INTERNATIONAL STANDARD

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

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

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Contents

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

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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 3.

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.

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

Annexes A, B, C and D of this International Standard are for information only.

Introduction

This International Standard has been prepared based on know-how and experience gained through the data collection project OREDA[1)], which has been carried out by several major oil companies since the early 1980s. During these years, a large amount of data have been collected and substantial knowledge in reliability data collection accumulated. The text of this International Standard relating to downhole equipment is based on know-how and experience gained through the WELLMASTER [2)] project.

In the petroleum and natural gas industry, great attention is being paid to safety, reliability and maintainability of equipment. Various analyses are used to estimate the risk of hazards, pollution or damage to equipment. For such analyses, Reliability and Maintenance (RM) data are vital.

More emphasis has recently been put on cost-effective design and maintenance for new plants and existing installations. In this respect data on failures, failure mechanisms and maintenance have become of increased importance.

Data collection is an investment. By standardization and improved facility information management systems that allow electronic collection and transfer of data, quality can be improved. A cost-effective way to maximize the amount and type of data is through industry cooperation. To make it possible to collect, exchange and analyse data based on common ground, a standard is required. This International Standard gives recommendations to the petroleum and natural gas industry on specification and execution of RM data collection, both as a separate exercise and in the day-to-day recording of historical data in maintenance management systems.

1) Guideline for Data Collection.

2) User's Guide and Reliability Data Collection Guidelines for Well Completion Equipment (1995): ISBN 82-595-8586-3.

Petroleum 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 in the areas of drilling, production, refining and transport by pipeline of petroleum and natural gas.

This International Standard presents guidelines for the specification, collection and quality assurance of RM data, facilitating the collection of RM data. The data will enable the user to quantify the reliability of the equipment and to compare the reliability of equipment with similar characteristics.

By analysing the data, reliability parameters can be determined for use in design, operation and maintenance. However, this International Standard is not applicable to the method of analysis for RM data.

The main objectives of this International Standard are:

a) to specify the data to be collected for analysis of:

- system design and configuration;
- safety, reliability and availability of systems and plants;
- life cycle cost;
- planning, optimization and execution of maintenance.

b) to specify data in a standardized format in order to:

- permit exchange of RM data between plants, owners, manufacturers and contractors;
- ensure that RM data are of sufficient quality for the intended analysis.

This International Standard is applicable to all equipment types used in the petroleum and natural gas industry, such as process equipment (used on onshore and offshore installations), subsea equipment, well-completion equipment and drilling equipment. In annex A several examples are included.

This International Standard is applicable to data collected in the operational phase.

Due to the variety of different uses for RM data, it is stressed that, for each data collection programme, attention should be given to the appropriate level of data required.

NOTE It is recognized that to strengthen the goal of this International Standard, a normative reference detailing all the taxonomy codes for each of these equipment classes is appropriate. However, since no comprehensive taxonomy listing covering all equipment classes exists at the time of publication of this International Standard, a sample of taxonomies for process equipment, subsea equipment, well-completion equipment and drilling equipment is contained in informative annex A.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, this publication do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

3.1.1
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

[IEC 60050-191:1990]

3.1.2
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

[IEC 60050-191:1990]

NOTE For more specific information, refer to Figure 191-10 "Maintenance time diagram" in IEC 60050-191.

3.1.3
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

[IEC 60050-191:1990]

NOTE For more specific information, refer to Figure 191-10 "Maintenance time diagram" in IEC 60050-191.

3.1.4
critical failure
failure of an equipment unit which causes an immediate cessation of the ability to perform its required function

NOTE For well-completion equipment, see additional information in A.4.5.

3.1.5
data acquirer
person or organization in charge of the data collection process

3.1.6
demand
activation of the function (includes both operational and test activation)

3.1.7
down state
state of an item characterized either by a fault or by a possible inability to perform a required function during preventive maintenance

[IEC 60050-191:1990]

3.1.8
down time
time interval during which an item is in a down state

[IEC 60050-191:1990]

NOTE For more specific information, refer to Figure 191-10 "Maintenance time diagram" in IEC 60050-191.

