

DR 93042  
(AMDT 2)

DR 96030  
FND 97017  
AS 1228—1990

AMDT 1 1991.04.15  
Amdt. 2: 1994.06.20

Australian Standard®

1997 AS

---

**Boilers—Water-tube**

---



**STANDARDS AUSTRALIA**



L

This Australian Standard was prepared by Committee ME/1, Boilers and Unfired Pressure Vessels. It was approved on behalf of the Council of Standards Australia on 25 July 1989 and published on 16 February 1990.

---

The following interests are represented on Committee ME/1:

Aluminium Development Council  
Australian Compressed Air Institute  
Australian Institute for Non-destructive Testing  
Australian Institute of Energy  
Australian Institute of Petroleum  
Australian Liquefied Petroleum Gas Association  
Australian Valve Manufacturers Association  
Boiler and Pressure Vessel Manufacturers Association of Australia  
Bureau of Steel Manufacturers of Australia  
Confederation of Australian Industry  
Department of Defence  
Department of Industrial Affairs, Qld  
Department of Labour and Industry, Tas.  
Department of Labour, S.A.  
Department of Labour, Vic.  
Department of Occupational Health, Safety and Welfare, W.A.  
Department of Territories  
Electricity Supply Association of Australia  
Institute of Metals and Materials, Australia  
Institution of Engineers, Australia  
Insurance Council of Australia  
Metal Trades Industry Association of Australia  
National Association of Consulting Authorities, Australia  
Railways of Australia Committee  
Society of Mechanical Engineers of Australasia  
Sugar Research Institute  
Welding Technology Institute of Australia  
Workcover Authority, N.S.W.  
Work Health Authority, N.T.

---

*Review of Australian Standards.* To keep abreast of progress in industry, Australian Standards are subject to periodic review and are kept up-to-date by the issue of amendments or new editions as necessary. It is important therefore that Standards users ensure that they are in possession of the latest edition, and any amendments thereto.

Full details of all Australian Standards and related publications will be found in the Standards Australia Catalogue of Publications; this information is supplemented each month by the magazine 'The Australian Standard', which subscribing members receive, and which gives details of new publications, new editions and amendments, and of withdrawn Standards.

Suggestions for improvements to Australian Standards, addressed to the head office of Standards Australia, are welcomed. Notification of any inaccuracy or ambiguity found in an Australian Standard should be made without delay in order that the matter may be investigated and appropriate action taken.

---

This Standard was issued in draft form for comment as DR 88028.

## STANDARDS AUSTRALIA

---

**Amendment No 1**  
to  
**AS 1228—1990**  
**Boilers—Water-tube**

---

## CORRECTIONS

The 1990 edition of AS 1228 is amended as follows; the amendments should be inserted in the appropriate place.

*SUMMARY:* This Amendment applies to Equation 3.2.7.6(4), Figure 3.3.4.2 and running head on Page 82.

Published on 15 April 1991.

---

AMDT  
No 1  
APR  
1991

**Page 36 Equation 3.2.7.6(4)**

Delete  $\eta_3 = \frac{(d_1 + d_2) \cos \alpha}{2a}$  and substitute

$$\eta_3 = 1 - \frac{(d_1 + d_2) \cos \alpha}{2a}$$


---

AMDT  
No 1  
APR  
1991

**Page 43 Figure 3.3.2**

Delete the Note below the title and substitute:

NOTE:  $t_1 = \sqrt{(2R_1t)}$  or  $d_o/2$  whichever is less;  $L_2$  shall not exceed  $\sqrt{(d_oL_1)}$ .

---

AMDT  
No 1  
APR  
1991

**Page 82 Running head (top left-hand of page)**

Delete 'AS 1228—1989' and substitute 'AS 1228—1990'.

---

Australian Standard®

---

**Boilers—Water-tube**

---

For history before 1972 see Preface.  
AS 1228 first published 1972.  
Second edition 1980.  
Third edition 1984.  
Fourth edition 1990.

## PREFACE

This edition of this Standard was prepared by the Standards Australia Committee on Boilers and Unfired Pressure Vessels, to supersede AS 1228—1984. The Standard was first published in 1974 as part of the program of revision of the *SAA Boiler Code*, which at that time was designated AS CB1. It forms part of the current *SAA Boiler Code* (AS 1200) which is referred to in Statutory Regulations in Australia, and which covers requirements for land installations of shell boilers, water-tube boilers, unfired pressure vessels, pressure piping, welder certification, and related matters.

