



## Lifting components for Grade T(80) and V(100) chain slings



This Australian Standard® was prepared by Committee ME-025, Lifting Tackle. It was approved on behalf of the Council of Standards Australia on 22 August 2014. This Standard was published on 11 December 2015.

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- 

This Standard was issued in draft form for comment as DR AS 3776.

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

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Australian Standard<sup>®</sup>

## Lifting components for Grade T(80) and V(100) chain slings

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## PREFACE

This Standard was prepared by Standards Australia Committee ME-025, Lifting Tackle, to supersede AS 3776—2006, *Lifting components for Grade T chain slings*.

In the preparation of this Standard, cognizance was taken of the following Standards:

EN 1677-1:2000, *Components for slings—Safety, Part 1: Forged steel components, Grade 8*

EN 1677-2:2000, *Components for slings—Safety, Part 2: Forged steel lifting hooks with latch, Grade 8*

EN 1677-3:2001, *Components for slings—Safety, Part 3: Forged steel self-locking hooks, Grade 8*

EN 1677-4:2000, *Components for slings—Safety, Part 4: Links, Grade 8*

The objective of this Standard is to provide requirements for lifting components for use in Grade T(80) and Grade V(100) chain slings and ensure that product supplied meet its design intent. This Standard is for reference by manufacturers, suppliers, testers, users and regulators.

This edition includes the following changes from the previous edition:

- (a) Further explanation and conditions for testing links and self-locking hooks.
- (b) Requirements for fatigue testing.
- (c) Requirements for the competent person have been introduced.
- (d) Addition of Grade V(100) components.

Statements expressed in mandatory terms in notes to Tables are deemed to be requirements of this Standard.

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.

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## STANDARDS AUSTRALIA

**Australian Standard****Lifting components for Grade T(80) and V(100) chain slings**

## SECTION 1 SCOPE AND GENERAL

**1.1 SCOPE AND APPLICATION****1.1.1 Scope**

This Standard specifies requirements for forged lifting components for use in chain sling assemblies with corresponding sizes of Grade T(80) and Grade V(100) chain complying with AS 2321. The components include hooks with eyes, clevises and other joining devices, mechanical connecting devices, and any other terminal fittings used in a lifting system based on Grade T and Grade V chain.

This Standard does not apply to welded components other than welded master links, welded multi-link assemblies, welded joining links nor does it apply to components subject to an existing Australian Standard.

## NOTES:

- 1 AS 2321 specifies chain in terms of the ISO quality grade designation system. The ISO system also permits Grade T to be designated as Grade 8 and Grade V to be designated as Grade 10.
- 2 A list of Standards applicable to components used in lifting systems is given in Appendix D.

**1.1.2 Application**

Section 2 specifies general requirements that apply to all components. Sections 4 to 8 specify requirements for particular types of component that shall be applied in conjunction with the general requirements.

Section 3 provides the test methods for verification of product conformity. Other aspects of conformity assessment are set out in Appendix E.

**1.2 REFERENCED DOCUMENTS**

The following documents are referenced in this Standard:

## AS

- |        |                                                                                                                       |
|--------|-----------------------------------------------------------------------------------------------------------------------|
| 1171   | Non-destructive testing—Magnetic particle testing of ferromagnetic products, components and structures                |
| 1442   | Carbon steels and carbon-manganese steels—Hot-rolled bars and semifinished products                                   |
| 1444   | Wrought alloy steels—Standard, hardenability (H) series and hardened and tempered to designated mechanical properties |
| 2062   | Non-destructive testing—Penetrant testing of products and components                                                  |
| 2193   | Calibration and classification of force-measuring systems                                                             |
| 2318   | Swivels for hoists                                                                                                    |
| 2321   | Short-link chain for lifting purposes                                                                                 |
| 3775   | Chain slings for lifting purposes—Grade T(80) and V(100)                                                              |
| 3775.2 | Part 2: Care and use                                                                                                  |

## AS/NZS

- 3998 Non-destructive testing—Qualification and certification of personnel
- 1554 Structural steel welding
- 1554.4 Part 4: Welding of steel structures subject to high levels of fatigue loading
- 3842 Guide 62: General requirements for bodies operating assessment and certification/registration of quality systems

## AS/NZS ISO

- 9001 Quality management systems—Requirements
- 31000 Risk management—Principles and guidelines

## ISO

- 9712 Non-destructive testing—Qualification and certification of personnel

### 1.3 DEFINITIONS

For the purposes of this Standard the definitions below apply.

