

Australian Standard™

**Safety requirements for electrically
heated Type 1 ovens in which flammable
volatiles occur**

This Australian Standard was prepared by Committee EL-014, Electrical Equipment in Hazardous Areas. It was approved on behalf of the Council of Standards Australia on 21 May 2002 and published on 19 June 2002.

The following are represented on Committee EL-014:

Association of Consulting Engineers Australia
Auckland Regional Chamber of Commerce
Australian Association of Certification Bodies
Australian Chamber of Commerce and Industry
Australian Coal Association
Australian Electrical and Electronic Manufacturers Association
Australian Gas Association
Australian Industry Group
Australian Institute of Petroleum
Australian Institute of Refrigeration Air Conditioning and Heating
Department of Mineral Resources, N.S.W.
Department of Mines and Energy, Qld
Electricity Supply Association of Australia
Institute of Electrical Inspectors
Institute of Instrumentation and Control Australia
Institution of Engineers Australia
Ministry of Commerce New Zealand
National Electrical and Communications Association
New Zealand Association of Marine, Aviation and Power Engineers
New Zealand Employers and Manufacturers Association
New Zealand Hazardous Areas Electrical Coordinating Committee
Regulatory authorities (electrical)
WorkCover New South Wales

Keeping Standards up-to-date

Standards are living documents which 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 Standards may also be withdrawn.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 which may have been published since the Standard was purchased.

Detailed information about Standards can be found by visiting the Standards Australia web site at www.standards.com.au and looking up the relevant Standard in the on-line catalogue.

Alternatively, the printed Catalogue provides information current at 1 January each year, and the monthly magazine, *The Australian Standard*, has a full listing of revisions and amendments published each month.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at mail@standards.com.au, or write to the Chief Executive, Standards Australia International Ltd, GPO Box 5420, Sydney, NSW 2001.

This Standard was issued in draft form for comment as DR 98183.

STANDARDS AUSTRALIA

RECONFIRMATION

OF

AS 1681—2002

Safety requirements for electrically heated Type 1 ovens in which flammable volatiles occur

RECONFIRMATION NOTICE

Technical Committee EL-014 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

Certain documents referenced in the publication may have been amended since the original date of publication. Users are advised to ensure that they are using the latest versions of such documents as appropriate, unless advised otherwise in this Reconfirmation Notice.

Approved for reconfirmation in accordance with Standards Australia procedures for reconfirmation on 8 April 2013.

The following are represented on Technical Committee EL-014:

Australian Chamber of Commerce and Industry
Australian Industry Group
Australian Institute of Petroleum
Australian Petroleum Production and Exploration Association
Australian Pipeline Industry Association
Aviation and Marine Engineers Association
Bureau of Steel Manufacturers of Australia
Department of Natural Resources and Mines, Qld
Department of Trade and Investment, Regional Infrastructure and Services, NSW
Electrical Compliance Testing Association
Electrical Contractors Association of New Zealand
Engineers Australia
Institute of Electrical Inspectors
Institution of Professional Engineers New Zealand
Ministry of Business, Innovation and Employment (New Zealand)
New Zealand Employers and Manufacturers Association (Central)
WorkCover New South Wales

NOTES

Australian Standard™

**Safety requirements for electrically
heated Type 1 ovens in which flammable
volatiles occur**

Originated as AS C360—1965.
Previous edition AS 1681—1974.
Second edition 2002.

COPYRIGHT

© Standards Australia International

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.

Published by Standards Australia International Ltd
GPO Box 5420, Sydney, NSW 2001, Australia
ISBN 0 7337 4589 X

 **Documents**
Document Sharing Hub

PREFACE

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee EL-014, Electrical Equipment in Hazardous Areas. After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian, rather than an Australian/New Zealand Standard.

This Standard supersedes AS 1681—1974, *Electrically heated ovens in which flammable volatiles occur—Type 1 Ovens*.

This Standard is intended for the guidance of users and manufacturers of industrial ovens and regulatory authorities concerned with the safe usage, operation and installation of such ovens. It prescribes requirements for design, construction and ventilation of these ovens.

This Standard is similar to corresponding American Standard 86, *Ovens and furnaces*, issued by the National Fire Protection Association (NFPA), and acknowledgment is made of assistance received from that source.

Changes to the 1974 edition are essentially editorial and no technical alterations have occurred.

