet piping.
 - (c) Be suitable for the application.

2.9.8.3 *Location of appliance isolating valve*

The appliance isolating valve shall be located as follows:

- (a) It shall be located upstream of—
 - (i) all other controls; and
 - (ii) the start gas line.
- (b) It shall be in close proximity to the appliance.
- (c) It shall be accessible to enable quick isolation of the gas supply.

2.9.8.4 *Identification of appliance isolating valve*

Where the location of the appliance isolating valve is such that the valve is not readily identifiable, a notice shall be provided to clearly indicate—

- (a) the function of the valve; and
- (b) the appliance that it isolates.

2.9.8.5 *Connection of appliance isolating valve*

The valve train shall be connected to the appliance isolating valve by means of a flange or union.

NOTE: This enables the valve train to be disconnected from the gas supply.

2.9.9 Main burner isolation

2.9.9.1 *Main burner isolation valve location*

Where multiple burners are fitted to an appliance and the appliance can continue to operate with one or more burners and its associated valve train being serviced, each burner shall be fitted with permanent means of isolation to allow the safe removal of valve train components, and the servicing and commissioning of the burner.

Where the appliance burner is located remote from the appliance isolation valve, a separate approved burner isolation valve shall be fitted unless the appliance isolating valve is capable of being locked in the 'off' position.

NOTES:

- 1 For the purposes of Clause 2.9.9.1, 'remote' is taken to mean it requires access by means of a ladder over 1.5 m to reach the burner or that it is in excess of 5 m from the burner at the same level.
- 2 The intent of the additional requirement is to facilitate quick location and access to the appliance isolation valve and, in the case of servicing, allow safe isolation of gas to the burner or appliance being serviced.

2.9.9.2 Main burner isolation for commissioning

For the purposes of commissioning at the start gas rate, a permanent means shall be provided to prevent gas from flowing at rates other than the start gas rate specified in Clause 3.2.3.

NOTE: Suitable permanent means of isolation include one of the following:

- (a) A manual shut off valve (test firing valve) located immediately downstream of the main gas safety shut off valve(s).
- (b) A test firing valve located between the start gas take-off point and the first main gas safety shut off valve.
- (c) A clearly marked removable electrical plug, a positive action switch or link in the electrical supply to the main-gas safety shut off valves (or the main-gas control function within the safety shut off valves) which cannot be inadvertently or incorrectly reconnected to the electrical supply. Disconnection of electrical wiring does not satisfy this requirement.
- (d) A burner management system, incorporating a parameterized function that is designed to stop the burner start-up sequence at the ignition/pilot gas position for checking of the start gas rate.
- (e) Other means may be used to set the start gas rate to meet the intent of this Clause.

2.9.10 Restriction on test firing valve

A test firing valve, if fitted, shall not be used to regulate gas input to the main burner under normal operating conditions.

2.9.11 Pilot burner isolating valve

A manual shut off valve shall—

- (a) be fitted to the gas supply line of a pilot burner;
- (b) enable the gas supply to a pilot burner to be turned off independently of the main burner; and
- (c) be in accordance with the Type 1 requirements of AS 4617 and be approved.

NOTE: The use of a manually-opened pilot take-off port incorporated in an approved thermoelectric flame safeguard, meeting the requirements of AS 4620 or AS 4624, will satisfy the requirements of this Clause.

2.10 GAS PRESSURE REGULATION

2.10.1 Gas pressure regulator to be fitted

A gas pressure regulator shall be fitted to the following:

- (a) The main gas supply to an appliance, a burner or group of burners, unless some other equally effective means of pressure and flow control is provided, other than the service regulator.
- (b) The start gas supply, unless—

- (i) the start gas take-off point is downstream of the main gas pressure regulator; and
- (ii) the main gas pressure regulator in accordance with Clause 2.10.3 at the start gas rate.

NOTES:

- 1 In the case of a pilot burner, the commissioning person should confirm that significant pilot shrinkage does not occur during the main flame establishment period, see Clauses 2.23.1(a) and 2.23.1(b).
- 2 Alternatives to gas pressure regulators may be fitted according to supporting documentation from the OEM. This documentation should support the fitness for purpose of the alternate means of pressure and flow regulation for the appliance. Site commissioning is acceptable evidence of conformity.

2.10.2 Requirements for a gas pressure regulator

The requirements for a gas pressure regulator are as follows:

- (a) A regulator with a maximum design inlet pressure not exceeding 7 kPa and of a nominal size not exceeding 50 mm shall be in accordance with the Grade 10 requirements of AS 4618 and be approved.

or

- (b) A regulator shall be of the lock-up type with a lock-up pressure not greater than 25% above the set outlet pressure where—
 - (i) the nominal inlet pressure for the regulator exceeds 7 kPa;
 - (ii) the design pressure drop across the regulator is greater than 20% of the nominal inlet pressure; or
 - (iii) the nominal size exceeds 50 mm.