#### 1.3.1 Breaking force (BF)

The maximum force that a test sample of a chain component withstands during a destruction test.

#### 1.3.2 Chain connector

A mechanical joining device that is specifically designed for the use with chain.

#### 1.3.3 Chain grade T(80)

A grade of chain with a specified nominal stress at breaking force of 800 MPa. T(80) is also known as T(8) or T(800).

#### 1.3.4 Chain grade V(100)

A grade of chain with a specified nominal stress at breaking force of 1000 MPa. V(100) is also known as V(10) or V(1000).

#### 1.3.5 Chain sling

An assembly of lifting components made in a configuration of one or more chain legs for attaching loads to be lifted by the hook of a crane or other lifting appliance.

#### 1.3.6 Clevis

An integrated part of a lifting component, for direct connection to a chain, incorporating a fork or yoke integral with the end fitting, a load pin and a retaining mechanism (see also integral joining device).

#### 1.3.7 Competent person

A person who has, through a combination of training, education and experience, acquired knowledge and skills enabling that person to correctly perform assessments of components for short-link chain for lifting purposes.

NOTE: Requirements for competent persons are specified in Clause 1.4.

#### 1.3.8 Cradle grab hook

A lifting component (usually attached to the upper end of a sling assembly) that is used to reduce the length of a sling leg, and which may have no de-rating effect on the chain [see Figure 8.1(b) and (d)].

### 1.3.9 Grab hook

A lifting component (usually attached to the upper end of a sling assembly) that is used to reduce the length of a sling leg and which may have a de-rating effect on the chain [see Figure 8.1(c) and (e)].

### 1.3.10 Integral joining device

Means of connection that does not depend on welding and is integrated with the component. [See Figures 5.1(c), (d), (e), 6.1(a) and 8.2(b), (c), (e).]

### 1.3.11 Intermediate link

Link used to connect one or two legs of a sling to a master link [see Figure 5.1(b)].

### 1.3.12 Latch

A spring-loaded or positive latch mechanism that ensures the load cannot become unintentionally disconnected.

### 1.3.13 Lifting component

A component used in a sling.

### 1.3.14 Link

Master link or intermediate link. (See Figure 5.1.)

### 1.3.15 Lot

Total number of components from which samples are selected for testing purposes, and that have been manufactured from the same cast of steel and subjected to the same heat treatment process.

NOTE: This Standard uses the term 'lot'. The term 'batch' is used in other Standards.

### 1.3.16 Lower terminal

Link, hook or other device fitted at the end of a leg of a sling, remote from the master link or upper terminal.

### 1.3.17 Manufacturing proof force (MPF)

Force applied to the component during the manufacturing proof test.

### 1.3.18 Master link

Link forming the upper terminal of a sling by means of which the sling is attached to the hook of a crane or other lifting machine. [See Figure 5.1(a).]

### 1.3.19 Master link assembly

Assembly consisting of a master link together with two intermediate links. [See Figure 5.1(b).]

### 1.3.20 Mechanical joining device

A fitting for connection to an upper or lower terminal fitting or to another length of chain either directly or through an intermediate link (see Figure 4.1).

### 1.3.21 Multi-link assembly

See master link assembly.

### 1.3.22 Nominal size (of lifting component)

Equal to the nominal size of compatible Grade T(80) or Grade V(100) chain complying with AS 2321.

NOTE: Tables A1 and A2 in Appendix A, list compatible chain sizes for lifting components.

### **1.3.23 Self-colour**

A surface finish arising from the essential manufacturing operations, usually being a closely adhering oxide film due to the heat treatment and subsequent handling.

### **1.3.24 Self-locking hook**

Hook containing a locking mechanism, capable of being activated by the action of the load, which, once correctly closed and locked, can only be opened in the unloaded condition by de-activation of the locking mechanism.

### **1.3.25 Shall**

Indicates that a statement is mandatory.

### **1.3.26 Shortening clutch or grab hook**

A lifting component usually attached to the upper end of a sling assembly that is used to reduce the length of a sling leg (see Figure 8.1).

### **1.3.27 Should**

Indicates a recommendation.

### **1.3.28 Size**

The nominal diameter of chain with which the component is designed to be used.

### **1.3.29 Sling**

Assembly consisting of chain, wire rope or textile joined to upper and lower terminal fittings suitable for attaching loads to the hook of a crane or other lifting machine.