3.1.9
equipment class
class of equipment units

EXAMPLE All pumps.

NOTE For well-completion equipment, see additional information in A.4.5.

3.1.10
equipment unit
specific equipment unit within an equipment class as defined within the main boundary

EXAMPLE A pump.

3.1.11
equipment unit redundancy
⟨on the equipment unit level⟩ existence of more than one means for performing the required function

EXAMPLE 3 × 50 %.

3.1.12
failure
termination of the ability of an item to perform a required function

[IEC 60050-191:1990]

3.1.13
failure cause
circumstances during design, manufacture or use which have led to a failure

[IEC 60050-191:1990]

NOTE Identification of the failure cause normally requires some in-depth investigation to uncover the underlying human or organizational factors as well as the technical cause.

3.1.14
failure descriptor
apparent, observed cause of a failure

NOTE As normally reported into the maintenance management system.

3.1.15
failure mechanism
physical, chemical or other process which has led to a failure

[IEC 60050-191:1990]

3.1.16
failure mode
observed manner of failure

3.1.17
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

[IEC 60050-191:1990]

3.1.18
item
any part, component, device, subsystem, functional unit, equipment or system that can be individually considered

[IEC 60050-191:1990]

3.1.19
maintainable item
item that constitutes a part, or an assembly of parts, that is normally the lowest level in the hierarchy during maintenance

3.1.20
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

[IEC 60050-191:1990]

3.1.21
maintenance man-hour

accumulated durations of the individual maintenance times, expressed in hours, used by all maintenance personnel for a given type of maintenance action or over a given time interval

[IEC 60050-191:1990]

NOTE For more specific information, refer to Figure 191-10 "Maintenance time diagram" in IEC 60050-191.

3.1.22
non-critical failure
failure of an equipment unit which does not cause an immediate cessation of the ability to perform its required function

NOTE For well-completion equipment, see additional information in A.4.5.

3.1.23
operating state
state when an item is performing a required function

[IEC 60050-191:1990]

3.1.24
operating time
time interval during which an item is in an operating state

[IEC 60050-191:1990]

NOTE For well-completion equipment, see additional information in A.4.5.

3.1.25
preventive maintenance
maintenance carried out at predetermined intervals or according to prescribed criteria, and intended to reduce the probability of failure or the degradation of the functioning of an item

[IEC 60050-191:1990]

3.1.26
redundancy
⟨in an item⟩ existence of more than one means for performing a required function

[IEC 60050-191:1990]

3.1.27
reliability
performance
ability of an item to perform a required function under given conditions for a given time interval

[IEC 60050-191:1990]

3.1.28
required function
function, or combination of functions, of an item which is considered necessary to provide a given service

[IEC 60050-191:1990]

3.1.29
severity class
effect on equipment unit function

3.1.30
subunit
assembly of items that provides a specific function that is required for the equipment unit within the main boundary to achieve its intended performance

3.1.31
surveillance period
interval of time between the start date and end date of data collection

3.2 Abbreviations

BEN	Benchmarking
LCC	Life Cycle Cost
MI	Maintainable Item
OREDA	Project for collection of oil and gas industry equipment reliability and maintenance data
PM	Preventive Maintenance
QRA	Quantitative Risk Assessment
RAM	Reliability, Availability and Maintainability analysis
RCM	Reliability-Centred Maintenance
RM	Reliability and Maintenance
WELLMASTER	Reliability data collection for well-completion equipment

4 Quality of data

4.1 Definition of data quality

Confidence in the collected RM data, and hence any analysis, is strongly dependent on the quality of the data collected. High-quality data is characterized by:

— completeness of data in relation to specification;

— compliance with definitions of reliability parameters, data types and formats;

— accurate input, transfer, handling and storage of data (manually or electronic).