2.10.3 Gas pressure regulator accuracy

Over the controlled flow rate range, a gas pressure regulator shall maintain the outlet pressure within plus or minus 10% of the set pressure.

2.10.4 Position of gas pressure regulator

A gas pressure regulator shall be positioned so that—

- (a) it is in accordance with the requirements of Clause 2.2;
NOTE: A gas pressure regulator should be located upstream of the safety shut off valves unless a downstream location will not adversely affect burner light-up and be in accordance with the requirements of Clause 2.10.1.
- (b) the breather vent outlet cannot be readily blocked; and
- (c) the possibility of ignition of any gas leaking from the breather vent outlet is minimized.

2.10.5 Venting of gas pressure regulator

A gas pressure regulator shall be vented in accordance with AS/NZS 5601.1.

NOTE: A restricting orifice in a regulator breather vent outlet may be fitted, provided it does not adversely affect the operation of the regulator.

2.11 GAS OVER-PRESSURE PROTECTION

2.11.1 Requirement where over-pressure protection shuts off the gas supply

Where an over-pressure protection system shuts off the gas supply, it shall require a manual reset to restore the supply.

2.11.2 Where over-pressure protection system is to be fitted

An over-pressure protection system shall be fitted where any of the following apply:

- (a) The rated working pressure of any piping or valve train component downstream of the appliance gas pressure regulator does not otherwise conform with the requirements of Clause 2.9.4.2.
- (b) The inlet pressure to the last regulator before a burner exceeds 7 kPa and is more than 35% above the minimum operating outlet pressure, unless the burner can maintain satisfactory combustion, in accordance with Clause 3.6.1, with the regulator in the wide open position.

NOTE: Where a component performs the function of both gas pressure regulator and gas/air ratio control in response to combustion air pressure changes, the minimum operating gas pressure is taken to be the outlet pressure at the maximum gas flow rate.

- (c) The failure of a regulator could result in the burner start gas rate exceeding the maximum allowable in Clause 3.2.3.

2.11.3 Setting of over-pressure protection system

The over-pressure protection system shall be set to ensure the following:

- (a) No piping or valve train component can be subjected to a pressure in excess of its rated working pressure.
- (b) Where Clause 2.11.2(b) applies, the following requirements shall be met:
 - (i) Where a separate flow rate control valve is used, the shut off pressure at the system sensing point shall not exceed 35% above the minimum operating pressure with the appliance operated over its entire firing range.

NOTES:

- 1 A higher set pressure could allow the air-gas ratio to fall below 84% of the stoichiometric rate (i.e. gas/air mixture is fuel rich), and allow carbon monoxide to be formed in sufficient quantities to form an explosive mixture.
- 2 In the case where the pressure at the burner exceeds the critical ratio, then the setting of the overpressure switch ensures that at the trip point the aeration level will not fall below 84% of stoichiometric air-gas ratio.

- (ii) Where a combination gas control performs the function of both gas pressure regulator and gas/air ratio control in response to combustion air pressure changes, the shut off pressure at the system sensing point shall be as low as possible without causing nuisance shutdowns but shall not exceed 35% above the pressure at the highest normal firing rate.

NOTE: In order to prevent the production of excessive quantities of carbon monoxide at less than the maximum burner firing rate, the shut off pressure should be set to the lowest setting possible without nuisance shutdowns occurring.

2.11.4 Location of over-pressure protection system sensing point

The sensing point for the over-pressure protection system shall be located as follows:

- (a) It shall ensure that the requirements of Clause 2.11.3(a) can be met.
- (b) It shall be either—
 - (i) downstream of a gas pressure regulator; or
 - (ii) downstream of a combination gas control performing the function of both gas pressure regulator and gas/air ratio control in response to combustion air pressure changes.

NOTE: The sensing point should not be located between the double block valves.

2.12 GAS LOW-PRESSURE PROTECTION

2.12.1 Low-gas-pressure detector to be fitted

A low-gas-pressure detector shall be fitted where a reduction in supply pressure may cause a burner to become unstable or combustion to become unsatisfactory before the flame safeguard system goes to lockout.

NOTES:

- 1 A low-pressure trip valve on the gas pressure regulator or a low-pressure switch connected into the safety shut off circuit are acceptable methods.
- 2 Burners with UV flame detection systems should be checked to confirm that they lockout the burner before unstable combustion occurs.

2.12.2 Requirements of low-gas-pressure detector

A low-gas-pressure detector shall—

- (a) be downstream of the appliance gas pressure regulator; and
- (b) cause safety shutdown of all burners affected by an under-pressure condition.

2.13 GAS PRESSURE TEST POINTS

2.13.1 Location of pressure test points

Suitable and sufficient means for assessing the gas tightness of safety shut off systems and the pressure and flow throughout a gas valve train shall be provided.

