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Automatic gas burner control systems for gas burners and gas burning appliances with or without fans

Feuerungsautomaten für Gasbrenner und Gasgeräte mit oder ohne Gebläse

Systèmes de commande et de sécurité pour brûleurs et appareils avec ou sans ventilateur utilisant les combustibles gazeux

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Contents

Foreword

This document has been prepared by CEN/TC 58, "Safety and control devices for gas-burners and gas-burning appliances".

This document is currently submitted to the Formal Vote.

This document replaces EN 298:1993.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this document.

This European Standard covers type testing only.

This document has to be implemented at national level, either by publication of an identical text or by endorsement, by **month year**, and conflicting national standards have to be withdrawn by **month year**.

It was discussed and agreed in CEN/TC 58 that controls that have been type tested and manufactured according to EN298:1993 before the date of withdrawl (dow) can be installed for a transition period of 3 years.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this document: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

Whilst this European Standard is written primarily for Automatic Gas Burner Control Systems used on or in appliances for cooking, heating, hot water production, refrigeration, lighting or washing and having, where applicable, a normal water temperature not exceeding 105 °C, it may be usefully quoted, as a whole or in part, by standards for other equipment.

The functional characteristics of the automatic burner control systems, programming units, and their associated flame detector devices, in so far as they are not laid down in this standard, are given by the standards for the appliances for which the automatic burner control systems are intended.

This standard deals with immunity aspects of Electromagnetic Compatibility (EMC) only. Since automatic burner control systems are intended for use as an integrated or incorporated part of an appliance, further EMC tests (both immunity and emission) may be required for the intended use.

1 Scope

This European Standard specifies requirements for the construction and function, test methods and marking of automatic burner control systems and also programming units and their associated flame detector devices for gas burners and gas burning appliances with or without fans.

This standard also applies to automatic burner control systems, programming units and their associated flame detector devices that include additional functions.

Automatic burner control systems utilizing thermo-electric flame supervision devices are not covered by this standard.

This European Standard covers type testing only.

NOTE European Standards for burners, appliances or processes which use automatic burner control systems, programming units or flame detectors may override the requirements of this standard.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 60068-2-6:1995, *Environmental testing — Part 2: Tests, Tests Fc: vibration (sinusoidal) (IEC 60068-2-6:1995, Corrigendum:1995).*

EN 60335-1:1994, *Safety of household and similar electrical appliances — Part 1: General requirements (IEC 335-1:1991, modified).*

EN 60529:1991, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989).*

EN 60730-1:2000, *Automatic electrical controls for household and similar use — Part 1: General requirements (IEC 60730-1:1999, modified).*

EN 60730-2-5:2001, *Automatic electrical controls for household and similar use — Part 2: Particular requirements for automatic electrical burner control systems (IEC 60730-2-5:2000, modified).*

EN 60947-5-1:1997, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Section 1: Electromechanical control circuit devices (IEC 60947-5-1:1997).*

EN 61000-4-2:1995, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques — Section 2: Electrostatic discharge immunity test – Basic EMC publication (IEC 61000-4-2:1995).*

EN 61000-4-3:1996, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques — Section 3: Radiated, radio-frequency, electromagnetic field immunity test — Basic EMC publication (IEC 61000-4-3:1995, modified).*

EN 61000-4-4:1995, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques — Section 4: Electrical fast transient/burst immunity test — Basic EMC publication (IEC 61000-4-4:1995).*

EN 61000-4-5:1995, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques — Section 5: Surge immunity test (IEC 61000-4-5:1995).*

EN 61000-4-6:1996, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques — Section 6: Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6:1996).*

EN 61000-4-11:1994, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques — Section 11: Voltage dips, short interruptions and voltage variations immunity tests (IEC 61000-4-11:1994).*

EN 61558-2-6:1997, *Safety of power transformers, power supply units and similar – Part 2-6: Particular requirements for safety isolating transformers for general use (IEC 61558-2-6:1997).*

EN 61558-2-17:1997, *Safety of power transformers, power supply units and similar — Part 2-17: Particular requirements for transformers for switch mode power supplies (IEC 61558-2-17:1997).*

EN 61810-1:1998, *Electromechanical non-specified time all-or-nothing relays — Part 1: General requirements (IEC 61810-1:1998).*

ENV 50204:1995, *Radiated electromagnetic field from digital radio telephones — Immunity test.*

IEC 60127-1:1999, *Miniature fuses; part 1: definitions for miniature fuses and general requirements for miniature fuse-links (IEC 60127-1:1988).*

IEC 60384-14:1993, *Fixed capacitors for use in electronic equipment — Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains.*

IEC 60384-16:1982, *Fixed capacitors for use in electronic equipment — Part 16: Sectional specification: Fixed metallized polypropylene film dielectric d.c. capacitors.*

3 Definitions

For the purpose of this standard the following definitions apply.

3.1
flame detector device
device by which the presence of a flame is detected and signalled;

it can consist of a flame sensor, an amplifier and a relay for signal transmission. These parts, with the possible exception of the actual flame sensor, may be assembled in a single housing for use in conjunction with a programming unit

3.2
flame sensor
actual flame-sensing element, the output signal or value of which is used as the input for the flame detector amplifier

3.3
Sensed flame and flame signal

3.3.1
sensed flame
physical value monitored by the flame sensor

3.3.2
flame signal
signal given by the flame detector device in case of sensed flame

3.4
flame simulation
condition which occurs when the flame signal indicates the presence of a flame when in reality no flame is present

3.5
programming unit
unit which reacts to signals from control and safety devices, gives control commands, controls the start-up sequence, supervises the burner operation and causes controlled shut-down, and if necessary safety shut-down and lock-out;

the programming unit follows a predetermined sequence of actions and always operates in conjunction with a flame detector device

3.6
automatic burner control system
system comprising at least a programming unit and all the elements of a flame detector device;

the various functions of an automatic burner control system may be in one or more housings

3.7
start position
stage, where the system is not in lock-out position, has not yet received the start signal but can proceed with the start-up sequence when required;

at this stage, the output terminals for any automatic shut-off valve and ignition device are not energized

3.8
start signal
signal e. g. from a thermostat, which releases the system from its start position and commences the predetermined programme

3.9
programme
sequence of control operations determined by the programming unit involving switching on, starting up, supervising and switching off the burner;

safety actions such as safety shut down and lock out are also part of the programme

3.10
purge
forced introduction of air through the combustion chamber and flue passages in order to displace any remaining fuel/air mixture and/or products of combustion

3.10.1
pre-purge
purge which takes place between the start signal and the energization of the ignition device

3.10.2
post-purge
purge which takes place immediately following shut-down

3.11
first safety time
interval between the pilot gas valve, the start gas valve or main gas valve, as applicable, being energized and the pilot gas valve, start gas valve or main gas valve, as applicable, being de-energized if the flame detector signals the absence of a flame

NOTE Where there is no second safety time, this is called the safety time.

3.12
second safety time
where there is a first safety time applicable to either a pilot or start gas flame only, the interval between the main gas valve being energized and the main gas valve being de-energized if the flame detector signals the absence of a flame

3.13
burner without fan
burner where the primary air required for combustion is provided by the action of the gas and the secondary air is freely available from the surroundings

3.14
burner with fan
burner in which some or all of the air required for the combustion is supplied by means of a fan (i. e. forced draught or induced draught)

3.15
running position of the system
position of the system in which the burner is in normal operation under the supervision of the programming unit and its flame detector device

3.16
controlled shut-down
process by which the power to the gas shut-off valve(s) is removed before any other action takes place, e. g. as a result of the action of a controlling function

3.17
safety shut-down
process which is effected immediately following the response of a protection device or the detection of a fault in the automatic burner control system and puts the burner out of operation;

the resulting state of the system is defined by deactivated terminals for the gas shut-off valves and the ignition device

3.18
Lock-out

3.18.1
non-volatile lock-out
safety shut-down condition of the system, such that a restart can only be accomplished by a manual reset of the system and by no other means

3.18.2
volatile lock-out
safety shut-down condition of the system, such that a restart can only be accomplished by either the manual reset of the system, or an interruption of the main power and its subsequent restoration

3.19
spark restoration
process by which, following loss of flame signal, the ignition device will be switched on again without total interruption of the gas supply

3.20
recycling
process by which, after a safety shut-down a full start-up sequence is automatically repeated

3.21
Functions of automatic burner control systems

3.21.1
waiting time
for burners without fans, the interval between the start signal being given and the energization of the ignition device or gas valves, which ever comes first;

during this time natural ventilation of the combustion chamber and the flue passages may take place

3.21.2
pre-purge time
period during which purge takes place at the proven air rate prior to the energization of the ignition device or gas valves, which ever comes first

3.21.3
post-purge time
period during which purge takes place at the proven air rate between any shut-down and the moment the fan is switched off

3.21.4
inter-purge time
period during which purging of the combustion chamber takes place at the proven air rate after unsuccessful ignition and prior to the next recycle attempt

