Welding

Useful Fabrication Information
The following data provides information on the weldability of a range of BlueScope Steel plate grades. Although most of the steels listed are readily weldable, an incorrect choice of welding conditions may lead to unnecessary difficulty. The data gives recommendations for the control of heat affected zone hardness and thus provides a measure of protection against heat affected zone cracking, through the correct combination of welding energy (heat) input and preheat for the welding process concerned.

The use of controlled heat inputs for reasons other than the avoidance of heat affected zone cracking, eg. specifically for control of notch toughness, joint strength, weld metal cracking, or avoidance of hot cracking, is outside the scope of this brochure.

The basis of the Weldability Guide is a Group Number based on the steel grade composition. Grades having a low Group Number (low carbon equivalent) are readily welded, whilst high Group Numbers (high carbon equivalent) indicate need for care in the selection of welding conditions.

Reference should be made to Welding Technology Institute of Australia (W.T.I.A) Technical Note 1 for additional guidance regarding practical welding variables.

Whilst these recommendations can be used with a high level of confidence, they are a guide only, and as such, BlueScope Steel cannot guarantee that cracking will never occur.

The preheat and weldability recommendations provided herein do not override the user’s obligation to demonstrate suitability of the planned welding procedures through the use of procedure qualification tests as prescribed by AS/NZS 1554.1:2000 and other applicable fabrication standards. Additionally, it is assumed welding is performed by suitably qualified welders ie. capable of complying with the minimum requirements of AS/NZS 1554.1:2000 Section 4.12.2 Welder Qualifications.

The user should also be aware that good joint fit up under moderate levels of restraint are assumed, and that additional preheat beyond that recommended will be required where fit up is poor or where high levels of restraint are likely to be encountered.

**Figure 1**

**Method of establishing Joint Weldability Index (A to L) from Grade Group Number and Joint Combined Thickness**

Combined Thickness = \( t_1 + t_2 + t_3 + t_4 \) mm

For welds between \( t_1 \) and \( t_2 - t_3 \), ignore \( t_4 \) unless it is already welded to \( t_2 - t_3 \).

\( t_1 \) = average thickness over distance of 75 mm

For welds between \( t_3 \) and \( t_2 \), ignore \( t_1 \) unless it is already welded to \( t_2 \).

BlueScope Steel Grade 350, CE 0.45 Max AS3678 Grade 250 AS3678 Grade 200
Figure 2
Method of establishing Pre-heat Temperature using Joint Weldability Index Letter and Welding Energy Input

Pre-heat and Energy Input
Requirements for Low Hydrogen Electrodes (EXX15, EXX16, EXX18, EXX28) Semi-automatic and Automatic Welding Processes

Pre-heat and Energy Input
Requirements for Manual Metal Arc Welding with other than Low Hydrogen Electrodes

Typical Energy Input
Requirements for Various Welding Processes.
(Electrode wire sizes shown in brackets - mm)
Procedure for Determining Preheat and Welding Energy Input

To find the welding energy input and the preheat temperature required for use with a particular welding process and steel grade of known thickness, the steps given below should be followed:

Step 1: From Table 1 find the "Group Number" for the steel grade. For joints containing different steels use the higher Group Number.

Step 2: Using Figure 1 calculate the "Combined Thickness" of the joint.

Step 3: From Figure 1 find the closest curve to the intersection of Combined Thickness and Group Number. This curve designates the Joint Weldability Index Letter.

Step 4: From Figure 2 and using the curve bearing the same Joint Weldability Index Letter found from Step 3, read off the preheat temperature for the welding energy input or vice versa.

Suggested Further Reading

1. Welding Technology Institute of Australia Technical Notes
   - Note 1 The Weldability of Steels
   - Note 2 Care of Manual Arc Welding Steel Electrodes
   - Note 5 Flame Cutting of Steels
   - Note 6 Control of Lamellar Tearing
   - Note 8 Design for Economic Welding
   - Note 11 Commentary on the Structural Steel Welding Standard AS/NZS 1554
   - Note 12 Minimisation of Corrosion in Welded Steel Structures

2. Steel Structures - A manual for use in the design and construction of structural steelwork. Prepared by the Australian Institute of Steel Construction and published by the Standards Association of Australia.


4. AS/NZS 1554.1 Structural Steel Welding Part 1: Welding of Steel Structures.

Table 1 - Weldability Guide - Steel Grades and Group Numbers

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<th>Grade Designation</th>
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Shipbuilding Grades

Lloyds, Norske Veritas
- Grade A | 4 | O |
- Grade D | 4 | O |
- Grade E | 4 | O |

Boiler & Pressure Vessel Grades

AS 1548 - 5 - 490 | 5 | H/O |
- 7 - 460 | 4 | O |
- 7 - 490 | 4 | O |