AS CB1, the original *SAA Boiler Code*, was initially issued in 1931 to provide detailed guidance on the practices to be adopted in the design, construction and testing of boilers, unfired pressure vessels and associated equipment, and also to assist in obtaining uniform statutory requirements throughout Australia. It was revised and re-issued several times, and immediately prior to the publication of the first edition of AS 1228 in 1972, water-tube boilers were covered in the following Parts:

- Parts I-IV—1952 *Boilers and unfired pressure vessels and their appurtenances*
- Part V—1951 *Welding*

Revisions and additions have been made throughout the Standard; those Clauses, Tables, and Figures which have been subject to technical change are given in the List of Technical Changes following the Index. The changes include the addition of definitions for boiler components, revision of grades of steel plate, reduction in the required minimum thickness of drums and headers, review of requirements for bending of plates and tubes, clarification and review of non-destructive examination and heat treatment requirements for heating surface tubes and integral piping, and review of requirements for safety valves and water level gauges.

The revisions relating to heat treatment may affect welding procedure requirements but it is not intended that existing approved welding procedures will be invalidated by minor changes such as small variations in heat treatment temperatures.

The Standard follows, in principle, other parts of the *SAA Boiler Code* by giving guidance to manufacturers, inspecting authorities, and users in the form of minimum engineering standards for the design, construction, inspection, testing and installation of water-tube boilers.

It is based on BS 1113 *Specification for design and manufacture of water-tube steam generating plant (including superheaters, reheaters and steel tube economizers)*, which includes the relevant requirements of ISO/R 831, *Rules for Construction of Stationary Boilers*.

The ISO Recommendations and the Standards in this series have been formulated with the object of providing adequate protection of life and property, a reasonably long and safe period of usefulness, and a proper margin for deterioration in service.

The Standard contains basic data necessary for design, including material specifications, design parameters, requirements for fabrication, inspection, and testing. These requirements are specified in terms of principles to the fullest possible extent, supplemented where necessary by further detail to obtain uniform interpretation of principles and guidance as to best methods.

In other areas the Standard indicates where caution is necessary because it is felt that a direct prohibition would be unwise at the present level of knowledge.

The specific design requirements of the Standard are based on a simplified engineering approach and are intended to be the standard methods of design. However, in special instances, particularly where guidance is not provided in this Standard, other methods may be used provided that the validity of the design is satisfactorily established.

Section 4 of this Standard (manufacture and workmanship) includes requirements for those matters which come within the normal function of the manufacturers. Requirements as to workmanship for plates, tubes, forgings and castings in the condition in which they are normally supplied to the manufacturer are included in the relevant Standards specifying such materials.

This Standard does not specify individual welding processes or procedures. It provides guidance by which a welding process or procedure or the application of equipment or material for various welding processes or procedures by individual manufacturers may be approved for the manufacture of water-tube boilers and their ancillary pressure parts. It also specifies requirements whereby the competence of individual welders may be established and qualified.

In general, the tests required for the approval of welding procedures, for the competence of welders and for production control, together with the requirements for non-destructive examination, have been formulated with fusion welding processes in mind. Where a pressure welding process is employed, e.g. flash welding for joining tubes, it will be necessary to modify or extend these requirements to ensure that adequate precautions are taken for the avoidance of faults peculiar to the process used. Special requirements of this nature should be subject to prior agreement between the manufacturer and the Inspecting Authority.

No guidelines on construction can be written in sufficient detail to ensure good workmanship in construction. Each boiler manufacturer is responsible for taking every necessary step to make sure that the quality of workmanship and construction is such as will ensure compliance with good engineering practice.

The user will also need to consider many factors beyond those covered by this Standard in the final specification of a boiler and is cautioned that the Standard is not a complete design handbook and that he should be aware of the need for competent engineering judgement.

It should be noted that the Standard has been written primarily to suit conditions in Australia where there is a strong relationship between the manufacturer (and designer) and the Inspecting Authority. However, it is not intended to weaken the important link between these parties and the purchaser, who will be concerned with many aspects beyond the scope of this Standard and who may specify additional or alternative requirements, but such requirements must not be less than those already specified in the Standard and must comply with the requirements of the Inspecting Authority in the State where the boiler is to be operated. Statements of above requirements should form part of the contract documents between the purchaser and manufacturer. Attention is drawn to Appendix D which sets out information that should be supplied by the purchaser and the manufacturer.