2.13.2 Sealing of a pressure test point

A gas pressure test point shall be provided with a means of sealing the outlet and be suitable for the maximum operating pressure.

NOTE: This requirement is typically met by the provision of a manual isolating valve and plug or cap.

2.13.3 Maximum orifice size of a pressure test point

The diameter of a restricting orifice in a non-self-sealing gas pressure test point shall not exceed 1 mm.

NOTE: This provision applies to only pressure test points with screw seals designed for push on hoses where a manual isolating valve and plug or cap is not used and only applies to operating pressures of 7 kPa or less.

2.14 GAS FILTER

2.14.1 Filter to be fitted

A filter shall be fitted in the appliance valve train where any one of the following apply:

- (a) The nominal inlet pressure to the appliance regulator for the main burner or start gas supply exceeds 7 kPa.
- (b) The upstream supply is not filtered to at least 1 mm.
- (c) An appliance over-pressure protection system shuts off the gas supply.
- (d) The appliance is supplied with gas not conforming to AS 4564 (natural gas) or AS 4670 (LPG).

NOTE: Gas supplied at 2.75 kPa from a commercially supplied LP Gas cylinder is considered to be a filtered gas supply.

2.14.2 Requirements and location of filter

The filter(s) required by Clause 2.14.1 shall—

- (a) prevent the passage of foreign particles larger than 1 mm or that are specified by the appliance or valve OEM;
- (b) be located so that gas to any device that shuts off the gas supply is filtered; and
- (c) be located as close as practical to the first device in the appliance valve train that safely shuts off the gas supply.
- (d) For multiple appliance installations, one filter may be fitted upstream of the appliances, provided it gives adequate protection to all components and burners.

NOTES:

- 1 Where possible, the location of the filter should be immediately downstream of the appliance manual isolating valve and for appliances 5 GJ/hr or less the filter should be typically located within 5 m.
- 2 A safety shut off valve that incorporates a filter in its design may meet these requirements.
- 3 In the special case where finer particles and other contaminants will interfere with the plant operation or cause damage, the filter may be fitted immediately upstream of individual or groups of appliances. It is essential that the intervening pipework is thoroughly cleared of debris prior to commissioning, and during and after any pipework installation or modification. Examples of such installations are the use of a coalescing filter and stainless steel pipework for groups of appliances such as gas turbines and large gas engines.
- 4 Knockout drums, coalescers or pots which are designed to remove oil/liquid/other suspensions that carry over with a fuel gas sent to a flare or any other gas utilization or recovery system to minimum acceptable level, in accordance with the site requirements, are considered to act as filters.

2.15 SAFETY SHUT OFF SYSTEMS

2.15.1 Safety shut off valve and vent valve

Safety shut off valves and vent valves shall be in accordance with AS 4629 and be approved except where a safety shut off valve is part of a thermoelectric flame safeguard, in which case it shall be in accordance with AS 4620 or AS 4624 and be approved. For valves outside the scope of AS 4629, AS 4620 or AS 4624, the safety requirements detailed in those Standards shall be met at least at an equivalent level and the valves shall be approved. EN 161, ANSI Z21.21/CSA 6.5, ISO 23551-1 and UL 429 may be considered as alternative equivalent Standards for imported fully assembled appliances. A declaration by the OEM of the valves together with documentation which supports the fitness for purpose of the valves for the application is acceptable evidence of conformity if audited by a competent person.

NOTES:

- 1 Refer to AS/NZS 4024 1401 for guidance on the physical strength for the hand-operation of manual reset valves.
- 2 Where a class of automatic shut off valve or vent valve is referred to, the following classification of valves applies:
 - (a) *Class 1* An automatic shut off valve having the tightest shut off requirements with respect to closure against reverse flow conditions.
 - (b) *Class 2* An automatic shut off valve with a lower shut off requirement than a Class 1 valve with respect to closure against reverse flow.
 - (c) *Class 3* An automatic shut off valve with no closure requirements against reverse flow.
- 3 See Appendix O for guidance on a fitness for purpose assessment.

2.15.2 Function of safety shut off system

A safety shut off system shall be connected so that it will shut off at the approach or presence of an unsafe condition.

NOTE: The need for a safety shut off valve system is dependent on the fitting of flame safeguards and limit devices, that may be required by other Sections of this Standard. There may be occasions where none of these is fitted, e.g. in the case of a permanently manned, fully manual operation of open atmospheric burners where adequate operating instructions are displayed. In such a case, the function of the safety shut off valve system is performed by the operator closing a manual valve.

