

Steel storage racking

Part 2: Operation and maintenance

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Australian Standard®

Steel storage racking

Part 2: Operation and maintenance

Section 1 Scope and general

1.1 Scope

This document sets out minimum requirements for the installation, operation, inspection and maintenance of steel storage racking.

This document covers racking —

- (a) made of cold-formed or hot-rolled steel structural members installed as a free-standing structure within a building; and
- (b) subjected to operational interactions with material handling equipment (MHE) such as industrial trucks.

This document does not cover —

- (i) other types of racking such as drive-in racking, cantilever racking, mobile racking or racking made of materials other than steel; or
- (ii) low-rise shelving-type racking which is loaded and unloaded by hand.

NOTE For guidance on the operation and maintenance of racking systems not covered by this document, refer to EN 15620 and EN 15635.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1319, *Safety signs for the occupational environment*

AS 4068, *Flat pallets for materials handling*

AS 2312.1, *Guide to the protection of structural steel against atmospheric corrosion by use of protective coatings, Part 1: Paint coatings*

AS/NZS 2312.2, *Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings, Part 2: Hot dip galvanizing*

AS 4084.1, *Steel Storage Racking — Design*

1.3 Terms and definitions

For the purposes of this document, the terms and definitions in AS 4084.1 and the following apply.

1.3.1

aisle length

total length of all *bays* (1.3.3) in a continuous run of racking

Section 3 Operational requirements

3.1 General

When working with steel storage racking, the following operational requirements shall be met:

- (a) Racking shall be constructed and installed as specified by the manufacturer.
- (b) The foundation shall be able to resist the loads applied by the storage racking.

NOTE The foundation is usually a concrete floor.
- (c) Safe Working Load (SWL) signs and safe operation and maintenance signs shall be installed in accordance with [Clause 4.2](#).
- (d) The condition of unit loads shall be managed so that operating clearances are maintained in accordance with [Clause 2.3](#).
- (e) Material handling equipment shall be able to operate within the aisle dimensions of the racking application. To minimize the risk of damage, operating procedures and traffic management plans shall conform to AS 2359.2.
- (f) The manufacturer, supplier or competent person shall provide the end user with information on the safe use of the racking, including procedures for the safe storage and retrieval of unit loads.

3.2 Modifications to racking systems

Modifications to racking systems can affect the load carrying capacity and reliability of the operation. To maintain operational viability, a competent person shall be consulted prior to modifications being carried out so that all relevant safety issues are taken into account.

Modifications may be required if any of the following occur:

- (a) Change of type or make of MHE.
- (b) Change in the method of handling unit loads or the pallet type.
- (c) Change in the type of goods handled.
- (d) Change in the weight or size of unit loads.
- (e) Introduction of overhanging loads or load make up accessories.
- (f) Change in the throughput of the storage system.
- (g) Change to racking specifications.

If modifications are carried out, working load limits, safety-related information and SWL signage shall be updated to reflect the current configuration, see [Clause 4.2](#).

Section 4 Signage and documentation

4.1 General

Safe working load (SWL) signs shall clearly display the storage limits for —

- (a) unit loads;
- (b) shelf loads; and
- (c) bay loads.

SWL information is usually conveyed by SWL signs; however, other methods that clearly communicate the relevant information are also acceptable.

Training shall be provided in the interpretation of all signage fitted to the racking.

NOTE Deviations to racking configurations may require alterations to signs, operational procedures and refresher training for operators.

4.2 Signage

4.2.1 Safe working load signs

SWL signs shall be positioned in one or more conspicuous locations on or adjacent to the storage equipment. Signs shall be mechanically secured to the racking structure approximately 2 m above floor level.

The signs shall be permanent, corrosion-resistant and sized not less than A3. Signs shall be indelibly printed using UV stable materials. The colours and symbols used on the sign shall conform to AS 1319. Maximum load action figures shall be in a font at least 20 mm in height.

SWL signs shall display the following information:

- (a) Permissible working unit load limit.
- (b) Permissible total working unit load limit for each pallet beam level.
- (c) Permissible total working unit load limit for each bay.
NOTE Permissible working load is determined as the unfactored working load inclusive of pallet weight.
- (d) Maximum distance from base plate level to the first beam level and the maximum distance between first and second beam levels.
- (e) Installation tolerance grade of the rack, see [Table 2.2\(B\)](#).
- (f) Racking manufacturer's name.
- (g) Supplier's name.
- (h) Company responsible for the structural design of the rack.
- (i) Installation date.
- (j) Customer's name.