3.21.5
inter-waiting time
period during which natural ventilation of the combustion chamber takes place after unsuccessful ignition and prior to the next recycle attempt

3.22
Sequences

3.22.1
start-up sequence
sequence of actions executed by the system which brings the burner from the start position to the running position

3.22.2
first stage
part of the start-up sequence which allows the release of start gas into the combustion chamber

3.22.3
second stage
part of the start-up sequence which allows the release of further gas into the combustion chamber (if applicable)

3.23
systems for permanent operation
systems that are designed to remain in the running position for longer than 24 h without interruption

3.24
systems for non-permanent operation
systems that are designed to remain in the running position for less than 24 h

3.25
self-checking function of the flame detector device
automatic internal function of the system which checks the operation of the flame detector device

3.26
air flow simulation
condition which occurs when the air flow sensor indicates the presence of air flow when in reality no air flow is present

3.27
spark supervision
process of monitoring the ignition spark

3.28
pilot or start gas flame proving period
interval between the end of the first safety time and the beginning of the second safety time which is used to prove that the pilot or gas flame is stable

3.29
intermittent first stage
first stage that is ignited prior to ignition of the main flame and is shut off simultaneously with it

3.30
interrupted first stage
first stage that is ignited each time the burner is started up and which is extinguished at the end of the main flame establishment period

4 Classification

To assist with the specification of systems with regard to particular applications, the following codes shall be used.

Table 1 — Classification codes

1st character	denotes as	
	Fanned	F
	Atmospheric	A
	Both	B
2nd character	denotes type of first stage:	
	interrupted start gas	I
	intermittent start gas	T
	Both	B
	direct main burner ignition	M
3rd character	denotes first action following flame failure:	
	non-volatile lock-out	L
	volatile lock-out	V
	Recycling	C
	spark restoration	R
4th character	denotes type of final action:	
	non-volatile lock-out	L
	volatile lock-out	V
	spark restoration	R
5th character	denotes:	
	fixed times	X
	adjustable times	J
	Both	B

6th character	denotes:	
	self-check as required in 7.4.5	K
	non-self-check	N
	Both	B
NOTE Other required specification data are given in clause 11.		

The letter O shall be used for any character that is not relevant.

If the functional behaviour of the system deviates from this standard (see 7.1) it shall be classified with the letter "S" exclusively. Other characters are not used in combination with S.

5 Conditions for testing and measuring tolerances

All the tests shall be carried out under this conditions unless otherwise specified. The test conditions are:

— rated voltage or rated voltage range;

— rated frequency;

— ambient temperature of (20 ± 5) °C.

The error of measurement shall not exceed:

— for time measurements: ± 0,1 s;

— for temperature measurements: ± 1 K;

— for supply frequency measurements: ± 0,1 Hz;

— for electrical supply measurements: ± 0,5 %.

All measurements shall be made after stable temperature conditions have been achieved. All tests are performed in the order written in this standard except for that of 6.5.2 and clause 9.

The tests shall be carried out in the mounting positions specified by the manufacturer.

When several mounting positions are specified, the tests shall be carried out with the system installed in the least favourable position.

6 Constructional requirements

6.1 General

The quality of the materials, the design and the structure of the components used shall be such that the system will operate safely and in accordance with the requirements of this standard for a reasonable period of time (service life) under the normally expected mechanical, chemical, thermal and environmental conditions, even in the event of such carelessness as may occur in normal use, provided that the manufacturer's instructions for installation, adjustment, operation and maintenance are complied with. Compliance is checked by carrying out the tests specified in this standard.

The system shall be designed such that changes in critical circuit component values (such as those affecting timing or sequence) within the component manufacturer's declared worst case tolerances, including the long term stability, shall result in the system continuing to function in accordance with this standard. Compliance shall be checked by worst case analysis.

The construction of any additional functions included in the automatic burner control system, programming unit or flame detector for which no provisions exist in this standard, shall be such that they do not degrade the safe and correct operation of the automatic burner control system, programming unit or flame detector.

The system shall include at least two operating elements to directly de-energize the safety relevant gas valve terminals.

NOTE A single relay switching two independent contacts is considered to be only one operating element.

6.2 Protection provided by the enclosure

The class of protection for systems with their own enclosure shall be a minimum of EN 60529:1991 IP 40 or protection shall be provided by the appliance in which it is installed. For systems for use in the open air the protection shall conform to at least EN 60529:1991 IP 54.

6.3 Electrical equipment

The electrical equipment shall comply with the relevant requirements of EN 60730-2-5:2001, Clauses 8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, and 24, except 11.3.4, 11.3.106, to 11.3.108, 11.4.101 to 11.4.106 and 11.101 and 12.1.1 which are covered in this Standard.

If the supply voltage polarity can affect the safety either provisions to avoid an uncontrolled opening of a gas valve shall be provided or clear warnings shall be given in the installation and operating instruction (see 11.2 d)).

6.4 Electrical components

6.4.1 Performance of electrical components

The electrical components shall be designed for their intended use.

6.4.2 Test

An examination of the circuit shall be carried out according to the requirements of clause 9 and Annex A.

6.5 Long-term performance

6.5.1 General

All components of the system, and its associated flame detector device shall be able to withstand 250 000 burner start-up operations and still comply with this standard. This requirement shall be checked by carrying out the tests detailed in 6.5.2.

6.5.2 Stress test and long-term performance test

6.5.2.1 General

The test of 6.5.2.2 and the test of 6.5.2.3 shall not be carried out on the same test sample. The tests as described in 7.6 shall be carried out before and after the long-term performance tests of 6.5.2.2 and 6.5.2.3. Additionally, on completion of the tests described in 6.5.2.3, the tests described in EN 60730-1:2000, 13.2.2 through 13.2.4 shall be carried out.

6.5.2.2 Stress test [by the test laboratory]

6.5.2.2.1 Thermal stress test

The thermal stress test shall be carried out with the terminals loaded with the loads and power factors as declared by the manufacturer.

The system and its flame detector device shall be tested under the following conditions.

a) The purpose of the test is to cycle components of an electronic circuit between the extremes temperature likely to occur during normal use and which may result from ambient temperature variation, mounting surface temperature variation, supply voltage variation, or the change from an operating condition to a non-operation condition or vice versa.

   The following conditions shall form the basis of the test:

   Duration of test: 14 days at thermal conditions.

   Electrical conditions

   The system is loaded according to the ratings declared by the manufacturer, the voltage then being increased to 110 % of maximum declared rated voltage except that for 30 min during each 24 h period of the test the voltage is reduced to 90 % of minimum declared rated voltage. The change of voltage shall not be synchronized with the change of temperature. Each 24 h period shall also include at least one period in the order of 30 s during which the supply voltage is switched off.

   Thermal conditions

   The ambient temperature and/or the mounting surface temperature are varied between the maximum declared ambient temperature or 60 °C whichever is higher, and the minimum declared ambient temperature or 0 °C, whichever is lower, to cause the temperature of the components of the electronic circuit to be cycled between the resulting extremes. The rate of ambient and/or mounting surface temperature change shall be in the order of 1 °C/min and the extremes of temperature maintained for approximately 1 h.

NOTE Care should be taken to avoid the occurrence of condensation during this test.

   Rate of operation

   During the test the system shall be cycled through its operational modes at the fastest possible rate up to a maximum of six cycles/min subject to the need to cycle components between their temperature extremes.

   The number of cycles of operation completed during this test shall be recorded and if this number is less than 45 000 the remaining cycles shall be executed at the declared rated voltage and at ambient temperature.

b) 2 500 operations at the maximum declared ambient temperature or 60 °C whichever is higher, and at 110 % of the maximum declared rated voltage.

c) 2 500 operations at the minimum declared ambient temperature or 0 °C whichever is lower, and at 85 % of the minimum declared rated voltage.

d) The system shall also be tested under the following conditions:

   1) 2 500 cycles without flame presence

   2) 2 500 cycles, with the flame signal disappearing during operation.

During the tests a), b), c) and d) described above, the system shall be operated in such a way that the normal start-up sequence is performed. The time that the system is held in the running position and the time that the control loop is interrupted before the cycle is repeated shall be agreed between the manufacturer and the test authority.

NOTE By agreement between the manufacturer and the test authority the safety and purge times used during the above tests may be chosen to be as short as practicable so that the endurance test is not unnecessarily prolonged.

If times have been shortened (see note above), on completion of the endurance test, the purge times shall not have decreased nor the safety times have increased from those times measured before the commencement of the test.

6.5.2.2.2 Vibration test

When resistance to vibration is declared by the manufacturer (see 11.2 q), the following sinusoidal vibration test is to be carried out.

The object of the test is to demonstrate the ability of the system to withstand the long-term effects of vibration at levels declared by the manufacturer.

During the exposures the system shall be mounted on a rigid fixture by means of the specified fastening arrangement.