2.15.3 Safety shut off valve system requirements for main and start gas supplies

2.15.3.1 General

Except in accordance with Clauses 2.15.3.2 to 2.15.3.8, 5.8.2.1 and 5.8.2.2, the main burner gas supply and the start gas supply shall be fitted with separate safety shut off valve systems that conform with the following minimum requirements, selected on the basis of the gas rate through the individual system:

- (a) Valves shall be of the Class 1 automatic shut off type.
- (b) For a gas rate not exceeding 5 GJ/h (1.4 MW), the valve arrangement shall be two valves in series.
- (c) For a lighter-than-air gas where the gas rate exceeds 5 GJ/h (1.4 MW) but does not exceed 20 GJ/h (5.5 MW), the valve arrangement shall be—
 - (i) double block and vent; or
 - (ii) double block with a leakage detection system.
- (d) For a lighter-than-air gas where the gas rate exceeds 20 GJ/h (5.5 MW) the valve arrangement shall be—
 - (i) double block and vent with a position-proving system (see Clause 2.15.9); or
 - (ii) double block with a leakage detection system.

If both position proving and leak detection are provided only one needs to be in accordance with this Standard if the non-conforming system has been shown by risk assessment to improve the overall safety of the appliance.

NOTE: The risk assessment should consider the requirements of Clause 2.15.9 for position proving systems and Clause 2.15.10 for leakage detection systems, in particular Clause 2.15.10.5(d).

- (e) For a heavier-than-air gas where the gas rate exceeds 5 GJ/h (1.4 MW), the valve arrangement shall be double block with a leakage detection system.

NOTES:

- 1 On multiple burner appliances, the minimum requirement is double block on main gas for each individual burner.
- 2 When using a double block and vent valve configuration to prevent excess gas venting the vent valve should not be open at any time the block valves are open.
- 3 The vent valve should close before the block valves are opened or open after the block valves are closed.
- 4 See Clause 2.25.5 for the operation of the valve system.

2.15.3.2 Concession for atmospheric burner not exceeding 500 MJ/h

An atmospheric burner not exceeding 500 MJ/h (140 kW), fitted with an intermittent or permanent pilot, or which is manually ignited, may use a single Class 3 safety shut off valve or a thermoelectric flame safeguard for the gas supply to both main and pilot burners.

2.15.3.3 *Concession for atmospheric burner not exceeding 1 GJ/h*

An atmospheric burner not exceeding 1 GJ/h (275 kW), which is manually ignited or fitted with a permanent pilot, may use—

- (a) a single Class 1 safety shut off valve for the main burner gas supply, and either a single Class 3 safety shut off valve or thermoelectric flame safeguard for the pilot burner gas supply; or
- (b) two Class 2 safety shut off valves for the main burner gas supply and a single Class 2 safety shut off valve for the pilot burner gas supply.

2.15.3.4 *Concession for forced or induced draught burner up to 200 MJ/h*

A forced or induced draught burner not exceeding 200 MJ/h (60 kW) may use two Class 2 safety shut off valves for the main burner gas supply and a single Class 2 safety shut off valve for the start gas supply.

2.15.3.5 *Concession for forced or induced draught burner up to 1 GJ/h*

A manually operated forced or induced draught burner not exceeding 1 GJ/h (275 kW) may use a single Class 1 safety shut off valve, provided that the valve is only actuated by a flame safeguard or limit device.

2.15.3.6 *Concession for a main burner up to 1 GJ/h igniting at low rate*

A burner not exceeding 1 GJ/h (275 kW) that employs ignition of the main burner at a low rate in order to be in accordance with Clause 3.2.3 may be fitted with one double block safety shut off valve system, to cover both main and start gas rates, provided the downstream safety shut off valve is a two-stage valve that employs an independently energized second stage such that energizing the second stage alone does not open the valve. It shall either—

- (a) incorporate a position indicator switch to ensure that the second stage is not operated before or during the start gas establishment period; or
- (b) incorporate a closed position indicator switch that conforms with AS 4629 and is approved.

2.15.3.7 *Concession for a main burner up to 1 GJ/h with no start gas line*

A burner not exceeding 1 GJ/h (275 kW) may be fitted with one double block safety shut off valve system, to cover both main and start gas rates, provided the critical time calculated using the maximum main burner gas rate is in accordance with the requirements of Clause 3.2.3.

2.15.3.8 *Concession for a burner using a separate start gas line*

A start gas line may use a single Class 1 safety shut off valve, provided the start gas rate—

- (a) does not exceed 500 MJ/h (140 kW); and
- (b) does not exceed 40% of the maximum rate specified in Clause 3.2.3.

2.15.3.9 *Provision for start gas to be taken from between safety shut off valves for a main burner directly ignited at a low rate*

A start gas supply may be taken from between two main gas safety shut off valves, provided the following requirements are conformed with:

- (a) For a main burner with a total input not exceeding 500 MJ/h (140 kW) (see Figure 2.1), no additional start gas safety shut off valve is required, provided—
 - (i) the downstream safety shut off valve is fitted with a closed position indicator switch; and
 - (ii) the start gas rate is not more than 40% of the rate permitted in Clause 3.2.3.