### **1.3.30 Traceability code**

Identification marked on a component that enables its manufacturing history to be traced.

### **1.3.31 Upper terminal fitting**

A fitting or other lifting component forming the upper terminal fitting of a chain sling by means of which it is attached to the hook of a crane or other lifting appliance.

### **1.3.32 Upper terminal link**

See master link.

### **1.3.33 Working load limit (WLL)**

The maximum load that is permitted to be applied to the lifting component.

NOTE: The working load limit may be de-rated for particular conditions of use.

## **1.4 COMPETENT PERSON REQUIREMENTS**

### **1.4.1 General**

Competent persons shall be suitably trained, qualified by knowledge and practical experience, and with the necessary instruction to enable the required work to be carried out. They shall be able to detect and evaluate defects and weaknesses that may affect the intended performance of the equipment.

### **1.4.2 Competency standards and procedures**

Competency standards and procedures relating to the role and duties of competent persons shall include the requirements of this Standard. They shall incorporate an established competency-based training course. Documentation of competency standards and procedures shall be maintained.

### 1.4.3 Visual acuity

The competent person shall have satisfactory near and medium range vision. The visual acuity of a competent person shall be tested periodically, with a maximum duration of 2 years between each test, by an optometrist or suitably trained person. The competent person shall be able to demonstrate clear near vision. Near vision acuity (Jaeger No. 1) shall permit reading a minimum of Times Roman 4.5 points vertical height at not less than 300 mm with one or both eyes, either corrected or uncorrected.

NOTE: AS 3978 gives guidance on visual acuity for visual inspections.

## SECTION 2 GENERAL DESIGN, MANUFACTURING AND MECHANICAL PROPERTIES

### 2.1 DESIGN

#### 2.1.1 Articulation

The components shall be such as to ensure articulation so that the force applied is transmitted axially.

#### 2.1.2 Load pin retention device

A satisfactory retention method shall be provided for any load pin, which shall withstand failure of the clevis component under test loading conditions up to the minimum specified break force. The system should not be easily demountable.

Load pin and load-pin retention devices should not protrude beyond the body of the clevis.

### 2.2 MATERIALS AND HEAT TREATMENT

#### 2.2.1 Forgings, links and load pins

##### 2.2.1.1 *Quality of material*

The type of steel shall be selected to be used so that the finished component, when suitably heat-treated, conforms to the mechanical properties specified in this Standard.

##### 2.2.1.2 *Type of steel production*

The steel shall be produced by an electric process or by an oxygen-blown process.

##### 2.2.1.3 *Deoxidation*

The steel shall be fully killed and stabilized against strain age embrittlement. The austenitic grain size shall be 6 or finer.

NOTE: Protection from strain age embrittlement during service can be accomplished by ensuring that the steel contains sufficient aluminium (minimum 0.025%).

##### 2.2.1.4 *Composition and heat treatment*

###### 2.2.1.4.1 *General*

Lifting components shall be of heat-treated steel complying with Tables 2.2.1.4(A), (B) and (C).

Each component shall be hardened from a temperature above the AC3 point and tempered before being subjected to the manufacturing proof force. The tempering temperature shall be determined to ensure that all mechanical properties specified in this Standard are achieved.

Surface hardening shall not be permitted for load-bearing parts of the component.

**TABLE 2.2.1.4(A)**  
**STEEL AND HEAT TREATMENT (Grade T(80) and V(100))**

| 1                      | 2                            | 3                     | 4                                              | 5          | 6      | 7                 |
|------------------------|------------------------------|-----------------------|------------------------------------------------|------------|--------|-------------------|
| Material specification | Steel type                   | Welding of components | Maximum allowable cast analysis of elements, % |            |        | Heat treatment    |
|                        |                              |                       | Carbon                                         | Phosphorus | Sulfur |                   |
| AS 1442<br>AS 1444     | Fully-killed<br>fine-grained | Welded                | 0.30                                           | 0.025      | 0.025  | Harden and temper |
|                        |                              | Non-welded            | 0.45                                           |            |        |                   |

#### 2.2.1.4.2 Grade V(100) requirements

The specified nominal stress at breaking force of this grade is 1000 MPa. Grade V(100) components can be produced by using materials that are suitable for a 200°C or 380°C maximum operating temperatures. Each material has specific minimum alloying element requirements. V200 refers to grade V(100) components that have a maximum operating temperature of 200°C, V400 refers to grade V(100) components that have a maximum operating temperature of 380°C.