The test shall be performed in accordance with EN 60068-2-6:1995, test Fc.

The test is performed with the following minimum severity conditions:

Acceleration amplitude:	1,0 g or higher if declared by the manufacturer
Frequency range:	10 Hz to 150 Hz
Sweep rate:	1 octave per minute
Number of sweep cycles:	10
Number of axes:	3, mutually perpendicular.

The systems shall be in the start position during the exposure. A performance test as described in 7.6.1 shall be carried out towards the end of each exposure. A visual inspection shall be carried out after the termination of the exposure. No mechanical damage shall be found.

6.5.2.3 Long term performance test [by the manufacturer]

The manufacturer shall declare that the system has completed a minimum of 250 000 burner start-up operations with the terminals loaded with the loads and power factors as declared, without failure.

The system and its flame detector shall have been tested under the following conditions.

a) The number of operations at the declared rated voltage and at ambient temperature shall be 225 000.

b) The number of operations at the maximum declared ambient temperature or 60 °C, whichever is higher, and at 110 % of the maximum declared rated voltage shall be 12 500 operations.

c) The number of operations at the minimum declared ambient temperature or 0 °C, whichever is lower, and at 85 % of the minimum declared rated voltage shall be 12 500 operations.

NOTE The safety and purge times used during the above tests may be chosen to be as short as practicable so that the endurance test is not unnecessarily prolonged.

During the tests described above, the system shall be operated in such a way that a complete start-up sequence is performed.

If times have been shortened (see note above), on completion of the endurance test the purge times shall not have decreased nor the safety times have increased from those times measured before the commencement of the test.

7 Functional requirements

7.1 General

Any additional functions included in the automatic burner control system, programming unit or flame detector for which no provisions exist in this standard, shall be such that they do not degrade the safe and correct operation of the automatic burner control system, programming unit or flame detector.

If the functional behaviour deviates from this standard the manufacturer has to declare this by giving detailed information and reasons for the deviation (see clauses 4 and 11).

Adjustment of parameters e.g. programme timings and programme sequences is permitted but shall only be possible by means providing protection against access by uninstructed persons or shall be declared as requiring such protection in the application.

7.2 Programme

7.2.1 General

7.2.1.1 The programme shall be in accordance with the details provided by the manufacturer's instructions.

7.2.1.2 The programme shall be such that it is not possible to perform two or more actions which in combination could cause injury to persons or damage to property. The order of the actions shall be fixed in such a manner that it is not possible to change their order.

7.2.1.3 The automatic shut-off valve(s) controlling the appropriate start gas rate shall not normally be energized before the ignition device.

If for certain applications the automatic shut-off valve(s) controlling the appropriate start gas rate are energized before the ignition device, this shall be declared by the manufacturer (see 11.2 e)).

The ignition device shall be de-energized at or before the end of the first safety time.

In the case of hot surface ignitors, the automatic shut-off valves shall not be energized before the ignition device has reached sufficient temperature to ignite the gas.

7.2.1.4 When a system has a start gas flame proving period it shall be no less than that declared by the manufacturer.

7.2.1.5 In case of spark supervision, this function shall be performed prior to the release of gas.

7.2.1.6 During each start-up sequence, the system shall check for a flame signal. If a flame signal occurs, the system shall either not initiate the next step in the start-up sequence, or proceed at least to safety shut-down. This checking operation shall take place before any gas valve is energized and shall be of sufficient duration to ensure a safe and reliable check.

7.2.2 Safety actions

The required checks in the programme shall lead to the following actions:

— The supervision of the (proven) pre-purge time as well as of the combustion air flow for burners with fan(s) shall be achieved in such a manner and by using such devices as are prescribed in the relevant burner and/or appliance standards. If any air supervision device indicates an inadequate air supply, the system shall proceed to at least safety shut-down.

  If during the start-up sequence the no air check (in order to detect air flow simulation) fails, or during burner operation the air flow proving signal fails, the system shall also proceed to at least safety shut-down.

— If no flame signal is sensed at the end of the first or second safety time, the system shall proceed to lock-out or recycle, if applicable.

— Operation of an external protection device shall lead to at least safety shut-down.

— If a spark supervision device is utilized, failure to detect a spark during the manufacturer's declared spark supervision period shall lead to at least safety shut-down.

7.2.3 Flame failure

Depending on the design of the system, one of the following actions shall occur following loss of flame signal during burner operation:

— spark restoration (see 7.2.5)

— recycling (see 7.2.4)

— lock-out (see 7.3.6)

7.2.4 Recycling

Systems with recycling shall be designed such that they meet the requirement of 7.3.4 and the subsequent start-up sequence shall be that which is normally performed by the system. (For systems for intermittent operation where the fan remains switched on after flame failure, the air flow simulation check may be excluded.)

Following this action, the flame signal shall be present by the end of the first safety time of the last permitted recycle attempt; if not, the system shall proceed to lock-out.

7.2.5 Spark restoration

Systems with spark restoration shall be designed such that, following the loss of the sensed flame, the ignition device shall be energized within 1 s.

Following this action, the flame signal shall be present before the end of a time span equal to the first safety time; if not, the system shall proceed to lock-out.

7.2.6 Supervision of other external devices during the start-up sequence

If the system controls and/or supervises external devices (e. g. air damper actuators, auxiliary contacts of gas valves, automatic leakage test devices or other devices) which shall be position-checked prior to or during each start-up sequence, the start-up sequence shall continue only after these external devices have been successfully checked.

7.2.7 Start following safety shut down

Start-up sequence may occur when the cause of the safety shut down conditions disappears.

7.2.8 Inter-purge and inter-waiting time

For systems that give more than one ignition attempt, an inter-purge or inter-waiting time prior to recycling (see 7.2.4) shall be provided after an unsuccessful ignition attempt.

These timings shall be not less than declared in 11.2 e).

7.3 Times

7.3.1 General

Adjustment of pre-purge, post-purge, waiting and safety times is permitted but shall only be possible by means of tools and be impossible from outside the enclosure in which the component is housed (see 7.1).

Where these times can be adjusted using an existing scale on the component, the scale shall be accurate to ± 10 % of the indicated value. The means of adjustment shall be readily identifiable (e. g. colour-coded).

The nominal values and if necessary the limits of the timings shall be declared by the manufacturer (see 11.2 e)).

NOTE These times are dependent on the application.

7.3.2 Purge and waiting times

Shortening of these times shall not take place due to internal failures such as wear and tear, drop in accuracy of adjustments, and similar causes.

The times shall be not less than the value indicated by the manufacturer. In the case of a system having adjustable times, the times shall be not less than the value initially measured at test conditions (see clause 5).

7.3.3 Safety times

Lengthening of these times shall not take place due to internal failures such as wear and tear, a drop of accuracy in adjustment devices, and similar causes.

The times shall be not greater than the value as declared by the manufacturer.

In the case of a system having adjustable times, the times shall be not greater than the value initially measured at test conditions (see clause 5).

NOTE For programming units, not having a safety time, these requirements do not apply.

7.3.4 Response time in case of flame failure

The response time between loss of sensed flame and the resulting de-energizing of the terminals for the safety shut-off valves shall not exceed 1 s unless otherwise accepted by a specific application standard.

The minimum and maximum value of the sensed flame shall be declared by the manufacturer (see 11.2 i))

7.3.5 Reaction time to achieve safety shut-down

The time to achieve safety shut-down, whenever this is required, shall not exceed 1 s unless otherwise accepted by a specific application standard.

7.3.6 Reaction time to achieve lock-out

Whenever lock-out is required, it shall be achieved within 30 s of the safety shut-down.

7.4 Flame detector device

7.4.1 Spark detection by the flame detector device is allowed as part of the programme.

7.4.2 Flame detector devices using optical flame sensors shall be dedicated to UV-light (wave length smaller than 400 nm) or to infra-red light (wavelength larger than 800 nm).

Flame detector devices using infra-red sensors shall only react to the flicker property of the flame. The mounting fixture shall contain a form of switching such that when the device is removed from its mounting position it switches off.

This mounting fixture shall be designed in such a way, that prevents the unintended loosening of the flame detector. This requirement can be disregarded if the flame detector is not sensitive to mains frequency or harmonics of that frequency up to 400 Hz. A tolerance of $\pm$ 3 Hz shall be taken into account.

Flame detector devices using UV sensors shall not react to static infra-red light. The flame detector device shall not indicate the presence of the flame when the sensor is illuminated with 10 lx or less at a colour temperature of 2 856 K with the spectrum being cut off below the wavelength of 400 nm by means of a filter.

7.4.3 Ionization flame detector devices shall only make use of the rectification property of the flame. The minimum value of the rectification current for a flame signal shall be declared by the manufacturer.

7.4.4 When discharge tubes are used for flame supervision, the programme shall include a check for ageing of the tube, i. e. striking without flame presence. Examples of suitable techniques are:

— periodic, automatically executed supervision of the sensor function;

— application of a voltage prior to fuel release which is at least 15 % higher than the voltage applied to the tube during the remainder of the sequence;

— a check that there is no flame signal with the amplifier continually powered after each controlled shut-down.