4.2 Guidance for obtaining quality data

To obtain high quality data, the following measures shall be emphasized before the data collection process starts:

— investigate the data sources to make sure the required inventory data can be found and the operational data are complete;

— define the objective for collecting the data in order to collect relevant data for the intended use. Examples of analyses where such data may be used are: Quantitative Risk Analysis (QRA); Reliability, Availability and Maintainability Analysis (RAM); Reliability-Centred Maintenance (RCM); Life Cycle Cost (LCC);

— investigate the source(s) of the data to ensure that relevant data of sufficient quality is available;

— identify the installation date, population and operating period(s) for the equipment from which data may be collected;

— a pilot exercise of the data collection methods and tools (manual, electronic) is recommended to verify the feasibility of the planned data collection procedures;

— prepare a plan for the data collection process, e.g. schedules, milestones, sequence and number of equipment units, time periods to be covered, etc.;

— train, motivate and organize the data collection personnel;

— plan for quality assurance of the data collection process. This shall as a minimum include procedures for quality control of data and recording and correcting deviations. An example of a checklist is included in Annex C.

During and after the data collection exercise, analyse the data to check consistency, reasonable distributions, proper codes and correct interpretations. The quality control process shall be documented. When merging individual data bases it is imperative that each data record has a unique identification.

4.3 Data source systems

The facility maintenance management system constitutes the main source of RM data. The quality of the data which can be retrieved from this source is dependent on the way RM data is reported in the first place. Reporting of RM data according to this International Standard shall be allowed for in the facility maintenance management system, thereby providing a more consistent and sound basis for transferring RM data to equipment RM databases.

The level of detail of RM data reported and collected shall be closely linked to the production and safety importance of the equipment. Prioritization shall be based on regularity, safety and other criticality evaluations.

Those responsible for reporting RM data will derive benefit from the use of these data. Involvement of these staff in determining and communicating these benefits is a requirement for quality RM data.

5 Equipment boundary and hierarchy

5.1 Boundary description

A clear boundary description is imperative for collecting, merging and analysing RM data from different industries, plants or sources. The merging and analysis will otherwise be based on incompatible data.

For each equipment class, a boundary shall be defined indicating what RM data are to be collected.

An example of a boundary diagram for a pump is shown in Figure 1.