If clarification of SWL signage is required, a competent person should be consulted.

Signage shall at all times reflect the current configuration. Any modifications to the storage equipment shall require amendment of SWL signage by a competent person.

NOTE An example of SWL signage is shown in [Figure 4.2.1](#).

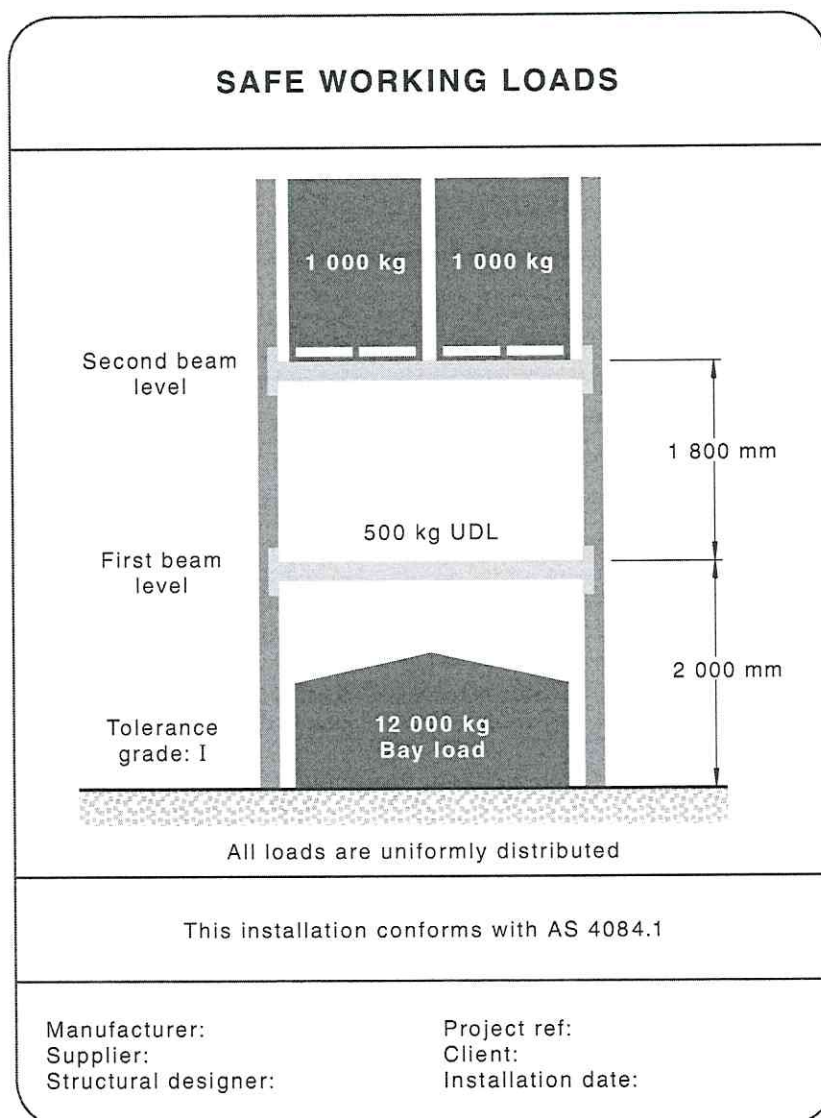


Figure 4.2.1 — SWL sign for racking with two unit loads per pair of beams

4.2.2 Operation and maintenance signs

Operation and maintenance signs shall display the following messages:

- No climbing on racking.
- Do not alter the racking structure without checking with the racking designer or a competent person.
- Report all damage.
- Carry out inspections to check for correct application and use of racking, adherence to safe working loads, and impact damage.

- (e) Ensure that correct clearances are maintained between racking and stored unit loads.
- (f) Do not use tools to modify the structure without checking with the racking designer or a competent person.
- (g) Ensure that the product is secured to the pallet.
- (h) Instruct operators on correct use of unit load handling equipment.
- (i) If in doubt, always contact the supplier, manufacturer, racking designer or competent person.

Signage shall be legible and use commonly recognized symbols as specified in AS 1319.

4.3 Documentation

The following documentation shall be provided:

- (a) Load application, racking configuration drawings and specifications shall be provided with each racking installation. Drawings shall include a notice to caution the end user that any deviation from the drawings may impair the safety of the racking installation.