NOTE Internal faults on components of the checking circuit are not considered.

7.4.5 In addition to all other applicable requirements, in case of a system designed for permanent operation, the flame detector device shall also be provided with a self-checking function that operates at least once in every hour when the system is in the running position. The test shall be carried out in accordance with clause 9.

7.4.6 Open circuiting of the sensor or its connecting cable shall cause loss of flame signal.

7.5 Lock-out and reset device

7.5.1 Lock-out function

The lock-out function shall be checked for proper operation during each start-up sequence. The failure modes as described in Annex A shall be taken into consideration during the analysis of the electronic circuit. In the case of a mechanical actuator a test up to but not including the switching contacts is sufficient.

If the test of the lock-out function fails, the system shall proceed to safety shut-down.

NOTE Internal faults on components of the checking circuit are not considered.

7.5.2 Reset device

The system shall be so constructed that a restart attempt following non-volatile lock-out shall only be possible following a manual reset, e. g. with an integrally or remotely mounted reset button.

Misuse or tampering with the reset device, whether integrally or remotely mounted (e. g. continuous pressing of the manual reset button or an internal fault of the reset device) or shorting of the connecting cables to the reset device, or between the connecting cables and earth, shall not cause the system to operate outside the requirements of this standard or prevent it from going to shut-down or lock-out.

Switching action of a thermostat or similar devices can result in a reset from volatile lock-out (see 11.2 o)).

7.6 Performance tests

7.6.1 At ambient temperature

The switching times and sequence of a complete programme are measured in the delivered state. The system is connected and installed according to the manufacturer's instructions.

These tests shall be performed under test conditions (see clause 5):

— at the manufacturer's declared rated voltage(s), or if this is a range, at the lowest and highest rated voltages;

— at 85 % of the lowest declared rated voltage;

— at 110 % of the highest declared rated voltage.

The switching times and order of actions recorded shall comply with the requirements of 7.2, 7.3 and 7.5.

7.6.2 At low temperature

The tests according to 7.6.1 shall be repeated at 0 °C or at the lowest declared ambient temperature where this is lower than 0 °C.

7.6.3 At high temperature

The tests according to 7.6.1 shall be repeated at 60 °C or at the highest declared ambient temperature where this is higher than 60 °C.

8 Protection against environmental influences

NOTE 1 In the basic EMC publications EN 61000-4 series "system" is commonly referred to EUT (Equipment under test).

NOTE 2 The assessment criteria a) and b) mentioned in 8.3 to 8.8 are corresponding to the severity levels 2 and 3 in the basic EMC publications EN 61000-4 series.

NOTE 3 Any components which are specifically intended for protection against EMC disturbances that fail during any of this test, will lead to non compliance of this standard.

8.1 Temperature range

The system and its flame detector shall meet the requirements of this standard over the ambient temperature range from 0 °C to 60 °C or wider if so declared by the manufacturer (see 7.6.2 and 7.6.3).

8.2 Supply voltage variations

8.2.1 General

For voltage variations between 85 % and 110 % of the rated voltage or of the voltage range declared by the manufacturer, the system shall meet the requirements of this standard (see 7.6.1).

At voltages lower than 85 % of the rated voltage the system shall comply with 8.2.2.

8.2.2 Requirements for operation below 85 % of rated voltage

If the system initiates a signal to energize the gas valves at less than 85 % of rated voltage or of the lower limit of the rated voltage range the system shall comply with the requirements of 8.2.2.1 to 8.2.2.8.

8.2.2.1 Being in the running position the system shall proceed to safety shut-down or operate with timings as declared by the manufacturer.

8.2.2.2 Being in any other position the operating sequence shall comply with the declared programme. The safety time shall not exceed the declared value under worst case conditions.

Compliance is checked by the following:

8.2.2.3 The system shall be connected to a variable voltage supply means. This supply voltage shall be connected to a voltmeter while the system is maintained at the lowest declared ambient temperature.

For the test purpose precautions shall be taken to assure that there will be a normal flame signal at any level of the supply voltage. The signal may be artificially simulated to prevent that the burner control system de-energizes the gas valves as a result of flame disappearance instead of low supply voltage at the gas valves being reduced to zero. This actual closing of the gas valves shall be ignored.

8.2.2.4 The system shall be operated in its running position for at least 2 min at rated voltage after which the supply voltage shall be gradually decreased at 25 % per minute of its rated value until the voltage at the output terminals for the valve is reduced to zero. During the decrease no abnormalities shall occur. The value of the supply voltage where de-energization of the output terminals for the valve takes place shall be recorded.

8.2.2.5 The supply voltage of the system shall be reduced to zero for at least 2 min, and then, after having removed the flame signal and with the heat demand being present, the supply voltage shall be increased gradually at 25 % per minute of its rated value until the system starts and the output terminals for the valve are energized. The value of the supply voltage where energization of the output terminals for the valve takes place shall be recorded.

8.2.2.6 The supply voltage shall then be restored to rated voltage, the system operated for at least 2 min in its running position. The supply voltage shall be adjusted to 1,05 times the value identified in 8.2.2.4. At this voltage and at the lowest declared ambient temperature the operating sequence shall continue to comply with the declared programme, and the safety time shall not exceed the declared value under worst case conditions.

8.2.2.7 The supply voltage shall be reduced to zero for at least 2 min and then the supply voltage shall be adjusted at 1,05 times the value identified in 8.2.2.5. At this voltage and at the lowest declared ambient temperature the operating sequence shall continue to comply with the declared programme, and the safety time shall not exceed the declared value under worst case conditions.

8.2.2.8 The tests of 8.2.2.3 to 8.2.2.7 shall be repeated at the highest declared ambient temperature.

8.3 Supply voltage dips, short interruptions and voltage variations immunity

8.3.1 General

The system shall tolerate voltage dips, short interruptions and voltage variations in the electricity supply so that when tested in accordance with 8.3.2:

a) for the values of table 2 line a): it shall continue to function in accordance with the requirements of this standard. It shall neither proceed to safety shut-down or lock-out, nor shall it reset from lock-out.

b) for the values of table 2 line b): it shall either perform as in a) or it may proceed to safety shut-down which may be followed by an automatic restart, or if in volatile lock-out it may proceed to an automatic restart. If in non volatile lock-out it shall remain in that condition.

When the power supply is restored, the automatic restart shall comply with the requirements for a normal start-up sequence.

Requirement b) can be ignored, provided that the power failure occurs during the start-up sequence and is shorter than 60 s. On restoration of the power the programme may be continued from the point at which it was interrupted.

A shortened start-up sequence, e. g. a start-up sequence without pre-purge or waiting time, is allowed provided that the power failure occurs within 60 s, after the end of the start-up sequence and is shorter than 60 s.

Table 2 — Voltage dips, short interruptions and voltage variations

Assessment criteria	Period of time	Percentage of the rated voltage or mean value of rated voltage range	
	ms	50 %	0 %
a)	10	—	X
	20	—	X
b)	50	x	X
	500	x	X
	1 000	x	X

The test shall be performed in accordance with 8.3.2.

8.3.2 Supply voltage dips, short interruptions and voltage variations test

The system is tested in accordance with EN 61000-4-11:1994.

The supply voltage to the system shall be reduced according to the values shown in table 2. The periods of times are examples only; intermediate as well as higher values may be used. The voltage dips, short interruptions and voltage variations at random phase with respect to the mains frequency shall be performed three times in each of the following operating conditions:

a) During pre-purge or waiting time.

b) During first and (where applicable) second safety time.

c) In the running position.

d) In the lock-out position.

Between the voltage dips, short interruptions and voltage variations a waiting time of at least 10 s shall be observed.

8.4 Supply frequency variations

8.4.1 General

8.4.1.1 Variations

If the system incorporates clock circuitry which is synchronized with or compared against the supply frequency, it shall be designed so that in the event of variations in the mains supply frequency, it complies with 8.4.1.2 and 8.4.1.3.

8.4.1.2 Variations of up to 2 % in supply frequency

When tested in accordance with 8.4.2.1, the system shall continue to function in accordance with this standard without safety shut-down or volatile or non-volatile lock-out. Variation in programme timings shall not exceed the percentage of the applied frequency variations.

8.4.1.3 Variations of between 2 % and 5 % in supply frequency

When tested in accordance with 8.4.2.2, the control system shall:

a) continue to operate in accordance with 8.4.1.2; or

b) proceed to safety shut-down provided that on restoration of the nominal supply frequency this is followed by an automatic restart or

c) proceed to lock-out.

8.4.2 Supply frequency variations test

8.4.2.1 Variations up to 2 % in supply frequency

Vary the main supply frequency about the nominal 50 Hz, within the range 49,0 Hz to 51,0 Hz. Sequence the system through its complete start-up and shut-down programme a minimum of three times at each of the following supply frequencies: 49,0 Hz, 49,5 Hz, 50,5 Hz and 51,0 Hz.