Users of this Standard are reminded that it has no legal authority in its own right, but may acquire legal standing in one or more of the following circumstances:

- (a) Adoption by a government or other authority having jurisdiction.
- (b) Adoption by a purchaser as the required Standard of construction when placing a contract.
- (c) Adoption where a manufacturer states that a vessel is in accordance with this Standard.

Statements expressed in mandatory terms in Notes to Tables and Figures are deemed to be requirements of this Standard.

© Copyright — STANDARDS AUSTRALIA

Users of Standards are reminded that copyright subsists in all Standards Australia publications and software. Except where the Copyright Act allows and except where provided for below no publications or software produced by Standards Australia may be reproduced, stored in a retrieval system in any form or transmitted by any means without prior permission in writing from Standards Australia. Permission may be conditional on an appropriate royalty payment. Requests for permission and information on commercial software royalties should be directed to the Head Office of Standards Australia.

Standards Australia will permit up to 10 percent of the technical content pages of a Standard to be copied for use exclusively in-house by purchasers of the Standard without payment of a royalty or advice to Standards Australia.

Standards Australia will also permit the inclusion of its copyright material in computer software programs for no royalty payment provided such programs are used exclusively in-house by the creators of the programs.

Care should be taken to ensure that material used is from the current edition of the Standard and that it is updated whenever the Standard is amended or revised. The number and date of the Standard should therefore be clearly identified.

The use of material in print form or in computer software programs to be used commercially, with or without payment, or in commercial contracts is subject to the payment of a royalty. This policy may be varied by Standards Australia at any time.

CONTENTS

	<i>Page</i>
FOREWORD .....	6
<b>SECTION 1. SCOPE AND GENERAL</b>	
1.1 SCOPE .....	7
1.2 REFERENCED DOCUMENTS .....	7
1.3 CONDITIONS FOR COMPLIANCE WITH THIS STANDARD .....	7
1.4 DEFINITIONS .....	7
1.5 VALVES AND FITTINGS .....	8
1.6 NOTATION .....	8
1.7 HEATING SURFACE .....	8
1.8 UNITS .....	8
1.9 DESIGNATION .....	8
<b>SECTION 2. MATERIALS AND DESIGN STRENGTHS</b>	
2.1 MATERIALS .....	9
2.2 DESIGN STRENGTHS .....	9
<b>SECTION 3. DESIGN</b>	
3.1 GENERAL .....	29
3.2 CYLINDRICAL SHELLS, DRUMS AND HEADERS SUBJECT TO INTERNAL PRESSURE .....	29
3.3 DISHED ENDS SUBJECT TO INTERNAL PRESSURE .....	38
3.4 RECTANGULAR SECTION HEADERS .....	45
3.5 HEADER ENDS .....	47
3.6 PRESSURE PARTS OF IRREGULAR SHAPE .....	47
3.7 BRANCHES, NOZZLES, AND STUBS .....	47
3.8 TUBES AND INTEGRAL PIPES .....	67
3.9 STRUCTURAL ATTACHMENTS TO TUBES .....	70
<b>SECTION 4. MANUFACTURE AND WORKMANSHIP</b>	
4.1 PRESSURE PARTS .....	71
4.2 WELDING .....	75
4.3 HEAT TREATMENT .....	78
4.4 APPROVAL OF WELDING PROCEDURES .....	85
4.5 WELDING PERSONNEL .....	88
4.6 PHYSIC QUALIFICATION OF WELDERS .....	88
<b>SECTION 5. INSPECTION AND TESTING</b>	
5.1 INSPECTORS .....	92
5.2 INSPECTION DURING CONSTRUCTION .....	92
5.3 TEST PLATES AND MECHANICAL TESTS OF PRODUCTION WELDS .....	93
5.4 NON-DESTRUCTIVE EXAMINATION .....	96
5.5 HYDROSTATIC TESTS .....	105
<b>SECTION 6. DOCUMENTATION AND MARKING</b>	
6.1 DRAWINGS, DOCUMENTS, AND DATA SHEETS .....	106
6.2 CERTIFICATES .....	106
6.3 MARKING .....	106
<b>SECTION 7. VALVES, GAUGES, AND OTHER FITTINGS</b>	
7.1 GENERAL REQUIREMENTS .....	107
7.2 SAFETY VALVES .....	108
7.3 WATER GAUGES .....	110