NOTE If the rack has been designed for seismic or wind loads then the basis of the design should be indicated on the drawings.
- (b) If the racking is required to be used in more than one configuration, structural drawings shall include each required configuration.
- (c) If the maximum extent of frame damage assumed in the design differs from that in Clause 5.3, then values for maximum damage shall be specified in the drawings and specification.

Section 5 Inspections and maintenance

5.1 General

5.1.1 Documentation

Documentation relating to inspection and maintenance shall be provided by the manufacturer, supplier or a competent person. It shall include inspection requirements, damage reports, and steps to be taken when damage occurs.

The ongoing safety of the storage equipment shall be the responsibility of the end user.

5.1.2 Working load limits

The unit load limit per storage level and the total unit load limit per bay for the racking installation shall not be exceeded. The permissible unit load limit and permissible bay load limit shall be displayed in accordance with Clause 4.2.

5.1.3 Specific applications and use of racking

Racking in external environments shall comprise components which are either hot-dip galvanised or manufactured from pre-galvanised coil. If powder-coated racking is installed externally, the frequency of formal inspections shall be increased in order to monitor the degradation in the protective coating over time.

Racking shall be installed on a concrete floor.

Installation on alternate substrates such as asphalt should not be undertaken without an engineering assessment of the foundation properties and the applied loads from the racking.

Fall protection such as netting and mesh shall be installed where there is potential for product stored at height in the racking to fall onto pedestrians. Such protection should form part of the overall design of the racking system.

Components to minimize accidental damage such as upright protectors and rack-end protectors should be installed to protect the racking system. Such components shall be designed in accordance with AS 4084.1.

5.2 Inspections

5.2.1 General

Inspections of racking and unit loads shall be conducted to check that racking is being used as specified and damage is being reported and rectified.

Inspections, reports and repairs relating to racking shall be documented and retained by the end user until the racking is removed from service.

Damage incurred, however minor, shall be reported and documented immediately to enable the effect on safety to be immediately assessed.

Hazardous situations involving the operation or maintenance of the racking installation shall be reported, actioned and documented immediately.

5.2.2 Informal inspections

Informal inspections are the responsibility of the end user.

NOTE The end user may nominate a person to conduct these inspections.

Informal inspections should be conducted at a frequency based on —

- (a) the results of a risk assessment (e.g. daily or weekly); or
- (b) at intervals recommended by a competent person.

Informal inspections are predominantly conducted visually from ground level with the aid of simple gauges and measuring tools.

Informal inspections should be conducted using the checklist given in [Clause 5.2.4](#).

5.2.3 Formal inspections

Formal inspections shall be conducted by a competent person.

Formal inspections shall be conducted at intervals not exceeding 12 months.

The actual frequency of such inspections, if less than 12 months, should be based on —

- (a) the results of a risk assessment; or
- (b) the recommendation of a competent person for formal inspections.

Formal inspections of racking systems that are under 8 m in height may be conducted visually from ground level.

Formal inspections of racking systems above 8 m in height should be conducted using systems and equipment such as elevating work platforms or other ground-based technologies.

Formal inspections shall be conducted using the checklist given in [Clause 5.2.4](#).

The results of the formal inspection shall be documented and include observations and proposals for any corrective action.

5.2.4 Inspection checklist

Inspections, both formal and informal, shall —

- (a) determine if storage equipment is being applied and used as specified;
- (b) determine if working load limits for unit and bay loads are current and being adhered to;
- (c) determine if unit loads adhere to specified dimensions such that operating clearances are maintained as specified;
- (d) determine if unit loads are stable;
- (e) determine if the racking installation has been modified using the information specified on the load sign or configuration drawings held on site;
- (f) check that all signage is current, legible and free from damage and obstruction.
- (g) determine if all racking components including, frames, beams, floor fixings, bracing and ancillary devices are consistent with the design;
- (h) assess for damage to racking uprights, beams, baseplates and frame bracing caused by impact, see [Clause 5.3](#);
- (i) check for out-of-plumb (non-vertical) racking uprights in both the cross-aisle and down-aisle directions;
- (j) check for absence of pallet beam safety locks and for disengagement of beam connectors from racking uprights;

- (k) examine beam connectors for deformation or signs of weld cracking;
- (l) identify any corrosion of racking components, see [Clause 5.3.9](#);
NOTE Components include upright frames, beams, beam connectors, safety clips (beam clips), frame, plan and spine bracing, base plates and floor fixings.
- (m) inspect base plates and floor fixings;
- (n) examine the floor condition, checking for signs of deformation, out of level and cracks; and
- (o) check that racking is —
 - (i) not attached to a building; or
 - (ii) if attached to a building, has approval for such attachment from a structural engineer.

