International standardization in the reliability engineering & technology arena

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Collection and exchange of reliability and maintenance data for equipment

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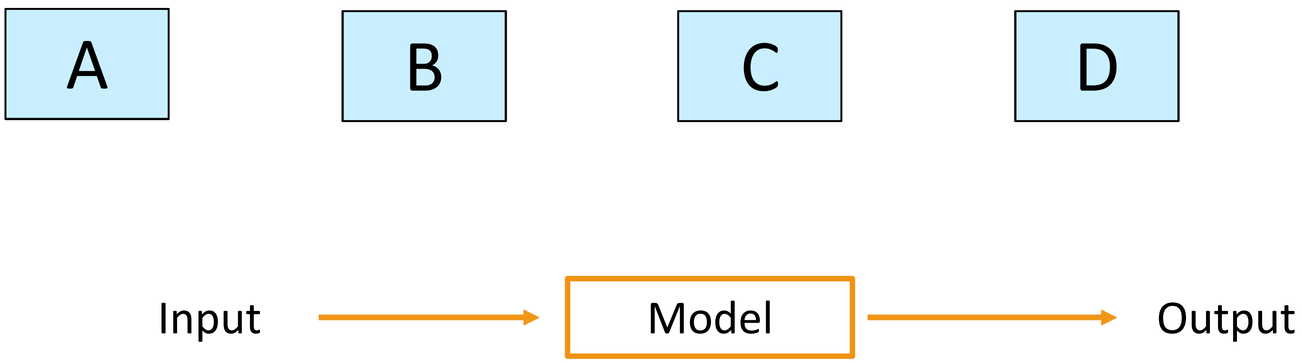
Objective

Use of International Standard ISO 14224:

a) Brief introduction to the standard
b) Sharing of experiences from RM data collection and use

«Data collection is an investment»

Keywords:
reliability data, maintenance data, decision-making



Models: Several mathematical models are used with the objective of supporting decision making (output).

Reliability and maintenance data needed (input).

Benefits/ objective

- Prevent accidents and equipment damages
- Improvements; Increase operating availability, reduce maintenance costs
- Obtain good industry reputation
- Benchmarking & trending
- Meet requirements

a) A brief introduction to the standard

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Editions

› First Edition: ISO 14224: 1999

› Second Edition : ISO 14224: 2006

Scope of the standard

- Describe RM data collection principles
- Key definitions
- Basis for communicating equipment experience (reliability language)
- Normative terminology e.g.
  - Failure modes (per equipment class)
  - Failure mechanism and failure cause (generic across all equipment classes)
- Applicable for all type of facilities and operations in petroleum, petrochemcial and natural gas industries (up-stream, mid-stream and down-stream coverage)

Outside scope

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- Data on (direct) cost issues
- Data from laboratory testing and manufacturing (e.g. ALT)
- 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 analyzing and applying RM data (some principles for calculating of some basic reliability and maintenance parameters are included)
- Recommended values for RM parameters

Contents

Normative parts

Contents

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Understanding the language

- A total of 51 definitions are listed in Clause 3

Some key parameters often used in reliabilility assessment of safety systems:

- Failure mode
- Failure cause (root cause)
- Failure mechanism
- Failure impact

Failure mechanisms, failure cause, failure mode and failure impact

- **failure cause (root cause):** circumstances associated with design, manufacture, installation, use and maintenance that have led to a failure

- **failure mechanism:** physical, chemical or other process that leads to a failure

Failure mechanisms and Failure causes Generic for all equipment classes

Failure mechanisms are classified as:

1. Mechanical failures
2. Material failures
3. Instrumentation failures
4. Electrical failures
5. External influence
6. Miscellaneous

ISO 14224, Annex B2.2

(includes also sub-groups)

Failure causes are classified as:

1. Design-related causes
2. Fabrication/installation-related causes
3. Failures related to operation/maintenance
4. Failures related to management
5. Miscellaneous

ISO 14224, Annex B2.3

(includes also sub-groups)

Failure mechanisms, failure cause, failure mode and failure impact

- **failure cause (root cause):** circumstances associated with design, manufacture, installation, use and maintenance that have led to a failure

- **failure mechanism:** physical, chemical or other process that leads to a failure

- **failure mode:** effect by which a failure is observed on the failed item

- **failure impact:** impact of a failure on an equipment's function(s) or on the plant

RM parameters in relation to taxonomy levels

Recorded RM data	Hierarchy level				
	4 Plant/Unit	5 Section/ System	6 Equipment unit	7 Subunit	8 Component/ Maintainable item
Failure impact on equipment			X	(X)	(X)
Failure mode		(X)	X	(X)	(X)
Failure mechanism			(X)	(X)	X
Failure cause				(X)	X
Detection method		(X)	X	(X)	(X)
X = default, (X) = possible alternatives.					