8.4.2.2 Variations of between 2 % and 5 % in supply frequency

Vary the mains supply frequency about the nominal 50 Hz, within the range 47,5 Hz to 52,5 Hz. Sequence the system through its complete start-up and shut-down programme a minimum of three times at each of the following supply frequencies: 47,5 Hz, 48,0 Hz, 48,5 Hz, 51,5 Hz, 52,0 Hz and 52,5 Hz.

8.5 Surge immunity

8.5.1 General

The system shall tolerate voltage surges on the mains supply and relevant signal terminals, so that when tested in accordance with 8.5.2:

a) for the values of table 3, line a): it shall continue to function in accordance with the requirements of this standard.

   It shall neither proceed to safety shut-down or lock-out nor shall it reset from lock-out.

b) for the values of table 3, line b): either it shall perform as in a) or it may proceed to safety shut-down which may be followed by an automatic restart, or if in volatile lock-out it may proceed to an automatic restart. If in non volatile lock-out it shall remain in that condition.

Table 3 — Open circuit test voltages ± 10 % for AC mains systems

Assess-ment criteria	Severity level	Mains		DC inputs and DC outputs power ports		Ports for process measurement and control lines [sensors and actuators]	
		Line to line	lines to earth	line to line	lines to earth	line to line	Lines to earth
		kV	kV	kV	kV	kV	kV
a)	2	0,5	1,0	0,5	1,0	no test	1,0
b)	3	1,0	2,0	1,0	2,0	no test	2,0

8.5.2 Surge immunity test

The system is tested in accordance with EN 61000-4-5:1995.

The tests shall be carried out by subjecting the system to five pulses and with the voltage and current values listed in table 3 a) and b) at intervals not less than 60 s. Shorter intervals are allowed if specified by the manufacturer.

The five pulses of each polarity (+, –) and each phase angle as described in EN 61000-4-5:1995 are delivered in the following order:

— 2 pulses with the system in the lock-out position

— 1 pulse with the system in the running position

— 2 pulses randomly applied during the start-up sequence.

The tests on interface cables are not carried out if the manufacturer explicitly specifies that the length of that cable shall not exceed 10 m (see 11.2 k).

8.6 Electrical fast transient/burst immunity

8.6.1 General

The system shall tolerate electrical fast transient/bursts on the mains supply and signal lines, so that when tested in accordance with 8.6.2:

a) for the values of table 4, line a): it shall continue to function in accordance with the requirements of this standard. It shall neither go to safety shut-down or lock-out, nor shall it reset from lock-out.

b) for the values of table 4, line b): either it shall perform as in a) or it may proceed to safety shut-down which may be followed by an automatic restart, or if in volatile lock-out it may proceed to an automatic restart. If in non volatile lock-out it shall remain in that condition.

Table 4 — Open circuit output test voltages ± 10 % and repetition rate of the impulses ± 20 %

Assessment criteria	Severity level	L1, L2, PE Voltage peak kV	L1, L2, PE Repetition rate kHz	I/0 Voltage peak kV	I/0 Repetition rate kHz
a)	2	1	5	0,5	5
b)	3	2	5	1	5

8.6.2 Electrical fast transient/burst immunity test

The system is tested in accordance with EN 61000-4-4:1995.

The test shall be performed for 20 cycles with the system after having reached the running position, remaining in the running position for a minimum of 30 s within each cycle. The test shall also be performed for a minimum of 2 min with the system in the lock-out position and with the system in the start position.

The tests on interface cables are not carried out if the manufacturer explicitly specifies that the length of that cable shall not exceed 3 m (see 11.2 k).

8.7 Electromagnetic conducted and radiated disturbances induced by radio-frequency fields

NOTE Tests in this clause are limited to the frequency bands specified in the tables, however with the introduction of equipment assuming other frequencies and power ratings e. g. mobile phones it may be necessary to consider the effects on the EUT of this frequencies.

8.7.1 Immunity to conducted disturbances, induced by radio-frequency fields

8.7.1.1 General

The system shall tolerate conducted disturbances, induced by radio-frequency fields on the main supply and relevant control lines so that when tested in accordance with 8.7.1.2:

a) for the values of table 5, line a): it shall continue to function in accordance with the requirements of this standard.

It shall neither go to safety shut-down or lock-out, nor shall it reset from lock-out.

b) for the values of table 5, line b): either it shall perform as in a) or it may proceed to safety shut-down which may be followed by an automatic restart, or if in volatile lock-out it may proceed to an automatic restart. If in non volatile lock-out it shall remain in that condition.

Table 5 — Test voltages for conducted disturbances on mains and I/0 lines

Frequency range		150 kHz to 80 MHz	
Assessment criteria	Severity level	Voltage level (emf) U_o (V)	
		150 kHz to 80 MHz	ISM and CB bands
a)	2	3	6
b)	3	10	20
The levels in the ISM, CB bands are chosen to be 6 dB higher.			
ISM: Industrial, scientific and medical radio frequency equipment (13,56 ± 0,007) MHz, (40,68 ± 0,02) MHz			
CB: Citizen Band: (27,125 ± 1,5) MHz			

The tests on interface cables are not carried out if the manufacturer explicitly specifies that the length of that cable shall not exceed 1 m (see 11.2 k).

8.7.1.2 Immunity to conducted disturbances, induced by radio-frequency fields, test

The system is tested in accordance with EN 61000-4-6:1996.

The system has to be swept through the complete frequency range at least once with the system in each of the following positions:

— start position;

— running position;

— lock-out position.

NOTE During sweeping through the frequency range the dwell time at each frequency shall not be less than the time necessary for the system to be exercised and be able to respond. Sensitive frequencies or the frequencies of dominant interest may be analysed separately.

8.7.2 Immunity to radiated disturbances, induced by radiated fields

8.7.2.1 General

The system shall tolerate radiated electromagnetic fields so that when tested in accordance with 8.7.2.2:

a) for the values of table 6, line a): it shall continue to function in accordance with the requirements of this standard.

   It shall neither go to safety shut-down or lock-out, nor shall it reset from lock-out.

b) for the values of table 6, line b): either it shall perform as in a) or it may proceed to safety shut-down which may be followed by an automatic restart, or if in volatile lock-out it may proceed to an automatic restart. If in non volatile lock-out it shall remain in that condition.

Table 6 — Test levels for radiated disturbances

Frequency range		80 MHz to 1 000 MHz	
Assessment criteria	**Severity level**	**Test field strength (V/m)**	
		80 MHz to 1 000 MHz	ISM, GSM bands
a)	2	3	6
b)	3	10	20
The levels in the ISM, GSM bands are chosen to be 6 dB higher.			
ISM: Industrial, scientific and medical radio-frequency equipment (433,92 ± 0,87) MHz according to ENV 50204:1995:			
GSM: Group Special Mobile: (900 ± 5,0) MHz, modulated by (200 ± 2) Hz pulses of equal mark/space ratio (2,5 ms on and 2,5 ms off)			
NOTE For DECT(Digital European Cordless Telephone) (1 890 ± 10) MHz, modulated by (200 ± 2) Hz pulses of equal mark/space ratio (2,5 ms on and 2,5 ms off) values of field strength are under consideration.			

8.7.2.2 Radiated, radio-frequency, electromagnetic field immunity, test

The system is tested in accordance with EN 61000-4-3:1996.

The system has to be swept through the complete frequency range at least once with the system in each of the following positions:

— start position;

— running position;

— lock-out position.

NOTE During sweeping through the frequency range the dwell time at each frequency should not be less than the time necessary for the system to be exercised and be able to respond. Sensitive frequencies or the frequencies of dominant interest may be analysed separately.

8.8 Electrostatic discharge immunity

8.8.1 General

The system shall tolerate electrostatic discharges so that when tested in accordance with 8.8.2:

a) for the values of table 7, line a): it shall continue to function in accordance with the requirements of this standard.

   It shall neither go to safety shut-down or lock-out, nor shall it reset from lock-out.

b) for the values of table 7, line b): either it shall perform as in a) or it may proceed to safety shut-down which may be followed by an automatic restart, or if in volatile lock-out it may proceed to an automatic restart. If in non volatile lock-out it shall remain in that condition.

This requirement is applied only to automatic burner control systems or units having their own protective enclosure.

Table 7 — Test voltages for direct and indirect electrostatic discharges

Assessment criteria	Severity level	Contact discharge	Air discharge
a)	2	4 kV	4 kV
b)	3	6 kV	8 kV

8.8.2 Electrostatic discharge immunity test

The system is tested in accordance with EN 61000-4-2:1995.

The system has to be tested in each of the following positions:

— start position;

— running position;

— lock-out position.

NOTE The object of this test is to demonstrate the immunity of the automatic burner control system to electrostatic discharges caused by personnel who may have become electrostatically charged, touching the system or other equipment nearby. The tests are therefore performed using representative operating conditions for the equipment under test.