SEE AMENDMENT 2

SEE AMENDMENT 2

	<i>Page</i>
7.4 PRESSURE GAUGES .....	112
7.5 FEED SYSTEMS .....	112
7.6 STOP AND ISOLATING VALVES .....	114
7.7 BLOWDOWN FITTINGS .....	114
7.8 HIGH AND LOW WATER ALARMS AND CONTROLS .....	114
7.9 BOILER MANAGEMENT SYSTEM .....	115
<b>SECTION 8. PLANT INSTALLATIONS</b>	<b>SEE AMENDMENT.....2</b>
8.1 HOUSING AND ACCESS .....	117
8.2 LIGHTING AND VENTILATION .....	117
8.3 FLUES AND CHIMNEYS .....	117
8.4 BOILER SETTINGS .....	117
8.5 FEEDWATER .....	117
8.6 BLOWDOWN .....	117
8.7 COMBUSTION EQUIPMENT AND CONTROLS .....	117
<del>8.8 INSTALLATION OF HOT WATER BOILERS .....</del>	<del>118</del>
	<b>SEE AMENDMENT.....2</b>
<b>SECTION 9. COIL-TYPE FORCED CIRCULATION BOILERS</b>	
9.1 GENERAL .....	119
9.2 LIMITATIONS .....	119
9.3 REQUIREMENTS .....	119
<b>SECTION 10. SEE AMENDMENT.....2</b>	
<b>APPENDICES</b>	
A DERIVATION OF MATERIAL DESIGN STRENGTH .....	120
B NOTES ON PIPING STRESS ANALYSIS .....	122
C EXAMPLE OF THE DESIGN OF A BOILER DRUM .....	124
D INFORMATION TO BE SUPPLIED BY THE PURCHASER AND THE MANUFACTURER .....	130
E EXAMPLE OF PRINCIPAL INTEGRAL BOILER PIPEWORK COVERED BY THIS STANDARD .....	131
F ANALYTICAL DESIGN METHOD FOR REINFORCEMENT OF OPENINGS .....	132
G LIST OF REFERENCED DOCUMENTS .....	141
INDEX .....	144
LIST OF TECHNICAL CHANGES .....	148
RECORD OF AMENDMENTS .....	149

## FOREWORD

The application of the several Standards that form the SAA Boiler Code may give rise to a need for consideration of unusual and other designs which do not comply in all respects with the requirements of the relevant Standard or which are not adequately covered in any Standard.

Where it is desired to use materials or methods which do not comply with the requirements of, or are not adequately covered by the relevant Standard, designs incorporating such departures should be submitted to the relevant Inspecting Authority for approval. Where necessary, Standards Australia Committee ME/1, Boilers and Unfired Pressure Vessels, may be asked to serve in an advisory capacity in the determination of the suitability of such designs. (See also Clause 1.4.)

It is emphasized that this activity of the committee is limited to technical aspects of the Code and that the committee has no power or jurisdiction to adjudicate upon contractual matters or regulatory matters or the duties of any persons concerned with the subject of the submission.

It is further emphasized that the committee will undertake consideration of only those matters which relate to interpretation of, or proposed changes to, the Standards for which it is responsible. In particular it will not consider or make recommendations indicating approval of proprietary equipment, materials, components or methods.

A method developed by the committee for communicating its findings is the use of Rulings. A Ruling is issued in reply to a specific enquiry from a specific organization and applies only to the set of circumstances referenced in the Ruling. Rulings may be used by the authorities as the basis for approval of the particular application or for approval of similar submissions from other organizations. Current Rulings are available under the reference AS 1200 Supplement 1.

Where the committee judges the subject to be suitable, a Ruling may be incorporated in an amendment to the relevant Standard, whereupon the Ruling is withdrawn. If the timing is appropriate, the finding of the committee may be issued directly as an amendment.

### NOTES:

1. In the past some Rulings have been designated 'Committee Opinions' but this term is no longer used.
2. In the past, the committee has also issued 'Interpretations' which were considered to be equivalent to an amendment. The practice has been discontinued and all Interpretations have now been withdrawn.

## STANDARDS AUSTRALIA

**Australian Standard**  
**Boilers—Water-tube**

## SECTION 1. SCOPE AND GENERAL

**1.1 SCOPE.** This Standard sets out requirements for materials, design, construction, installation, inspection, and testing of those parts of water-tube steamboilers and water-heating boilers subject to pressure.

