

Australian Standard<sup>®</sup>

**Analysis techniques for dependability—  
Event tree analysis (ETA)**



This Australian Standard® was prepared by Committee QR-005, Dependability. It was approved on behalf of the Council of Standards Australia on 19 October 2011. This Standard was published on 14 November 2011.

---

The following are represented on Committee QR-005:

- Asset Management Council
  - Australian Industry Group
  - Australian Organisation for Quality
  - CSIRO Information and Communication Technologies Centre
  - Department of Defence (Australia)
  - Energy Networks Association
  - Engineers Australia
  - Independent Transport Safety & Reliability Regulator
  - Risk Management Association of Australia
  - Risk Management Institution of Australasia
  - The University of New South Wales
  - University of Wollongong
- 

This Standard was issued in draft form for comment as DR AS IEC 62502.

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.

---

#### **Keeping Standards up-to-date**

Australian Standards® are living documents that reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued.

Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments that may have been published since the Standard was published.

Detailed information about Australian Standards, drafts, amendments and new projects can be found by visiting [www.standards.org.au](http://www.standards.org.au)

Standards Australia welcomes suggestions for improvements, and encourages readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at [mail@standards.org.au](mailto:mail@standards.org.au), or write to Standards Australia, GPO Box 476, Sydney, NSW 2001.

---

Australian Standard<sup>®</sup>

**Analysis techniques for dependability—  
Event tree analysis (ETA)**

First published as AS IEC 62502—2011.

**COPYRIGHT**

© Standards Australia Limited

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968.

Published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001, Australia

ISBN 978 0 7337 9958 7

## PREFACE

This Standard was prepared by the Standards Australia Committee QR-005, Dependability.

The objective of this Standard is to specify the basic principles of event tree analysis and to provide guidance on modelling the consequences of an initiating event using the event tree methodology. It explains how to analyse those consequences qualitatively and quantitatively and provides examples of event tree applications in the context of dependability and risk managements.

This Standard is identical with, and has been reproduced from IEC 62502, Ed.1.0 (2010), *Analysis techniques for dependability—Event tree analysis (ETA)*.

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number appears on the cover and title page while the International Standard number appears only on the cover.
- (b) In the source text ‘this International Standard’ should read ‘this Australian Standard’.
- (c) A full point substitutes for a comma when referring to a decimal marker.

References to International Standards should be replaced by references to Australian or Australian/New Zealand Standards, as follows:

<i>Reference to International Standard</i>	<i>Australian Standard</i>
IEC	AS IEC
61025 Fault tree analysis (FTA)	61025 Fault tree analysis (FTA)

Only international references that have been adopted as Australian or Australian/New Zealand Standards have been listed.

The term ‘informative’ has been used in this Standard to define the application of the annex to which it applies. An ‘informative’ annex is only for information and guidance.

## CONTENTS

1	Scope.....	7
2	Normative references .....	7
3	Terms, definitions, abbreviations and symbols.....	7
3.1	Terms and definitions .....	7
3.2	Abbreviations and symbols.....	8
3.2.1	Abbreviations .....	8
3.2.2	Symbols .....	9
4	General description .....	9
5	Benefits and limitations of ETA.....	11
5.1	Benefits.....	11
5.2	Limitations.....	11
6	Relationship with other analysis techniques.....	12
6.1	Combination of ETA and FTA.....	12
6.2	Layer of protection analysis (LOPA) .....	13
6.3	Combination with other techniques.....	13
7	Development of event trees .....	14
7.1	General.....	14
7.2	Steps in ETA.....	14
7.2.1	Procedure.....	14
7.2.2	Step 1: Definition of the system or activity of interest.....	15
7.2.3	Step 2: Identification of the initiating events of interest .....	15
7.2.4	Step 3: Identification of mitigating factors and physical phenomena.....	16
7.2.5	Step 4: Definition of sequences and outcomes, and their quantification.....	16
7.2.6	Step 5: Analysis of the outcomes.....	17
7.2.7	Step 6: Uses of ETA results.....	17
8	Evaluation .....	18
8.1	Preliminary remarks .....	18
8.2	Qualitative analysis – Managing dependencies.....	18
8.2.1	General .....	18
8.2.2	Functional dependencies .....	19
8.2.3	Structural or physical dependencies .....	20
8.3	Quantitative analysis .....	22
8.3.1	Independent sequence of events .....	22
8.3.2	Fault tree linking and boolean reduction .....	23
9	Documentation .....	24
	Annex A (informative) Graphical representation .....	26
	Annex B (informative) Examples .....	27
	Bibliography.....	41
	Figure 1 – Process for development of event trees .....	10
	Figure 2 – Simple graphical representation of an event tree.....	18
	Figure 3 – Functional dependencies in event trees .....	20

