

ANSI/IEC/ASQ D61165-1997

Application of Markov techniques

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Approved as an American National Standard by:

American Society for Quality

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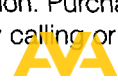
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An American National Standard Approved on September 16, 1997

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10 9 8 7 6 5 4 3 2 1

Printed in the United States of America

♾ Printed on acid-free paper

Published by:

American Society for Quality



Quality Press
611 East Wisconsin Avenue
Milwaukee, Wisconsin 53201-3005
800-248-1946
Web site <http://www.asq.org>

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Contents

	Page
Foreword.....	1
Introduction.....	2
Clause	
1 Scope	3
2 Normative references	3
3 Definitions	3
4 Symbols	4
4.1 State-transition diagram	4
4.2 Dependability measures.....	4
4.3 Example.....	5
5 General.....	5
6 Assumptions	6
7 Development of Markov diagrams	7
7.1 Precautions	7
7.2 Rules.....	7
7.3 Examples.....	8
8 Evaluation of state-transition diagrams.....	11
8.1 General.....	11
8.2 Evaluation of reliability	12
8.3 Evaluation of availability and maintainability.....	12
9 Simplifications and approximations	12
10 Collapsed state-transition diagram	13
11 Reliability and availability expressions for system configurations	15
12 Presentation of results	15

ANSI/IEC/ASQ D61165-1997**Annexes**

A	Example: Numerical evaluation of some dependability measures of a two-unit active redundant system	17
B	Tables of reliability and availability expressions for basic system configurations	20
C	Bibliography	22

Application of Markov Techniques

Foreword

- 1) The IEC (International Electrotechnical Commission) is a world-wide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international cooperation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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- 3) They have the form of recommendations for international use published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

International Standard IEC 1165 has been prepared by IEC Technical Committee No. 56: Dependability.

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

Six Months' Rule	Report on Voting
56(CO)164	56(CO)176

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

Annexes A, B and C are for information only.

ANSI/IEC/ASQ D61165-1997**Introduction**

Several distinct analytical methods of dependability analysis are available, of which Markov analysis is one.

IEC 60300-3-1 gives an overview of available methods and their general characteristics.

The relative merits of various methods and their individual or combined applicability in evaluating the dependability of a given system or component, should be examined by the analyst prior to deciding on the use of Markov analysis. For each method, consideration should also be given to the results produced, the data required to perform the analysis, the complexity of analysis, and other identified factors.

Application of Markov Techniques

1 Scope

This International Standard provides guidance on the application of Markov techniques to dependability analysis.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(191): 1990, *International Electrotechnical Vocabulary (IEV), chapter 191: Dependability and quality of service*.

IEC 61078: (1991), *Analysis techniques for dependability—Reliability block diagram method*

3 Definitions

For the purposes of this International Standard the terms and definitions of IEC 60050(191) apply. In addition, the following terms and definitions are used:

3.1 unit: A component or set of components, which function as a single entity.

NOTE—As such, the unit can exist in only two states: functional or failed (see 3.3 and 3.4). For convenience, the term **unit state** will be used to denote the state of a unit.

3.2 system state: A system state is a particular combination of unit states.

NOTE—Several system states may be combined into one state.

3.3 functional state: A system (or unit) state in which the system (or unit) performs the required function.

3.4 failed state: A system (or unit) state in which the system (or unit) does not perform the required function.

NOTE—A system can have several distinguishable failed states.

3.5 transition: A change from one state to another, usually as a result of failure or restoration.

NOTE—A transition may be also caused by other events such as human errors, external events, reconfiguration of software, etc.

3.6 transition probability: The probability of transition between one state and another state.

ANSI/IEC/ASQ D61165-1997

3.7 initial state: The system state at time $t = 0$.

NOTE—Following a system failure, the system may be restored to the initial state. Generally, a system starts its operation at $t = 0$ from the complete functional state in which all units of the system are functioning and transits towards the final system state, which is a failed state, via other system functional states having progressively fewer functioning units.

3.8 absorbing state: A state from which, once entered, transitions are not possible.

NOTE—Once in an absorbing state, the system will stay there until in effect it is replaced, in its entirety, by a fully functional system.

3.9 restorable system: A system containing units which can fail and then be restored to their functional state, without necessarily causing system failure.

NOTES

1 This corresponds to transitions in the state diagram in the direction towards the initial state. For this to be possible, the units concerned will invariably operate in redundant configurations.

2 For a restorable system, dependability measures such as reliability, MTTF, and availability are calculated.

3.10 non-restorable system: A system, the state transition diagram of which contains only transitions in the direction towards the final system failure state.

NOTE—For a non-restorable system, reliability measures such as reliability and MTTF are calculated.

4 Symbols and abbreviations

4.1 Symbols for state-transition diagrams

4.1.1 state symbol: A state is represented by a circle or a rectangle.

4.1.2 state description: The state description is placed inside the state symbol and may take the form of words or alphanumeric characters defining those combinations of failed and functioning units which characterize the state.

4.1.3 state label: A state label is a number in a circle, placed adjacent to the state symbol, or in the absence of a state description, within the symbol itself.

NOTE—The state can often be adequately represented by a circle with the state number.

4.1.4 transition arrow: The transition arrow indicates the direction of a transition (as a result of failure or restoration).

4.1.5 rates: Restoration rates and/or failure rates are written on the transition arrow.

4.2 Other symbols and abbreviations

Symbols for dependability measures follow those of IEC 50(191), where available. In this standard, the following symbols are used:

Symbol/abbreviation	Term	IEC 50(191)/No
R(t)	reliability	
	NOTE—191-12-01 used the general symbol $R(t_1, t_2)$	
MTTF	mean time to failure	191-12-07