1. Industry
2. Business category
3. Installation

(…)

9. Part

Data collection - RM data

Summary of equipment covered: Annex A

The following main categories of data are to be collected:

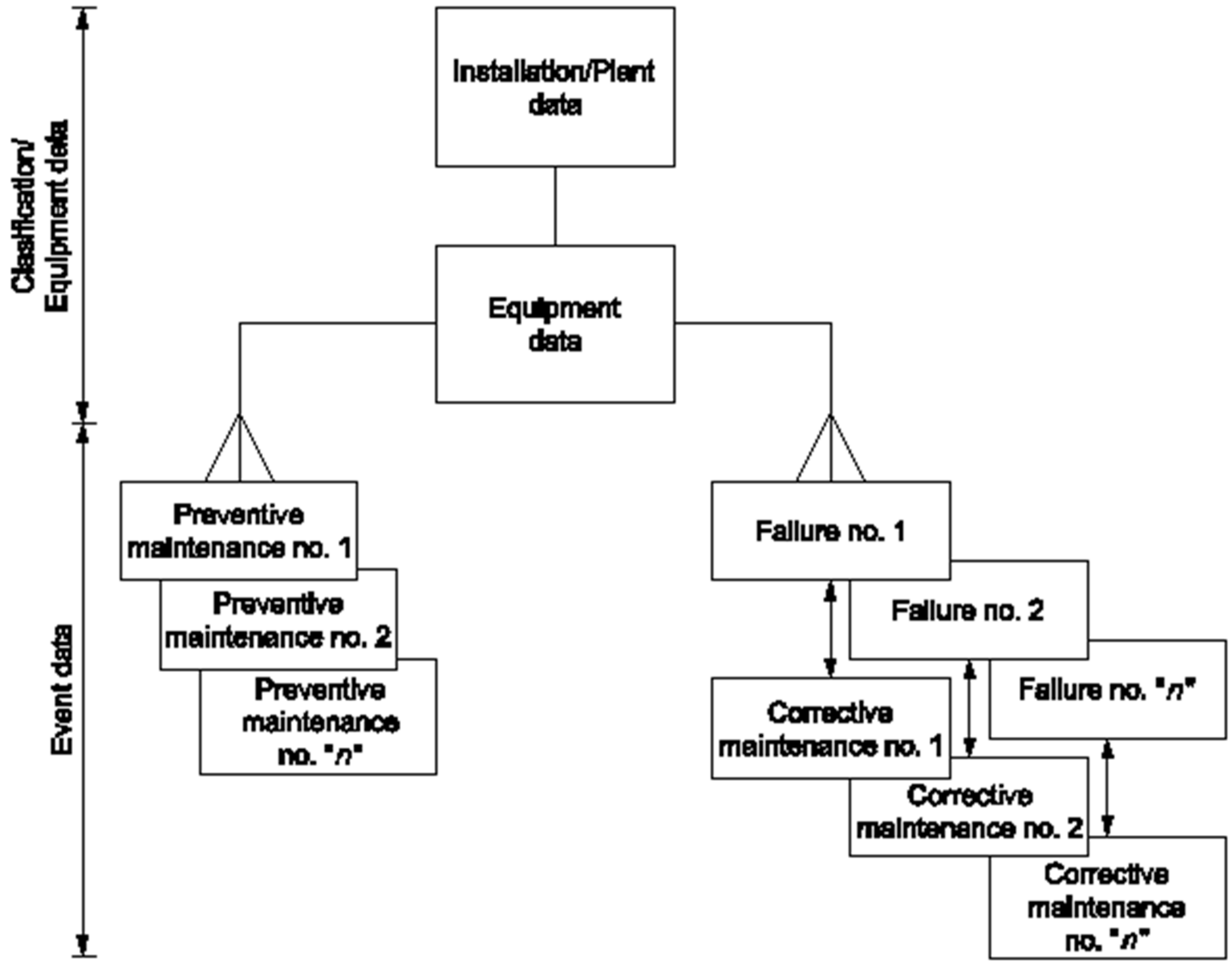
- equipment data, e.g. equipment taxonomy, equipment attributes;
- failure data, e.g. failure cause, failure consequence;
- maintenance data, e.g. maintenance action, resources used, maintenance consequence, down time.