5.3 Racking damage

5.3.1 General

Racking damage from impact, usage or the environment as determined from informal and formal inspections shall be assessed in accordance with [Clauses 5.3.2 to 5.3.9](#). The extent of impact damage shall be classified in accordance with [Clause 5.5](#).

5.3.2 Uprights

Damage to uprights producing an overall bend shall not exceed 3 mm in the cross-aisle direction and 5 mm in the down-aisle direction when assessed over 1 m, as shown in [Figure 5.3.2](#).

NOTE 1 Localized bends over a length of less than 1 m may be judged pro-rata to the 1 m limits.

Damage to uprights producing an overall twist, as viewed from directly above the upright member, should not exceed 6°.

NOTE 2 Each 6° of twist is represented by one minute on a virtual analogue clock.

Uprights should not exhibit localized dents, cracks or splits that exceed limits provided by the OEM or a competent person. The advice of a competent person should be sought to determine whether affected uprights should be unloaded.

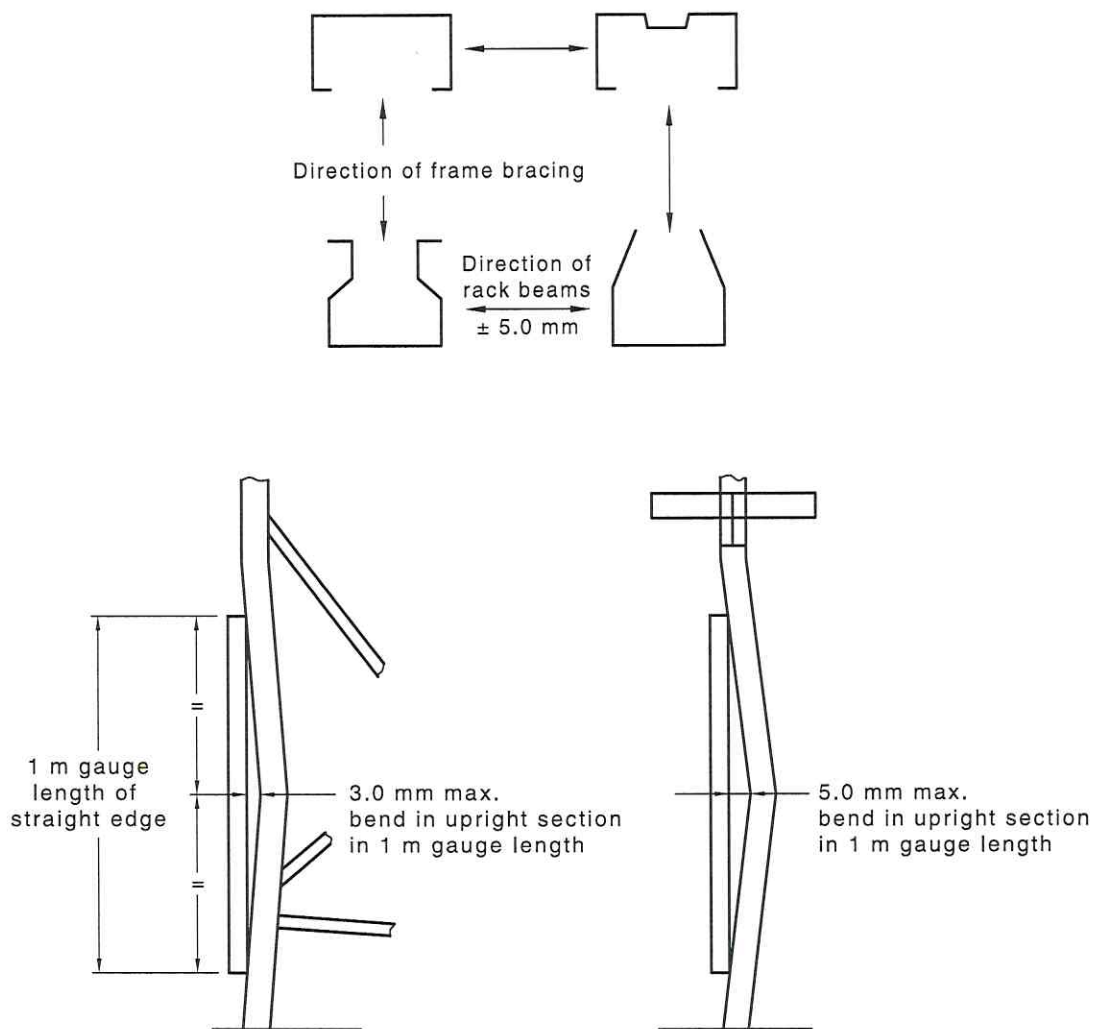


Figure 5.3.2 — Measurement of deformation in uprights

5.3.3 Frame bracing

For frame bracing, the member deviation from a 1 m long straight edge in either plane shall not exceed 10 mm.

NOTE For bracing members less than 1 m in length, damage may be assessed on a pro-rata basis.

Frame bracing should not exhibit localized dents, cracks or splits that exceed limits provided by the OEM or a competent person. A competent person should determine whether affected frames should be unloaded.

5.3.4 Beams

The residual, vertical deformation when unloaded shall not exceed 20 % of the allowed vertical deflection under serviceability loads in accordance with AS 4084.1.

The residual, horizontal deformation measured at the top or bottom edge of the beam shall not exceed 50 % of the allowed vertical deflection under serviceability loads. If these limits are exceeded, the beam shall be unloaded and advice sought from a competent person.

