

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

ICS 75.180.01

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW



Document Sharing Hub

National foreword

This British Standard reproduces verbatim ISO 14224:1999 and implements it as the UK national standard.

The UK participation in its preparation was entrusted to Technical Committee PSE/17, Materials and equipment for petroleum and natural gas industries, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the ISO title page, pages ii to vi, pages 1 to 68 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 October 1999

© BSI 03-2000

ISBN 0 580 35375 3

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
National foreword	Inside front cover
Foreword	v
Text of ISO 14224	1

INTERNATIONAL
STANDARD

ISO
14224

First edition
1999-07-15

**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*



Reference number
ISO 14224:1999(E)

Contents

	Page
Foreword	v
Introduction	1
1 Scope	1
2 Normative reference	2
3 Terms, definitions and abbreviated terms	2
3.1 Terms and definitions	2
3.2 Abbreviations	5
4 Quality of data	5
4.1 Definition of data quality	5
4.2 Guidance for obtaining quality data	5
4.3 Data source systems	6
5 Equipment boundary and hierarchy	6
5.1 Boundary description	6
5.2 Guidance for defining an equipment hierarchy	7
6 Information structure	8
6.1 Data categories	8
6.2 Data format	9
6.3 Database structure	12
7 Equipment, failure and maintenance data	12
7.1 Equipment data	12
7.2 Failure data	13
7.3 Maintenance data	13
Annex A (informative) Equipment class attributes	14
A.1 Advisory notes	14
A.2 Process equipment	14
A.3 Subsea equipment	48
A.4 Well-completion equipment	52
A.5 Drilling equipment	57
Annex B (informative) Failure and maintenance notations	62
Annex C (informative) Quality control checklist	65
C.1 Quality control before and during data collection	65
C.2 Verification of collected data	66
Annex D (informative) Typical requirements for data	66
Bibliography	68
Figure 1 — Example of boundary diagram (pumps)	7
Figure 2 — Example of equipment hierarchy	8
Figure 3 — Database structure	12
Figure A.1 — Equipment boundary — Combustion engines	15
Figure A.2 — Equipment boundary — Compressors	18
Figure A.3 — Equipment boundary — Control logic units	21
Figure A.4 — Equipment boundary — Electric generators	23
Figure A.5 — Equipment boundary — Electric motors	25
Figure A.6 — Equipment boundary — Fire and gas detectors	27
Figure A.7 — Equipment boundary — Gas turbines	31
Figure A.8 — Equipment boundary — Heat exchangers	33
Figure A.9 — Equipment boundary — Process sensors	35
Figure A.10 — Equipment boundary — Pumps	38
Figure A.11 — Equipment boundary — Turboexpanders	41
Figure A.12 — Equipment boundary — Valves	44
Figure A.13 — Equipment boundary — Vessels	47

