

# Reliability Standards

Reliability and dependability standards provide quick guides for reliability details. They are an efficient method for avoiding the not invented here (NIH) syndrome. A wide variety of subjects are available from [IEC](#) (International Electrical Congress) [TC-56 subcommittee for publications](#) (Technical Committee 56 is responsible for dependability issues driven by a [strategic policy statement](#)).

IEC defines dependability as- “Dependability describes the availability performance and its influencing factors: reliability performance, maintainability performance and maintenance support performance”. The committee was formed in 1965 as TC 56 Reliability and Maintainability and the title was changed to Dependability in 1989 and in 1990 it was agreed that the scope should no longer be limited to the electrotechnical field but should address generic dependability issues across all disciplines. TC 56 is attempting to minimize standards and duplication by cross-committee membership with organizations such as [IEEE](#) and [ASQ](#). Some of the 50 IEC publications are:

• <a href="#">Analytical techniques</a>	• <a href="#">ReliabilityStressScreening</a>
• <a href="#">Collection and presentation of dependability data</a>	• <a href="#">ReliabilityTesting</a>
• <a href="#">Dependability management</a>	• <a href="#">RiskAnalysis</a>
• <a href="#">Design review</a>	• <a href="#">RiskManagement</a>
• <a href="#">Integrated logistic support</a>	• <a href="#">SamplingAndInspectionProcedures</a>
• <a href="#">Life cycle costs</a>	• <a href="#">SoftwareAspectsOfDependability</a>
• <a href="#">MaintainabilityAndMaintenanceSupport</a>	• <a href="#">Specifications</a>
• <a href="#">Miscellaneous</a>	• <a href="#">WeibullAnalysis</a>
• <a href="#">Prediction</a>	•
• <a href="#">Reliability centered maintenance</a>	•
• <a href="#">Reliability growth</a> (Crow/AMSAA)	•

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**Dependability management:**

[IEC 60300-1 \(2003-06\) Dependability management-Part 1](#) (17 pages, ~US\$52)

Dependability management systems. Deals with dependability performance issues including availability performance, reliability performance, maintainability performance, and maintenance support performance.

[IEC 60300-2 \(2004-03\) Dependability management-Part 2](#) (103 pages, ~US\$92)

Provides guidelines for dependability management of product design, development, evaluation and process enhancements. Life cycle models are used to

describe product development or project phases. Applicable for detailed planning and implementation of a dependability program to meet specific product needs.

[IEC 60300-3-1 \(2003-01\)](#) **Dependability management-Part 3-1** (59 pages, ~US\$117)

Application guide-Analysis techniques for dependability-Guide on methodology. Describes a general overview of common dependability analysis techniques along with advantages/disadvantages for choosing the appropriate method.

[IEC 60300-3-2 \(2004-11-10\)](#) **Dependability management-Part 3** (79 pages, US\$114)

Application guide-**Section 2**: Collection of dependability data from the field. Describes guidelines for the collection of data relating to reliability, maintainability, availability, and maintenance support performance in the field.

[IEC 60300-3-3 \(2004-07\)](#) **Dependability management-Part 3** (127 pages, ~US\$147)

Application guide-**Section 3**: Life cycle costing. This part of IEC 60300 provides a general introduction to the concept of life cycle costing and covers all applications. This standard is intended for general application by both customers (users) and suppliers of products. It explains the purpose and value of life cycle costing and outlines the general approaches involved. It also identifies typical life cycle cost elements to facilitate project and programme planning.

[IEC 60300-3-4 \(2007-09\)](#) **Dependability management-Part 3-4** (71 pages, ~US\$120)

Guide to the specification of dependability requirements.

[IEC 60300-3-5 \(2001-03\)](#) **Dependability management-Part 3-5** (139 pages, ~US\$137)

Application guide-**Reliability test** conditions and statistical test principles. Describes guidelines for planning and performing reliability tests and the use of statistical methods to discover weaknesses in the design that could be corrected to improve performance, quality, safety, robustness, reliability, availability, and reduce costs.