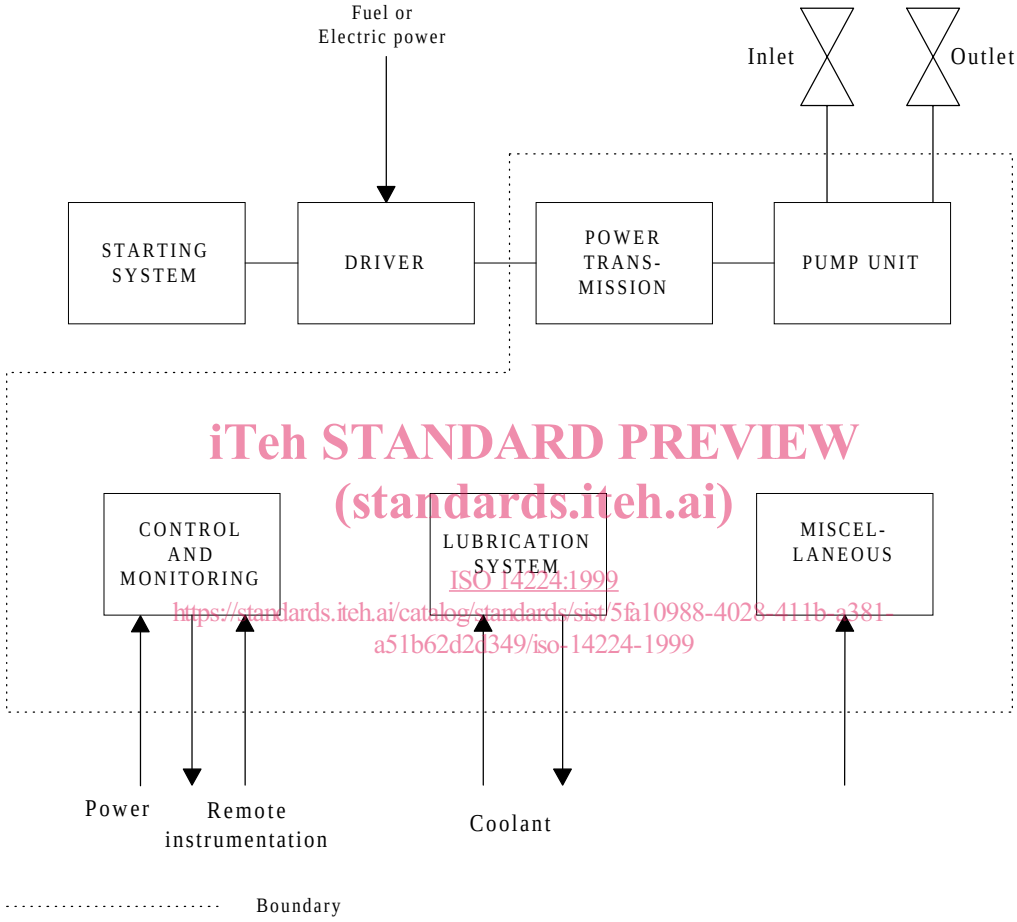

Figure 1 — Example of boundary diagram (pumps)

The boundary diagram shall show the subunits and the interfaces to the surroundings. Additional textual description shall, when needed for clarity, state in more detail what shall be considered inside and outside the boundaries.

Due attention shall be paid to the location of the instrument elements. In the above example, the central control and monitoring items are typically included within the “Control and monitoring” subunit, while individual instrumentation (trip, alarm, control) is typically included within the appropriate subunit, e.g. lubrication system.

5.2 Guidance for defining an equipment hierarchy

Preparation of a hierarchy for the equipment is recommended. The highest level is the equipment unit class. The number of levels for subdivision will depend on the complexity of the equipment unit and the use of the data. Reliability data need to be related to a certain level within the equipment hierarchy in order to be meaningful and comparable. For example, the reliability data “severity class” shall be related to the equipment unit, while the failure cause shall be related to the lowest level in the equipment hierarchy.

A single instrument may need no further breakdown, while several levels are required for a compressor. For data used in availability analyses, the reliability at the equipment unit level may be the only desirable data needed, while an RCM analysis will need data on failure mechanism at maintainable item level.

A subdivision into three levels for an equipment unit will normally be sufficient. An example is shown in Figure 2, viz. equipment unit, subunit and maintainable items.