	Page
Figure A.14 — Equipment boundary — Wellhead and Xmas trees	49
Figure A.15 — Equipment boundary — Top drives	58
Table 1 — Equipment data	10
Table 2 — Failure data	11
Table 3 — Maintenance data	11
Table A.1 — Taxonomy classification — Combustion engines	14
Table A.2 — Equipment unit subdivision — Combustion engines	16
Table A.3 — Equipment unit specific data — Combustion engines	16
Table A.4 — Failure modes — Combustion engines	17
Table A.5 — Taxonomy classification — Compressors	17
Table A.6 — Equipment unit subdivision — Compressors	18
Table A.7 — Equipment unit specific data — Compressors	19
Table A.8 — Failure modes — Compressors	20
Table A.9 — Taxonomy classification — Control logic units	20
Table A.10 — Equipment unit subdivision — Control logic units	21
Table A.11 — Equipment unit specific data — Control logic units	22
Table A.12 — Failure modes — Control logic units	22
Table A.13 — Taxonomy classification — Electric generators	22
Table A.14 — Equipment unit subdivision — Electric generators	22
Table A.15 — Equipment unit specific data — Electric generators	23
Table A.16 — Failure modes — Electric generators	24
Table A.17 — Taxonomy classification — Electric motors	24
Table A.18 — Equipment unit subdivision — Electric motors	25
Table A.19 — Equipment unit specific data — Electric motors	26
Table A.20 — Failure modes — Electric motors	26
Table A.21 — Taxonomy classification — Fire and gas detectors	27
Table A.22 — Equipment unit subdivision — Fire and gas detectors	27
Table A.23 — Equipment unit specific data — Fire and gas detectors	28
Table A.24 — Data recording times for combinations of repair type/failure mode for fire and gas detectors and process sensors	29
Table A.25 — Failure modes — Fire and gas detectors	30
Table A.26 — Taxonomy classification — Gas turbines	30
Table A.27 — Equipment unit subdivision — Gas turbines	31
Table A.28 — Equipment unit specific data — Gas turbines	32
Table A.29 — Failure modes — Gas turbines	32
Table A.30 — Taxonomy classification — Heat exchangers	33
Table A.31 — Equipment unit subdivision — Heat exchangers	34
Table A.32 — Equipment unit specific data — Heat exchangers	34
Table A.33 — Failure modes — Heat exchangers	34
Table A.34 — Taxonomy classification — Process sensors	35
Table A.35 — Equipment unit subdivision, process sensors	36
Table A.36 — Equipment unit specific data — Process sensors	36
Table A.37 — Failure modes — Process sensors	37
Table A.38 — Taxonomy classification — Pumps	37
Table A.39 — Equipment unit subdivision — Pumps	38
Table A.40 — Equipment unit specific data — Pumps	39
Table A.41 — Failure modes — Pumps	40
Table A.42 — Taxonomy classification — Turboexpanders	40

	Page
Table A.43 — Equipment unit subdivision — Turboexpanders	40
Table A.44 — Equipment unit specific data — Turboexpanders	42
Table A.45 — Failure modes — Turboexpanders	43
Table A.46 — Taxonomy classification — Valves	43
Table A.47 — Equipment unit subdivision — Valves	44
Table A.48 — Equipment unit specific data — Valves	45
Table A.49 — Failure modes — Valves	46
Table A.50 — Taxonomy classification — Vessels	46
Table A.51 — Equipment unit subdivision — Vessels	47
Table A.52 — Equipment unit specific data — Vessels	48
Table A.53 — Failure modes — Vessels	48
Table A.54 — Taxonomy classification — Wellhead and Xmas trees	48
Table A.55 — Equipment unit subdivision — Wellhead and Xmas trees	50
Table A.56 — Equipment unit specific data — Wellhead and X-mas trees	51
Table A.57 — Failure modes — Wellhead and X-mas trees	52
Table A.58 — Item database format and name specification	53
Table A.59 — Data collection format for string item example — Tubing	54
Table A.60 — Failure data report — Well-completion equipment	55
Table A.61 — Environmental data — Monthly average	56
Table A.62 — Critical and non-critical failures — Tubing-retrievable surface-controlled subsurface safety valve (TR-SCSSV) example	57
Table A.63 — Taxonomy classification — Top drives	57
Table A.64 — Equipment unit subdivision — Top drives	59
Table A.65 — Equipment unit specific data — Top drives	60
Table A.66 — Failure mode	61
Table B.1 — Failure descriptors	62
Table B.2 — Failure causes	63
Table B.3 — Method of detection	64
Table B.4 — Maintenance activity	65
Table C.1 — Data quality control form (example)	66
Table D.1 — Data requirements for various applications	67

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*.

Annex A, Annex B, Annex C and Annex 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 OREDA¹⁾, 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 WELLMASTER²⁾ 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 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.

¹⁾ Guideline for Data Collection.

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

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 $3 \times 50\%$

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.