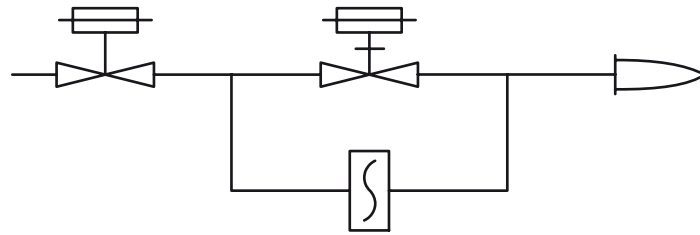


FIGURE 2.1 BURNERS UP TO 500 MJ/h (140 kW)

- (b) For a main burner with a total input exceeding 500 MJ/h (140 kW) but not exceeding 5 GJ/h (1.4 MW) (see Figure 2.2)—
- (i) an additional Class 1 safety shut off valve is fitted in the start gas line; and
 - (ii) the downstream main gas safety shut off valve is fitted with a closed position indicator switch.

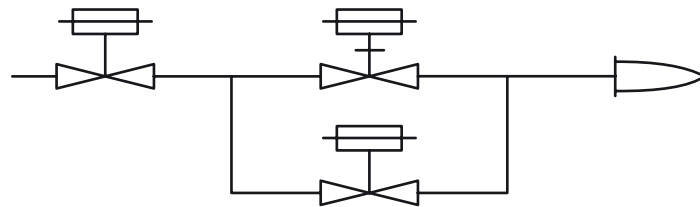


FIGURE 2.2 BURNERS OVER 500 MJ/h (140 kW) AND UP TO 5 GJ/h (1.4 MW)

- (c) For a main burner with a total input exceeding 5 GJ/h (1.4 MW) but not exceeding 20 GJ/h (5.5 MW) (see Figure 2.3), an additional Class 1 safety shut off valve is fitted in the start gas line and either—
- (i) a leakage detection system is fitted; or
 - (ii) the downstream main gas safety shut off valve is fitted with a proof-of-closure switch.

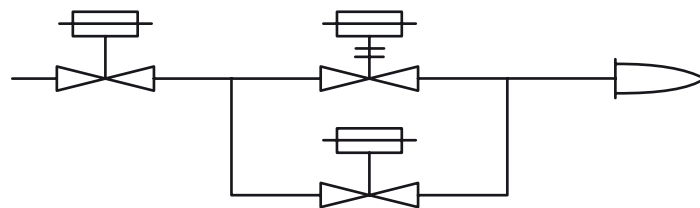
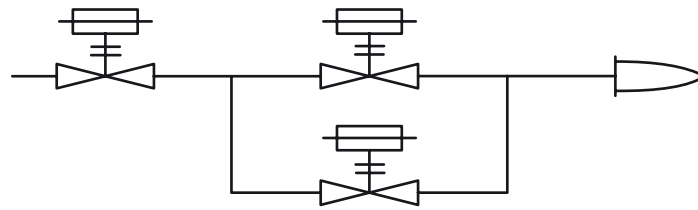


FIGURE 2.3 BURNERS OVER 5 GJ/h (1.4 MW) AND UP TO 20 GJ/h (5.5 MW)

- (d) For a main burner with a total input exceeding 20 GJ/h (5.5 MW) (see Figure 2.4), an additional Class 1 safety shut off valve is fitted in the start gas line and either—
- (i) a leakage detection system is fitted; or
 - (ii) all the safety shut off valves are fitted with proof-of-closure switches.



NOTE: The use of a leakage detection system is an alternative.

FIGURE 2.4 BURNERS OVER 20 GJ/h (5.5 MW)

2.15.4 Energizing of automatic safety shut off valves

In a system that is in accordance with Clause 2.15.3.8 no safety shut off valve shall be energized, except as part of a program in a leakage detection system, unless the following apply immediately prior to start-up where fitted:

- (a) All closed position indicator switches indicate correct valve position.
- (b) All proof-of-closure switches prove correct valve position.
- (c) A leakage detection system proves correct valve position.

2.15.5 Ignition of main burner by separate pilot

Where a main burner is ignited by a separate pilot and the flow rate through the main burner safety shut off valve system exceeds 1 GJ/h (275 kW) at start-up, one of the safety shut off valves in the main burner gas supply, downstream of the pilot gas take off, shall have an opening time of not less than 5 s.

2.15.6 Requirements for a safety shut off valve and vent valve

2.15.6.1 Rated working pressure

The operating pressure of a safety shut off valve and vent valve shall not exceed the maximum rated working pressure.

2.15.6.2 Orientation

A safety shut off valve or vent valve shall be fitted in an orientation for which it is designed.

2.15.6.3 Size of vent valve for a double block and vent safety shut off system or an emergency isolation and vent system

2.15.6.3.1 Size of vent valve for a double block and vent safety shut off system

Except as permitted in Clause 2.15.6.4, the minimum size of a vent valve that is part of a double block and vent safety shut off system shall be in accordance with Table 2.2 up to pressures of 200 kPa.

