
**Road vehicles — Wheels and rims —
Use, general maintenance and safety
requirements and out-of-service
conditions**

*Véhicules routiers — Roues et jantes — Exigences en matière
d'utilisation, de maintenance générale et de sécurité, et conditions de
mise hors service*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 33, *Vehicle dynamics and chassis components*.

This second edition cancels and replaces the first edition (ISO 14400:2005), which has been technically revised.

The main changes are as follows:

- added off-road vehicles to the scope since the sections apply equally to that as well as road vehicles.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The purpose of this document is to ensure the safe operation of vehicles. The wheel is a highly stressed component of the vehicle that in service may be subject to extreme forces. Therefore, it is absolutely necessary to handle these parts with care and to pay particular attention to their mounting, removal and maintenance in order to ensure safe operations and to prevent servicing accidents.

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Road vehicles — Wheels and rims — Use, general maintenance and safety requirements and out-of-service conditions

1 Scope

This document specifies requirements for the use, general maintenance and safety of wheels and rims including multi-piece wheels and rims. This document defines their out-of-service conditions, such as cracked, worn and bent wheels and rim components. It is applicable to wheels intended for use on road as defined in ISO 3833 and off road vehicles. This document does not include mopeds and motorcycles.

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. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3911, *Wheels and rims for pneumatic tyres — Vocabulary, designation and marking*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3911 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Use and general maintenance requirements

WARNING — On multi-piece rims, the use of the wrong ring components can result in catastrophic wheel failure.

4.1 Wheel and wheel components

Wheels or parts of wheels which cannot be identified shall not be used even if they seem to have the correct functions and the identical dimensions. The characteristics of the wheel centre shall correspond exactly to vehicle parts, especially the axle hub and the brake, in order to guarantee a proper fitting and an effective load transmission.

A neutral non-aggressive mounting paste or liquid shall be used to lubricate the tyre beads. The hub, studs, nuts and the wheel attachment face shall be carefully cleaned. In the case of multi-piece wheels, all contact surfaces shall be cleaned.

Inspect parts for out-of-service conditions, see [Clause 6](#). If cleaning does not restore the original condition for the mating surfaces or if the parts have any of the conditions described in [Clause 6](#), the parts shall be replaced.

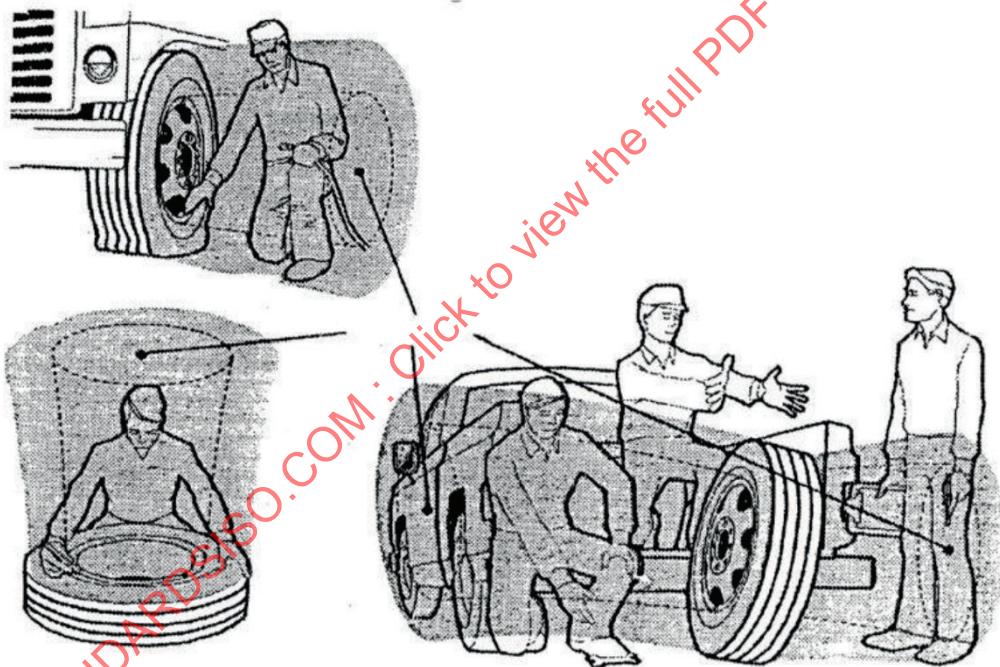
4.2 Wheel mounting and removal

Mounting and removal of wheels shall be carried out by trained personnel only. Only the correct tools shall be used to carry out the various operations.