- (a) For Grade V(100) welded master links, the steel shall contain nickel and at least one of the other elements in the minimum percentage as per Table 2.2.1.4(B).
- (b) For Grade V(100) components including forged master links, the steel shall contain at least two of the three alloying elements as per Table 2.2.1.4(C).

**TABLE 2.2.1.4(B)**  
**ADDITIONAL REQUIREMENTS FOR GRADE V(100) MASTER LINKS**

| Grade | Nickel (min.) | Chromium (min.), % | Molybdenum (min.), % |
|-------|---------------|--------------------|----------------------|
| V200  | 0.40          | 0.40               | 0.15                 |
| V400  | 0.70          | 0.50               | 0.30                 |

**TABLE 2.2.1.4(C)**  
**ADDITIONAL REQUIREMENTS FOR GRADE V(100) COMPONENTS**

| Grade         | Nickel (min.) | Chromium (min.), % | Molybdenum (min.), % |
|---------------|---------------|--------------------|----------------------|
| V200 and V400 | 0.40          | 0.40               | 0.15                 |

NOTE: Alternative Grade V(100) materials may be used provided:

- (a) The type test requirements, all mechanical properties as well as the fatigue test requirements of this Standard are fully complied with.
- (b) A comparative risk assessment in using the specified material and the alternative material has been completed, which analyses both the interaction of the material with the chain manufacturing process as well as the application of the finished chain during use and no additional risks are identified.

## 2.2.2 Latches

Latches may be forged, cast or pressed metal.

## 2.3 MANUFACTURING METHODS AND WORKMANSHIP

### 2.3.1 Manufacture of forged components

Each forged part of a component shall be forged hot in one piece. Excess metal from the forging operation shall be removed cleanly, leaving the surface free from sharp edges. After heat-treatment, furnace scale shall be removed.

Edges of machined surfaces shall be rounded to eliminate cutting edges and to ensure attainment of mechanical properties of the component.

Welding shall not be used on forged components.

### 2.3.2 Surface finish

The surface finish shall be one of the following:

- (a) Self-colour.

NOTE: See Clause 1.3.23 for the definition of self-colour.

- (b) Painted coating.

- (c) Any other surface finish that does not cause a degradation of the mechanical properties of the finished product.

## 2.4 MECHANICAL PROPERTIES

### 2.4.1 Permanent set

When tested under the conditions specified in Appendix B, each lifting component shall be capable of supporting a force equal to the minimum proof test force specified by the relevant tables in Appendix A, without sustaining any permanent set of more than 1% of its original dimension after the load has been applied and removed. For testing of master links, refer to Clause 5.4.2 for the proof force calculations.

### 2.4.2 Strength

Each lifting component in its finished condition shall be capable of achieving a minimum breaking force of 4 times the working load limit of the matching size Grade T(80) and V(100) chain under the conditions specified in Appendix B.

NOTE: Compliance with the requirements of Clauses 2.4.2 and 2.4.3 can be demonstrated on a lifting component that has previously been loaded to demonstrate compliance with the requirements of Clause 2.4.1.

### 2.4.3 Ductility

#### 2.4.3.1 General

The ductility of lifting components shall be such that, in the event of a lifting component being loaded under the conditions specified in Appendix B, Paragraph B1 until the lifting component meets or exceeds the minimum breaking load, it would not release the load. Any failure shall occur in a ductile manner. The failure should be away from any weld zone. Such a failure for a hook type of lifting component (excluding shortening and grab hooks) should be an opening out of the hook. Shortening hooks and grab hooks shall demonstrate deformation prior to release of the load.

On completion of the static tensile test (see Clause 3.1.3), all links shall show evidence of elongation of not less than 20%.

#### 2.4.3.2 Bend tests for welded links

The ductility of welded links shall be such that each link will pass the bend test for weld links given in Clause 5.5.2.

#### 2.4.3.3 Bend and impact tests for self-locking hooks

The ductility of self-locking hooks shall be such that each self-locking hook will pass the bend and impact tests given in Clauses 7.6.1.2 and 7.6.1.4.

## SECTION 3 TESTING AND VERIFICATION

### 3.1 TYPE TESTING OF MECHANICAL PROPERTIES

#### 3.1.1 General

Compliance of each design with the requirements of Clause 2.4 shall be demonstrated.

