10 Welding in the transport industry 2013

Note that the welder certification standard, AS/NZS 2980:2007, has been superseded by AS/NZS ISO9606: 2017 or AS/NZS 2980:2018, Qualification of welders for fusion welding of steels. Welder certificates to AS/NZS 2980:2007 will not be recognised once they run out and not at all after 1 April 2020.

Memo 72 - 28 February 2013

Introduction

This document is an update of the publication *Welding in the Transport Industry*, Version 2 June 1998 ISBN 0478206607 which was produced by the Land Transport Safety Authority (LTSA) for the use of engineers, fabricators and others involved in heavy motor vehicle construction and repair. It outlined the LTSA's expectations of these people and their organisations. Copyright is held by the NZ Transport Agency.

This document has been revised and updated by the NZTA with assistance from the HVETIG (formerly the RTCE), including the references and Appendices 1-5 and is published in Memo form as an instruction to all HV certifiers.

A guide to key reference documents is included.

Policy for the use of this document

The information in this document is intended to provide useful guidance on manufacture and fabrication of vehicles and components in the heavy transport industry. It can also be used for guidance when undertaking repairs and modifications where welding to the chassis is indicated, but only in cases where the manufacturer allows welding on the chassis or where the manufacturer's position on welding the chassis is unobtainable. It is NZTA policy that the modifier and repairer must follow the vehicle manufacturer's instructions and standards (eg as outlined in the manufacturer's repair and/or body builder's manual). **If the manufacturer does not permit welding, then welding must not be used for modification or repair purposes.** In such cases modifications and repairs must be done in accordance with the manufacturer's instructions, which may mean such modification or repair **must not** be carried out.

An alternative approach

A chassis can be welded where sound engineering judgement and calculations provide justification even where the OE manufacturer does not support such modification or repair. However, in such cases the HV Certifier takes full responsibility and must be able to support and defend such an approach. At a minimum, substantial reinforcing over the welded section that has been designed to meet the chassis moment of resistance is expected. Such reinforcement would be designed to reduce the cyclic stresses in the weld so that fatigue issue in the welded joint are eliminated. Most manufacturers using a quenched and tempered (QT) chassis provide welding recommendations within their manuals even when their opening statement says that the chassis must not be welded although these welding recommendations are usually supplied as a field repair and assume the affected rail will be replaced at the earliest opportunity. Always look for the manufacturer's welding recommendations in the first instance.

Applicable standards and weld quality

The applicable welding standard is the joint New Zealand and Australian standard, AS/NZS 1554.1:2011, Structural Steel Welding, Part 1, Welding of Steel Structures (minimum yield strength not exceeding 500 MPa). **Superseded standards must not be used.**

Other applicable joint standards are:

- AS/NZS 1554.4:2010, Part 4, Welding of High Strength Quenched and Tempered Steels (minimum yield strength not exceeding 1000 MPa)
- AS/NZS 1554.5:2011, Part 5, Welding of Steel Structures Subject to High Levels of Fatigue (minimum yield strength not exceeding 450 MPa)
- AS/NZS 1554.6:2012, Part 6, Welding of Stainless Steel.
- AS/NZS 1665:2004 Welding of Aluminium Structures

Note that the welder certification standard, NZS 4711, has been superseded by AS/NZS 2980:2007, Qualification of welders for fusion welding of steels, and welder certificates to NZS4711will not be recognised once they run out after 1. April 2011.

Choosing the appropriate standard

The choice of standard will depend on the types of steels above to be welded. There are several additional factors that must also be considered when determining the most appropriate standard to use. For example, if the chassis is made from quenched- and tempered-type high strength steel, use AS/NZS 1554.4 Part 4 2010. (see **Appendix 2**).

For materials which fall outside the range of the standards, follow the manufacturer's recommendations and develop particular weld procedures, or refer to **Appendix 3**: **'Finding out the mechanical properties of the material in the *as welded* condition'**.

Chassis repairs and modifications (general case)

Certifying engineers issuing Design Certificates for chassis or structural manufacture, repairs or modifications have total accountability for fulfilling all statutory and legal obligations concerning such activities. A Design Certificate (Statement of Design Compliance) is a formal declaration that the certifying engineer has fulfilled all such requirements and is accountable for the integrity of the manufacture, repair or modification.

The certifying engineer must:

- Identify the parent metal, and
- Choose the appropriate standards for design and fabrication, and
- Ensure compliance with those standards of all parties encompassed in the certification, and
- Provide evidence of sufficient strength of the welded component.

