BS ISO 12132:2017

BSI Standards Publication

Plain bearings — Quality assurance of thin-walled half bearings — Design FMEA

bsi.

National foreword

This British Standard is the UK implementation of ISO 12132:2017. It supersedes BS ISO 12132:1999 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MCE/12, Plain bearings.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2017

ISBN 978 0 580 92969 4

ICS 21.100.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2017.

Amendments/corrigenda issued since publication

Date	Text affected

BS ISO 12132:2017

INTERNATIONAL STANDARD

ISO 12132

Second edition
2017-03

Plain bearings — Quality assurance of thin-walled half bearings — Design FMEA

Paliers lisses — Assurance qualité des demi-coussinets minces — AMDE à la conception

Reference number
ISO 12132:2017(E)

Contents

Page

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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 5, *Quality analysis and assurance*.

This second edition cancels and replaces the first edition (ISO 12132:1992), which has been technically revised.

Introduction

FMEA (Failure Mode and Effects Analysis) is a form of analytical method that helps to define potential defects of the designed products and to eliminate these defects at the stage of designing.

FMEA is based on combining the experience gained in practice in designing and operation of plain bearings with the theory of probability.

FMEA increases reliability and quality of the product in question and that of its technology and also reduces the expenses for testing the product and for improving the technological process.

Systems for the implementation of a Design FMEA are well documented elsewhere and are outside the scope of this document. These systems aid in the analysis of complex designs, both existing and projected.

Plain bearings — Quality assurance of thin-walled half bearings — Design FMEA

1 Scope

This document gives guidelines for the preparation of a Design FMEA for thin-walled half bearings used in machinery, e.g. internal combustion engines (the Process FMEA is the responsibility of the supplier). It lists the common potential failure mode(s), potential effect(s) and potential cause(s) of failure.

The numerical evaluation of risks in terms of occurrence, severity and detection can be specific to each application, manufacturer and customer.

Since they have to be assessed in each case, the numerical data are not included in this document. General guidance on statistical assessment can be obtained from the references.

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.

IEC 60812, *Analysis techniques for system reliability — Procedure for failure mode and effects analysis (FMEA)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60812 and the following apply.

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

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
Failure Mode and Effects Analysis
FMEA
method of reliability analysis intended to identify potential failures which have significant consequences affecting the system performance in the application considered

3.2
Design FMEA
FMEA (3.1) carried out by designers when developing the product

3.3
failure mode
effect by which a failure is observed in the bearing

3.4
failure effect
consequence of a *failure mode* (3.3) on the bearing system and equipment condition and operation

3.5
failure cause
deficiency or defect which causes a *failure mode* (3.3)

4 Common potential failure modes, effects and causes for half bearing shells

The connecting rod and main half bearing shells of a machine are only one part of an integrated system involving the lubricating oil, the lubrication system, the crankshaft, the engine block, the connecting rods and the half bearing shells themselves. Even the cylinder head material, bolt tightening and cylinder head gasket material have been known to influence bearing performance. Hence, any consideration of internal combustion engine bearing design shall include all elements of the system not just the half bearing shells.

Table 1 gives a list of common potential bearing failure modes and the effects of bearing failure together with possible causes of failure. It is rare for failures to be encountered uniquely but rather they are found in combination such that the actual initial failure mode, and hence the causes, may be difficult to determine. Failure modes of the other bearing system components are not included.

Table 1 — Potential failure modes of half bearings and their effects and causes

No.	Potential failure mode	Potential effects of failure	Potential cause of failure	
			Bearing-related	System-related
1	Fatigue (see ISO 7146-1:2008, 6.3)	Reduced bearing durability and/or bearing seizure Contamination of oil by fatigue debris Engine inoperative	Insufficient bearing diameter Insufficient bearing length Incorrect material selection (fatigue resistance) Localized overloading due to presence and location of bearing features (holes, grooves, etc.) Excessive bearing material thickness Excessive overlay thickness Unsupported bearing areas	Incorrect specification of cylinder pressures firing load Oil pump capacity calculation Insufficient effective journal length Poor journal geometry (ovality, axial form, lobing) Poor housing geometry (ovality, lobing) Insufficient housing dynamic stiffness (circumferential, radial or axial) Excessive oil temperature and/or insufficient oil cooling Bearing system contaminated by foreign particles or wear debris from other components
2	Accelerated wear (Insufficient oil film thickness or debris contamination) (see ISO 7146-1:2008, 6.6 and 6.7.1)	Reduced bearing durability and/or bearing seizure Noise Reduction of oil pressure	Insufficient bearing length Insufficient bearing diameter Incorrect material selection (wear resistance, embeddability) Inappropriate overlay thickness (wear resistance, embeddability) Poorly located bearing features (holes, grooves, etc.) Inadequate oil grooves and holes Incorrect bearing thickness (inadequate clearance or excessive clearance) Incorrect bearing thickness geometry (taper, eccentricity, etc.)	Incorrect lubricant choice Incorrect oil additive specification Poor oil and/or oil additive stability Poor lubricant supply (inadequate oil pressure or supply capacity, drilling diameters too small or poorly positioned, etc.) Aerated or “poor quality” oil supply (rough drillings or sharp bends in lubrication system, poor sump baffling, poor oil pick up, etc.) Inadequate oil filtration Insufficient effective journal length Insufficient journal diameter Poor journal geometry (ovality, axial form, lobing) Poor journal surface topography (finish, lay, etc.) Poor engine balance Poor housing geometry (ovality, lobing) Unsupported bearing areas Insufficient oil temperature and/or insufficient oil cooling