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	4
 SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE.....	5
1.2 OBJECTIVE	5
1.3 APPLICATION	5
1.4 REFERENCED DOCUMENTS.....	5
1.5 DEFINITIONS.....	6
1.6 ELECTRICAL SAFETY REQUIREMENTS	7
1.7 COMPLIANCE WITH REGULATORY AUTHORITIES, REQUIREMENTS.....	7
 SECTION 2 CONSTRUCTION REQUIREMENTS	
2.1 GENERAL REQUIREMENTS.....	8
2.2 EQUIPOTENTIAL BONDING	9
2.3 EXPLOSION-RELIEF VENTS	9
2.4 DUCTS.....	11
 SECTION 3 HEATING SYSTEMS	
3.1 ELECTRICAL INSTALLATION.....	12
3.2 CONTROLS	12
3.3 RESISTANCE HEATERS.....	12
3.4 INDUCTION AND DIELECTRIC HEATERS.....	13
 SECTION 4 VENTILATION	
4.1 DESIGN CONSIDERATIONS.....	14
4.2 RATE OF VENTILATION.....	15
4.3 MECHANICAL VENTILATION.....	15
4.4 FRESH AIR SUPPLY.....	15
4.5 EXHAUST AIR.....	15
4.6 DAMPERS	15
4.7 FANS.....	15
4.8 VENTILATION CONTROLS	16
 SECTION 5 MARKING	
5.1 GENERAL.....	17
5.2 ADDITIONAL INFORMATION	17
 APPENDICES	
A COMBUSTION CHARACTERISTICS FOR COMMON FLAMMABLE LIQUIDS	18
B METHODS FOR CALCULATION OF VENTILATION	23
C OVEN SAFETY DESIGN FORM	31

FOREWORD

The purpose of this Standard is to establish requirements for a type of electrically heated oven in which flammable atmospheres are evolved within the oven without risk of fire or explosion. Accordingly, safeguards are specified herein for the location, construction and operation of such ovens.

To prevent an ignition or explosion within an oven, the specification requires the introduction of a sufficient quantity of fresh air ventilation into the oven so as to dilute any possible flammable vapour or mixture to a safe concentration below the lower explosive limit. The method of calculating the amount of ventilation required is given in Section 4, and the following basic principles apply:

- (a) There is a reliable and continuous supply of ventilating air while the oven is operating and flammable vapours are being given off.
- (b) Failure of any ventilation equipment automatically shuts down the heating system.
- (c) The oven is pre-ventilated before the heating system (which may originate ignition) can be started, in order to dissipate any accumulated vapour due to a work charge left in an unventilated oven, either accidentally following failure of safety ventilation, or following normal shutdown.

It is not intended to imply that the requirements of the specification will ensure compliance with the Standards of AS 2380 series—*Electrical equipment for explosive atmospheres—Explosion-protection techniques* and/or AS/NZS 60079 series—*Electrical apparatus for explosive gas atmospheres* and/or the AS 2381 series—*Electrical equipment for explosive atmospheres—Selection, installation and maintenance*. Careful consideration must, therefore, be given to the hazards peculiar to each individual project. This consideration of safety will include all supplementary equipment in the vicinity of the oven, such as spray booths or dip tanks; the mixing, handling or storage of flammable material; or auxiliary operations, such as impregnating, washing, surfacing, coating or combining by the use of adhesives. Where the atmosphere in which the oven is installed is likely to become hazardous, due to the processing of such materials, it must be rendered non-hazardous by means which are deemed to be adequate by the relevant regulatory authority (e.g. Ventilation in accordance with AS 1482—*Electrical equipment for explosive atmospheres—Protection by ventilation—Type of protection v*)

There must be constant supervision over all operating conditions that might otherwise become unsafe.

A procedure needs to be in place to ensure that electrical equipment and instrumentation are maintained in safe and operational conditions.

Partial protection might be, and in many cases is, much more dangerous than no protective equipment at all. Insufficient, ill-chosen, or improperly installed or maintained safety control equipment may cause operators to lapse into carelessness by supposing safety which is not actually present.

The requirements of this Standard are based, in part, on tests conducted by the Underwriters' Laboratories Inc., USA, to obtain data on the explosion limits of the solvents commonly used in connection with ovens. The actual figures vary considerably with different solvents, but properties of some common solvents are tabulated in Appendix A.

STANDARDS AUSTRALIA

Australian Standard

Safety requirements for electrically heated Type 1 ovens in which flammable volatiles occur

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out the requirements for the design, construction and ventilation of electrically heated Type 1 ovens.

It also provides guidelines for the location and operation of such ovens.

Compliance with this Standard does not imply compliance with the Standards of the AS 2380 series and/or AS/NZS 60079 series and/or the AS 2381 series.

1.2 OBJECTIVE

The objective of this Standard is to enable designers, manufacturers, suppliers, employers and users of electrically heated Type 1 ovens to minimize the risks to health and safety of employees and others working with or otherwise near such type of ovens.

1.3 APPLICATION

The requirements of this Standard apply to electrically heated ovens in which the temperature does not exceed 540°C (Type 1 ovens).

NOTE: For ovens having heating systems based on gas or oil see AS 1375.