If the strength of the steel used for the chassis is achieved through the heat treatment of a weldable steel, (eg, some US specification chassis) the certifying engineer must ensure that the design requirements and welding procedure for the modification meet:

1. The original vehicle manufacturer's specifications, or, if this information is not available
2. The design and fabrication engineering practice as described in this document.

The certifying engineer takes responsibility for the modification or repair, and must satisfy the NZTA that the vehicle has been restored to within safe tolerance of its original structural strength. Requirements to be met are contained in **Land Transport Rule: Heavy Vehicles 2004**

If, under Section 6.4 or 7.1(2) of the Heavy Vehicles Rule, the chassis rating has ceased to be appropriate because of the modification or repair, the certifying engineer takes responsibility for the modification or repair and must issue a new chassis rating as specified in HVS Certifier Memo 57a (**Technical bulletin 3**) and subsequent relevant memos.

Chassis modifications for alteration of the chassis rating

When chassis modifications are for the purpose of alteration to the established chassis rating outside the scope of the HV Rule and/or HVS Certifier Memos 57a and 57b (**Technical bulletin 3**) and other relevant instructions, the NZTA will expect, in the first instance, the certifying engineer to obtain approval from the original chassis manufacturer. **The manufacturer should recommend a procedure for modification that will sustain the original specifications.**

If the modification does not fall within the scope of or meet the Rule or relevant Memos or instructions then the NZTA may impose any conditions deemed necessary, including prohibition, and may alter the vehicle ratings according to the information provided by the certifying engineer, vehicle inspector or Transport Officer.

The NZTA may ask the certifying engineer to provide additional information from the manufacturer or other expert sources (eg Industrial Research Ltd (IRL), Heavy Engineering Research Association (HERA), materials testing agencies) to confirm the safety of the modification.

As with any repairs or modifications, failure to observe the relevant Land Transport Rules, regulatory, statutory requirements and standards, may result in the removal of the chassis rating and the withdrawal of the certificate of loading.

Design and Fabrication

Standard AS 1250:1981 is now superseded. It has been incorporated into the revised and reissued AS 3990:1993 Mechanical equipment – Steelwork**. AS 3990-1993 or BS 7608:1993 are the standards to use in all design, fabrication and repair work in the truck/trailer industry.** Section 9.8 of AS 3990-1993 requires that all welds comply with AS 1554 which has been updated to AS/NZS 1554.

Auditing

For the purposes of traceability complete documentation must be available to a NZTA audit so that there is a trail of evidence of compliance.

Penalties and enforcement

Failure to meet the legislative requirements may expose:

- The vehicle's operator to an infringement fee of $150 for operating a vehicle that does not meet the prescribed requirements of **Land Transport Rule: Heavy Vehicles 2004** (Rule 31002), and
- The certifying engineer to sanctions up to and including revocation of their notice of appointment, and
- The certifying engineer and others involved in the modification work, who knowingly fail to meet the prescribed requirements, to criminal charges and/or liability.

The prescribed technical requirements will be enforced by the NZTA and the Police. Any vehicle that does not comply with the prescribed technical requirements may be ordered off the road by the Police.

Reference documents

- Current New Zealand Standards are available for purchase from *Standards New Zealand:* **http://www.standards.co.nz**
- Land Transport Rules are available for free download from the New Zealand Transport Agency (NZTA): **http://www.nzta.govt.nz/resources/rules/about/index.html**

- WTIA Technical Note TN01-06 is available for purchase from *Welding Technology Institute of Australia* (WTIA): **http://www.wtia.com.au/catalog.htm**
- 'NZ Welding Centre Report R8-07 High strength steel: Design and fabrication: Appendices: 1992'. Available for purchase from the *Heavy Engineering Research Association* (HERA): **http://www.hera.org.nz**
- The Welding Technology Institute of Australia (WTIA) was formed in 1989 by the amalgamation of the Australian Welding Institute (AWI) and the Australian Welding Research Association (AWRA). The AWRA document, 'Welding Quenched and Tempered Steels' Technical Note 15 (1985) cited in the 1998 Version of 'Welding in the Transport Industry', was renamed WTIA Technical Note 15 and updated as 'Welding and Fabrication of Quenched and Tempered Steel' (1996). It is available for purchase from *Welding Technology Institute of Australia* (WTIA): **http://www.wtia.com.au/catalog.htm**
- Australian Standards are available for purchase from *SAI Global, Australia*: **http://infostore.saiglobal.com**

Appendices

Appendix 1: Definitions AS/NZS 1554

Appendix 1 provides definitions for the 'Responsible Parties' referred to in the document AS/NZS 1554 when specifically applied to the repair and manufacture of equipment operating in the New Zealand road transport industry.