Beams should not exhibit localized dents, cracks or splits that exceed limits provided by the OEM or a competent person. A competent person should determine whether affected beams should be unloaded.

5.3.5 Connectors

Connectors shall not show visible permanent deformation or signs of cracking of welds. Damage of this type requires that the beam shall be unloaded and advice sought from a competent person.

5.3.6 Connector safety locks

The presence of correctly matched and fitted beam locking devices shall be checked for during inspection, maintenance and repair. Missing, damaged, dislodged or ill-fitting beam locking devices shall be correctly installed or replaced immediately to prevent accidental dislodgement of beams. A supply of compatible and OEM-approved locking devices shall be stored on site.

5.3.7 Floor fixings

Damage to floor fixings or cracks to the concrete adjacent to the floor fixing shall be documented and advice sought from a competent person. For racking serviced by manually operated mechanical equipment, there shall be a minimum of two undamaged floor fixings per baseplate.

5.3.8 Out-of-plumb racking

Unloaded racking that is out-of-plumb due to impact or the installation not conforming to this document shall not exceed the finished tolerances given in [Table 2.2\(A\)](#), factored by 1.5. When this limit is exceeded, advice shall be sought from a competent person.

5.3.9 Corrosion

Visual inspections of corrosion should use [Figure 5.3.9](#) as a rating guide. Corrosion to racking components should be assessed in accordance with AS 2312.1 and AS/NZS 2312.2 using a tool such as an ultrasonic thickness gauge. Increasing corrosion levels on successive yearly inspections may indicate failure of the coating. If there is doubt about the safety of the system, the advice of a competent person should be sought.