On multi-piece rims, prior to inflation of the tyre, the correct positioning of the lock ring, the loose flange ring and rubber O-rings, or sealing rings if applicable, shall be carefully checked, always avoiding any correction by means of a hammer. In the case of incorrect positioning, all the air shall be let out of the tyre and the whole mounting procedure repeated.

When inflating tyres, the wheel shall be placed in a safety cage or else safety chains shall be put round the wheel. The operator shall not stay in the near dangerous areas or trajectories. **Trajectory** means any potential path or route that a rim wheel component can travel during an explosive separation, or the sudden release of the pressurized air, or an area at which an airblast from a single piece rim wheel can be released. Examples of such trajectories are shown by shaded areas in [Figure 1](#). The correct air pressure specified for the tyre shall be maintained and regular checks shall be made; otherwise, damage to tyre and/or wheel rim can occur.

Where multi-piece rims and divided (bolted) type wheels are involved, for safety reasons the tyres shall be fully deflated before the unbolting of the wheel and tyre assembly from the vehicle axle is started. This safety requirement applies to both tyres in a dual wheel application.



NOTE Under some circumstances, the trajectory can deviate from its expected path.

Figure 1 — Trajectories

4.3 Studs and nuts

All mounting parts such as studs and nuts (with flat captive washer or with spherical or conical seats) shall fit exactly to the wheel being mounted.

NOTE Any incorrect interchangeability or confusion can cause the wheel centre to fail.

Studs and nuts of all wheels shall be fastened, preferably using a torque wrench or in any case by means of a suitable tool capable of reaching the torque value specified by the vehicle manufacturer. The sequence is across and not round the wheel centre. The exact sequence shall conform to that given in the manual of the vehicle manufacturer.

On the new vehicle and always after a wheel replacement, the mounting torque shall be verified after approximately 50 km of running and, where necessary, the wheel nuts shall be retightened. Periodic checks should also be carried out.

5 General safety requirements

After removal, wheels, rims, studs and nuts shall be checked closely to ensure that they are in good condition: namely that any fracture, crack, deformation, corrosion, heavy wear or other kind of non-conformity are not present.

Moreover, no technical modification on the wheel shall be made. Repair by means of welding or by the addition of material on rims or wheel centres having breakage, fissures, cracks or high wears, shall not be made, as they can introduce additional stresses in the critical areas.

NOTE Further detailed information regarding safety recommendations can be found in the technical catalogues of the wheel and/or vehicle manufacturers.

6 Out-of-service conditions

Typical out-of-service conditions of wheels, rims and components are shown in the following tables and figures. The conditions of wheel centres are shown in [Table 1](#) and [Figures 2 to 14](#), and the conditions of rims and components are shown in [Table 2](#) and [Figures 15 to 29](#).

Before checking, wheels shall be cleaned of mud and dirt.

Wheels, rims and components in such conditions shall be removed from service and discarded. Rubber components (valves, sealing rings and O-rings) with excessive ageing, brittleness or cracks shall be removed from service and discarded.

Table 1 — Typical out-of-service conditions of wheel centres

Type	Appearance	Probable cause	See Figure
Crack	Bolt-hole cracks	<ul style="list-style-type: none"> — Insufficient tightening torque, loose nut — Improper installation procedure — Use of improper bolt/nut — Mounting surface not flat — Excessive load — Damaged or worn nut seat — Inequality of tightening torque between the nuts 	2
	Bolt-hole-to-bolt-hole cracks	<ul style="list-style-type: none"> — Insufficient tightening torque — Insufficient attachment face [hub] backup — Improper installation procedure — Mounting surface or attachment face [hub] not flat — Use of improper bolt/nut — Worn mounting surface/attachment face [hub] — Excessive load 	3

Table 1 (continued)