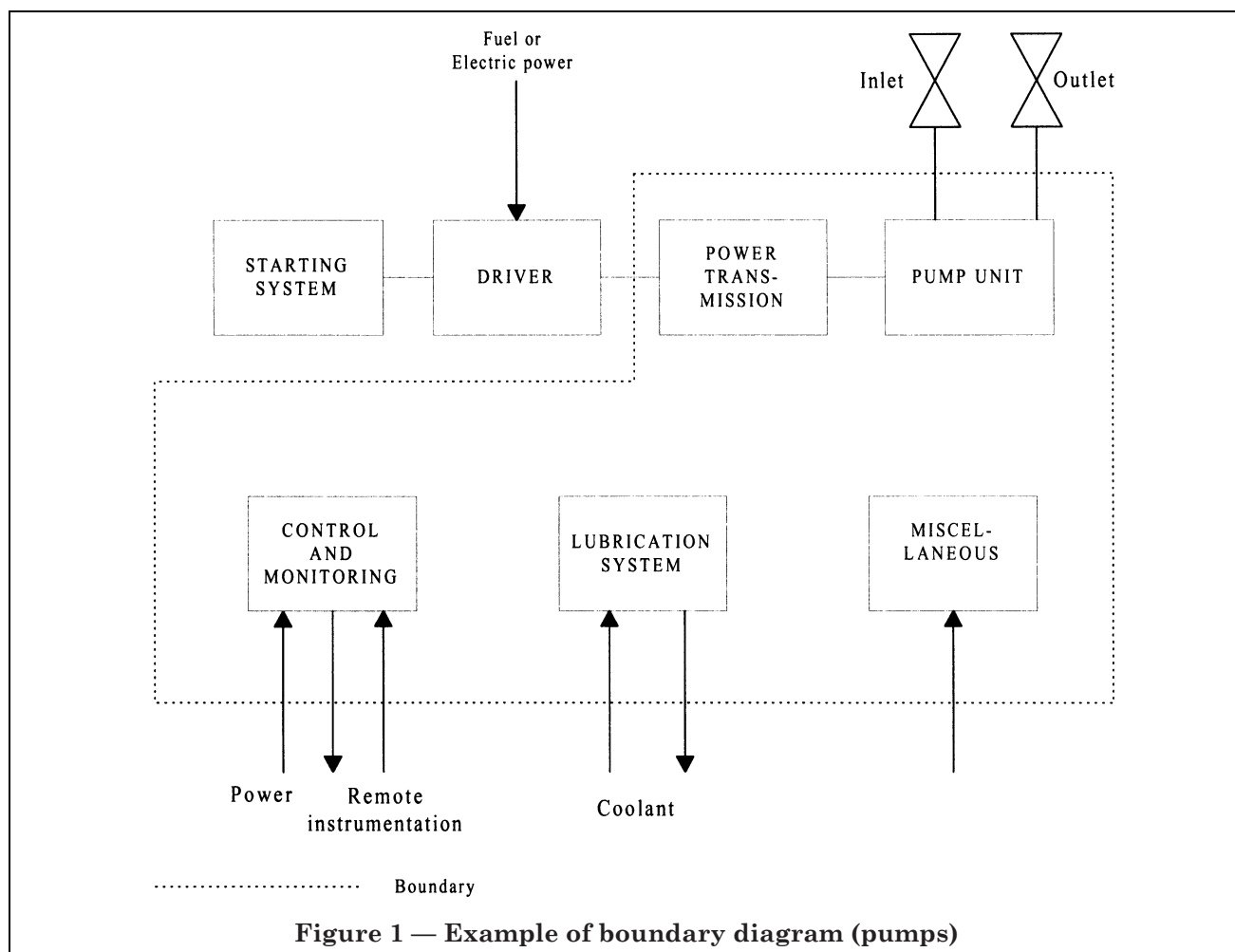
5 Equipment boundary and hierarchy

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.



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.