For pressures above 200 kPa, the pipe, vent valve and vent pipe volumes shall be designed and sized to vent the gas inventory to below 100 kPa in as short a time as practical.

NOTES:

- 1 The pipe volume between the double block and vent valves should be kept to a minimum to vent the gas inventory in as short a time as practical.
- 2 Typically for larger pipe volumes, this time should be no more than 10 s.

2.15.6.3.2 Size of vent valve for an emergency isolation and vent system

The minimum size of a vent valve that is part of an emergency isolation safety shut off valve and vent system shall be in accordance with Table 2.2 up to pressures of 200 kPa.

For pressures above 200 kPa, the pipe, vent valve and vent pipe volumes shall be designed and sized to vent the gas pressure to below 100 kPa in as short a time as practical.

NOTES:

- 1 The pipe volume between the emergency isolation safety shut off valve, vent valve and the downstream safety shut off system should be kept to a minimum to vent the gas inventory in as short a time as practical.
- 2 Typically for larger pipe volumes, this time should be between 10 to 60 s.

2.15.6.4 Size of vent valve for a leakage detection system

The size of the valve in the vent line of a leakage detection system shall not be less than 8 mm.

2.15.6.5 Arrangement for manual reset vent valve

A manual reset vent valve used in a double block and vent safety shut off system shall be arranged to prevent gas escaping through the vent line when the upstream safety shut off valve is open.

2.15.7 Safety shut off system not to be bypassed

A safety shut off system shall not be bypassed unless the bypass is fitted with a safety shut off system.

2.15.8 Vent line requirement

A vented safety shut off system shall be fitted with—

- (a) up to and including 200 kPa, the requirements in AS/NZS 5601.1; and
- (b) over 200 kPa, the requirements in AS 4041 and Section 2 of AS/NZS 5601.1.

NOTE: The design of vent pipework should anticipate any problems when venting at high pressure due to noise, thrust forces and the dispersion of the flammable gas envelope.

2.15.9 Requirements for a position-proving system**2.15.9.1 Safety shut off valve**

All safety shut off valves used in a position-proving system shall incorporate a proof-of-closure switch.

2.15.9.2 Vent valve

A vent valve used in a position-proving system of up to and including 200 kPa shall—

- (a) conform with Table 2.2; and
- (b) incorporate a position indicator switch.

For pressures above 200 kPa, a vent valve used in a position-proving system shall incorporate a proof-of-closure switch.

TABLE 2.2
MINIMUM SIZE OF VENT VALVE

Nominal size of largest safety shut off valve	Minimum size of vent valve mm	
	Double block and vent systems or Emergency isolation and vent systems	Position proving systems
Less than 20	Same as safety shut off valve	The lesser of 10 mm or same as safety shut off valve
20–40	20	15
50	25	15

(continued)

TABLE 2.2 (continued)

Nominal size of largest safety shut off valve	Minimum size of vent valve mm	
	Double block and vent systems or Emergency isolation and vent systems	Position proving systems
65	32	20
80	40	20
100	50	25
150	65	32
200	80	50

NOTE: Where a safety shut off valve greater than 200 NB is used, the vent valve may be sized using an appropriate method such as the one found in Appendix 5 of *Sizing of vents* of IGEM/UP/9 (for pressures >100 kPa).

2.15.9.3 *Position-proving system to be interlocked to prevent burner start-up*

The valves used in conjunction with a position-proving system shall be interlocked to prevent burner start-up (including pre-purge), where—

- (a) both safety shut off valves are not proved ‘closed’; or
- (b) the vent valve is not proved ‘open’.

2.15.9.4 *Alarm interlock*

A position-proving system for a gas consumption in excess of 20 GJ/h (5.5 MW) shall be interlocked to actuate an alarm if any one of the valves is not in its correct position immediately after any controlled or safety shutdown as follows, unless there is an additional automatic emergency isolation of the gas supply in accordance with Clause 5.8.2.4:

- (a) Any safety shut off valve is not proved ‘closed’.
- (b) The vent valve is not proved ‘open’.

NOTE: The nature and location of an alarm (i.e. audibility and visibility) should be such that the operator’s attention is attracted.

2.15.10 Requirements for a leakage detection system

2.15.10.1 *Conformity with Standard*

The operation of a leakage detection system shall not be adversely affected by any other system or equipment.

Where the system is commercially available, it shall be in accordance with either AS 4630 or an equivalent Standard. However, where the system is not commercially available (i.e. purpose-designed), it should be confirmed by the OEM that the system is in accordance with AS 4630 or an equivalent Standard.

NOTE: Examples of alternative standards are EN 1643 and AS ISO 21789 for gas turbines.