Type	Appearance	Probable cause	See Figure
	Bolt-hole-to-centre-hole cracks	<ul style="list-style-type: none"> — Insufficient tightening torque — Foreign material between mounting surface and attachment face [hub] which prevents flush contact 	4
	Bolt-hole-to-hand-hole cracks	<ul style="list-style-type: none"> — Excessive load 	5
	Hand-hole cracks	<ul style="list-style-type: none"> — Excessive load — Dent, bruise, sharp edge around hand hole 	6
	Circumferential cracks on mounting area of hub-piloted wheels	<ul style="list-style-type: none"> — Excessive load — Use of improper bolt/nut — Insufficient attachment face [hub] backup — Worn or damaged nut — Improper tightening torque 	7
	Cracks at stamp	<ul style="list-style-type: none"> — Excessive stamping depth — Excessive load 	8
	Disc-hat cracks	<ul style="list-style-type: none"> — Excessive load 	9
Deformation	Elongated bolt holes	<ul style="list-style-type: none"> — Loose or worn nut — Insufficient tightening torque — Excessive dirt or nut — Excessive paint buildup — Excessive tightening torque — Broken hardware 	10
	Distorted nut seat	<ul style="list-style-type: none"> — Loose inner nut — Use of improper or worn bolt/nut — Excessive tightening torque of inner nut — Improper installation procedure 	11
	Burrs around bolt holes	<ul style="list-style-type: none"> — Excessive tightening torque — Use of improper bolt/nut 	12
Wear / corrosion	Worn nut seat	<ul style="list-style-type: none"> — Excessive tightening torque — Rust — Improper inner nut contour 	13
	Excessive wear/corrosion of wheel attachment face	<ul style="list-style-type: none"> — Insufficient attachment face [hub] backup — Worn attachment face [hub] — Improper installation procedure 	14

Table 2 — Typical out-of-service conditions of rims and components

Type	Appearance	Probable cause	See Figure
Crack	Circumferential cracks in rim well	— Excessive load, excessive air pressure — Corrosion from excessive airline moisture or improper tyre mounting lubricants, etc.	15
	Valve-aperture cracks	— Excessive load, excessive air pressure — Improper finish of rim hole — Corrosion	16
	Butt-weld cracks	— Excessive load — Improper welding	17
	Bead-seat cracks	— Excessive load, excessive air pressure — Improper matching of tyre and rim — Tyre tool damage — Tyre bead not fully seated against flange	18
	Rim-gutter cracks	— Excessive load, excessive air pressure — Tyre tool damage — Dent by hammer — Excessive corrosion — Improper trimming of flash butt weld — Mismatch of rim and side ring — Improper tyre mounting	19
	Disc-to-rim weld cracks	— Excessive load, excessive air pressure — Improper welding	20
	Side-ring cracks	— Excessive load, excessive air pressure — Bent side ring — Excessive corrosion — Tyre tool damage — Damaged or distorted rim gutter area — Mismatch of rim and side ring — Use of mismatched tyre — Improper installation procedure of side ring	21

Table 2 (continued)

Type	Appearance	Probable cause	See Figure
	Lock-ring cracks	<ul style="list-style-type: none"> — Excessive load, excessive air pressure — Bent lock ring — Excessive corrosion — Tyre tool damage — Damaged or distorted rim gutter area — Use of mismatched lock ring — Improper installation procedure of lock ring 	22
Deformation	Bent rim flanges	<ul style="list-style-type: none"> — Impact from kerbs, holes, or road hazards — Abuse in tyre mounting or demounting 	23
	Distorted bead seat	<ul style="list-style-type: none"> — Impact damage — Run-flat running — Improper tyre installation procedure — Shipping damage 	24
	Distorted side ring	<ul style="list-style-type: none"> — Improper installation/removal of side ring — Impact damage 	25
	Excessive run-out	<ul style="list-style-type: none"> — Impact damage — Run-flat running — Improper installation procedure — Shipping damage 	26
	Burrs	<ul style="list-style-type: none"> — Tyre tool damage 	27
Wear/ corrosion	Rim flange wear	<ul style="list-style-type: none"> — Tyre chafing — Insufficient air pressure — Excessive load 	28
	Excessive corrosion on tyre side of rim and gutter area	<ul style="list-style-type: none"> — Excessive air line moisture — Improper tyre mounting lubricants — Accumulation of water, mud and salt in gutter area 	29