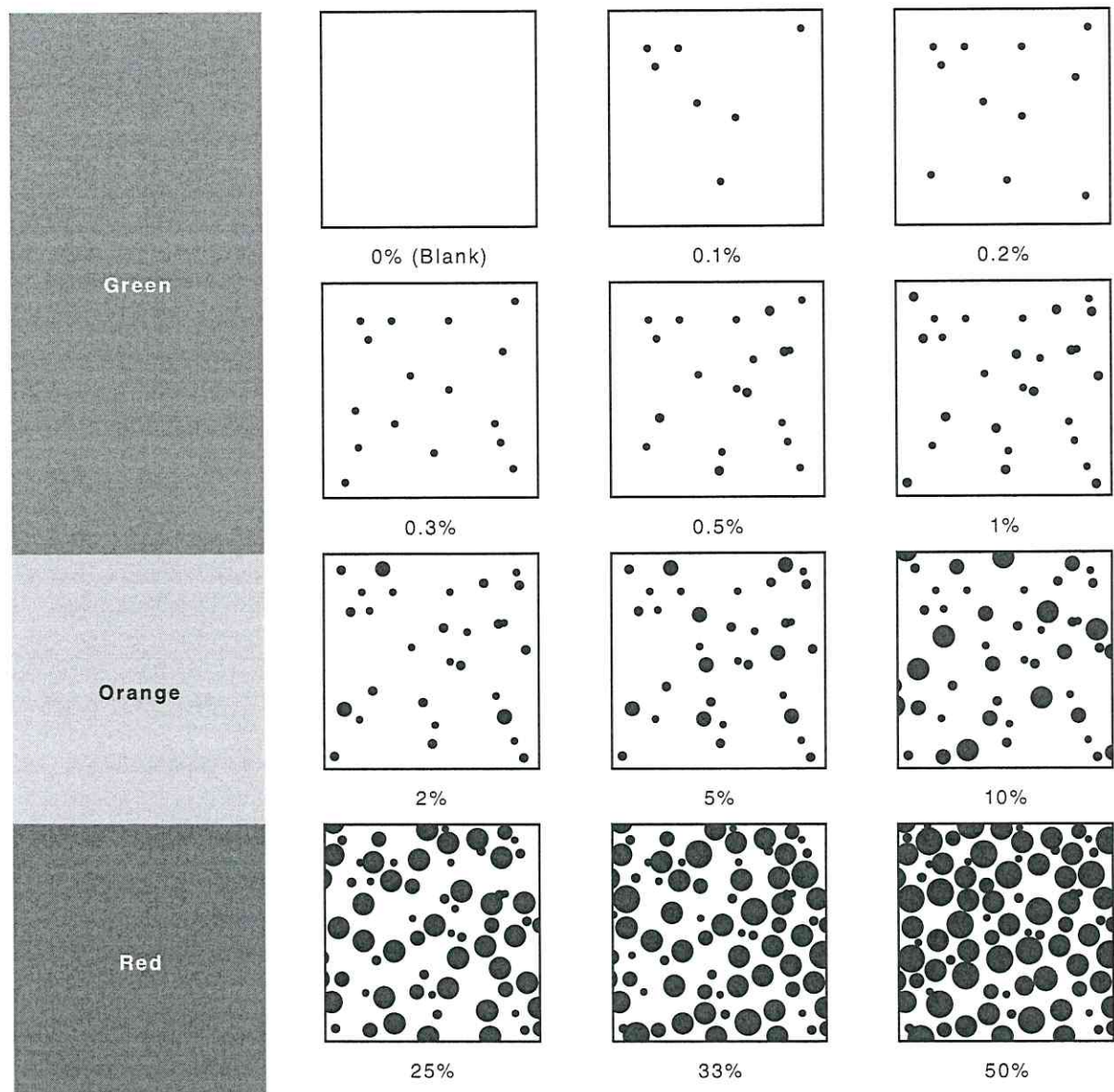


Figure 5.3.9 — Schematic examples for estimating rust percentages

5.4 Unit loads

Unit loads shall meet the following requirements:

- (a) All pallets shall be maintained in accordance with AS 4068. Pallets shall be placed onto pallet beams using the method defined by a competent person.
- (b) All goods stored on each pallet shall be safely stacked and stable;
- (c) Double-stacking of any pallet position shall not be undertaken, including the top-most position, unless the rack system is specifically designed for such loading. The pallet loads themselves shall also be suitable for double-stacking and secured to prevent accidental dislodgement.
- (d) Unit load dimensions (width, height, depth) shall be maintained as specified.

- (e) Unit load clearances shall be as specified in Clause 2.3 —
 - (A) in the down-aisle direction;
 - (B) in the across-aisle direction; and
 - (C) between units stored on a pallet beam pair.

5.5 Damage classification

5.5.1 General

Damage to racking shall be classified in an escalating hierarchical colour coding system designated by “green”, “amber” and “red” levels of severity (risk). Damage categorised as “green” is deemed acceptable, “amber” is deemed hazardous, and “red” is deemed very serious.

NOTE See Figure 5.5.4 for a visual representation of the damage classification procedure.

This assessment methodology applies only to damage that produces an overall permanent bend or twist in a member specified in Clauses 5.3.2 to 5.3.4. These limits do not apply to highly localized damage such as dents, buckles, cracks, tears and splits. Components subjected to such localized damage shall be immediately unloaded and replaced unless the advice of a competent person indicates otherwise.

NOTE For information on inspection processes or damage classification for equipment outside the scope of this document, refer to the European Materials Handling Federation, the Rack Manufacturers Institute and ANSI MH16.1.

5.5.2 Acceptable damage — “green” level

When the level of damage does not exceed the permissible limits specified in Clauses 5.3.2 to 5.3.4, the racking shall be deemed serviceable and will not require either unit load reduction or immediate unloading.

Damage shall be recorded on the damaged components to indicate that these components have been inspected and the racking is suitable for service until the next inspection when the components will be re-inspected and re-assessed, see Clause 5.2.