NOTE: With the approval of the Inspecting Authority, this Standard may also apply to the parts of 'water-tube type' vapour-generating and hot-liquid units subject to internal vapour or liquid pressure. **SEE AMENDMENT.....2.....**

This Standard specifically applies to land installations of water-tube boilers, as defined in Clause 1.4 including integral superheaters, reheaters, and steel tube economizers, and also to superheaters, reheaters, and steel tube economizers independently fired or heated.

It also applies to all pressure parts containing fluid up to and including the valves separating the pressure parts from—

- (a) steam pipes to and from other equipment;
- (b) water pipes to and from other equipment;
- (c) drain pipes; and
- (d) the surrounding atmosphere, except that for safety valves, their vent piping to the atmosphere is also covered.

For equipment such as reheaters which may not incorporate valves at their supply and return connection points, the Standard applies to the equipment included between the inlet to the inlet header and the outlet from the outlet header of such equipment.

The Standard does not apply to brickwork or similar settings, supports, insulation, air preheaters, mechanical stokers, ash disposal equipment, forced or induced draught equipment or their accessories, except for items important to basic safety and inspection (see Section 8).

**1.2 REFERENCED DOCUMENTS.** A list with titles of the documents referred to in this Standard is given in Appendix G.

**1.3 CONDITIONS FOR COMPLIANCE WITH THIS STANDARD.** Use of the provisions of this Standard for design and construction is valid only when the relevant requirements of other Standards listed in Appendix G are completely satisfied. Boilers and their auxiliary pressure parts may be marked and certified in accordance with Section 6 only when all relevant requirements of the Standards listed in Appendix G have been fulfilled.

**1.4 DEFINITIONS.** For the purposes of this standard, the definitions below apply.

**1.4.1 'Approved' and 'approval'**—approved by, or approval of the Inspecting Authority.

**1.4.2 Boilers.** **SEE AMENDMENT.....2.....**

**1.4.2.1 Boiler**—an arrangement of vessels and inter-

connecting parts, wherein steam, or other vapour, is generated or water or other liquid is heated at a pressure above that of the atmosphere by the application of fire or the products of combustion, or by electrical means or by solar means.

It also includes valves, gauges, and other fittings as required in Section 7 herein and, where consistent with the requirements of this Standard, include the boiler setting, and associated equipment. **SEE AMENDMENT.....2.....**

It does not include a fully flooded system or pressurized system where the water or other liquid is heated to a temperature lower than the normal atmospheric boiling temperature of the liquid.

**1.4.2.2 Water-tube boiler**—a boiler in which the heat transfer takes place through the wall of tubes inside which the fluid to be heated flows or circulates.

**1.4.2.3 Natural circulation boiler**—a water-tube boiler in which fluid circulation is a result of the thermodynamic head produced by heating.

**1.4.2.4 Forced, assisted, or controlled circulation boiler**—a water-tube boiler in which mechanical pumping is used either entirely or partly to promote the circulation of fluid through the tubes.

**1.4.2.5 Once-through boiler**—a water-tube boiler in which the fluid passes from the inlet to the outlet of the boiler without internal recirculation.

**1.4.3 Boiler components.**

**1.4.3.1 Drum**—a cylindrical pressure part having a diameter sufficiently large to admit personnel by design intent, for which purpose an access opening or branch is provided.

NOTE: A drum may have the function of a header, or additionally or alternatively other functions, such as to separate steam from water or to act as a reservoir for boiler water.

**1.4.3.2 Header**—a pressure part whose principal purpose is to collect fluid from, or distribute fluid to, arrays of tubes directly connected to it.

**1.4.3.3 Tube**—a tubular pressure part that is either exposed over much of its length to hot gases for purposes of heat transfer, or is directly butt welded to such a tubular pressure part.

NOTE: This definition also includes a stub on a drum or header.

**1.4.3.4 Integral pipe**—a tubular pressure part that is not a tube, drum, or header.

NOTES:

1. The term 'pipe' implies that there is no design intent to effect heat transfer through the wall of the pressure part.
2. The term 'integral' implies that the pressure part is connected directly to other pressure parts without any intervening valve.
3. The term 'integral pipe', subject to Note 2, includes those parts of pipes that carry a flow of steam or water during normal operation, those that carry intermittent flow, e.g. drain pipes, and those in which no flow occurs, e.g. instrument piping. The principal integral pipework covered by this Standard is shown diagrammatically in Appendix E.