2.15.10.2 *Leakage detection system to be interlocked to cause lockout*

A leakage detection system shall be interlocked to cause lockout where the leakage rate exceeds the maximum allowed under Clause 2.15.10.4 before any source of ignition is energized or introduced into the combustion chamber.

2.15.10.3 *Commencement of leakage detection test*

The commencement of a leakage detection test shall occur as follows:

- (a) For an appliance, other than an appliance with an induced draught burner, during or immediately before the pre-purge cycle.
- (b) For an appliance with an induced draught burner, immediately before the pre-purge cycle begins.

NOTES:

- 1 It is recommended that for a gas consumption in excess of 20 GJ/h (5.5 MW) after any controlled shutdown, a leakage detection test be carried out.
- 2 The nature and location of an alarm (i.e. audible and visible) indicating failure of a leakage detection test should be such that the operator's attention is attracted.

2.15.10.4 *Maximum allowable leakage rate*

The maximum allowable leakage rate into or out of the space between the safety shut off valves shall be 0.05% of the maximum gas rate through the system.

2.15.10.5 *Leakage detection system that uses gas at line pressure*

Where a leakage detection system using gas at line pressure as the testing medium is employed, the following additional requirements shall be met:

- (a) When pressurizing the space between the safety shut off valves—
 - (i) the gas rate used shall satisfy the requirements of Clause 3.2.3; or
 - (ii) the upstream safety shut off valve shall not be open for more than 5 s, and where the maximum burner gas rate exceeds 20 GJ/h, the safety shut off valve that is to remain closed during the first part of the test, is to incorporate a position indicator switch or position proving switch.
- (b) The rise from atmospheric pressure and the fall from line pressure shall be monitored by—
 - (i) separate pressure switches performing each of the two required monitoring functions; or
 - (ii) a single pressure switch performing the two required monitoring functions where the leakage detection system used is in accordance with EN 1643; or
 - (iii) a single pressure transmitter performing the two required monitoring functions.
- (c) The pressure settings of switches referred to in Item (b) shall not overlap.
- (d) Where the contents of the space between the safety shut off valves are to be released into the combustion chamber all of the following shall apply:
 - (i) The contents of the space shall be released through the burner head.
 - (ii) A Class 1 safety shut off valve shall be used.
 - (iii) The average flow rate shall be in accordance with the requirements of Clause 3.2.3.
 - (iv) The valve used shall not be open for more than 5 s.
 - (v) The purge air flow shall be—
 - (A) proved before the valve is opened; or
 - (B) programmed to start immediately upon completion of a successful leakage detection cycle.
 - (vi) The pre-purge requirements of Clause 2.20 shall be met after the valve has closed as part of the leakage detection cycle.

NOTE: Line pressure is expected to be no less than the outlet pressure of the next upstream regulator.

2.15.11 Function of interlocks

Where a safety shut off system controls a gas consumption in excess of 20 GJ/h to a burner(s) which fires into a combustion chamber either connected to a common flue or with multiple burners firing into it, then the interlocks required by Clauses 2.15.9.3 and 2.15.10.2 shall—

- (a) where the appliance is unattended, act on all burners sharing the combustion chamber or common flue; or
- (b) where an operator is in attendance, activate an alarm.

NOTE: The nature and location of an alarm (i.e. audibility, visibility) should be such that the operator's attention is attracted.

2.15.12 Requirements of safety shut off system actuators

2.15.12.1 Individual actuators to be fitted

All valves in a double block and vent safety shut off system shall be individual valves fitted with their own individual actuators unless the valve is in accordance with the requirements of either Clause 2.15.12.2 or Clause 2.15.12.3.

2.15.12.2 Single three-way valve permitted

The combining of a safety shut off valve and a vent valve in a single three-way valve is permitted provided that all the following conditions are met:

- (a) The safety shut off valve is the downstream safety shut off valve.
- (b) When energized the valve is open from inlet to outlet and closed to vent.
- (c) When de-energized the valve is open from inlet to vent and closed to the outlet.

2.15.12.3 Use of rigidly coupled actuators

Where the valves of a double block and vent safety shut off system are to be rigidly coupled to a common actuator, all of the following requirements shall be met:

- (a) The coupled vent and safety shut off valves shall be downstream of another safety shut off valve.
- (b) The upstream safety shut off valve shall be fitted with an independent actuator.
- (c) The failure of an interlock that serves all burners shall cause all safety shut off valves to close and all vent valves to open.
- (d) Any condition requiring lockout of an individual burner or burner unit shall cause all safety shut off valves to close and all vent valves to open on the individual burner or burner unit.
- (e) The means of connecting the rigidly coupled valves shall be constructed so that it is not readily interfered with.

NOTE: A fixed cover is an acceptable means of preventing interference.

