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Petroleum, petrochemical and natural gas industries — Collection and exchange of reliability and maintenance data for equipment

Industries du pétrole, de la pétrochimie et du gaz naturel — Recueil et échange de données de fiabilité et de maintenance des équipements

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 14224 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*.

This second edition cancels and replaces the first edition (ISO 14224:1999), which has been technically modified and extended. Annex B, which contains failure and maintenance notations, has been made normative. Further, additional informative Annexes A, C, D, E and F give recommendations on the use of reliability and maintenance data for various applications.

Introduction

This International Standard has been prepared based on ISO 14224:1999, experience gained through its use, and know-how and best practices shared through the international development process.

In the petroleum, natural gas and petrochemical industries, great attention is being paid to safety, reliability and maintainability of equipment. The industry annual cost of equipment unreliability is very large, although many plant owners have improved the reliability of their operating facilities by such attention. A stronger emphasis has recently been put on cost-effective design and maintenance for new plants and existing installations among more industrial parties. In this respect, data on failures, failure mechanisms and maintenance related to these industrial facilities and its operations have become of increased importance. It is necessary that this information be used by, and communicated between, the various parties and its disciplines, within the same company or between companies. Various analysis methodologies are used to estimate the risk of hazards to people and environment, or to analyse plant or system performance. For such analyses to be effective and decisive, equipment reliability and maintenance (RM) data are vital.

These analyses require a clear understanding of the equipment technical characteristics, its operating and environmental conditions, its potential failures and its maintenance activities. It can be necessary to have data covering several years of operation before sufficient data have been accumulated to give confident analysis results and relevant decision support. It is necessary, therefore, to view data collection as a long-term activity, planned and executed with appropriate goals in mind. At the same time, clarity as to the causes of failures is key to prioritizing and implementing corrective actions that result in sustainable improvements in reliability, leading to improved profitability and safety.

Data collection is an investment. Data standardization, when combined with enhanced data-management systems that allow electronic collection and transfer of data, can result in improved quality of data for reliability and maintenance. A cost-effective way to optimize data requirements is through industry co-operation. To make it possible to collect, exchange and analyse data based on common viewpoints, a standard is required. Standardization of data-collection practices facilitates the exchange of information between relevant parties e.g. plants, owners, manufacturers and contractors throughout the world.

Petroleum, petrochemical and natural gas industries — Collection and exchange of reliability and maintenance data for equipment

1 Scope

This International Standard 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 the normative part of this International Standard can be used as a "reliability thesaurus" for various quantitative as well as qualitative applications. This International Standard also describes data quality control and assurance practices to provide guidance for the user.

Standardization of data-collection practices facilitates the exchange of information between parties, e.g. plants, owners, manufacturers and contractors. This International Standard establishes requirements that any 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.

Annex A contains a summary of equipment that this International Standard covers.

- This International Standard recommends a minimum amount of data that is required to be collected and it focuses on two main issues:
  - data requirements for the type of data to be collected for use in various analysis methodologies;
  - 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 cause, failure consequence;
  - maintenance data, e.g. maintenance action, resources used, maintenance consequence, down time.

NOTE Clause 9 gives further details on data content and data format.

- The main areas where such data are used are the following:
  - reliability, e.g. failure events and failure mechanisms;
  - availability/efficiency, e.g. equipment availability, system availability, plant production availability;
  - maintenance, e.g. corrective and preventive maintenance, maintenance supportability;
  - safety and environment, e.g. equipment failures with adverse consequences for safety and/or environment.

- This International Standard does not apply to the following:
  - — 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;
  - — methods for analysing and applying RM data (however, principles for how to calculate some basic reliability and maintenance parameters are included in the annexes).

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 60034-1:2004*, Rotating electrical machines — Part 1: Rating and performance*

IEC 60076-1:2000, *Power transformers — Part 1: General*

IEC 60076-2:1993, *Power transformers — Part 2: Temperature rise*

EC 60076-3, *Power transformers — Part 3: Insulation levels, dialectric tests and external clearances in air*

IEC 60529:2001, *Degrees of protection provided by enclosures (IP Code)*

IEC 62114, *Electrical insulation systems — Thermal classification*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE Some derived RM parameters, which can be calculated from collected RM data covered by this International Standard, are contained in Annex C. References to Annex C are given as deemed appropriate.

3.1
availability
ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided

NOTE For a more detailed description and interpretation of availability, see Annex C.

3.2
active maintenance time
that part of the maintenance time during which a maintenance action is performed on an item, either automatically or manually, excluding logistic delays

NOTE 1 A maintenance action can be carried out while the item is performing a required function.

NOTE 2 For a more detailed description and interpretation of maintenance times, see Figure 4 and Annex C.