Figure 4 – Modelling of structural or physical dependencies.....	21
Figure 5 – Sequence of events .....	22
Figure 6 – Fault tree linking .....	23
Figure A.1 – Frequently used graphical representation for event trees .....	26
Figure B.1 – Event tree for a typical fire incident in a diesel generator building .....	28
Figure B.2 – Simplified event tree for a fire event .....	29
Figure B.3 – Level-crossing system (LX).....	31
Figure B.4 – ETA for the level-crossing system.....	33
Figure B.5 – Simple example .....	36
Figure B.6 – Fault Tree for the Failure of System 1 .....	36
Figure B.7 – Fault Tree for the Failure of System 2.....	37
Figure B.8 – Modified event tree .....	38
Figure B.9 – Event tree with "grouped faults" .....	39
Table A.1 – Graphical elements .....	26
Table B.1 – Symbols used in Annex B .....	29
Table B.2 – System overview.....	31
Table B.3 – Risk reduction parameters for accidents from Figure B.4 .....	34

## INTRODUCTION

This International Standard defines the basic principles and procedures for the dependability technique known as Event Tree Analysis (ETA).

IEC 60300-3-1 explicitly lists ETA as an applicable method for general dependability assessment. It is also used in risk and safety analysis studies. ETA is also briefly described in the IEC 60300-3-9.

The basic principles of this methodology have not changed since the conception of the technique in the 1960's. ETA was first successfully used in the nuclear industry in a study by the U.S. Nuclear Regulatory Commission, the so-called WASH 1400 report in the year 1975 [31]<sup>1</sup>.

Over the following years, ETA has gained widespread acceptance as a mature methodology for dependability and risk analysis and is applied in diverse industry branches ranging from the aviation industry, nuclear installations, the automotive industry, chemical processing, offshore oil and gas production, to defence industry and transportation systems.

In contrast to some other dependability techniques such as Markov modelling, ETA is based on relatively elementary mathematical principles. However, as mentioned in IEC 60300-3-1, the implementation of ETA requires a high degree of expertise in the application of the technique. This is due in part to the fact that particular care has to be taken when dealing with dependent events. Furthermore, one can utilize the close relationship between Fault Tree Analysis (FTA) and the qualitative and quantitative analysis of event trees.

This standard aims at defining the consolidated basic principles of the ETA and the current usage of the technique as a means for assessing the dependability and risk related measures of a system.

---

<sup>1</sup> Figures in square brackets refer to the bibliography.

## AUSTRALIAN STANDARD

# Analysis techniques for dependability—Event tree analysis (ETA)

## 1 Scope

This International Standard specifies the consolidated basic principles of Event Tree Analysis (ETA) and provides guidance on modelling the consequences of an initiating event as well as analysing these consequences qualitatively and quantitatively in the context of dependability and risk related measures.

More specifically, this standard deals with the following topics in relation to event trees:

- a) defining the essential terms and describing the usage of symbols and ways of graphical representation;
- b) specifying the procedural steps involved in the construction of the event tree;
- c) elaborating on the assumptions, limitations and benefits of performing the analysis;
- d) identifying relationships with other dependability and risk-related techniques and elucidating suitable fields of applications;
- e) giving guidelines for the qualitative and quantitative aspects of the evaluation;
- f) providing practical examples.

This standard is applicable to all industries where the dependability and risk-related measures for the consequences of an initiating event have to be assessed.

## 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 60050-191:1990, *International Electrotechnical Vocabulary – Chapter 191: Dependability and quality of service*

IEC 61025:2006, *Fault tree analysis (FTA)*

## 3 Terms, definitions, abbreviations and symbols

For the purposes of this document, the following terms and definitions, as well as those given in IEC 60050-191, apply.

### 3.1 Terms and definitions

#### 3.1.1 node

point in the graphical representation of the event tree depicting two or more possible outcomes for the mitigating factor

NOTE The top event of the corresponding fault tree can directly be linked to a node.

#### 3.1.2 common cause

cause of occurrence of multiple events

[IEC 61025:2006, 3.15]