9 Protection against internal faults

9.1 Internal faults

9.1.1 General

The automatic burner control system shall be fail-safe. Systems which comply with this clause and if applicable, 10.2 are considered to be inherently fail-safe.

The circuitry and the construction of the system shall be such that they meet the requirements of clause 7 and shall be appraised according to the requirements of 9.1.2, 9.1.3 and 9.1.6 or 9.1.4, 9.1.5 and 9.1.6.

Components shall be dimensioned on the basis of the worst-case conditions which can arise in the system, as stated by the manufacturer.

Internal faults of the checking circuit for discharge tubes (see 7.4.4) shall not be considered.

NOTE A component failure could cause a degradation of safety critical insulation. This should be considered when making assessment against this clause.

The fault assessment of the burner control unit, which includes the fault assessment during lock-out or safety shut-down is based on a second fault analysis. A third independent fault is not considered.

9.1.2 Systems for non-permanent operation: first fault

Any first fault (see annex A) in any one component or any one fault together with any other fault arising from that first fault shall result in either:

a) the system becoming inoperative with all valve terminals de-energized;

NOTE In this case de-energize means a reduction of electrical power such that gas valves close.

b) the system proceeding to safety-shut-down within 3 s, or to lock-out, provided that subsequent reset from the lock-out condition under the same fault condition results in the system returning to the lock-out condition; continue with fault assessment during lock-out or safety shut-down according to 9.1.6.2

c) the system continuing to operate, the fault being identified during the next start-up sequence, the result being a) or b);

d) the system remaining operational in accordance with all other functional requirements of this standard (see 7.2 to 7.5).

9.1.3 Systems for non-permanent operation: second fault

If when appraised according to the test conditions and criteria of 9.2, a fault results in the system remaining operational in accordance with the requirements of this standard (see 9.1.2 d)), any further independent fault considered together with the first fault shall result in either 9.1.2 a), b), c) or d).

During assessment, the second fault shall only be considered to occur when a start-up sequence has been performed between the first and the second fault.

9.1.4 System for permanent operation: first fault

For systems for permanent operation, any fault (see annex A) in any one component or any one fault together with any other fault arising from that first fault shall result in either:

a) the system becoming inoperative with all valve terminals de-energized;

NOTE In this case de-energize means a reduction of electrical power such that gas valves close.

b) the system, within 3 s of the fault manifesting itself in such a way that the system fails to comply with the requirements of this standard, proceeding to safety shut-down, or to lock-out, provided that subsequent reset from the lock-out condition under the same fault condition results in the system returning to the lock-out condition, continue with fault assessment during lock-out according to 9.1.6.2;

c) the system remaining operational in accordance with all other functional requirements of this standard (see 7.2 to 7.5).

Systems for permanent operation shall also comply with 7.4.5.

9.1.5 System for permanent operation: second fault

If when appraised according to the test conditions and criteria of 9.2, a fault results in the system remaining operational in accordance with the requirements of this standard (see 9.1.4 c)), any further independent fault considered together with the first fault shall result in either 9.1.4 a), b) or c).

9.1.6 During assessment, the second fault shall not be considered to occur within 24 h after the first fault. Systems for permanent and non-permanent operation: faults during lock-out or safety- shut-down

If lock-out or safety shut-down occurs an additional fault assessment shall be performed in that stage.

Whenever lock-out or safety shut down is reached without an internal fault, an assessment according to 9.1.6.1 and 9.1.6.2 shall be performed.

Whenever lock-out or safety shut down is reached with an internal fault, an additional single fault assessment according to 9.1.6.2 shall be performed.

9.1.6.1 First fault introduced during lock-out or safety- shut-down

Any first fault (together with any other fault arising from that fault) in any one component (see annex A), induced while the system is staying in the safety-shut-down or lock-out position, shall result in either:

a) The system remaining in safety-shut-down or lock-out, valve terminals remaining de-energized;

b) the system becoming inoperative with all valve terminals remaining de-energized;

c) in case of a subsequent restart: the system during one single restart resulting in a) or b) as mentioned in this clause under the condition that the valve terminals are energized not longer than the safety time. If the cause of the original safety shut-down or lock-out condition no longer remains the system may perform a full restart in accordance with the functional requirement of this standard and the second fault assessment shall be carried out in accordance with 9.1.3 or 9.1.5.

9.1.6.2 Second fault during lock-out or safety- shut-down

Any second fault (together with any other fault arising from that fault) in any one component (see annex A), induced while the system is staying in the safety-shut-down or lock-out position, shall result in either 9.1.6.1 a), b) or c).

During assessment, the second fault shall not be considered to occur within 24 hours after the first fault.

9.2 Circuit and construction evaluation

9.2.1 Test conditions

The effect of internal faults shall be assessed by simulation and/or by an examination of the circuit design.

The fault shall be considered to have occurred at any stage in the system programme sequence.

When carrying out the appraisal described in 9.1 the system shall be operated or considered to operate under the following conditions:

a) at the most unfavourable voltage in the range 85 % to 110 % of the rated supply voltage;

b) loaded with the most unfavourable load declared by the manufacturer;

c) in an ambient temperature of (20 ± 5) °C, unless there are significant reasons for conducting the test at another temperature within the manufacturer's declared range;

d) with any actuating member placed in the most unfavourable position;

e) with tissue paper placed on the supporting surface(s) of the system;

f) with sparks of about 3 mm in length and having an energy of not less than 0,5 J applied to those components which are likely to liberate flammable gases during the test.

9.2.2 Test criteria

During the appraisal, it shall be verified that under the conditions described above, the following criteria are satisfied.

a) The system shall not emit flames, hot metal or hot plastics, the tissue paper shall not ignite, no explosion shall result from the liberation of flammable gases and any flame produced shall not continue to burn for more than 10 s after switching off the spark generator. When a system is incorporated with any appliance, any enclosure afforded by the appliance is taken into consideration.

b) If the system continues to function, it shall comply with clauses 8 and 13 of EN 60730-2-5:2001. If it ceases to function, it shall still continue to comply with clause 8 of EN 60730-2-5:2001.

After the tests there shall be no deterioration of the various parts of the system that would result in failure to comply with clause 20 of EN 60730-2-5:2001.

NOTE Heating elements consisting of wire-wound resistors are considered to be short-circuit proof (see annex A)

10 Additional requirements for complex electronics

10.1 General

10.1.1 Complex electronics denote assemblies which use electronic components with the following characteristics:

a) The component provides more than one functional output.

b) It is impractical or impossible to represent the failure mode of such a component by stuck-at and cross-links at the pins or by other failure modes which are described in annex A.

10.1.2 Failures of complex electronics can be caused by either systematic errors (built into the design) or by random faults (component faults). Therefore, the system shall be designed in such a way that systematic errors are avoided and random faults shall be dealt with by a proper system configuration (see 10.2 Fault avoidance and fault tolerance).

10.2 Fault avoidance and fault tolerance

A system using technology as described in 10.1.1 shall be designed in accordance with clause 9 (taking into account the failure modes of annex A) and in accordance with EN 60730-2-5:2001, annex H.11.12.

The design of the software and hardware shall be based on the functional analyses of the burner system resulting in a structured design explicitly incorporating the control flow, data flow and time related functions required by the application. In the case of custom-chips special attention is required with regard to measures taken to minimize systematic errors.

The system configuration shall be designed in accordance with clause 9 (taking into account the failure modes of annex A) and in accordance with EN 60730-2-5:2001, annex H.11.12.

This shall result in a system configuration which is either inherently failsafe or in which components with direct safety-critical functions (e. g. gas valve drivers, microprocessors with their associated circuits, etc.) are guarded by safeguards (in accordance to EN 60730-2-5:2001, annex H, Software class C). These safeguards shall be built into hardware (e. g. watch-dog, supply voltage supervision) and can be supplemented by software (e. g. ROM-test, RAM-test, etc.). It is important that these safeguards can cause a completely independent safety-shut-down. Reaction times of these (primary) safeguards shall be in accordance with the requirements of this standard.

If time slot monitoring is used, it shall be sensitive to both an upper and a lower limit of the time interval. Faults resulting in shift of the upper and/or lower limit shall be taken into account.

If a single fault in a primary safeguard can render the safeguard inoperative, a secondary safeguard shall be provided. The reaction time of the secondary safeguard shall be in accordance with clause 9.

NOTE The secondary guarding can be realised by:

a) A physically separate circuit monitoring the primary safeguard; or

b) mutual action between the circuit being safeguarded and the primary safeguard (e. g. a watch-dog guarded by the microprocessor); or

c) action between primary safeguards (e. g. a ROM-test guarding a RAM-test).

10.3 Documentation

10.3.1 The functional analysis of an automatic burner control system and the safety related programs under its control shall be documented in a clear hierarchical way in accordance with the safety philosophy and the programme requirements.