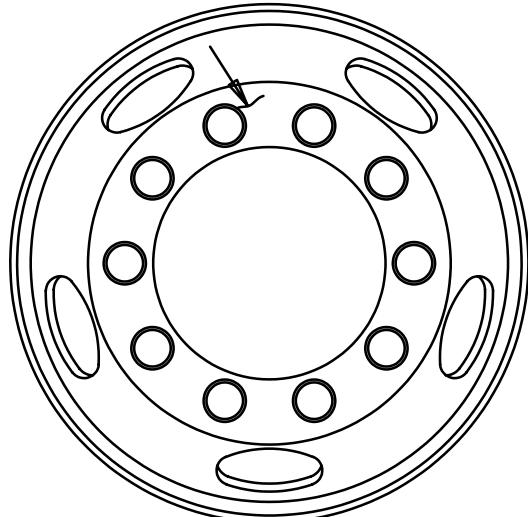


Figure 2 — Bolt-hole cracks

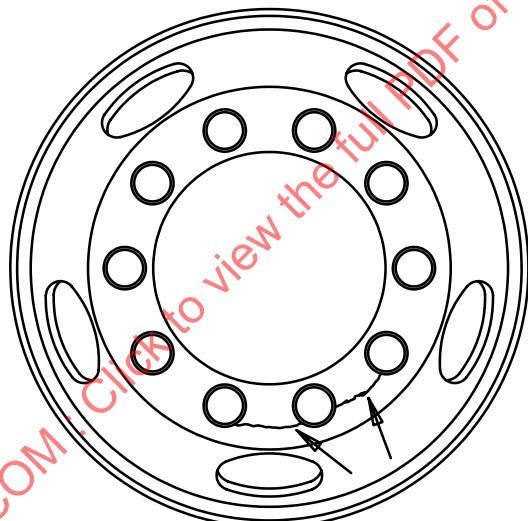


Figure 3 — Bolt-hole-to-bolt-hole crack

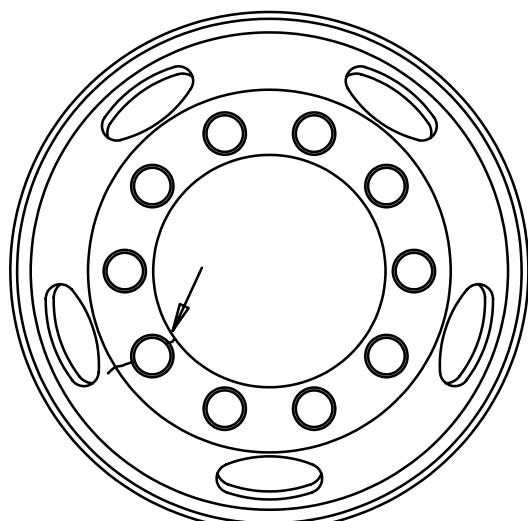


Figure 4 — Bolt-hole-to-centre-hole cracks

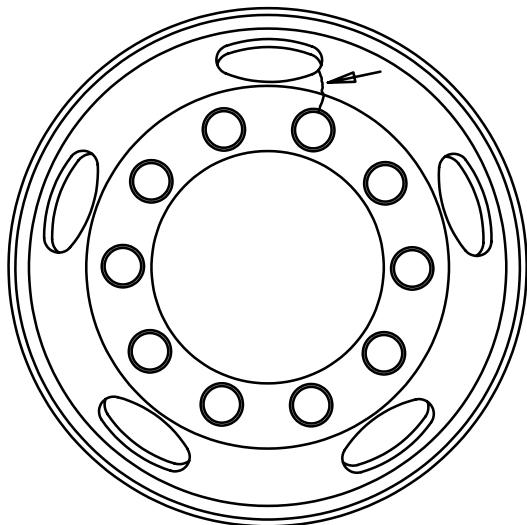


Figure 5 — Bolt-hole-to-hand-hole cracks

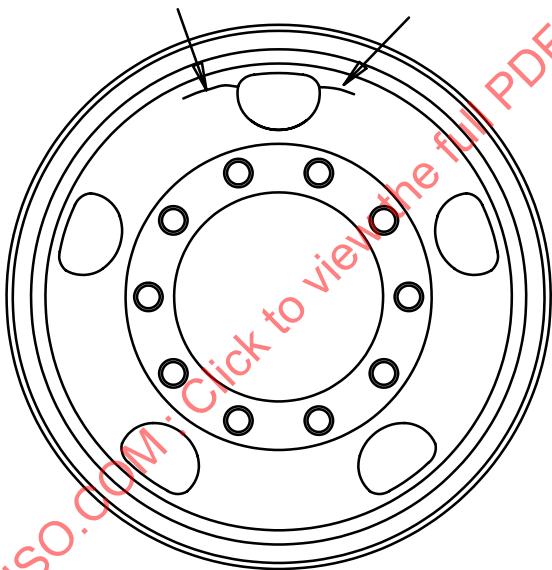


Figure 6 — Hand-hole cracks

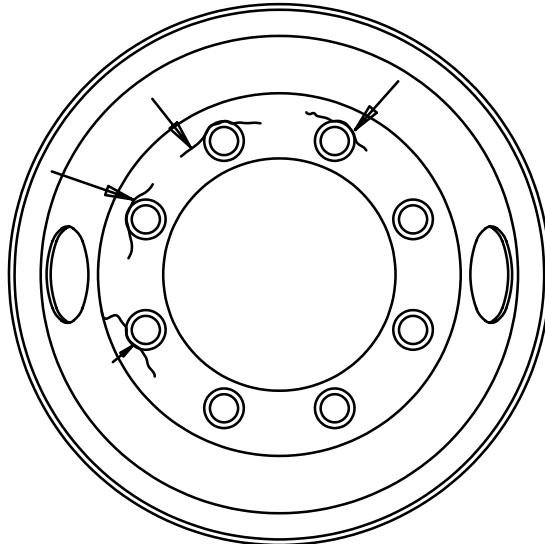


Figure 7 — Circumferential cracks on mounting area of hub-piloted wheels