NOTE: The test of each design is known as the type test, which determines the adequacy of the design for achieving the required performance.

Each change in manufacturing process, grade of material, design, and size necessitates separate type testing, to demonstrate compliance with the requirements of Clause 2.4.

In addition to type testing, effective quality control necessitates systematic testing of each lot to ensure continuing compliance with the requirements of Clause 2.4.

#### 3.1.2 Test for deformation

A minimum of three samples shall be tested, and each shall sustain the manufacturing proof force specified for the component in Tables A1 and A2, Appendix A. Following the removal of the force, the dimensions shall comply with the manufacturer's specifications. Permanent set shall comply with Clause 2.4.1 after the manufacturing proof force has been applied and removed as described in Clause 3.2.2.

#### 3.1.3 Static tensile test

A minimum of three samples shall be tested and each shall have a breaking force at least equal to the minimum value specified for the component in Tables A1 and A2 of Appendix A, and meet the requirements of Clauses 2.4.2 and 2.4.3.

NOTE: This test may be carried out on the same components subjected to the deformation test.

#### 3.1.4 Bend test

The bend tests for welded links shall be in accordance with Clause 5.5.2.

The bend tests for self-locking hooks shall be in accordance with Clause 7.6.1.2.

#### 3.1.5 Examination for articulation and relative movement

One sample of each design shall be examined for conformity to the requirements of Clauses 2.1 and 2.3.

#### 3.1.6 Fatigue resistance

Components, including load-bearing pins, if used, with a working load limit up to 32 t, shall withstand, without breaking, at least 20 000 cycles of application.

Three samples shall be tested and each shall be able to withstand at least 20 000 cycles of the force range (specified below) without breaking.

The maximum force applied during each cycle shall be equivalent to 1.5 times the working load limit given in Table A1 and A2. The minimum force in each cycle shall be positive and less than or equal to 3 kN. The frequency of force applications shall be not greater than 25 Hz.

#### 3.1.7 Acceptance criteria for type tests

Where all samples pass all the tests, the component of the size submitted for type testing shall be deemed to conform to this Standard.

Where one sample fails, two further samples shall be tested and both shall pass the test. In addition corrective action shall be taken with respect to the failed sample in order for the component of the size submitted for testing to be deemed to conform to this Standard.

Where two or three samples fail the test, the component of the size submitted for type testing shall be deemed not to conform to this Standard.

## **3.2 MANUFACTURING TESTS**

### **3.2.1 Manufacturing examination**

Finished components shall be examined for defects that would render them incapable of conformity to the requirements of Clauses 2.1 and 2.3.

### **3.2.2 Manufacturing proof test**

Components in their finished condition (except they may be painted or unpainted) shall, under the conditions specified in Appendices B and E, be subjected to a proof force at least equal to the manufacturing proof force specified in Tables A1 and A2 of Appendix A. After removal of the force, there shall be no visible defects, and the permanent set shall comply with Clause 2.4.1. For master links, mandrels may be used in lieu of pins as specified in Paragraph B1(b) for the manufacturing proof test only. Refer to Appendix B for test certificate requirements.

### **3.2.3 Non-destructive test**

Where required by Appendix E, the forged surfaces of components, excluding load-bearing pins machined from drawn bar, shall, after heat treatment and de-scaling, be subjected to magnetic particle or dye penetrant testing in accordance with AS 1171 or AS 2062 (or international equivalent). Any such testing shall be undertaken by operators qualified in accordance with AS ISO 9712 (or international equivalent).

Indications greater than 2 mm in length shall not be permitted in areas of the component subjected to tensile stresses, in all foreseeable service conditions.

Where grinding is required to remove such indications then, after grinding, the component shall conform to the dimensions and tolerances specified by the manufacturer. A final examination shall show no indications greater than 2 mm in length.

NOTE: Care should be taken to ensure that the direction and roughness of grinding does not create starting points for fatigue failure and cause excessive heating, which may have a local effect on the heat-treated condition, or may cause cracks.

Load-bearing pins machined from drawn bar shall be tested (e.g. hardness testing or by using magnetic sorting techniques) to demonstrate that they have been satisfactorily heat-treated. They shall be examined following heat treatment and shall be free from visible defects.

### **3.2.4 Non-compliant components**

Components identified as being non-compliant shall be either repaired and retested to ensure they comply with Section 3 or discarded.