1.4 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- | | |
|--------|---|
| 1375 | Industrial fuel-fired appliances (known as the SAA Industrial Fuel-fired Appliances Code) |
| 1482 | Electrical equipment for explosive atmospheres—Protection by ventilation—Type of protection v |
| 2380 | Electrical equipment for explosive atmospheres—Explosion-protection techniques |
| 4024 | Safeguarding of machinery |
| 4024.1 | Part 1: General principles |

AS/NZS

- | | |
|--------|--|
| 2106 | Methods for the determination of the flash point of flammable liquids (closed cup) |
| 2381 | Electrical equipment for explosive atmospheres—Selection, installation and maintenance |
| 2381.1 | Part 1: General requirements |
| 3000 | Electrical installations (known as the Australian/New Zealand Wiring Rules) |
| 3100 | Approval and test specification—General requirements for electrical equipment |

AS/NZS

60079 Electrical apparatus for explosive gas atmospheres

60079.4 Part 4: Methods of test for ignition temperature

60079.12 Part 12: Classification of mixtures of gases or vapours with air according to their maximum experimental safe gaps and minimum igniting currents

60079.20 Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus

BS

2050 Specification for electrical resistance of conducting and antistatic products made from flexible polymeric material

NFPA

68 Venting of Deflagrations

86 Ovens and Furnaces

325 Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids

1.5 DEFINITIONS

For the purposes of this Standard the definitions below apply.

1.5.1 Batch process oven

An oven in which the work charge is introduced all at once so that the evaporation of flammable volatiles in the oven is not at a constant rate.

1.5.2 Continuous process oven

An oven in which the work charge may be continuously introduced, as by a conveyor, so that the evaporation of flammable volatiles within the oven approaches a constant rate.

1.5.3 Dielectric heater

An electric heater similar to an induction heater in which an alternating current of high frequency is passed through the charge.

1.5.4 Flashpoint

Lowest liquid temperature at which, under certain standardized conditions, a liquid gives off vapours in sufficient quantity such as to be capable of forming an ignitable vapour/air mixture.

NOTES:

- 1 Flashpoint data are normally associated with liquids, though they are also relevant to solids which sublime (refer to AS/NZS 60079.12 and AS/NZS 60079.20). Care must be taken in the use of flashpoint data in applications where the ignition source may itself raise the temperature of the combustible material.
- 2 The value for the flashpoint depends to some extent on the method of test. For the purposes of this Standard, flashpoint data are determined in accordance with AS/NZS 2106.

1.5.5 Fresh air

Air drawn from an atmosphere which is free from flammable material.

1.5.6 Ignition temperature (of an explosive gas atmosphere)

Lowest temperature of a heated surface at which, under specified conditions in accordance with AS/NZS 60079.4, the ignition of a flammable material in the form of a gas or vapour in mixture with air, will occur.

1.5.7 Induction heater

An electric heater consisting of a coiled conductor in the proximity of the work charge and designed to heat the work charge by producing induced currents in it, when an alternating current flows in the coil.

1.5.8 Infrared heater

A resistance heater in which the resistive conductors are enclosed in glass, quartz, ceramic envelope, or a metal sheath and are intended to provide heat by infrared radiation.

1.5.9 Infrared lamp heater

A resistance heater in which the resistive conductors are enclosed in glass bulbs similar to ordinary incandescent general service lamps and are intended to provide heat by infrared radiation.

1.5.10 Natural atmosphere

A mixture of air and the gases evolved from the charge in the heating chamber of an oven.

NOTE: For batch ovens the composition of such an atmosphere is variable during a heating cycle. For continuous ovens the natural atmosphere is mainly fresh air.

1.5.11 Oven

An enclosure into which manufactured articles or materials may be placed and subjected to heat in the course of treatment or processing, e.g. curing, drying, baking.

1.5.12 Prepared atmosphere

An atmosphere prepared for a particular purpose through which oxygen is generally excluded from the heating chamber.

1.5.13 Resistance heater

An electric heater in which heat is produced by current flow through a resistive conductor.

NOTE: Resistance heaters may be of 'open' type with bare elements or 'insulated sheathed' type with elements covered by a protecting sheath which may be filled with electrical insulating material.

1.5.14 Type 1 oven

An oven in which the temperature does not exceed 540°C, the pressure is approximately atmospheric and there is present an explosion hazard due to flammable volatiles from materials in the oven, e.g. flammable volatiles from paints and other finishing procedures such as dipped or sprayed material, impregnated material and coated fabrics.

NOTE: Other types of ovens may be required for which specifications would need to be developed.

1.6 ELECTRICAL SAFETY REQUIREMENTS

This Standard does not include the electrical safety requirements that should be observed to secure approval for connection of the oven to the electricity supply. The oven shall, therefore, in addition to complying with the requirements of this Standard, comply with the relevant requirements of AS/NZS 3000.