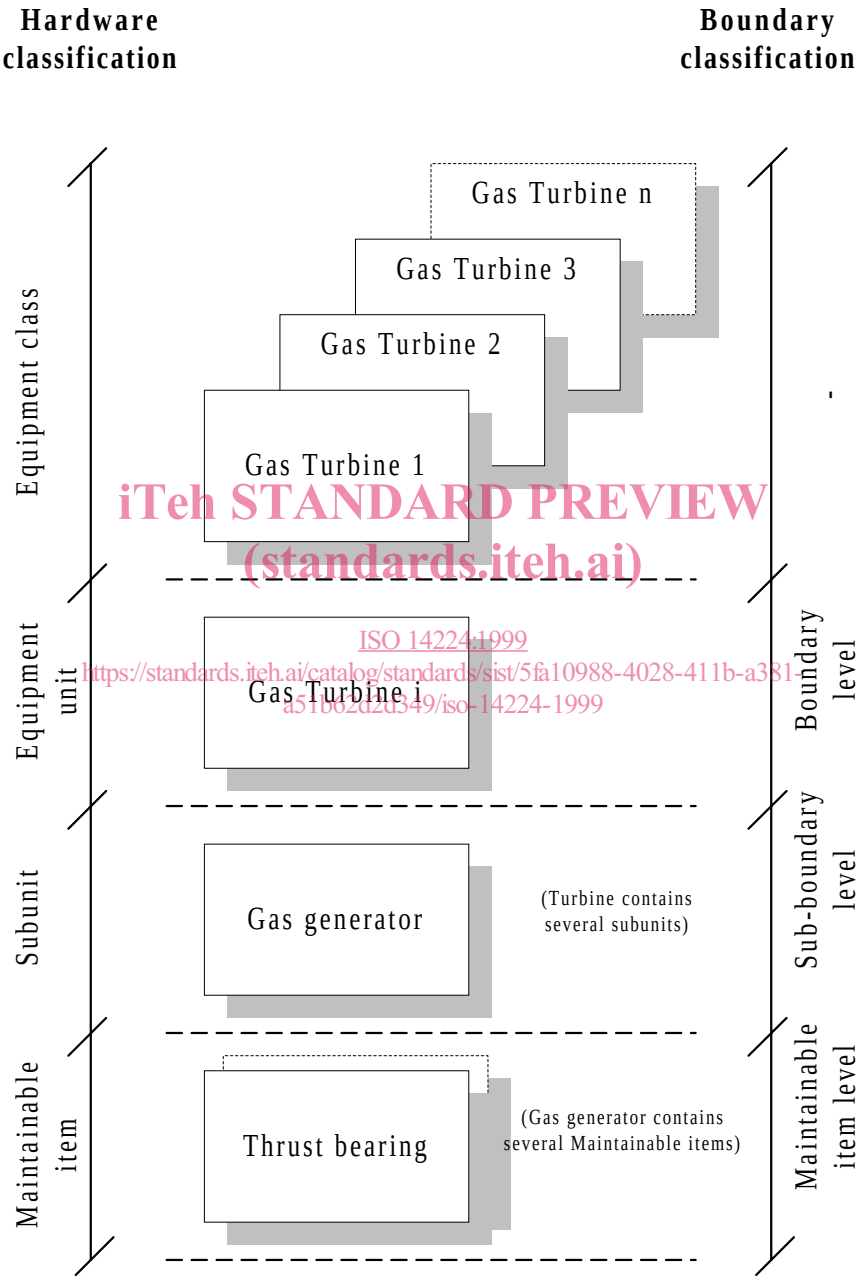

Figure 2 — Example of equipment hierarchy

6 Information structure

6.1 Data categories

The RM data shall be collected in an organized and structured way. The major data categories for equipment, failure and maintenance data are given below.

a) Equipment data

The description of equipment is characterized by:

1) identification data, e.g. equipment location, classification, installation data, equipment unit data;

2) design data, e.g. manufacturer's data, design characteristics;

3) application data, e.g. operation, environment.

These data categories shall be general for all equipment classes, e.g. type classification, and specific for each equipment unit, e.g. number of stages for a compressor. This shall be reflected in the database structure. For more details see Table 1.

b) Failure data

These data are characterized by:

1) identification data, failure record and equipment location;

2) failure data for characterizing a failure, e.g. failure date, maintainable items failed, severity class, failure mode, failure cause, method of observation.

For more details see Table 2.

c) Maintenance data

These data are characterized by:

1) identification data; e.g. maintenance record, equipment location, failure record;

2) maintenance data; parameters characterizing a maintenance, e.g. date of maintenance, maintenance category, maintenance activity, items maintained, maintenance man hours per discipline, active maintenance time, down time.

For more details see Table 3.

The type of failure and maintenance data shall normally be common for all equipment classes, with exceptions where specific data types need to be collected, e.g. subsea equipment.

Corrective maintenance events shall be recorded in order to describe the corrective action following a failure. Preventive maintenance records are required to retain the complete lifetime history of an equipment unit.

6.2 Data format

Each record, e.g. a failure event, shall be identified in the database by a number of attributes. Each attribute describes one piece of information, e.g. the failure mode. It is recommended that each piece of information be coded where possible. The advantages of this approach versus free text are:

— facilitation of queries and analysis of data;

— ease of data input;

— consistency check undertaken at input, by having pre-defined codes.