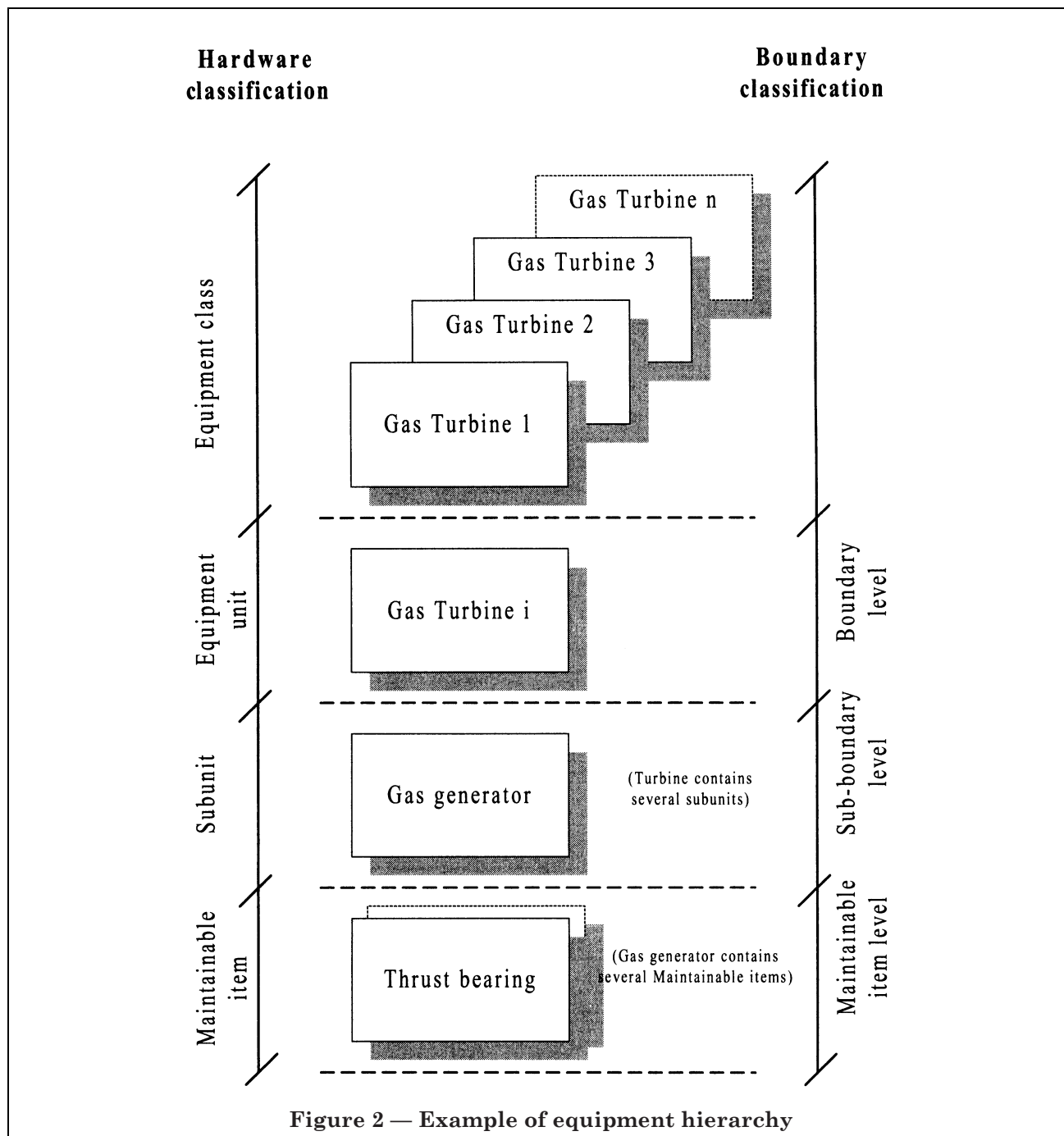
Due attention shall be paid to the location of the instrument elements. In the above example, the central control and monitoring items are typically included within the “Control and monitoring” subunit, while individual instrumentation (trip, alarm, control) is typically included within the appropriate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



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.

The range of pre-defined codes shall be optimized. A short range of codes may be too general to be useful. A long range of codes may give a more precise description, but will slow the input process and may not be used fully by the data acquirer. Examples of this are given in Annex A and Annex B for different equipment types and codes.

The disadvantage of a pre-defined list of codes versus free text is that some detailed information may be lost. It is recommended that free text be included to provide supplementary information. A free-text field with additional information is also useful for quality control of data.