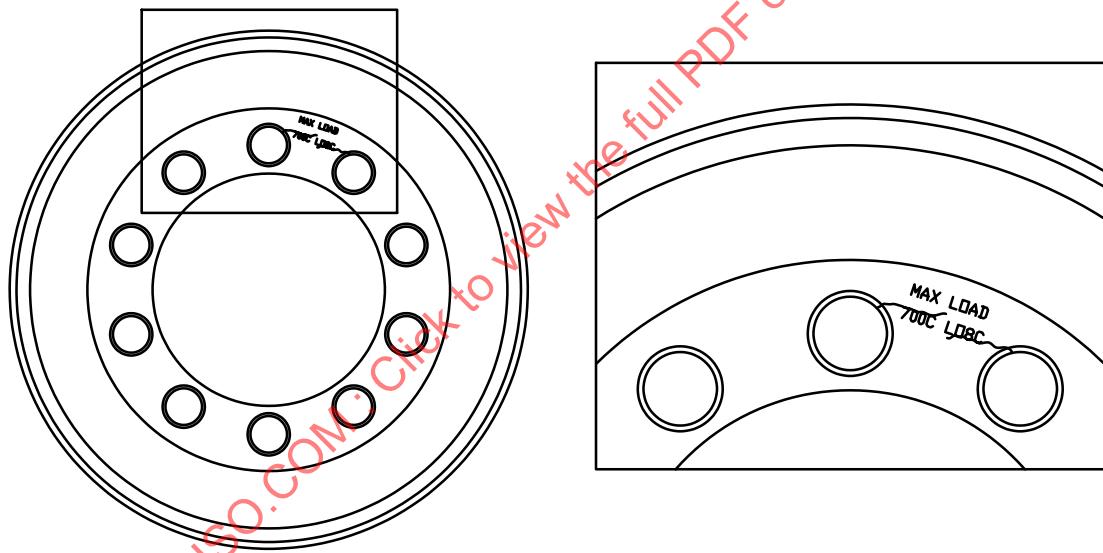


Figure 8 — Crack at stamp

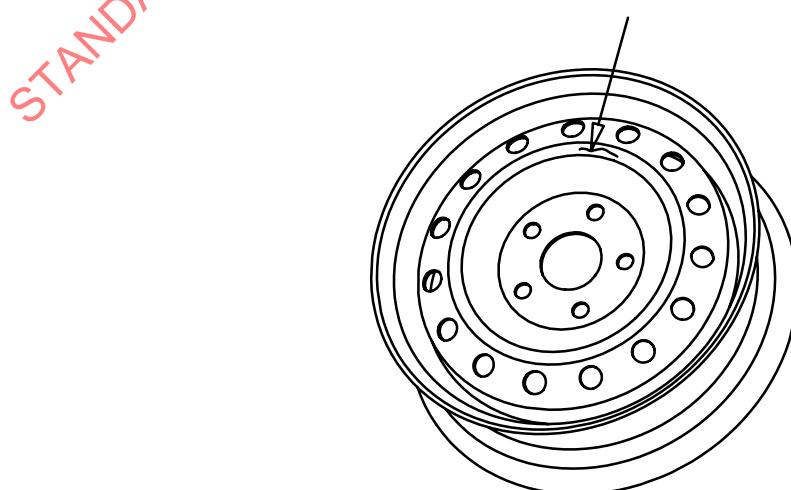


Figure 9 — Disc-hat cracks

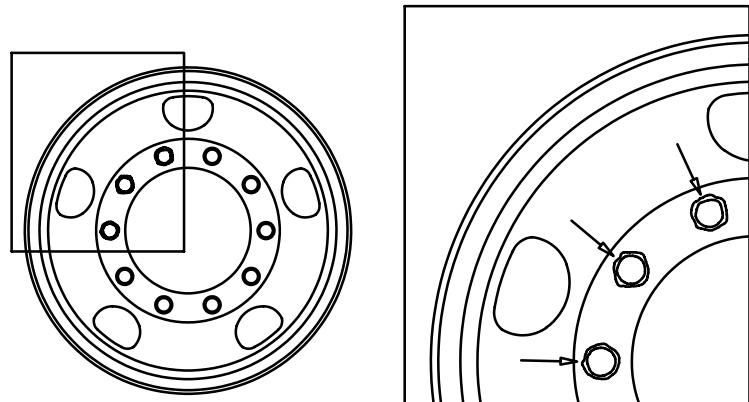
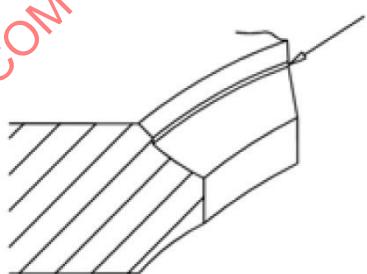
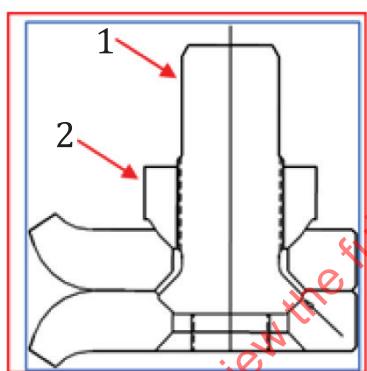


Figure 10 — Elongated bolt holes



Key

- 1 inner nut
- 2 outer nut

Figure 11 — Distort nut seat

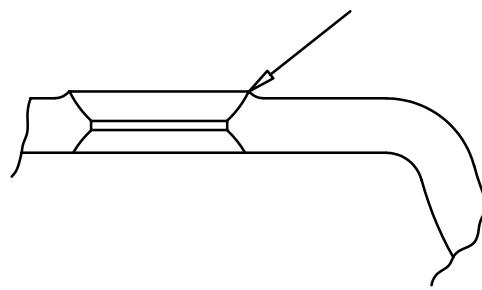
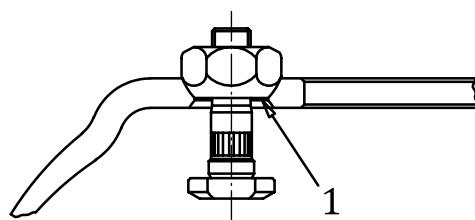


