

Australian Standard™

**Heat exchangers— Tubeplates—
Method of design**

This Australian Standard was prepared by Committee ME/1, Pressure Equipment. It was approved on behalf of the Council of Standards Australia on 16 April 1999 and published on 5 July 1999.

The following interests are represented on Committee ME/1:

A.C.T. WorkCover
Australasian Corrosion Association
Australasian Institute of Engineer Surveyor
Australian Aluminium Council
Australian Building Codes Board
Australian Chamber of Commerce and Industry
Australian Industry Group
Australian Institute of Energy
Australian Institute of Petroleum
Boiler and Pressure Vessel Manufacturers Association of Australia
Bureau of Steel Manufacturers of Australia
Department for Administration and Information Services, S.A.
Department of Employment Training and Industrial Relations, Qld
Department of Industries and Business, N.T.
Department of Infrastructure, Energy and Resources (Tasmania)
Department of Labour, New Zealand
Electricity Corporation of New Zealand
Electricity Supply Association of Australia
Institute of Materials Engineering Australasia
Institution of Engineers, Australia
Institution of Professional Engineers, New Zealand
National Association of Testing Authorities, Australia
New Zealand Engineering Federation
New Zealand Heavy Engineering Research Association
New Zealand Institute of Welding
New Zealand Petrochemical Users Group
Victorian WorkCover Authority
Welding Technology Institute of Australia
WorkCover N.S.W.
WorkSafe Western Australia

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which subscribing members receive, and which gives details of new publications, new editions and amendments, and of withdrawn Standards.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 99023.

Australian Standard™

**Heat exchangers— Tubeplates—
Method of design**

Originated as AS 3857—1990.
Second edition 1999.

Published by Standards Australia
(Standards Association of Australia)
1 The Crescent, Homebush, NSW 2140

ISBN 0 7337 2689 5

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee ME/1, Pressure Equipment, to supersede AS 3857—1990, *Heat exchangers—Tubeplates—Method of design*. Acknowledgment is gratefully made of the considerable assistance provided by Orica Engineering Pty Ltd (formerly ICI Australia Engineering Pty Ltd) which developed this method of design.

This Standard is the result of a consensus among representatives on the Joint Committee to produce it as an Australian Standard. Consensus means general agreement by all interested parties. Consensus includes an attempt to remove all objection and implies much more than the concept of a simple majority, but not necessarily unanimity. It is consistent with this meaning that a member may be included in the Committee list and yet not be in full agreement with all clauses of this Standard.

The main change in this revision is the incorporation of Amendment No. 1 to AS 3857—1990.

The Standard covers a method for the design of heat exchanger tubeplates. The Standard was originally drafted with the intention that it would be incorporated into AS 1210, *Pressure vessels*, as a replacement for the method contained in the first and second editions of AS 1210 but the draft was subsequently terminated. However, during the course of development of the proposal, its content was extended and it is now a self-contained method of design, suitable for publication as a separate Standard.

The Standard provides an additional method to other methods specified in AS 1210 for the design of tubeplates for heat exchangers complying with that Standard. The method may also be suitable for the design of some boiler tubeplates.

Although the design method may appear to be somewhat complex, it is no more so than some design methods for other pressure vessel components such as flanges.

While the method is applicable to long-hand calculations, its most effective use will be achieved by programming a computer. An appendix provides a simple algorithm for calculating Lord Kelvin's modified Bessel functions and this algorithm allows programs to be compiled on a computer. Tabulated values of the functions are also provided in the appendix. Suggested worksheets and worked examples of calculations are included in another appendix.

As the proposed design method allows actual stresses at any location to be determined, it can be used for heat exchangers designed to AS 1210 Supplement 1, *Unfired Pressure vessels—Advanced design and construction* (Supplement to AS 1210—1997).

The theoretical background for the method given in this Standard is given in a technical paper titled 'Australian Tubesheet Code' by P McGowan and I Mirovics presented at the ASME Conference on Pressure Vessels and Piping at Nashville, Tennessee in June 1990.

The terms 'normative' and 'informative' have been used in this Standard to define the application of the appendix to which they apply. A 'normative' appendix is an integral part of a Standard, whereas an 'informative' appendix is only for information and guidance.

CONTENTS

	<i>Page</i>
1 SCOPE	4
2 APPLICATION	4
3 REFERENCED DOCUMENTS	4
4 MATERIALS AND COMPONENTS	4
5 DESIGN	9

APPENDICES

A TUBE-TO-TUBEPLATE JOINT—DETERMINATION OF AXIAL BREAKING LOAD AND JOINT EFFICIENCY	23
B LORD KELVIN'S MODIFIED BESSEL FUNCTIONS	25
C SAMPLE CALCULATION SHEETS AND WORKED EXAMPLES	31

© 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.

STANDARDS AUSTRALIA

Australian Standard

Heat exchangers—Tubeplates—Method of design

1 SCOPE This Standard sets out a method for designing flat, circular tubeplates of the following configurations:

- (a) Fixed tubeplates as in heat exchangers consisting of two tubeplates clamped or welded to a shell between them, with or without an expansion joint in the shell.
(b) Tubeplates of U-tube or bayonet heat exchangers.
(c) Floating tubeplates.

Such tubeplates are used in shell-and-tube heat exchangers and in some types of boilers including fire-tube and waste heat boilers.

2 APPLICATION This Standard is intended for use in association with an appropriate pressure vessel or boiler Standard such as—

- (a) shell-and-tube heat exchangers AS 1210 or AS 1210 Supplement 1
(b) boilers AS 1228.

Calculated and permissible stresses in the tubeplates, tubes and shell shall be determined from this Standard but all other design criteria specified in the relevant pressure vessel or boiler Standard shall apply.

In the application of this Standard it will also be necessary to determine metal temperature from other sources (see Clause 5.1).

3 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

Table with 2 columns: Standard Reference and Description. Rows include AS 1210 (Pressure vessels), AS 1210 Supplement 1 (Unfired pressure vessels—Advanced design and construction), AS 1228 (Pressure equipment—Boilers), and EJMA (Standards of the Expansion Joint Manufacturers Association, Inc.).

4 MATERIALS AND COMPONENTS

4.1 Acceptable materials Materials for tubeplates and associated components shall comply with a material specification listed, or as otherwise permitted, in AS 1210, AS 1210 Supplement 1 or AS 1228, as appropriate.

4.2 Design strength The material design strengths, used in the analysis of the tubeplate, shall comply with the values specified, or as otherwise permitted, in AS 1210, AS 1210 Supplement 1 or AS 1228, as appropriate.

4.3 Coefficient of thermal expansion The values which shall be used for the mean coefficient of thermal expansion are given in Table 4.3.

4.4 Young modulus (modulus of elasticity) The values which shall be used for Young Modulus are given in Table 4.4.

4.5 Expansion joints Metallic expansion joints should comply with the requirements specified in the 'Standards of the Expansion Joint Manufacturers Associations, Inc.' or equivalent.