Table 1 — Equipment data

Main categories	Subcategories	Data
Identification	Equipment location	Equipment tag number (*)
	Classification	Equipment unit class, e.g. compressor (see Annex A) (*) Equipment type (see Annex A) (*) Application (see Annex A) (*)
	Installation data	Installation code or name (*) Installation category, e.g. platform, subsea, refinery (*) Operation category, e.g. manned, remote controlled (*) Geographic area, e.g. Southern North Sea, Adriatic Sea, Gulf of Mexico, continental Europe, Middle East
	Equipment unit data	Equipment unit description (nomenclature) Unique number, e.g. serial number Subunit redundancy, e.g. number of redundant subunits
	Manufacturer's data	Manufacturer's name (*) Manufacturer's model designation (*)
	Design characteristics	Relevant for each equipment class, e.g. capacity, power, speed, pressure, see Annex A (*)
Application	Operation (normal use)	Equipment unit redundancy, e.g. $3 \times 50\%$ Mode while in the operating state, e.g. continuous running, standby, normally closed/open, intermittent Date the equipment unit was installed or date of production start-up Surveillance period (calendar time)(*) The accumulated operating time during the surveillance period Number of demands during the surveillance period as applicable Operating parameters as relevant for each equipment class, e.g. operating power, operating speed, see Annex A
	Environmental factors	Ambient conditions (severe, moderate, benign) ^a Interior environment (severe, moderate, benign) ^b
Remarks	Additional information	Additional information in free text as applicable Source of data, e.g. process and instrumentation diagram, data sheet, maintenance system

^a Features to be considered, e.g. degree of protective enclosure, vibration, salt spray or other corrosive external fluids, dust, heat, humidity.

^b Features to be considered, e.g. for compressor, benign (gas — clean and dry), moderate (some droplets corrosion), severe sour gas, high CO₂, high particle content).

Table 2 — Failure data

Category	Data	Description
Identification	Failure record (*)	Unique failure identification
	Equipment location (*)	Tag number
Failure data	Failure date (*)	Date of failure detection (year/month/day)
	Failure mode (*)	At equipment unit level (see Annex A)
	Impact of failure on operation	Zero, partial or total (safety consequences may also be included)
	Severity class (*)	Effect on equipment unit function: critical failure, non-critical failure
	Failure descriptor	The descriptor of the failure (see Table B.1)
	Failure cause	Cause of the failure (see Table B.2)
	Subunit failed	Name of subunit that failed (see examples in Annex A)
	Maintainable item(s) failed	Specify the failed maintainable item(s) (see Annex A)
	Method of observation	How the failure was detected (see Table B.3)
Remarks	Additional information	Give more details, if available, on the circumstances leading to the failure, additional information on failure cause, etc.

Table 3 — Maintenance data

Category	Data	Description
Identification	Maintenance record (*)	Unique maintenance identification
	Equipment location (*)	Tag number
	Failure record (*)	Corresponding failure identification (corrective maintenance only)
Maintenance data	Date of maintenance (*)	Date when maintenance action was undertaken
	Maintenance category	Corrective maintenance or preventive maintenance
	Maintenance activity	Description of maintenance activity (see Table B.4)
	Impact of maintenance on operation	Zero, partial or total, (safety consequences may also be included)
	Subunit maintained	Name of subunit maintained (see Annex A) ^a
	Maintainable item(s) maintained	Specify the maintainable item(s) that were maintained (see Annex A)
Maintenance resources ^b	Maintenance man-hours, per discipline ^b	Maintenance man-hours per discipline (mechanical, electrical, instrument, others)
	Maintenance man-hours, total	Total maintenance man-hours
Maintenance time	Active maintenance time	Time duration for active maintenance work on the equipment ^c
	Down time	Time interval during which an item is in a down state
Remarks	Additional information	Give more details, if available, on the maintenance action, e.g. abnormal waiting time, relation to other maintenance tasks

^a For corrective maintenance, the subunit maintained will normally be identical with the one specified on the failure event report (see 7.2).

^b For subsea equipment, the following apply:

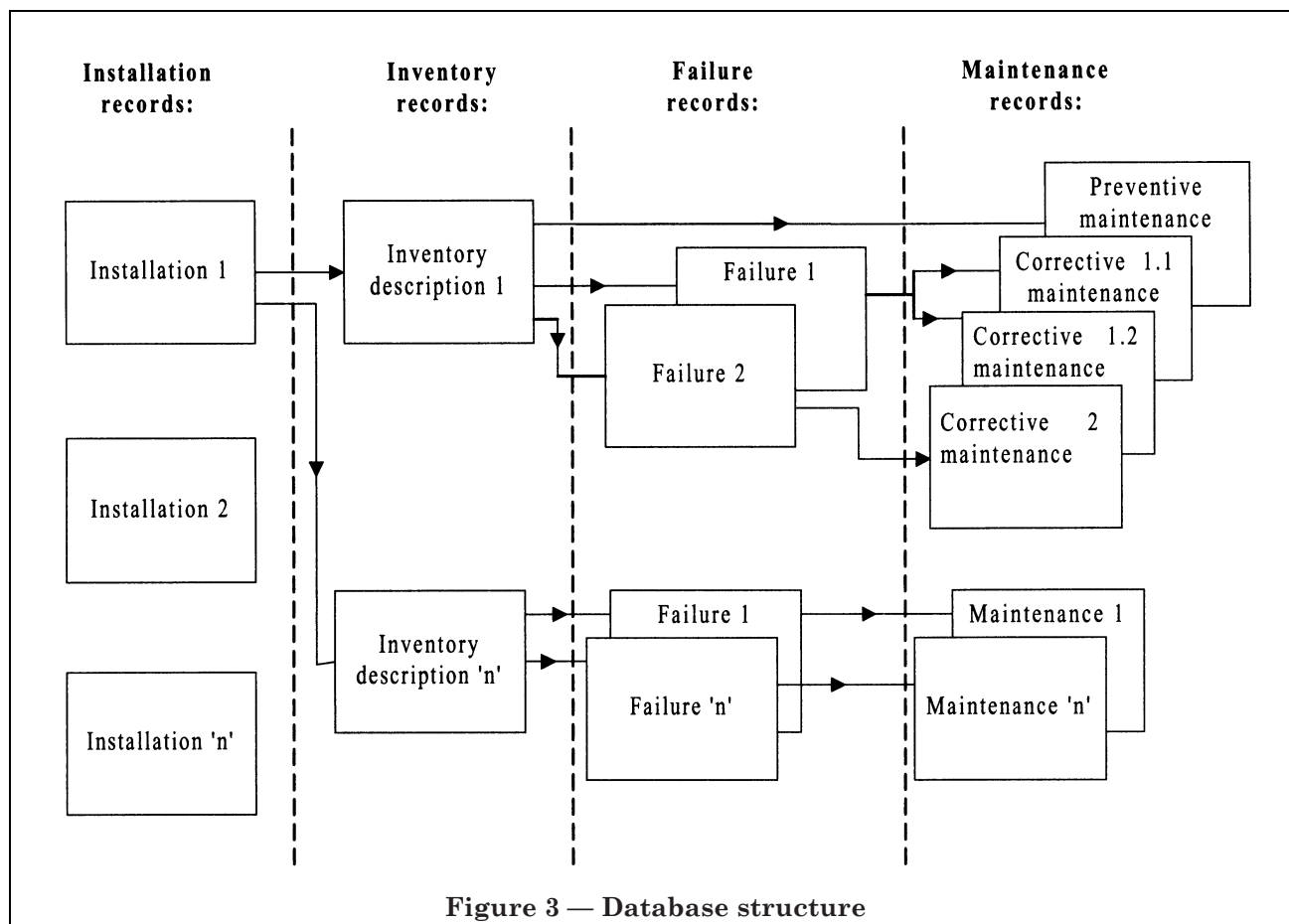
— type of main resource(s) and number of days used, e.g. drilling rig, diving vessel, service vessel (*);

— type of supplementary resource(s) and number of hours used, e.g. divers, ROV/ROT, platform personnel.

^c This information is desirable for RAM and RCM analyses. It is currently infrequently recorded in the maintenance management systems. The reporting of this information shall be improved.

6.3 Database structure

The data collected shall be organized and linked in a database to provide easy access for updates, queries and analysis, e.g. statistics, lifetime analysis. An example of how the information in the database may be logically structured is shown in Figure 3.



7 Equipment, failure and maintenance data

7.1 Equipment data

The classification of equipment into technical, operational and environmental parameters is the basis for the collection of RM data. This information is also necessary to determine if the data are suitable or valid for various applications. There are some data which are common to all equipment classes and some data which are specific for each equipment class.

To ensure that the objectives of this International Standard are met, a minimum of data shall be collected. These data are identified by an asterisk (*) in Table 1, Table 2 and Table 3.