Figure 12 — Burrs around bolt holes



Key

1 narrow land

Figure 13 — Worn nut seat

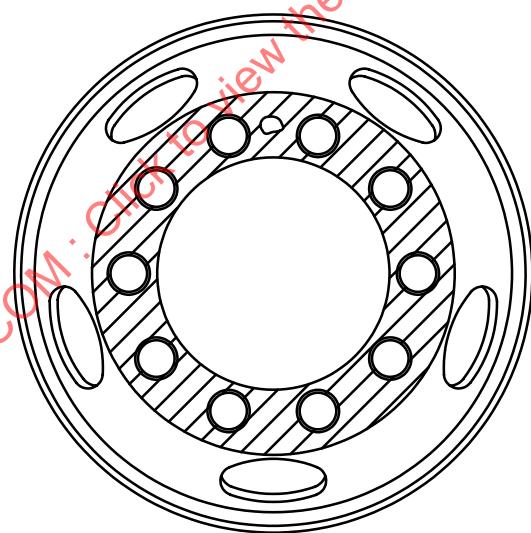


Figure 14 — Excessive wear/ corrosion of wheel attachment face

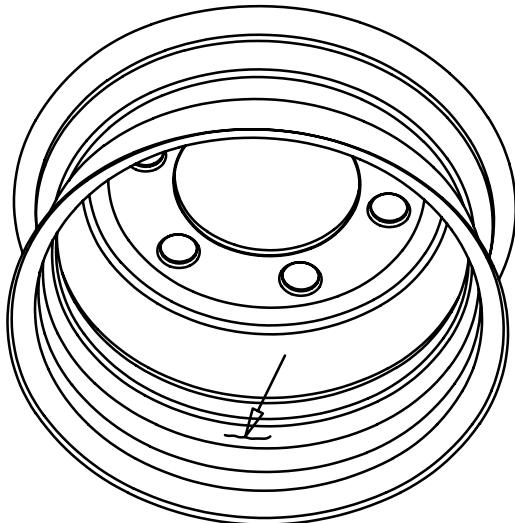


Figure 15 — Circumferential cracks in rim well

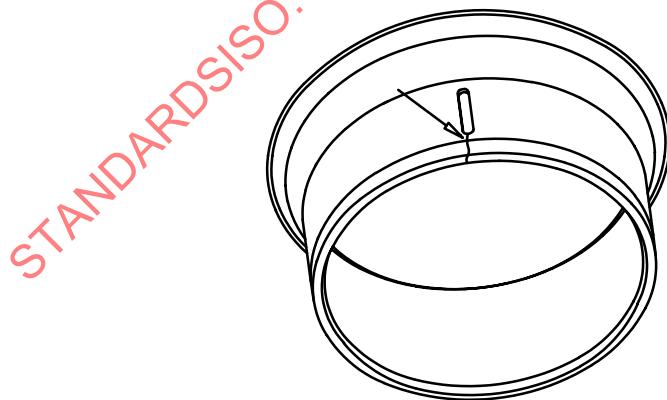
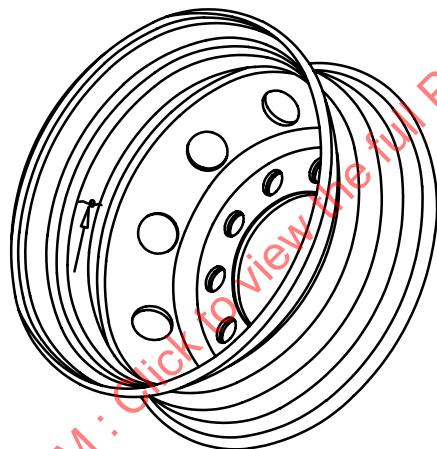