[IEC 60300-3-6 \(1997-11\)](#) **Dependability management-Part 3-6** (59 pages, ~US\$73)

Application guide-**Section 6**: Software aspects of dependability. Describes dependability elements and tasks for systems or products containing software. —This document has been withdrawn in 2004 and replaced by IEC [60300-2](#) for Dependability Management-Part 2: Guidelines for dependability management.

[IEC 60300-3-7 \(1999-05\)](#) **Dependability management-Part 3-7** (69 pages, ~US\$82)

Application guide-**Reliability stress screening** of electronic hardware. Describes and application guide to reliability stress screening for electronic hardware. This document was withdrawn in 2007 and replace by [IEC 61163-1](#) for Reliability stress screening-Part 1: Repairable assemblies manufactured in lots and [IEC 61163-2](#) for Reliability stress screening-Part 2: Electronic components.

[IEC 60300-3-9 \(1995-12\)](#) **Dependability management-Part 3** (67 pages, ~US\$82)

Application guide-**Section 9**: Risk analysis of technological systems. Describes guidelines for selecting and implementing risk analysis techniques for quality and

consistency in planning and execution for risk analysis. Withdrawn and replaced by [IEC/ISO 31010](#) Risk management-Risk assessment techniques published November 2009.

[IEC 60300-3-10 \(2001-01\)](#) **Dependability management-Part 3-10** (67 pages, ~US\$82)  
Application guide-**Maintainability**. Describes implementation of a maintainability program.

[IEC 60300-3-11 \(1999-03\)](#) **Dependability management-Part 3-11** (107 pages, ~US\$117)  
Application guide-**Reliability centered maintenance**. Describes development of a preventive maintenance program using RCM techniques.

[IEC 60300-3-12 \(2011-02\)](#) **Dependability management-Part 3-12** (104 pages, ~US\$101)  
Application guide-Integrated **logistic support**.  
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### **Life Cycle Costs**

[IEC 60300-3-3 \(2004-07\)](#) **Dependability management-Part3: Section 3: Life cycle costing**. Describes life cycle costing concepts and general guidance for conducting life cycle cost analysis. (127 pages, ~US\$147)  
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### **Specifications**

[IEC 60300-3-4 \(2007-09\)](#) **Dependability management-Part 3-4: Guide to the specification of dependability requirements**. (71 pages, ~US\$120).  
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[IEC 60319 \(1999-09\)](#) **Presentation and specification of reliability data for electronic components**. This standard provides guidance for the collection and presentation of data relating to the reliability of electronic components and their reliability characteristics. It also provides guidance to users as to how they should specify their reliability requirements to manufactures. (39 pages, ~US\$72)  
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[IEC 60863 \(1986-05\)](#) was withdrawn in 2004 and replaced by [IEC 60319](#) also described above and [IEC 61709](#) described below.  
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[IEC 61709 \(2011-06\)](#) **Electronic Components – Reliability – Reference conditions for failure rates and stress models for conversion**. Describes the use of failure rate data for reliability prediction of components in electronic equipment including the effects of complexity, stress models for conversion. (83 pages, ~US\$101).  
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## **Design Review**

[IEC 61160 \(2005-09\)](#) **Design Review**. Makes recommendations for the implementation of design review as a means of verifying that the design input requirements have been met and stimulating the improvement of the product's design. The intention is for it to be applied during the design and development phase of a product's life cycle.

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[IEC 61514-2 \(2004-01\)](#) Industrial process controls systems – Part 2: Methods of evaluating the performance of intelligent valve positioners with pneumatic outputs which specifies design reviews and tests intended to measure the valve characteristics.

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## **Analytical Techniques**

[IEC 60300-1 \(2003-06\)](#) **Dependability management-Part 1**: Dependability management systems. Deals with dependability performance issues including availability performance, reliability performance, maintainability performance, and maintenance support performance. (93 pages, ~US\$100)

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[IEC 60812 \(2006-01\)](#) **Analysis techniques for system reliability** – Procedure for failure mode and effects analysis ( FMEA ). Describes **FMEA** and **FMECA** with guidance for application. (41 pages, ~US\$64)

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[IEC 61025 \(2006-12\)](#) **Fault tree analysis (FTA )** Describes fault tree analysis and provides guidance on its application to perform an analysis, identifies appropriate assumptions, events and failure modes, and provides identification rules and symbols. (103 pages, US\$100)