Focus areas: data requirements, standardized data format

Equipment classes
Level 6 (Annex A - Table A.4)

Equipment category	Equipment class — Level 6	Example included in Annex A
Subsea production	Subsea production control	Yes
	Xmas trees	Yes
	Risers	Yes
	Subsea pumps	Yes
	Subsea processing equipment	No
	Templates	No
	Manifolds	No
	Pipelines	No
	Flowlines	No
	Subsea isolation equipment	No
	Intervention tools	No
	Electric-power distribution	No
Drilling	Blowout preventer [a]	Yes
	Top drive	Yes

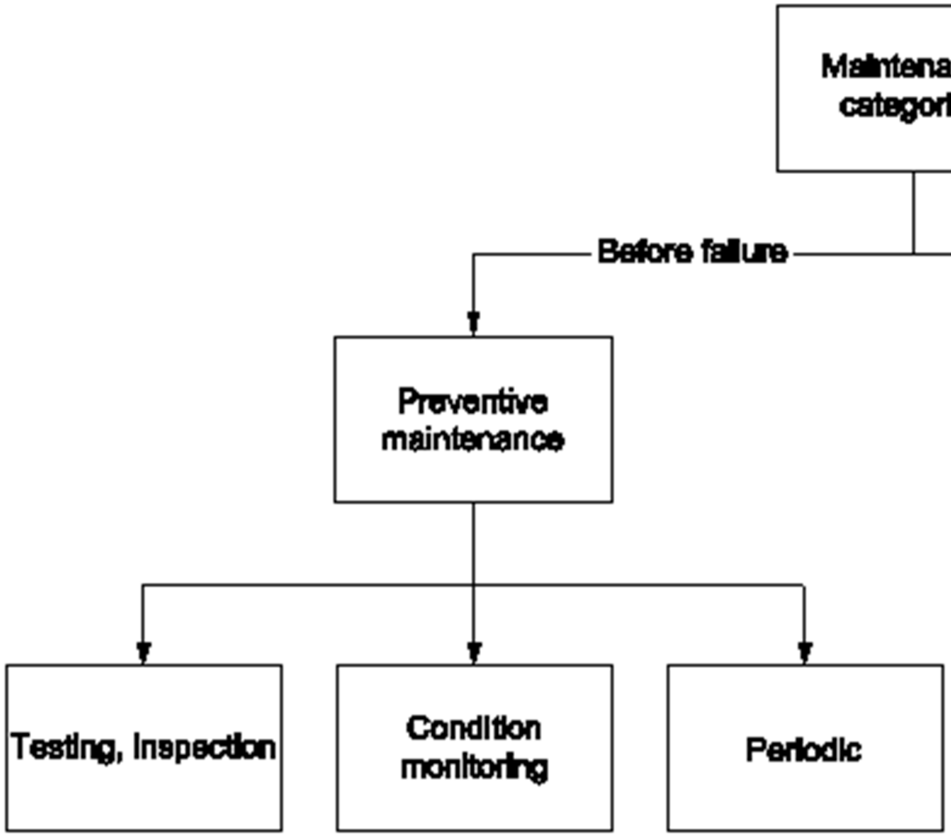
Associated data collected – Logical structure



Data collection - Failure data

Category	Data to be recorded	Description
Identification	Failure record (*)	Unique failure record identification
	Equipment identification/Location (*)	E.g. tag number (see Table 5)
Failure data	Failure date (*)	Date of failure detection (year/month/day)
	Failure mode (*)	Usually at equipment-unit level (level 6) (see B.2.6) a
	Failure impact on plant safety (e.g. personnel, environment, assets) b	Usually zero, partial or total
	Failure impact on plant operations (e.g. production, drilling, intervention) b	Usually zero, partial or total
	Failure impact on equipment function (*)	Effect on equipment-unit function (level 6): critical, degraded, or incipient failure c
	Failure mechanism	The physical, chemical or other processes which have led to a failure (see Table B.2)
	Failure cause	The circumstances during design, manufacture or use which have led to a failure (see Table B.3)
	Subunit failed	Name of subunit that failed (see examples in Annex A)
	Component/Maintainable item(s) failed	Name of the failed component/maintainable item(s) (see Annex A)
	Detection method	How the failure was detected (see Table B.4)
	Operating condition at failure	Running, start-up, testing, idle, standby
Remarks	Additional information	Give more details, if available, on the circumstances leading to the failure: failure of redundant units, failure cause(s) etc.
(*) indicates the minimum data that shall be collected.		