Certifier

NZTA appointed Specialist Certifier. In the absence of an Inspector, they are responsible to NZTA for ensuring specified work meets the requirements of NZS 1554.

Fabricator

Person or organisation responsible for the welding (may be the workshop owner).

Inspecting Authority

Organisation with the statutory authority to inspect and certify compliance of welding operators, welding procedures and final welds. A Specialist Certifier who holds appropriate qualifications could fulfil this role.

Inspector

Either a Specialist Certifier who meets the qualification requirements of AS/NZS 1554, or an appropriately qualified person employed by the Inspecting Authority.

Principal

This can be NZTA, the vehicle owner, or the manufacturer. A Specialist Certifier acts as the Principal's representative.

Report

The minimum requirement upon which to base a written report must be a visual inspection of all welding to be certified as complying to AS/NZS 1554.

Welder

A person who meets the qualification requirements of AS/NZS 1554 for the position and technique of the welding being performed.

Welding Supervisor

A person employed by the Fabricator who meets the qualification or experience requirements defined in AS/NZS 1554. A Specialist Certifier could be delegated this role by the Fabricator.

Appendix 2: Review AS/NZS 1554.5

Appendix 2 details applications of AS/NZS 1554.1 and AS/NZS 1554.5 regarding welds not exceeding/exceeding 500 MPa yield.

For materials not exceeding 500 MPa yield

This applies for welds subjected to fatigue loadings when the stress in the weld exceeds 80% of Category B of AS 3990 (or exceeds the stress range permitted for detail 112 of AS4100 or NZS 3404.1). AS/NZS 1554.1 should be used for all lower levels of fatigue stress.

Examples

80% Category B

Load condition 4 = 0.8 x 110 = 88 MPa | Range (over 2,000,000 cycles)

Load condition 3 = 96 MPa | Range (500000 – 2,000,000 cycles)

Load condition 2 = 148 MPa | Range (100000 – 500,000 cycles)

Reviewing differences between AS/NZS 1554.1 and AS/NZS 1554.5 for materials not exceeding 500 MPa yield: Generally, there are no differences between the two, except for the level of inspection required and levels of imperfections allowable. In broad terms, AS/NZS 1554.5 only allows levels of imperfections which are 50% of the allowable levels of imperfections in ASS/NZS 1554.1.

Materials exceeding 500 MPa yield

If the materials are High Strength Quenched and Tempered Steels, AS/NZS 1554.4 applies. If the stress in the weld exceeds 80% of category B of AS 3990, then this weld is designated FP (Fatigue Purpose). In this case, higher levels of inspection are required and lower levels of imperfection apply.

Appendix 3: As welded material properties

Appendix 3 details methods of Finding out the mechanical properties of the material in the as welded condition.

In the first instance, the certifying engineer must obtain material specifications and procedures from the original chassis manufacturer. If this information is not obtainable from the manufacturer, the certifying engineer must undertake the following course of action:

1. **Determine the properties of the unwelded parent metal** through a materials testing agency. It may be necessary to test tensile strength, yield strength, elongation, chemical composition and/or hardness.

2. **Assess the weldability of the steel**, in line with Welding Technology Institute of Australia (WTIA) Technical Note TN1 (2006). Use the weldability group number determined through TN1 when working out possible preheat. HERA recommend that, for practical reasons, only steels with a carbon equivalent of <0.50 (equivalent to Group 5) be considered for welding. If in doubt, seek expert advice (eg HERA, a practising metallurgist etc.).

3. **Choose the welding electrode carefully**. The choice of a matching strength electrode is only of value if the expected loss of strength in the Heat Affected Zone (HAZ) is insignificant. If in doubt, seek expert advice (eg HERA).

4. **Develop and qualify the welding procedure** in accordance with AS/NZS 1554.1. If the material is not pre-qualified, the procedure must be qualified by testing. Such cases can be treated the same as when qualifying non pre-qualified consumables for weld category SP. Obtain approval of the procedure by a suitably qualified person (e.g. HERA). The welder can be qualified to the procedure under AS/NZS 1554.1 or to AS/NZS 2980: 2007.