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[IEC 61078 \(2006-01\)](#) **Analysis techniques for dependability – Reliability block diagram and Boolean methods**. Describes procedures for modeling system reliability to calculate reliability and availability measures and contains a standard set of symbols related to reliability parameters. (73 pages, ~US\$75)

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[IEC 61165 \(2006-05\)](#) **Application of Markov techniques**. Describes Markov analysis methods for modeling maintenance strategies along with failure restorations events displayed in a pictorial way. (67 pages, US\$64)

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[IEC 61882 \(2001-05\)](#) **Hazard and operability studies ( HAZOP studies ) – Application guide**. Describes a guide for HAZOP studies with guide words. (113 pages, US\$117)

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[IEC 61649 \(2008-08\)](#) **Weibull Analysis**, Edition 2.0. (138 pages, ~US\$235)

IEC 61649:2008 second edition provides methods for analyzing data from a Weibull distribution using continuous parameters such as time to failure, cycles to failures, mechanical stress, etc. This standard is applicable whenever data on strength parameters, e.g., times to failure, cycles, stress, etc are available for a random sample of items operating under test condition or in-service, for the purpose of estimating measures of reliability performance of the population from which these item were drawn. The main changes with respect to the previous edition are as follows: the title has been shortened and simplified to read 'Weibull analysis', and provision of methods for both analytical and graphical solutions have been added.

The source document for this revision is [The New Weibull Handbook](#), 5<sup>th</sup> edition, by Dr. Robert B. Abernethy.

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### **Reliability Growth**

[IEC 61014 \(2003-07\)](#) **Programs for reliability growth**. Describes guidelines for exposure and removal of weaknesses in hardware and software items to make reliability grow and mathematical modeling is outlined briefly. (61 pages, ~US\$82)

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[IEC 61164 \(2004\)](#) **Reliability growth – Statistical test and estimation methods**. (55 pages, ~US\$190)

This second edition International Standard describes the power law reliability growth model and related projection model and gives step-by-step directions for their used. There are several reliability growth models available, the power law model being one of the most widely used.

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[IEC 61710 \(2000-11\)](#) along with corrigendum [IEC 61710 Corr.1 \(2001-09\)](#) **Power law model – Goodness-of-fit test and estimation methods**. Describes procedures to estimate the parameters of the power law model along with confidence intervals for failure intensity, and prediction intervals for the time to future failures along with a test of goodness of fit to data from repaired items. (77 pages, ~US\$92)

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### **Reliability Testing and Statistical Principles**

[IEC 60300-3-5 \(2001-03\)](#) **Dependability management-Part 3-5: Application guide-Reliability test conditions and statistical test principles**. Describes guidelines for planning and performing reliability tests and the use of statistical methods to discover weaknesses in the design that could be corrected to improve performance, quality, safety, robustness, reliability, availability, and reduce costs. (139 pages, ~US\$137)

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[IEC 60605-2 \(1994-10\)](#) **Equipment reliability testing-Part 2: Design of test cycles**. Describes the design of operating eand environmental test cycles referenced in section 8.1 and 8.2 of IEC 605-1 [which was withdrawn in 2001 and replaced by [IEC60300-3-5](#)]

(57 pages, ~US\$73).

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[IEC 60605-3-1 \(1986-09\)](#) **Equipment reliability testing-Part 3:** Preferred test conditions. Indoor portable equipment-Low degree of simulation. Describes tests for portable equipment operated in a stationary position. (19 pages, ~US\$32). This standard has been withdrawn.

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[IEC 60605-3-2 \(1986-09\)](#) **Equipment reliability testing- Part 3: Preferred test conditions. Equipment for stationary use in weather protected locations – High degree of simulation.** Describes preferred test conditions given in IEC 605-1 [which was **withdrawn** in 2001 and replaced by [IEC60300-3-5](#)] (21 pages, ~US\$35).