NOTE To indicate that racking or components are suitable for service until re-examined at future inspections, dated coloured adhesive labels may be used.

Exceeding the “green” risk level shall be considered hazardous or very serious and causes risk to the stability of the racking system.

5.5.3 Hazardous damage — “amber” level

When the level of damage exceeds the permissible limits specified in Clauses 5.3.2 to 5.3.4 by a factor between 1 and 2, it is designated “amber” risk level.

The damaged section shall be —

- (a) clearly identified;
- (b) unloaded as soon as practicable;
- (c) isolated; and
- (d) not reloaded until the necessary repairs have been carried out and the equipment assessed as safe for use.

NOTE To indicate that the racking is not to be reloaded, dated coloured adhesive labels may be used.

If repairs cannot be carried out within 30 days, the level of damage shall be escalated to “red” risk (very serious damage) level.

5.5.4 Very serious damage — “red” level

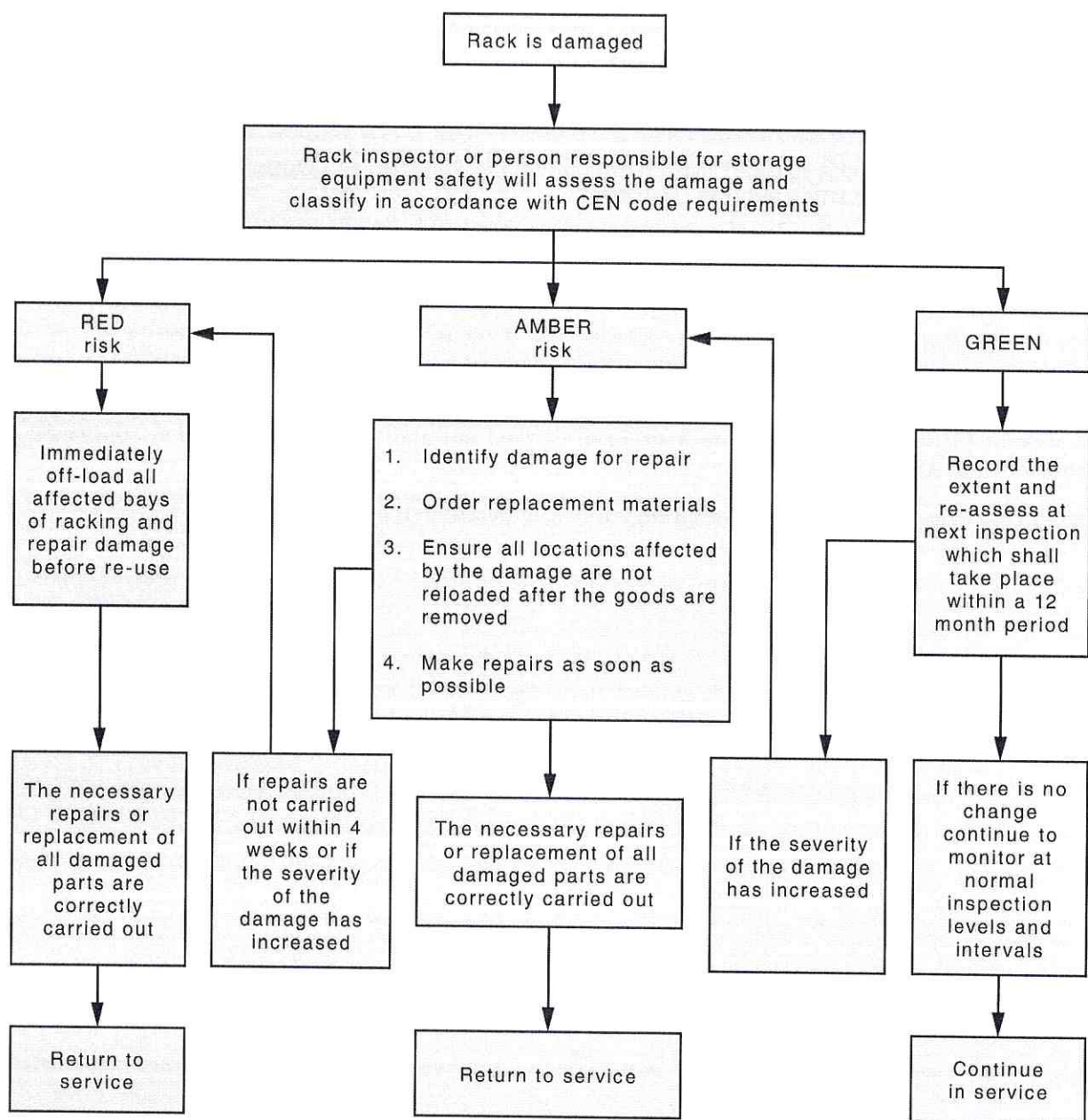
When the level of damage exceeds the permissible limits specified in Clauses 5.3.2 to 5.3.4 by more than a factor of 2, it is designated “red” risk level.