Data collection – Maintenance data



- ID
- Date/category/activity
- Resources used
- Duration

Some aspects characterizing high quality data

- 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)
- Sufficient population and adequate surveillance period to give statistical confidence
- Relevance to the data user's need

Critique of the RM data available and its usefulness

«The available RM data are recorded for equipment operating under different conditions»

«There are no quality data available for «novel technology»

From a practical perspective – How to collect the data

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- Clarify collection process
- Cost issues
- Database structure and content
- Standardizations and recommendations
- Database & analysis software (limitations?)
- Mapping available sources/ data
- Evaluating minimum data & quality needed

The data collector – an important player

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The data should be collected by competent and motivated personnel with involvement from company internal personnel

The collector should have:

- Available relevant documentation
- Available expert personnel
- Subsea system understanding
- Data handling understanding
- Analysis understanding
- Quality drive

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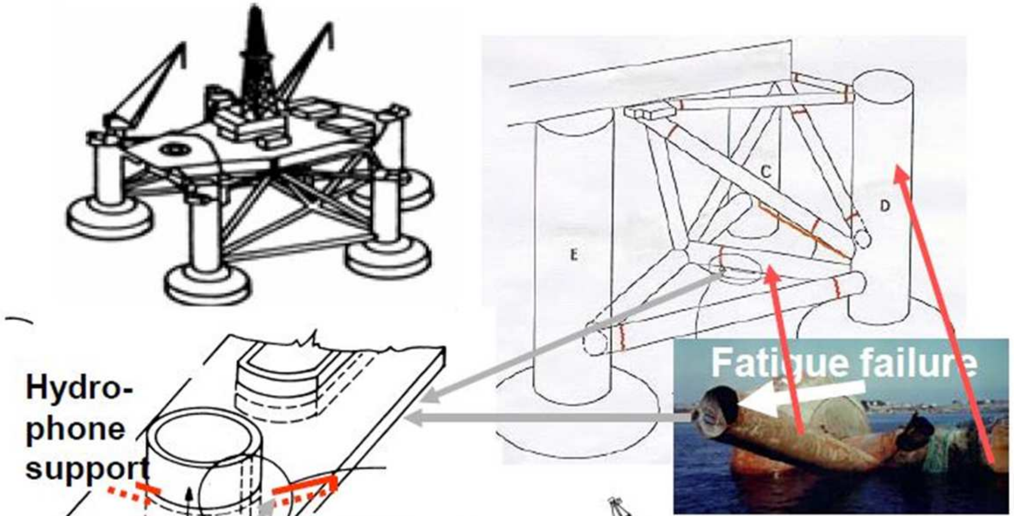
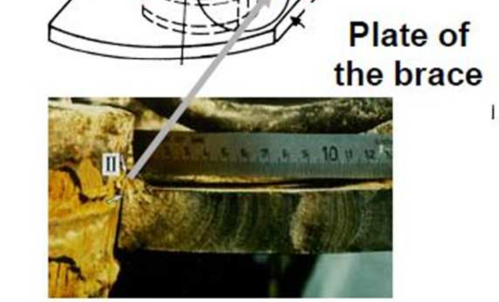
Experiences

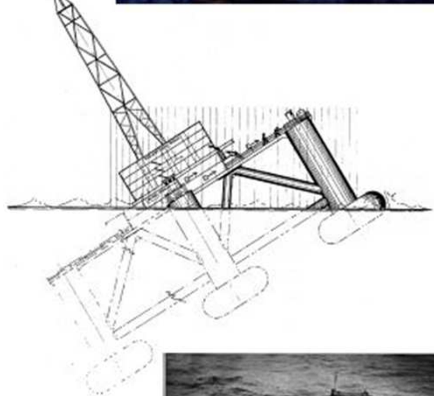
- There must be a clear understanding on possibilities and limitations
- Data collectors should have proper motivation and competence
- Data very relevant for optimising systems
- The benefit of collecting data must be made more visible for the operating and maintenance people
- Get better data on underlying mechanism and cause of failures
- Data collection should be a dynamic and continuous process
- Cost cutting in this industry will probably also result in data quality and availability “cutting”
- Quality is more important than quantity!

Thank you!

The Alexander Kielland Accident (1980)







Technical-physical Causes-consequences

- fatigue/ fracture in brace D-6
- rupture/collapse in the other 5 braces
- loss of column D

↓evacuation

↓escape

↓listing

↓flooding

↓capsizing

Moan (NTNU), 2010