Where tests are conducted on the oven as a whole, to prove compliance with any such requirements, the oven with all its mechanical and electrical parts shall be correctly assembled to ensure normal functioning as in use.

1.7 COMPLIANCE WITH REGULATORY AUTHORITIES, REQUIREMENTS

Attention is drawn to the necessity for compliance with any relevant requirements of regulatory authorities applying to the design, installation and operation of ovens.

SECTION 2 CONSTRUCTION REQUIREMENTS

2.1 GENERAL REQUIREMENTS

2.1.1 Ovens and related equipment

The oven and related equipment shall be of substantial and robust construction and their design shall take into account—

- (a) the fire hazard inherent in equipment operating at elevated temperature;
- (b) the hazards to operators from high temperature, electric shock, and operation of mechanical equipment; and
- (c) the need for ensuring reliable safe operation over the maximum expected life of the equipment.

2.1.2 Materials

Non-combustible materials shall be used throughout in the construction of the oven except that combustible materials may be used where approved by the relevant regulatory authority, subject to—

- (a) operating temperatures not in excess of 65°C; and
- (b) the material being unable to make contact with any other part, the temperature of which exceeds 100°C: this may be achieved by the use of suitable fire-resisting materials to separate such parts or by spacing the material at such a distance as will avoid the risk of ignition.

2.1.3 Interior surfaces

All interior surfaces shall be finished smooth and so arranged as to permit easy cleaning.

2.1.4 Insulating materials in walls

The construction of oven walls of thermal insulating material covered or encased in sheet metal shall be such as will prevent undue accumulation of flammable gases and vapours by the insulating material during service.

Explosion-relief vents shall be constructed so that the optimum mass of material is consistent with the insulation covering the relief vent.

NOTE: The mass of any relief vent should not exceed the minimum necessary for the provision of effective insulation and for freely relieving internal explosion pressures.

2.1.5 Expansion

Oven structural supports and conveyors shall be designed with adequate factors of safety at the maximum operating temperatures, consideration being given to the strains imposed by expansion.

Expansion joints, where necessary, shall be provided at suitable intervals in oven framing and panelling to prevent damage from expansion and contraction.

2.1.6 Doors

The doors of the oven shall be provided with secure fastenings to prevent them from suddenly opening in a dangerous manner simultaneously with the operation of the explosion reliefs.

Access doors and openings in adequate number and size shall be provided to facilitate inspection and maintenance and the effective use of extinguishers or hose streams to all parts of the oven. All access doors through which personnel may enter shall be provided with fittings which will permit manual opening from both inside and outside the oven.

2.1.7 Guarding of moving parts

All moving parts shall be effectively guarded in accordance with the requirements of the relevant regulatory authority.

NOTE: For further details on safeguarding of machinery see AS 4024.1.

2.1.8 Shelves

Shelves shall be of such a design as will not impede the circulation of fresh air or the exhaust of vapours from the oven.

NOTE: It has been demonstrated experimentally, that the use of grid-type shelves covering more than one-half of the shelf area may lead to a considerable increase in pressure if there is an explosion. Notwithstanding the requirements of this Clause, serious blockage may occur when the oven is heavily loaded with stock. The best procedure in such cases is to insert the loaded shelves after heating up the oven.

2.2 EQUIPOTENTIAL BONDING

To avoid dangerous sparking between metallic parts of the oven's structures, potential equalization shall be conducted in accordance with AS/NZS 2381.1.

2.3 EXPLOSION-RELIEF VENTS

2.3.1 Basic requirements

The oven shall be equipped with unobstructed explosion-relief vents for freely relieving internal explosion pressures. The vents shall be proportioned in the ratio of their area in square metres to the explosion-containing volume of the oven in cubic metres. The minimum ratio shall, wherever practicable, be 1:4.5, i.e. 1 m² of relief vent area to every 4.5 m³ of oven volume.

Large ducts shall also be fitted with explosion-relief vents. Their location along the duct may be established in a manner similar to the procedure given in the Note to Clause 2.3.2.

The design of the vents shall be such that they open fully before the pressure in the oven can build up to a dangerous level. In addition, they shall be so constructed and so located that in the event of an explosion occurring in the oven their movement is restricted and personnel are not exposed to injury.

2.3.2 Location in oven

The locations for explosion-relief vents in ovens shall be so chosen as to prevent the pressure in the oven from building up to a dangerous level during the discharge of the products of combustion formed by an explosion.

For a conveyor process oven the vents shall be located progressively along the oven.

NOTE: It is recommended that the best procedure is to regard conveyor process ovens as divided into a number of parts each of which is approximately cubical and to install a relief vent in each part. Although such ovens have open ends, the area of relief provided by the ends is neither large enough nor in the correct position to prevent an oven being damaged by an explosion. Whether the relief vents are installed in the sides or top of the oven will depend on the situation, construction and loading of the oven.