

# INTERNATIONAL STANDARD

# IEC 60812

Second edition  
2006-01

---

---

## Analysis techniques for system reliability – Procedure for failure mode and effects analysis (FMEA)

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*



Reference number  
IEC 60812:2006(E)

# INTERNATIONAL STANDARD

# IEC 60812

Second edition  
2006-01

---

---

---

## **Analysis techniques for system reliability – Procedure for failure mode and effects analysis (FMEA)**

© IEC 2006 Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland  
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: [inmail@iec.ch](mailto:inmail@iec.ch) Web: [www.iec.ch](http://www.iec.ch)



Commission Electrotechnique Internationale  
International Electrotechnical Commission  
Международная Электротехническая Комиссия

## CONTENTS

FOREWORD.....	7
1 Scope.....	11
2 Normative references .....	11
3 Terms and definitions .....	11
4 Overview .....	15
4.1 Introduction .....	15
4.2 Purpose and objectives of the analysis.....	17
5 Failure modes and effects analysis.....	19
5.1 General considerations.....	19
5.2 Preliminary tasks.....	21
5.3 Failure mode, effects, and criticality analysis (FMECA) .....	41
5.4 Report of analysis .....	55
6 Other considerations .....	59
6.1 Common-cause failures.....	59
6.2 Human factors.....	59
6.3 Software errors .....	61
6.4 FMEA regarding consequences of system failure .....	61
7 Applications.....	61
7.1 Use of FMEA/FMECA .....	61
7.2 Benefits of FMEA .....	65
7.3 Limitations and deficiencies of FMEA .....	65
7.4 Relationships with other methods.....	67
Annex A (informative) Summary of procedures for FMEA and FMECA .....	71
Annex B (informative) Examples of analyses.....	79
Bibliography.....	93
Figure 1 – Relationship between failure modes and failure effects in a system hierarchy .....	25
Figure 2 – Analysis flowchart .....	39
Figure 3 – Criticality matrix .....	47
Figure A.1 – Example of the format of an FMEA worksheet.....	77
Figure B.1 – FMEA for a part of automotive electronics with RPN calculation.....	81
Figure B.2 – Diagram of subsystems of a motor generator set .....	83
Figure B.3 – Diagram of enclosure heating, ventilation and cooling systems .....	85
Figure B.4 – FMEA for sub-system 20.....	87
Figure B.5 – Part of a process FMECA for machined aluminium casting.....	91

Table 1 – Example of a set of general failure modes .....	29
Table 2 – Illustrative example of a severity classification for end effects .....	35
Table 3 – Risk/criticality matrix .....	49
Table 4 – Failure mode severity .....	51
Table 5 – Failure mode occurrence related to frequency and probability of occurrence .....	51
Table 6 – Failure mode detection evaluation criteria .....	53
Table 7 – Example of a set of failure effects (for a motor vehicle starter) .....	57
Table 8 – Example of a failure effects probability .....	57
Table B.1 – Definition and classification of the severity of the effects of failures on the complete M-G system .....	83

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

### **ANALYSIS TECHNIQUES FOR SYSTEM RELIABILITY – PROCEDURE FOR FAILURE MODE AND EFFECTS ANALYSIS (FMEA)**

#### FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60812 has been prepared by IEC technical committee 56: Dependability.

This second edition cancels and replaces the first edition published in 1985 and constitutes a technical revision.

The main changes from the previous edition are as follows:

- introduction of the failure modes effects and criticality concepts;
- inclusion of the methods used widely in the automotive industry;
- added references and relationships to other failure modes analysis methods;
- added examples;
- provided guidance of advantages and disadvantages of different FMEA methods.

The text of this standard is based on the following documents:

FDIS	Report on voting
56/1072/FDIS	56/1091/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

## **ANALYSIS TECHNIQUES FOR SYSTEM RELIABILITY – PROCEDURE FOR FAILURE MODE AND EFFECTS ANALYSIS (FMEA)**

### **1 Scope**

This International Standard describes Failure Mode and Effects Analysis (FMEA) and Failure Mode, Effects and Criticality Analysis (FMECA), and gives guidance as to how they may be applied to achieve various objectives by

- providing the procedural steps necessary to perform an analysis;
- identifying appropriate terms, assumptions, criticality measures, failure modes;
- defining basic principles;
- providing examples of the necessary worksheets or other tabular forms.

All the general qualitative considerations presented for FMEA will apply to FMECA, since the latter is an extension of the other.

### **2 Normative references**

The following referenced documents are indispensable for the application 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 60300-3-1:2003, *Dependability management – Part 3-1: Application guide – Analysis techniques for dependability – Guide on methodology*

IEC 61025, *Fault tree analysis (FTA)*

IEC 61078, *Analysis techniques for dependability – Reliability block diagram method*