As a minimum the following documentation shall be provided with any system submitted for assessment:

a) A description of the system philosophy, the control flow, data flow and timings.

b) A clear description of the safety philosophy of the system with all safeguards and safety functions clearly indicated. Sufficient design information shall be provided to enable the safety functions or safeguards to be assessed.

c) Documentation for any software within the system.

10.3.2 Programming documentation shall be supplied in a programming design language declared by the manufacturer.

10.3.3 Safety related data and safety related segments of the operating sequence shall be identified and classified according to EN 60730-2-5:2001, annex H.

10.3.4 There shall be a clear relationship between the various parts of the documentation, for example the interconnections of process, hardware and the labelling used in software documentation.

10.3.5 If a manufacturer provides documentation of the analytical measures taken during the development stage of the hardware and software, this documentation shall be used by the test house as part of the assessment procedure.

10.4 Assessment

10.4.1 A thorough appraisal of the circuit shall be carried out to determine its performance under the specified fault conditions. This appraisal shall take the form of a theoretical analysis and a component failure simulation test. Fault simulations may also be carried out to simulate faults within complex devices, e. g. EPROM emulation tests.

10.4.2 Only the safety related software (Software class B and C) as identified according to 10.3.3 shall be subjected to further assessment. For the identification, a fault tree analysis may be used.

11 Marking, installation and operating instructions

11.1 Marking

The system and/or its components shall be marked in clear and indelible characters with:

— the name of the manufacturer and/or registered trade mark;

— a discrete reference, i. e. model number;

— a date-code or a serial number.

And also when the system has its own housing (see 3.6) with:

— the rated voltage(s) or rated voltage range and frequency, if applicable.

The following shall be clearly indicated on the system:

— the value of the replaceable fuse(s) and its characteristics, if applicable, on or near each fuse holder.

— marks, e. g. reference numbers on or near the terminals of the system.

— If the system is classified as S according to clause 4 it shall be marked with a separate S in a square.

A durability test on the marking shall be carried out according to annex A of EN 60730-1:2000.

11.2 Installation and operating instructions

Installation and operating instructions shall be supplied with each consignment, written in the language(s) of the country in which the devices will be delivered.

These instructions shall include the data required for the proper location, mounting, connection, operation and maintenance of the system.

These instructions shall at least include:

a) the supply voltage(s) and frequency,

b) the maximum and minimum ambient temperature(s),

c) an indication of the degree of protection (see 6.2),

d) clear indications for the connection in different supply voltage circuits (it shall, for instance, be clearly indicated that an isolating transformer which is earthed at one side shall be used if connection is to be made to a supply without an earth-bonded conductor or to a supply between the phases),

e) a listing and a diagram of limits of the programme times and details of their adjustment range(s) if any,

f) the maximum current rating of the output terminals,

g) the position(s) in which the system can be mounted,

h) the voltage and the frequency of the automatic burner control systems circuit(s),

i) the type of flame sensor(s) which can be applied. If the adjustment of the flame sensor sensitivity can cause an unsafe situation, the means of adjustment shall be suitably protected by the system installer. The minimum and the maximum sensed flame value shall be declared.

j) the type reference of the corresponding optical flame sensor(s) and the temperature range they can withstand,

k) the length and the type of cable for the connection of the flame sensor and other external components (see also 8.6.2),

l) a typical external wiring diagram,

m) the rated input in W of the system itself, if higher than 25 W,

n) the classification in accordance with clause 4,

o) an indication that switching action of a thermostat or a similar device can reset the burner control system from volatile lock-out,

p) if the time to achieve safety shut down (see 7.3.5) exceeds 1 s this time and the application standard on which this time is based shall be declared,

q) If the system is intended to be used in DC supplied mobile applications (see annex D) or if required by any other application, the resistance to vibration shall be declared by the manufacturer.

NOTE The following data provided by the manufacturer may be of use to the test laboratory:

1) Operational specification (a minimum operating temperature range of 0 °C to 60 °C is required, see 8.1).
2) Declarations as required by table 7.2 of EN 60730-2-5:2001.
3) Operational life (normally number of cycles; a minimum life of 250 000 is required, see 6.5)
4) Minimum cycling time from start to start for continued satisfactory operation.

5) A complete fault analysis covering the characteristic failure modes of all components (see annex A) and the effect of such failures on other components and the operation of the system.
6) The procedure for fault finding to be adopted while servicing the system,
7) Sufficient design details to enable assessment of the safety functions. This shall include the manufacturer's design calculation on the effect of tolerance on critical circuit components.
8) Installation, servicing and maintenance instructions and details of replacement parts,
9) Manufacturer's test schedules and relevant supplementary information,
10) Circuit diagram complete with component list with circuit reference, electrical ratings, relevant operating stresses and tolerances,
11) Software documentation (where applicable),
12) Component specifications including:
    - type,
    - values,
    - tolerances,
    - ratings,
    - operating values,
    - component manufacturer/supplier,
13) The applications for which the system is intended and where applicable, the type of pilot system for which the system is suitable.

11.3 Warning note

A warning note shall be attached to each consignment of controls. This notice shall state: 'Read the instructions before use. This control must be installed in accordance with the rules in force'.

Annex A
(normative)

Electrical/electronic component fault modes

Table A.1 — Electrical/electronic component fault modes

Component type	Short	Open [a]	Remarks
Fixed resistors:			
Thin film (wound filament)		x	Includes SMD type
Thick film (flat)		x	Includes SMD type
Wire-wound (single layer)		x	
All other types	x	x	
Variable resistors (e. g. potentiometer/trimmer):			
Wire-wound (single layer)		x	
All other types	x [b]	x	
Capacitors:			
X1 and Y types according to IEC 60384-14		x	
Metallized film according to IEC 60384-16		x	
All other types	x	x	
Inductors:			
Wire-wound		x	
All other types	x	x	
Diodes:			
All types	x	x	
Transistors:			
All types (e. g. Bipolar: LF; RF; microwave; FET; Thyristor; Diac; Triac; Uni junction)	x [b]	x	[c]
Hybrid circuit	[d]	[d]	
Integrated circuits			
All types not covered by clause H 11.12 of EN 60730-2-5:2001	x [e]	x	For IC outputs note [c] applies
Opto-couplers			
According to EN 60335-1:1994	x [f]	x	
Relays:			
Coils	x	x	If the relay complies with EN 61810-1 the failure mode short circuit need not be considered.
Contacts	x [g h]	x	
Reed-relays	x	x	Contacts only
Transformers:			
According to EN 61558-2-6:1997 or EN 61558-2-17:1997		x	
All other types	x	x	

Table A.1 (*continued)*

Component type	Short	Open [a]	Remarks
Crystals	x	x	[i]
Switches	x	x	[j]
Connections (jumper wire)		x	[k]
Cable, wiring and connectors		x	
Printed circuit board conductors	x [m]	x [l]	

[a] Only opening of one pin at a time.

[b] Short circuit each pin in turn with every other pin; only two pins at a time.

[c] For discrete or integrated thyristor type devices such as triacs and SCRs, fault conditions shall include short circuit of any terminals with the third terminal open circuited. The effect of any full wave type component, such as a triac going into a half wave condition, either controlled or uncontrolled (thyristor or diode, respectively) shall be considered.

[d] Failure modes for individual components of the hybrid circuit are applicable as described for the individual components in this table.

[e] The short circuit of any two adjacent terminals and the short circuiting of:

a) each terminal to the IC-supply, when applicable at the IC

b) each terminal to the IC-ground, when applicable at the IC

The number of tests implied for integrated circuits may normally make it impracticable to apply all the relevant fault conditions or to assess the likely hazards from an appraisal of the circuit diagram of the integrated circuit.

It is therefore permissible first to analyse in detail all the possible mechanical, thermal and electrical faults which may develop either in the control itself or its output, due to the malfunction of the electronic devices or other circuit components, separately or in any combination.

Except for types evaluated by EN 60730-2-5:2001, H11.12, a fault tree analysis shall be conducted to include the results of multiple steady state conditions to outputs and programmed bi-directional terminals for the purpose of identifying additional fault conditions for consideration. The failure mode "short circuit" is excluded between isolated sections for such ICs that have isolated sections. The isolation between the sections shall comply with the requirements of EN 60730-2-5:2001, clause 13.2 for operational insulation.

[f] When opto-couplers comply with EN 60335-1:1994, clause 29.2.2, the shorting between the input and output pins is not considered.

[g] The failure modes "short circuit" and "mechanical break-down" need not to be considered when the system – including the relay – successfully completed the long-term performance tests of clause 6.5 (under nominal load of relay contacts) and if the relay is successfully tested for 3 million cycles under no load condition in compliance with EN 60947-5-1, C.2, and declared by the manufacturer and if special precautions have been taken to prevent welding of contacts (see 6.1). Special precautions are:

1. Measures to avoid welding:

1.1 Contacts closing on short-circuit: Rating of the fuse according to IEC 60127-1:1999 with $I_{fuse} < I_{the}/2{,}75$.