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[IEC 60605-3-3 \(1992-11\)](#) **Equipment reliability testing – Part 3: Preferred test conditions – Section 3: Test Cycle 3: Equipment for stationary use in partially weather protected locations – Low degree of simulation.** Describes test cycles not intended to replace tests for other purposes. (29 pages, ~US\$42) This standard has been **withdrawn**.

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[IEC 60605-3-4 \(1992-07\)](#) **Equipment reliability testing. Part 3: Preferred test condition. Section 4: Test cycle 4: Equipment for portable and no-stationary use – Low degree of simulation.** Describes preferred test conditions as give in IEC 60605-1. (33 pages, ~US\$52) This standard has been **withdrawn**.

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[IEC 60605-3-5 \(1996-03\)](#) along with corrigendum [IEC 60605-3-5 Corr.1 \(1996-03\)](#) **Equipment reliability testing. Part 3: Preferred test condition. Section 5: Test cycle 4: Ground mobile equipment – Low degree of simulation.** Describes direct current (dc) powered mobile equipment tests as give in IEC 60721-2-1. (35 pages, ~US\$52) This standard has been **withdrawn**.

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[IEC 60605-3-6 \(1996-08\)](#) **Equipment reliability testing. Part 3: Preferred test condition. Section 6: Test cycle 6: Outdoor transportable equipment – Low degree of simulation.** Describes testing of outdoor transportable equipment operating in a stationary position in a “warm temperature” as per IEC 60721-2-1. (33 pages, ~US\$52) This standard has been **withdrawn**.

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[IEC 60605-4 \(2001-08\)](#) **Equipment reliability testing. Part 4: Statistical procedures for exponential distribution – Point estimates, confidence intervals, prediction intervals and tolerance intervals.** Describes statistical methods for evaluating point estimates, confidence intervals, prediction intervals, and tolerance intervals for the failure

rate of items whose time to failure follows and exponential distribution. (65 pages, ~US\$82)

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[IEC 60605-6 \(2007-05\)](#) along with corrigendum [IEC 60605-6 Corr.1 \(2000-12\)](#)  
**Equipment reliability testing – Part 6: Tests for the validity of the constant failure rate or constant failure intensity assumptions.** Describes procedures to verify the assumption of a constant failure rates as defined in [IEC 60050-191\(1990-12\)](#) (Terminology).

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[IEC 61070 \(1991-11\)](#) **Compliance test procedures for steady-state availability.** Describes compliance testing techniques for availability performance testing of frequently maintained items. (52 Pages, ~US\$168)

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[IEC 61123 \(1991-12\)](#) **Reliability testing – Compliance test plans for success ratio.** Describes procedures for compliance test plans for success ratio or failure ratio tests where each trial is statistically independent. Supersedes IEC 605-5. (61 pages, ~US\$190)

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[IEC 61124 \(2006-03\)](#) **Reliability testing – Compliance tests for constant failure rate and constant failure intensity.** Describes a number of optimized test plans, the corresponding operating characteristic curves and expected test times. In addition the algorithms for designing test plans using a spreadsheet program are also given, together with guidance on how to choose test plans. This standard does not cover guidance on how to plan, perform, analyse and report a test as this information can be found in [IEC 60300-3-5](#). (139 pages, ~US\$285)

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[IEC 61649 \(2008-08\)](#) **Goodness-of-fit tests, confidence intervals and lower confidence limits for Weibull distribution data.** Describes numerical methods for performing a Weibull goodness of fit test for two-parameter Weibull distribution using maximum likelihood methods. (138 pages, ~US\$285)

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[IEC 61650 \(1997-08\)](#) **Reliability data analysis techniques – Procedures for comparison of two constant failure rates and two constant failure (event) intensities.** Describes procedures to compare two observed failure rates, failure intensities, or rates/intensities of relevant events to determine apparent differences between the two sets of data—contains simple practical examples (39 pages, ~US\$95)

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### **Sampling And Inspection Procedures**

[IEC 60410 \(1973-01\)](#) **Sampling plans and procedures for inspection by attributes.**



Describes plans and procedures for inspection by attributes. (82 pages, ~US\$230)

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### **Reliability Stress Screening**

[IEC 60300-3-7 \(1999-05\)](#) **Dependability management-Part 3-7:** Application guide-**Reliability stress screening** of electronic hardware. Describes and application guide to reliability stress screening for electronic hardware. (69 pages, ~US\$82) —This document has been **withdrawn** in 2007 and replaced by [IEC 61163-1](#) and [IEC 61163-2](#) shown below.