Figure 16 — Valve-aperture cracks

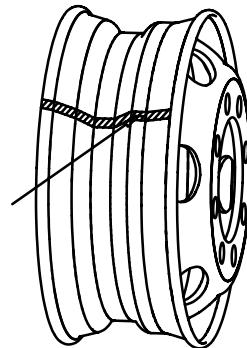


Figure 17 — Butt-weld cracks

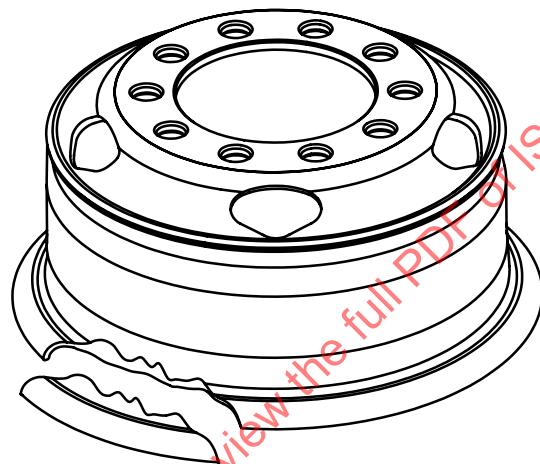


Figure 18 — Bead-seat cracks

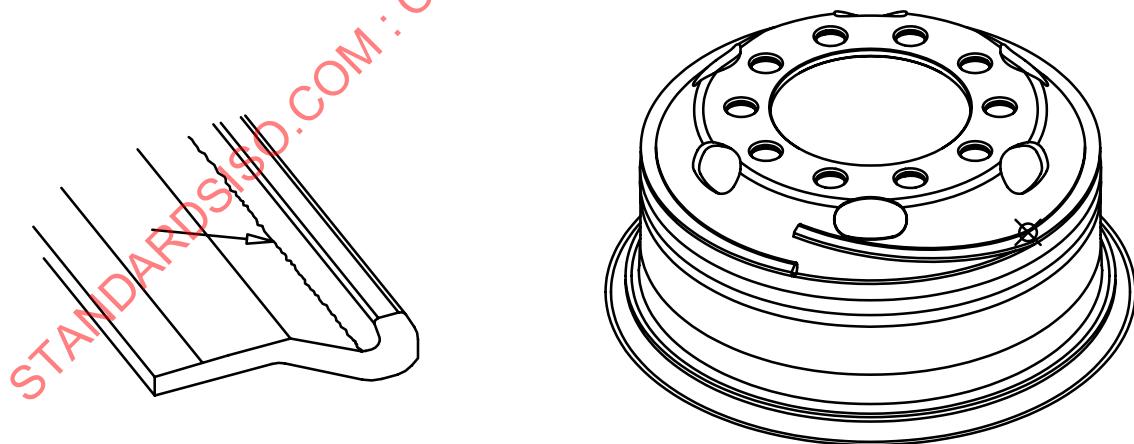