The damaged section and any relevant adjacent sections shall be —

- (a) clearly identified;
- (b) immediately unloaded; and
- (c) isolated

to prevent further use until repairs have been carried out and the damaged section confirmed as conforming to AS 4084.1.

Repairs shall be carried out in consultation with a competent person.



[SOURCE: © CEN, EN 15635:2008 Figure 15 © CEN, reproduced with permission]

Figure 5.5.4 — Flowchart of procedure for damage classification

5.6 Modifications and repairs

5.6.1 General

Racking systems are highly engineered, thin-walled storage systems requiring specialized installation and repair teams. Only a competent person shall undertake such repairs.

5.6.2 Modifications

Racking components shall not be modified without the approval of a competent person.

NOTE 1 Modifications may include physical alterations to uprights, bracing or pallet beams including the welding of additional connectors, bearers or other non-original components.

NOTE 2 Where the manufacturer or supplier is no longer operating and unable to approve the modification, modifications should be carried out by an alternative competent person.

Details of any modifications shall be documented in operating procedures, signs and drawings.

The nature of the load transfer between unit loads and the immediate supporting elements (e.g. uniformly distributed actions or concentrated actions) shall be incorporated in the design of racking modifications.

5.6.3 Repairs

5.6.3.1 Uprights

WARNING — Repairs or alterations to racking uprights are inherently dangerous given their load carrying function.

Where racking uprights have been repaired by splicing, the spliced racking materials shall be installed in accordance with the manufacturer's specifications.

NOTE Where the manufacturer or supplier is no longer operating and unable to approve the modification, modifications should be carried out by an alternative competent person.

There should be at least one beam level above and below the splice. The grade of upright used above the splice should be not less than the grade of upright below the splice. Splices should not be usually positioned at a height less than 1 800 mm.

The following repairs may alter the structural integrity of racking and shall not be permitted:

- (a) Repair of a damaged profile that has experienced impact damage resulting in permanent deformation.
- (b) Use of a splice kit to strengthen a member where damage to the profile has occurred without approval from a competent person.
- (c) Use of any components that are added to the upright to realign it.

If such repairs are identified during inspection, the affected uprights shall be immediately unloaded and advice sought from a competent person.

5.6.3.2 Beams

WARNING — Repairs or alterations to beams are inherently dangerous given their load carrying function.

The following repairs shall not be permitted:

- (a) Welds to any area of the beam.
- (b) Elements added to the beam to straighten or repair impact damage.

If such repairs are identified during an inspection, the affected beams shall be unloaded immediately and advice sought from a competent person.

5.6.3.3 Bracing

WARNING — Repairs or alterations to bracing are inherently dangerous given their load carrying function.

The following repairs shall not be permitted:

- (a) Welds or cuts in a bracing element.
- (b) Modification to the bracing pattern.

If such repairs are identified during inspection, the affected frames shall be unloaded immediately and advice sought from a competent person.

5.6.4 Non-original equipment manufacturer components in racking systems

The integrity of a racking system relies on the performance of its constituent components, the alteration of which can have a significant impact on the load carrying capacity of the entire system.

The use of non-original equipment manufacturer (OEM) components in a racking system can have undesirable and unintended consequences including —

- (a) poor fitment of pallet beams into uprights;
- (b) variations in the load carrying characteristics; and
- (c) subtle variation in frame dimensions and layout.

Non-OEM components shall not be installed in a racking system unless one of the following conditions has been met:

- (i) Confirmation from both the OEM and the provider of the non-OEM part that mixing is permissible.
- (ii) Testing documentation or calculations confirming that non-OEM components will operate within the design parameters specified by the OEM.

If the addition or mixing of non-OEM equipment is not approved by the OEM, a competent person shall designate the risk category for that application. Competent persons who conduct inspections shall document the OEM-designated risk category in their report and any recommended actions.