2.16 COMBUSTION AIR SUPPLY—GENERAL REQUIREMENTS

2.16.1 Combustion air supply equipment to be correctly sized

Combustion air supply equipment shall be correctly sized and arranged to ensure that the air flow is—

- (a) non-pulsating except in the case of purpose-designed pulse combustion systems; and
- (b) adequate for all operating conditions specified by the OEM.

2.16.2 Combustion air quality

Combustion air shall be free of contaminants such as suspended particles, flue gases, water or other gases or fuels that may adversely affect the combustion process.

NOTE: Flue gases, vapours or flammable substances introduced into the combustion air for emission or process control should not be considered to be contaminants.

2.16.3 Air openings to be of adequate size

Air openings shall be adequate to allow satisfactory combustion in accordance with Clause 3.6.1.

2.16.4 Air openings not to be obstructed

Measures shall be taken to prevent air openings from being obstructed.

2.17 COMBUSTION AIR FOR ATMOSPHERIC BURNERS

2.17.1 Primary aeration controls to be corrosion-resistant

Primary aeration control(s) shall be corrosion-resistant.

NOTE: Controls may be made of corrosion-resistant material or have a corrosion-resistant finish.

2.17.2 Effect of foreign matter on primary aeration controls to be minimal

Primary aeration controls shall be constructed so that any build-up of foreign matter does not adversely affect the flame characteristics.

2.18 FORCED AND INDUCED DRAUGHT BURNERS

2.18.1 Draught characteristics to be specified by the burner OEM

The air flow and pressure characteristics of a forced or induced draught combustion system shall be specified by the burner OEM.

2.18.2 Proving air flow

An appliance shall be fitted with devices for proving adequate air flow during the pre-purge, ignition and operation of the burner, including—

- (a) static or differential pressure sensing, where it can be shown that this provides satisfactory and reliable proof of air flow during pre-purge, ignition and subsequent firing; and
- (b) flow-sensing, where tapping points of a differential system shall be arranged so that the static pressure difference, in a system with a closed damper, does not result in an apparent flow signal being given.

NOTE: Proof of adequate air flow is normally obtained by one of the methods in Items (a) or (b). However, this list is not exhaustive and other methods are acceptable provided they are a direct measure of air flow, e.g. gas turbine and gas engine rotation speed (see Clause 5.8.3.4).

2.18.3 Self-check of air flow proving device

2.18.3.1 Self-check to be carried out

The air flow proving device shall be proved in the 'no-flow' state, prior to start-up.

NOTES:

- 1 Three-way vent solenoids can be used to provide the no air flow signal where it is impractical to shutdown or stop the air flow.
- 2 Pressure and flow transmitters that detect over and under scale are considered to fulfil this requirement provided they are maintained within the determined interlock functional proof test frequencies.
- 3 'No-flow' often is an actual low flow where it is impractical to prove no flow. For example, large boilers due to flue buoyancy effects and rotation speed of gas turbines where often the shaft never stops turning or is available for hot restart.

2.18.3.2 *Failure of air flow proving device during self-check*

Failure of the air flow proving device during a self-check shall cause—

- (a) start-up to be prevented; or
- (b) lockout.

2.18.4 **Safety shutdown to occur if air flow fails**

Air flow failure at any time during the pre-purge, ignition or operation of the burner shall cause the air flow proving device to initiate safety shutdown within 1 s.

NOTES:

- 1 Following safety shutdown due to incorrect air pressure or air flow, automatic restart is permitted provided that repetitive recycling could not cause a hazard.
- 2 The contactors of a combustion air fan and purging air fan (where fitted) should be interlocked to cause safety shutdown in the event of the contactors opening.

2.18.5 **Air-gas mixtures**

2.18.5.1 *Air-gas mixing machines and mixing blowers*

Air-gas mixing machines and mixing blowers shall be in accordance with the requirements of Clause 5.3.

2.18.5.2 *Maximum temperature of mixtures*

The temperature of an air-gas mixture to a burner(s) shall not exceed 50% of the auto-ignition temperature of the gas in degrees Celsius (°C).

NOTE: Typical values for auto-ignition temperatures are given in Table 2.3.

TABLE 2.3
TYPICAL VALUES FOR AUTO-IGNITION
TEMPERATURES (AIT) OF GASES

Fuel gas	Auto-ignition temperature °C
Natural gas	540
Simulated natural gas	450
Tempered liquefied petroleum gas	450
Liquefied petroleum gas (butane)	406
Liquefied petroleum gas (propane)	450
Town gas	560

2.19 **DAMPERS**

2.19.1 **Requirements for a fixed or adjustable damper**

A damper shall maintain satisfactory combustion in accordance with the requirements of Clause 3.6.1 and be—

- (a) secure against accidental displacement;
- (b) interlocked to prevent the pre-purge period from proceeding unless the damper is in the correct position and remains there for the full pre-purge period; and
- (c) interlocked to prevent ignition of the burner unless the damper is in the correct position for ignition.