Table 1 contains the data common to all equipment classes. In addition some data which are specific for each equipment class shall be reported. Annex A gives examples of such data for some equipment classes. In the examples in Annex A, priority data are indicated.

The minimum data needed to meet the objectives of this International Standard are identified by (*). However, certain additional data categories may significantly improve the potential uses for RM data, see Annex D.

NOTE Some features under main category “Application” in Table 1 may vary with time. Some of this information is linked with information gathered from the production consequence upon failure or maintenance. This information has a significant bearing on the interpretation of down time.

7.2 Failure data

A uniform definition of failure and a method of classifying failures are essential when data from different sources (plants and operators) need to be combined in a common RM database.

A common report for all equipment classes shall be used for reporting failure data. The data are given in Table 2.

The minimum data needed to meet the objectives of this International Standard are identified by (*). However, certain additional data categories may significantly improve the potential uses for RM data, see Annex D.

7.3 Maintenance data

Maintenance is carried out:

- a) to correct a failure (corrective maintenance). The failure shall be reported as described in 7.2;
- b) as a planned and normally periodic action to prevent failure from occurring (preventive maintenance).

A common report for all equipment classes shall be used for reporting maintenance data. The data required are given in Table 3.

The minimum data needed to meet the objectives of this International Standard are identified by (*). However, certain additional data categories may significantly improve the potential uses for RM data, see Annex D.

Annex A (informative)

Equipment class attributes

A.1 Advisory notes

A.1.1 General

Annex A gives examples in Table A.1 to Table A.66 on how some typical oil and gas equipment may be categorized as to taxonomy, boundary definition, inventory data and failure modes. These data are specific for each equipment unit. Data common for all equipment units are shown in Annex B.

In this categorization, a standardization approach has been applied to classification and subdivision of units. This means that the total number of different data categories and definitions are reduced, while at the same time there are fewer tailor-made definitions and codes for each individual equipment unit. The user should therefore apply those categories and codes which are applicable to the specific equipment unit for which data are being collected. For equipment units of special design, a more tailor-made categorization than that shown in these examples may be required.

In the tables in which equipment is broken down into “subunit” and “maintainable items” (e.g. Table A.2), it is recommended to include additional “maintainable items”, as needed, to cover instrumentation, and an “unknown” category in case information is not available.

A.1.2 Boundary definitions

The purpose of the boundary definition is to ensure a common understanding of what equipment is to be included within the boundary of a particular system, and hence which failures and maintenance to record. For definition of the boundaries, the following rules are recommended:

- exclude connected items from the equipment unit boundary, unless specifically included by the boundary specification. Failures that occur in a connection (e.g. leak), and which cannot be solely related to the *connected item*, should be included within the boundary definition;
- when a driver and the driven unit use a common subunit (e.g. lubrication system), relate failure on this subunit, as a general rule, to the *driven unit*;
- include instrumentation only where it has a specific control and/or monitoring function for the equipment unit in question and/or is locally mounted on the equipment unit. Control and supervisory instrumentation of more general use (e.g. SCADA-systems) should not, as a rule, be included.

A.1.3 Failure modes

In Annex A, a list of relevant failure modes is given for each equipment unit. The failure modes should be related to the equipment unit level in the hierarchy. The failure modes used can be categorized in three types:

- the desired *function is not obtained* (e.g. fail to start);
- there is a deviation in a specified *function outside accepted limits* (e.g. high output);
- there is a *failure indication* observed, but there is no immediate and critical impact on equipment unit function (e.g. leakage).

For the latter category the failure mode should describe the *failure indication on equipment unit level*, while the failure descriptor should describe the *cause of failure on the lowest level within the equipment hierarchy* for which this information is known.

A.2 Process equipment

A.2.1 Combustion engines (piston)

Table A.1 — Taxonomy classification — Combustion engines

Equipment class		Type		Application	
Description	Code	Description	Code	Description	Code
Combustion engines — piston (diesel/gas engines)	CE	Diesel engine	DE	Main power	MP
		Gas engine	GE	Essential power	EP
				Emergency power	EM
				Water injection	WI
				Oil handling	OH
				Gas handling	GH
				Water fire-fighting	FF
				Material handling	MH