Table 1 *(continued)*

No.	Potential failure mode	Potential effects of failure	Potential cause of failure	
			Bearing-related	System-related
				Contamination by wear debris from other components Excessive ingested debris Infrequent oil and/or oil filter change intervals Excessive coolant contamination Excessive contamination by fuel and combustion products
3	Excessive wear and scuff (over-heating) (see ISO 7146-1:2008, Clause 8)	Reduced bearing durability and/or bearing seizure	Incorrect bearing thickness (inadequate clearance or excessive clearance, poor bearing back conformability with housing) Incorrect bearing thickness geometry (taper, eccentricity, etc.) Poorly located bearing features (holes, grooves, etc.) Inadequate oil grooves and holes Inadequate circumferential length (inadequate interference fit) Inadequate bearing back contact Incorrect material selection (conformability, compatibility) Incorrect diffusion barrier material Excessive differential thermal expansion between housing and bearing shells or housing and shaft (loss of interference fit)	Incorrect journal diameter (clearance) Poor journal geometry (ovality, axial form, lobing) Unsuitable journal surface topography Incorrect fillet radius geometry Incorrect housing diameter (interference fit) Poor housing geometry (ovality, axial form, lobing) Insufficient housing clamping (bolt) load Poor lubricant supply (inadequate oil pressure or supply capacity, drilling diameters, too small or poorly positioned, etc.) Excessive oil drain down or delayed oil supply Aerated or "poor quality" oil supply (rough drillings or sharp bends in lubrification system, poor sump baffing, poor oil pick up, etc.) Insufficient "running-in" Insufficient axial clearance at ends of bearing

Table 1 *(continued)*

No.	Potential failure mode	Potential effects of failure	Potential cause of failure	
			Bearing-related	System-related
4	Excessive localized wear (see ISO 7146-1:2008, 6.4 and Clause 8)	Reduced durability Reduced oil pressure	Poorly located bearing features (holes, grooves, etc.) Incorrect bearing thickness geometry (axial form, eccentricity, etc.) Incorrectly specified internal chamfers (fillet ride) Incorrectly specified bearing bore relief Incorrectly specified locating tang (notch, lug or nick) Inadequate bearing back contact	Insufficient blending of crankshaft oil drilling into journal Incorrect fillet radius geometry Insufficient build cleanliness Poor housing geometry (ovality, axial form, lobing) Inadequate bearing housing cap location Poorly located housing features (holes, grooves, etc.) Insufficient housing stiffness (radial and axial) Incorrectly positioned bearing tang pockets in housing Poor bearing alignment (engine block alignment, connecting rod straightness or twist) Excessive off-set connecting rod loading Poor journal geometry (ovality, axial form, lobing) Poor crankshaft main journal alignment
5	Damage to the bearing back (see ISO 7146-1:2008, 7.2 and 7.3)	Reduced bearing durability and/or bearing seizure Connecting rod breakage	Inadequate circumferential length (interference fit) Inadequate bearing back contact Excessive differential thermal expansion between housing and bearing shells or housing and shaft (loss of interference fit) Incompatible housing material and bearing back material	Insufficient housing dynamic stiffness (circumferential, radial or axial) Insufficient housing clamping (bolt) load Incorrect housing diameter (interference fit) Unsupported bearing areas

Table 1 *(continued)*

No.	Potential failure mode	Potential effects of failure	Potential cause of failure	
			Bearing-related	System-related
6	Corrosion (see ISO 7146-1:2008, 6.7.2)	Reduced bearing durability and/or bearing seizure Increased wear and/or noise	Incorrect material selection (poor corrosion resistance)	Incorrect lubricant choice Incorrect oil additive specification Poor oil and/or oil additive stability Excessive oil temperature and/or insufficient oil cooling Infrequent oil change intervals Excessive coolant contamination Excessive contamination by fuel and combustion products
7	Cavitation erosion (see ISO 7146-1:2008, 6.8 and ISO 7146-2)	Poor cosmetic appearance but not normally damaging on overlay plated bearings Corrosion of substrate in extreme cases Localized fatigue failure in bimetallic bearings Reduced oil supply or pressure Subsequent scoring, indenting and embedment by removed lining material	Incorrect bearing calculation Inadequate oil groove chamfers Inadequate “run-in” grooves Excessive clearance Incorrect groove positions Inadequate groove detail design Incorrect material selection	Incorrect lubricant choice Poor lubricant supply (inadequate oil pressure or supply capacity, drilling diameters, too small or poorly positioned, etc.) Aerated or poor “quality” oil supply (rough drillings or sharp bends in lubrication system, poor sump baffling, poor oil pick up, etc.) Vibration

Bibliography

[1] ISO 7146-1:2008, *Plain bearings — Appearance and characterization of damage to metallic hydrodynamic bearings — Part 1: General*

[2] ISO 7146-2, *Plain bearings — Appearance and characterization of damage to metallic hydrodynamic bearings — Part 2: Cavitation erosion and its countermeasures*

ICS 21.100.10

Price based on 7 pages

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit, or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

Storing and using standards

Standards purchased in soft copy format:

- A British Standard purchased in soft copy format is licensed to a sole named user for personal or internal company use only.
- The standard may be stored on more than 1 device provided that it is accessible by the sole named user only and that only 1 copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.

Standards purchased in hard copy format:

- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than 1 copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright & Licensing team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email subscriptions@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Useful Contacts

Customer Services
Tel: +44 345 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 345 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.