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[IEC 61163-1 Ed. 2.0 \(2006-06-26\)](#) **Reliability stress screening – Part 1: Repairable items manufactured in lots.** Describes processes which are applicable for hardware items which have unacceptably low reliability in the early failure periods and when other methods such as reliability grow plots are not applicable. (161 pages, ~US\$295)

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[IEC 61163-2 \(1998-11\)](#) **Reliability stress screening – Part 2: Electronic components.** Describes guidance on reliability stress screening techniques and procedures for electronic components. (69 pages, ~US\$190)

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### **Software Aspects of Dependability**

[IEC 60300-3-6 \(1997-11\)](#) **Dependability management-Part 3:** Application guide-**Section 6:** Software aspects of dependability. Describes dependability elements and tasks for systems or products containing software. (59 pages, ~US\$170) This document was **withdrawn** in 2004 and replaced by [IEC 60300-2](#).

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[IEC 61713 \(2000-06\)](#) **Software dependability through the software life-cycle process-Application guide,** Describes activities to achieve dependable software to support IEC 60300-3-6 (1997-11) (**withdrawn** and replaced by [IEC 60300-2](#)) and the guide is useful for acquires, suppliers, developers, operators/maintainers of software.

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### **Maintainability And Maintenance Support**

[IEC 60300-3-10 \(2001-01\)](#) **Dependability management-Part 3-10:** Application guide-**Maintainability.** Describes implementation of a maintainability program. (67 pages, ~US\$82)

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IEC 60706-1 (1982-01) **Guide on maintainability of equipment. Part 1- Section One, Two and Three. Introduction, requirements and maintainability program.**

Describes the concept of maintainability, the general approach for maintainability, and gives maintainability objectives. (39 pages, ~US\$57). Withdrawn in 2006 and replaced by [IEC 60706-2 \(2006-03-20\)](#) see below.

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[IEC 60706-2 \(2006-03-20\)](#) **Maintainability of equipment-Part 2-Maintainability requirements and studies during the design and development phase.** Describes maintainability requirements and related design and use parameter, and discusses some activities necessary to achieve the required maintainability characteristics and their relationship to planning of maintenance. It described the general approach in reaching these objectives and shows how maintainability characteristics should be specified in a requirements document or contract. It is not intended to be a complete guide on how to specify or to contract for maintainability. Its purpose is to define the range of considerations when maintainability characteristics are included as requirements for the development or the acquisition of an item. (101 pages, ~US\$145)

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[IEC 60706-3 \(2006-04-27\)](#) **Maintainability of equipment. Part 3: Verification and collection, analysis and presentation of data.** Describes aspects of verification necessary to ensure that the specified maintainability requirements of an item have been met and provides suitable procedures and test methods. This standard also addresses the collection, analysis and presentation of maintainability related data, which may be required during, and at the completion of, design and during item production and operation. (75 pages, ~US\$145)

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IEC 60706-4 (1992-09) **Guide on maintainability of equipment. Part 4- Section 8: Maintenance and maintenance support planning.** Describes the tasks required for planning of maintenance and maintenance support—also describes the interface between reliability, maintainability and maintenance support planning. (63 pages, ~US\$82)  
Withdrawn in 2004 by TC/CS 56 committee. Replaced by [IEC 60300-3-14 Ed 1.0 \(2004\)](#).