3.3
boundary
interface between an item and its surroundings

3.4
common-cause failure
failures of different items resulting from the same direct cause, occurring within a relatively short time, where these failures are not consequences of another

NOTE Components that fail due to a shared cause normally fail in the same functional mode. The term common mode is, therefore, sometimes used. It is, however, not considered to be a precise term for communicating the characteristics that describe a common-cause failure.

3.5
corrective maintenance
maintenance carried out after fault recognition and intended to put an item into a state in which it can perform a required function

NOTE For more specific information, see IEC 60050-191:1990, Figure 191-10.

3.6
critical failure
failure of an equipment unit that causes an immediate cessation of the ability to perform a required function

NOTE Includes failures requiring immediate action towards cessation of performing the function, even though actual operation can continue for a short period of time. A critical failure results in an unscheduled repair.

3.7
degraded failure
failure that does not cease the fundamental function(s), but compromises one or several functions

NOTE The failure can be gradual, partial or both. The function can be compromised by any combination of reduced, increased or erratic outputs. An immediate repair can normally be delayed but, in time, such failures can develop into a critical failure if corrective actions are not taken.

3.8
demand
activation of the function (includes functional, operational and test activation)

NOTE For a more detailed description, see C.2.2.

3.9
down state
internal disabled state of an item characterized either by a fault or by a possible inability to perform a required function during preventive maintenance

NOTE This state is related to availability performance (see 3.1).

3.10
down time
time interval during which an item is in a down state

NOTE The down time includes all the delays between the item failure and the restoration of its service. Down time can be either planned or unplanned (see Table 4).

3.11
equipment class
class of similar type of equipment units (e.g. all pumps)

NOTE Annex A describes a variety of equipment classes.

3.12
equipment data
technical, operational and environmental parameters characterizing the design and use of an equipment unit

3.13
equipment unit
specific equipment unit within an equipment class as defined by its boundary (e.g. one pump)

3.14
error
discrepancy between a computed, observed or measured value or condition and the true, specified or theoretically correct value or condition

NOTE 1 An error can be caused by a faulty item, e.g. a computing error made by faulty computer equipment.

NOTE 2 The French term “erreur” can also designate a mistake.

3.15
failure
termination of the ability of an item to perform a required function

NOTE 1 After the failure, the item has a fault.

NOTE 2 “Failure” is an event, as distinguished from a “fault,” which is a state.

NOTE 3 This concept as defined does not apply to items consisting of software only.

NOTE 4 See also Table B.1 and Clauses F.2 and F.3.

3.16
failure cause
root cause
circumstances associated with design, manufacture, installation, use and maintenance that have led to a failure

NOTE See also B.2.3.

3.17
failure data
data characterizing the occurrence of a failure event

3.18
failure impact
impact of a failure on an equipment's function(s) or on the plant

NOTE On the equipment level, failure impact can be classified in three classes (critical, degraded, incipient); see 3.6, 3.7 and 3.26). Classification of failure impact on taxonomy levels 3 to 5 (see Figure 3) is shown in Table 3.

3.19
failure mechanism
physical, chemical or other process that leads to a failure

NOTE See also B.2.2.

3.20
failure mode
effect by which a failure is observed on the failed item

NOTE See also B.2.6.

3.21
failure on demand
failure occurring immediately when the item is solicited to start (e.g. stand-by emergency equipment)

NOTE See also Clause C.6.

3.22
fault
state of an item characterized by inability to perform a required function, excluding such inability during preventive maintenance or other planned actions, or due to lack of external resources

3.23
generic reliability data
reliability data covering families of similar equipment

3.24
hidden failure
failure that is not immediately evident to operations and maintenance personnel

NOTE Equipment that fails to perform an “on demand” function falls into this category. It is necessary that such failures be detected to be revealed.

3.25
idle time
part of the up time that an item is not operating

3.26
incipient failure
imperfection in the state or condition of an item so that a degraded or critical failure might (or might not) eventually be the expected result if corrective actions are not taken

3.27
indenture level
level of subdivision of an item from the point of view of maintenance action

3.28
item
any part, component, device, subsystem, functional unit, equipment or system that can be individually considered

NOTE In this International Standard, the common term “item” is used on all taxonomy levels 6 to 9 in Figure 3. See also 3.30, which defines a specific item level.

3.29
logistic delay
that accumulated time during which maintenance cannot be carried out due to the necessity to acquire maintenance resources, excluding any administrative delay

NOTE Logistic delays can be due to, for example, travelling to unattended installations, pending arrival of spare parts, specialist, test equipment and information, and delays due to unsuitable environmental conditions (e.g. waiting on weather).

3.30
maintainable item
item that constitutes a part or an assembly of parts that is normally the lowest level in the equipment hierarchy during maintenance

3.31
maintenance
combination of all technical and administrative actions, including supervisory actions, intended to retain an item in, or restore it to, a state in which it can perform a required function