Figure 19 — Rim-gutter cracks

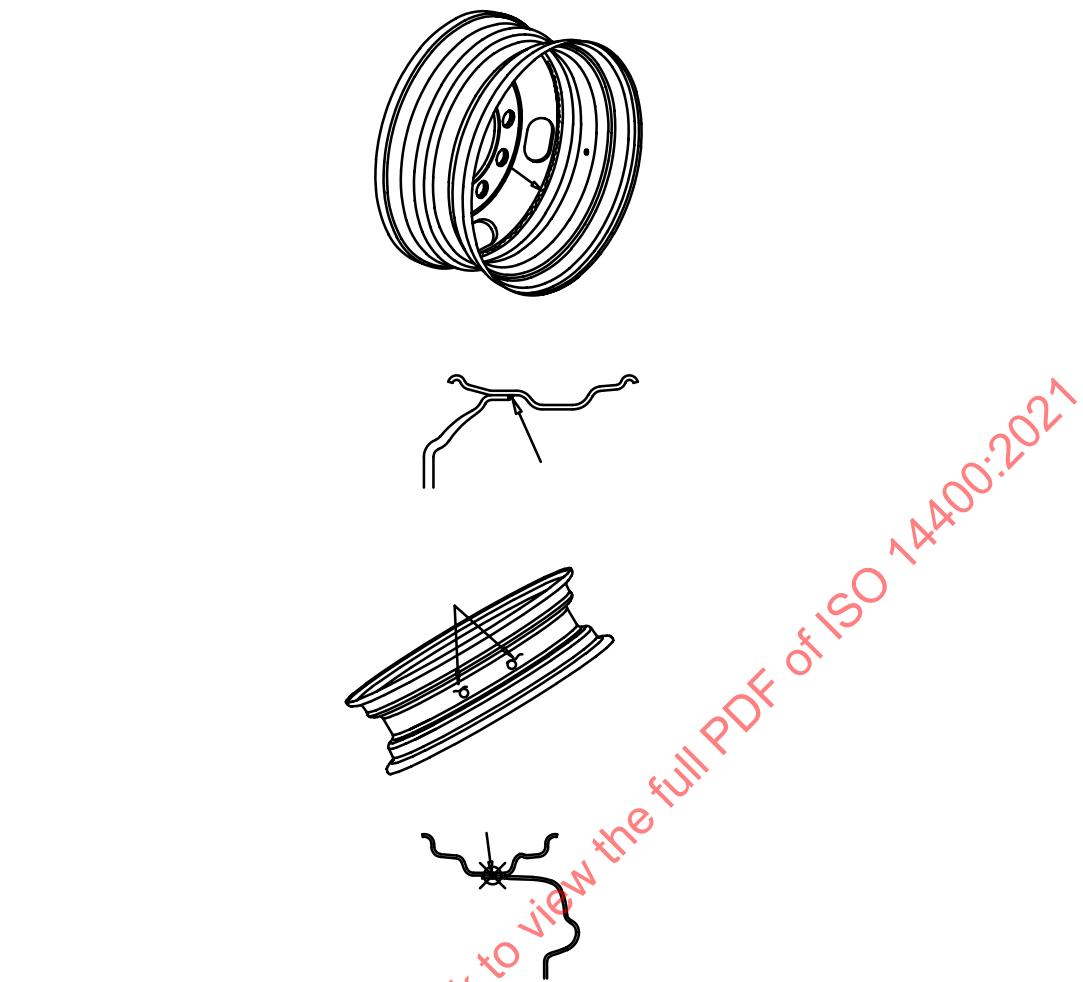


Figure 20 — Disc-to-rim weld cracks

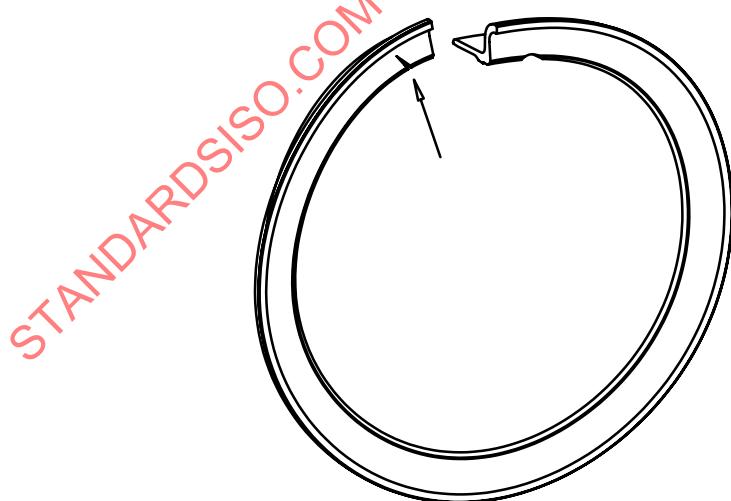


Figure 21 — Side-ring cracks