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[IEC 60706-5 \(2007-09\)](#) **Guide on maintainability of equipment. Part 5: Testability and diagnostic testing.** (126 pages, ~US\$185)

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IEC 60706-6 (1994-12) **Guide on maintainability of equipment. Part 6- Section 9: Statistical methods in maintainability evaluation.** Describes techniques covering quantitative aspects of maintainability. (41 pages, ~US\$64). Replaced in 2006 by [IEC 60706-3 \(2006-04-27\)](#)

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### **Reliability Centered Maintenance**

[IEC 60300-3-11 \(2003-01\)](#) **Dependability management-Part 3-11: Application guide-Reliability centered maintenance.** Describes development of a preventive maintenance program using RCM techniques. (107 pages, ~US\$190)

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### **Integrated Logistic Support**

[IEC 60300-3-12 \(2011-02\)](#) **Dependability management-Part 3-12:** Application guide-Integrated **logistic support**. Describes an application guide for the purchaser/supplier to complete product life cycle. (104 pages, ~US\$255)

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### **Risk Analysis**

[IEC 60300-3-9 \(1995-12\)](#) **Dependability management-Part 3: Section 9:** Risk analysis of technological systems. Describes guidelines for selecting and implementing risk analysis techniques for quality and consistency in planning and execution for risk analysis. (67 pages, ~US\$190) This standard has been **withdrawn**.

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### **Risk Management**

[IEC 62198 \(2001-04\)](#) **Project risk management – Application guidelines.** Describes a general introduction to project risk management, its sub-processes and influencing factors, and provides guidelines for implementing risk management at various phases of a project. (37 pages, ~US\$95)

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### **Collection And Presentation of Dependability Data**

[IEC 60300-3-2 \(2004-11\)](#) **Dependability management-Part 3: Section 2:** Collection of dependability data from the field. Describes guidelines for the collection of data relating to reliability, maintainability, availability, and maintenance support performance in the field. (79 pages, US\$210)

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### **Also refer to following documents for data collection:**

[ISO 14224:2006](#) **Petroleum, petrochemical and natural gas industries—Collection and exchange of reliability and maintenance data for equipment..** (170 pages, ~US\$250)

ISO 14224.2006 provides a comprehensive basis for the collection of reliability and maintenance (RM) data in a standard format for equipment in all facilities and operations within the petroleum, natural gas and petrochemical industries during the operational life cycle of equipment. It describes data-collection principles and associated terms and definitions that constitute a “reliability language” that can be useful for communicating operational experience. The failure modes defined in ISO 14224.206 can be used as a “reliability thesaurus” for various quantitative as well as qualitative applications. ISO 14224.2006 also describes data quality control and assurance practices to provide guidance for the users.

Standardization of data-collection practices facilitates the exchange of information between parties, e.g. plants, owners, manufacturers and contractors. ISO 14224.2006 establishes requirements that may in-house or commercially available RM data system is required to meet when designed for RM data exchange. Examples, guidelines, and principles for the exchange and merging of such RM data are addressed.

ISO 14224.2006 recommends a minimum amount of data that is required to be

collected and focuses on the two main issues: data requirements for the type of data to be collected for use in various analysis methodologies and standardized data format to facilitate the exchange of reliability and maintenance data between plants, owners, manufacturers and contractors.

The following main categories of data are to be collected: equipment data, e.g. equipment taxonomy, equipment attributes, failure data, e.g. failure causes, failure consequence, maintenance data, e.g. maintenance action, resources used, maintenance consequence, down time.

ISO 14224.2006 does not apply to data on (direct) cost issues, data from laboratory testing and manufacturing (e.g. accelerated lifetime testing): complete equipment data sheets (only data seen relevant for assessing the reliability performance are included); additional on-service data that an operator, on an individual basis, can consider useful for operation and maintenance; and methods for analyzing and applying RM data (however, principles for how to calculate some basic reliability and maintenance parameters are included).

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[Process Equipment Reliability Database \(PERD\)](#) with [taxonomies](#) and technical papers are available. [PERD publications](#) are available for sale and download. This project for the process industry pertains to data collection and analysis.

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[IEC 60319 \(1990-09\)](#) **Presentation and specification of reliability data for electronic components.** Describes data needed to characterizing reliability of components and gives guidance to users how to specify their reliability requirements to manufacturers. (39 pages, ~US\$57)

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### **Miscellaneous**

[IEC 60050-191\(1990-12\)](#) **International Electrotechnical Vocabulary, Chapter 191: Dependability and quality of service** (149 pages, ~US\$285)

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[IEC 61703 \(2001-09\)](#) **Mathematical expressions for reliability, availability, maintainability and maintenance support terms** (103 pages, ~US\$255)

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