1.2 lifetime/loadcycle rating: proof that the contact does not weld after 1 000 000 cycle on max rated contact load (4fold safety)

2. Measures to avoid microwelding

2.1 Proof that the permissible (maximum) capacitance loads have been part of the lifetime-test according to 1.2.

2.2 Proof that no mains-synchronous switching occurs, or the mains synchronous switching has not resulted in non-compliance with the lifetime test according to 1.2 (see also 6.1).

[h] If a fuse is used to protect against the hazard of relay contact welding the fuse shall only be replaced by the manufacturer according to EN 60730-1:2000, clause 2.13.7 .

[i] For crystal based clocks, harmonic and sub-harmonic frequency variations affecting the timings should be considered.

[j] If switches are applied for the selection of declared safety times, programs and/or other safety related settings, these devices should function so that in the event of their opening, the safest possible condition arises (for example, the shortest safety time or the longest purge time).

The short circuit failure mode is excluded for switches successfully tested to EN 60730-2-5:2001, clause 17. The successful test can be substituted by the use of a switch certified for the application.

[k] The requirements are the same as note 10, except they are applied to jumper wires intended for clipping when selecting a setting.

[l] The open circuit failure mode, i. e. interruption of a conductor, is excluded if the thickness of the conductor is equal to or greater than 35 µm and the breadth of the conductor is equal to or greater than 0,3 mm or the conductor has an additional precaution against interruption, e. g. roll-tinned, etc. If a short circuit at the output terminals causes the opening of a printed circuit board conductor, that conductor shall be subject to an open circuit fault analysis.

[m] The short circuit failure mode is excluded if the requirements of EN 60730-2-5:2001, clause 20 are fulfilled.

Annex B
(informative)

Functional characteristics of burner control systems, to be given by the appliance standard

Table B.1— Functional characteristics of burner control systems, to be given by the appliance standard

Clause(s)	Item	Remarks
3.11, 3.12, 7.3.3	Safety times	Maximum time
3.21, 7.2.1.6, 7.3.2	Purge or waiting times	Minimum time
7.3.4, 7.3.5	Response time in case of flame failure	Normally 1 s, unless otherwise specified.
3.18, 7.5	Volatile or non-volatile lock-out	Both are allowed unless otherwise specified.
3.19, 7.2.5	Spark restoration	Specify if applicable
3.20, 7.2.4	Recycling	Specify if applicable
3.23, 7.4.5	Permanent operation	Specify if applicable
3.27, 7.2.2	Spark supervision	
3.28, 7.2.1.4	Pilot or start gas flame proving period	Minimum time if applicable

Annex C
(normative)

Requirements for DC supplied burner

EN 298 applies with the following supplements or modifications of the corresponding clauses.

C.1 Scope

according to clause 1 and addition:

DC supplied controls will fall into one of the three following types:

— stand-alone battery systems; Type A

— battery systems for mobile vehicle applications; Type B

— systems which are intended to be connected to DC supply networks; Type C

C.2 Thermal stress test

according to clause 6.5.2.2.1 with modification:

replace "85 % of the minimum declared rated voltage" *with* "75 % of the minimum declared DC voltage"
replace "110 % of the maximum declared rated voltage" *with* "120 % of the maximum declared DC voltage"

C.3 Long term performance test [by the manufacturer]

according to clause 6.5.2.3 with modification:

replace "85 % of the minimum declared rated voltage" *with* "75 % of the minimum declared DC voltage"
replace "110 % of the maximum declared rated voltage" *with* "120 % of the maximum declared DC voltage"

C.4 At ambient temperature

according to clause 7.6.1 with modification:

replace "85 % of the minimum declared rated voltage" *with* "75 % of the minimum declared DC voltage"
replace "110 % of the maximum declared rated voltage" *with* "120 % of the maximum declared DC voltage"

C.5 Supply voltage variations

according to clause 8.2 with modification in the complete clause:

replace "85 % and 100 % of the rated voltage" *with* "75 % and 120 % of the rated DC voltage"
replace "85 % of the rated voltage" *with* "75 % of the rated DC voltage"

C.6 Supply voltage, supply frequency, surge immunity, electrical fast transient/burst, electromagnetic conducted disturbances

according to clause 8.3 to 8.8 with modification:

Table C.1

Clause	Stand-alone battery system	battery systems for mobile applications	systems which are intended to be connected to DC supply networks
	Type A	**Type B**	**Type C**
8.3 Supply voltage dips, short interruptions and voltage variations immunity	not applicable	not applicable	applicable
8.4 Supply frequency variations	not applicable	not applicable	not applicable
8.5 Surge immunity	Applicable (for cables longer than 10 m)	not applicable	applicable (for cables longer than 10 m)
8.6 Electrical fast transient/burst immunity	Applicable (for cables longer than 3 m)	not applicable	applicable (for cables longer than 3 m)
8.7.1 Immunity to conducted disturbances, induced by radio-frequency fields	Applicable (for cables longer than 1 m)	applicable (for cables longer than 1 m)	applicable (for cables longer than 1 m)
8.7.2 Radiated, radio frequency electromagnetic field immunity test	Applicable	applicable	applicable
8.8 Electrostatic discharge immunity	Applicable	applicable	applicable

C.7 Electrical transient conduction immunity for Type B only

according to clause 8.9 and addition:

C.7.1 General

Battery systems for mobile vehicle applications Type B shall tolerate electrical transient conduction on the supply lines, so that when tested in accordance with D 8.3.2:

a) for the values of table D.2 line a): it shall continue to function in accordance with the requirements of this standard. It shall neither go to safety shut-down or lock-out, nor shall it reset from lock-out.

b) for the values of table D.2 line b): either it shall perform as in a) or it may proceed to safety shut-down which may be followed by an automatic restart, or if in volatile lock-out it may proceed to an automatic restart. If in non volatile lock out it shall remain in that condition.

Table SEQC.2

Test pulse / Assessment criteria	Test Level	2 V	3a V	3b V	4 V	5 V	6 V	7 V
a)	Level I (12V Systems)	+25	–25	+25	–4	–	–50	–
	Level I (24V Systems)	+50	–50	+50	–8	–	–100	–
b)	Level III (12V Systems)	+75	–100	+75	–6	+66,5	–200	–60
	Level III (24V Systems)	+150	–200	+150	–12	+133	–400	–120

C.7.2 Electrical transient conduction immunity test

The system is tested in accordance with ISO 7637-1:1990 if the system is a 12 V system and is tested in accordance with ISO 7637-2:1990, if the system is a 24 V system.

For systems with different power supply voltage levels, the values for test pulses shall be adapted according to the required test level.

Test pulses 5 and 7 shall only be implemented when required by the application. This shall be declared by the manufacturer according to 11.2 q).

Annex ZA
(informative)

Identification of clauses which meet the Essential Requirements of the Gas Appliance Directive (90/396/EEC)

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive 90/396/EEC.

Warning: Other requirements and other EU Directives may be applicable to the product(S) falling within the scope of this standard.

The following clauses of this standard are likely to support requirements of Directive 90/396/EEC.

Compliance with the clauses of this standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

Table ZA.1

Essential requirement		Clause number in EN 298
1	**GENERAL CONDITIONS**	
1.1	Safety of operation	complete standard
1.2	Installation instructions User instructions Warning notices Official language of instructions	11 N/A 11 11
1.2.1	Installation instructions	11
1.2.2	User instructions	N/A
1.2.3	Warning notices	11
1.3	Correct operation	7; 11
2	**MATERIALS**	
2.1, 2.2	Suitability for safety and intended purpose	6
3	**DESIGN AND CONSTRUCTION**	
3.1	General	
3.1.1	Mechanical stability	6
3.1.2	Condensation	N/A
3.1.3	Risk of explosion	N/A
3.1.4	Water penetration	N/A
3.1.5	Normal fluctuation of auxiliary energy	7.6
3.1.6	Abnormal fluctuation of auxiliary energy	8
3.1.7	Hazards of electrical origin	6.3
3.1.8	Pressurized parts	N/A
3.1.9	Failure of safety, controlling and regulating devices	8, 9, 10, 7.4.6

Table ZA.1 (continued)

Essential requirement		Clause number in EN 298
3.1.10	Safety/adjustment	6.1, 7.1
3.1.11	Protection of parts set by the manufacturer	7.3.1
3.1.12	Controlling and setting devices	11
3.2	Unburned gas release	
3.2.1	Gas leakage	N/A
3.2.2, 3.2.3	Gas accumulation	N/A
3.3	Ignition	N/A
3.4	Combustion	N/A
3.5	Rational use of energy	N/A
3.6	Temperatures	6.3
3.7	Foodstuffs and water used for sanitary purposes	N/A
ANNEX II		
	Certification procedures	N/A
ANNEX III		
	CE conformity mark and inscriptions	
1	Mark	N/A
2	Data plate	**11**