5. **Determine the mechanical properties of the material in the as welded condition** from the welding procedure test, i.e. tensile, yield, elongation, and (if necessary) impact (charpy) values.

6. **Use the mechanical properties determined for the design calculation.** Please note:

- the weld strength including the heat affected zone (HAZ) for some of the high strength steel (HSS) chassis rails is typically below that obtained for the unwelded parent metal
- the fatigue strength of a welded detail is always considerably below that of the unwelded parent metal and does not depend on the strength of the parent metal
- remember to specify weld category to AS/NZS 1554 and the extent of non-destructive examination required
- refer to HERA NZ Welding Centre Report R8-07: High Strength Steel; Design and Fabrication, and Australian Welding Research Association (AWRA) Technical Note, Issue 15.

Appendix 4: Industry Standard Weld Procedures

Appendix 4 details some methods to obtain qualified weld procedures.

Compliance with AS/NZS 1554 (all parts) requires that all welding procedures used by workshops must be individualised to the workshop by way of a Macro test examination, as a minimum, provided that all other requirements for qualifying the procedure have been met.

Most welding tasks performed within the road transport manufacture and repair industry can be covered by a clearly defined range of welding procedures. This document supports the use of industry developed standard weld procedures which can be tailored for individual workshops and may be used by workshops without the need for further proving.

Such procedures may be developed by relevant industry groups (HERA, HVETIG, TTMF) for use by their members.

Where these procedures are used when HV Certification is required it must be under the supervision of a NZTA appointed Heavy Vehicle Certifier. Unless specified on a SoDC or other approved engineered solution, the certifier must take responsibility for specifying the procedure to be used and is also responsible for ensuring that the workshop, its equipment and personnel, are capable of meeting the parameters specified in the procedure.

For any tasks that are not clearly covered by available standard procedures a new procedure must be developed and must meet all the requirements of AS/NZS 1554.

Appendix 5: Brittle Fracture Considerations

Appendix 5 is a general discussion on the dangers and affects of brittle fracture.

HVSC's have a responsibility not to lose sight of potential Brittle Fracture problems throughout the complete design and certification process.

Brittle Fracture is not a matter for welder testing to AS/NZS2980 other than using a test procedure compliant with AS/NZS 1554.1. HV Certifiers are required to specify and ensure any job has been completed in compliance with AS/NZS 1554 pt 1-5. Therefore, with respect to welder testing HV Certifiers need to adopt WPS's which have been developed to reduce the size and incidence of defects in welds which are a major cause of brittle failure.

The other aspects of Brittle Fracture fall outside the realms of welding performance being material selection for Design Service Temperature, metallurgy, design and design detailing. All aspects that should be fully considered prior to a weld procedure being chosen.

Generally the shape changes (stress risers) and defects that increase the sensitivity of a structure to fatigue failure, also give rise to brittle fracture in notch sensitive materials.

Structures that are designed for fatigue are generally less prone to brittle fracture under normal loading conditions as the structure will be functioning below the notch sensitive stress levels.

In ductile structures the peak stress at a discontinuity or defect in the material, or in a weld, will result in local deformation and a redistribution of the stress tending to average the stress out. Repeated fluctuated loads will eventually lead to fatigue failure.

In a notch sensitive material, the material will tend to fracture rather than deform giving rise to an even higher level of peak stress at the point of the fracture and an increase in stress due to the reduction in section resulting in total failure.

Structures designed for high fatigue sensitivity, for example AS 3990 Category E load condition 3 (55MPA nominal stress) would be less prone to failure due to brittle fracture than if designed for load Category E condition 1 (140 MPa).

Towing connections with a design life of 10 year would be more prone to brittle fracture, than if designed for for a 20 year life.

Conclusion

Where a component is designed for a minimum fatigue life of 10 years brittle fracture can be considered to be accounted for by the fatigue design. For any reduction in the design life from 10 years the component will need to be designed for brittle fracture with appropriate material selection. All the welding requirements of NZS 1554 appendix B need to be followed.

High Strength Materials. Special attention must be paid to the fracture toughness when using high strength materials, ie yield strengths greater than 350 MPa. These materials may display good fracture toughness and fatigue properties but may be very prone to embrittlement due to poor welding procedures and may become notch sensitive. For these materials specific welding procedures must be applied and the requirements of NZS 1554 Parts 1 and 5 strictly adhered to.