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Območje nadzora na podlagi ocene tveganja

Risk based inspection framework (RBIF)

Risikobasierte Inspektion (RBIF)

Cadre d'inspection basée sur les risques (RBIF)

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Risk-based inspection framework

Cadre d'inspection basée sur les risques

Risikobasierte Inspektion (RBIF)

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European foreword

This document (EN 16991:2018) has been prepared by Technical Committee CEN/TC 319 "Maintenance", the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2018 and conflicting national standards shall be withdrawn at the latest by October 2018.

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Introduction

Since the late 1990s, inspection and maintenance approaches in industry have been globally moving from prescriptive, time-based towards risk-based ones. This trend has clearly been established by the wish to increase the on-stream production time, to reduce unscheduled downtime due to corrective maintenance, to avoid shutdown due to equipment failure and/or to reduce undesirable impacts on process safety.

This European Standard provides the essential elements of risk-based assessment of industrial assets according to the approach developed and demonstrated in the European pre-standardization document CWA 15740:2008 [1]. The CWA 15740 document was updated in 2011, and from 2014 its further development continued within this document and the corresponding EU Project RIMAP (Risk-Based Inspection and Maintenance Procedures for European Industry) [2] [3].

The document is intended for managers and engineers establishing the RBIM (Risk-based Inspection and Maintenance) policies in the process, power, steel and other relevant industries. This document is intended to be used in conjunction with the relevant internationally accepted practices, national regulations and RBI company policies. The document aims to provide a common reference for formulating the RBI policies and developing the corresponding inspection and maintenance programs.

The background of the RBIM methodology is provided by the EU project RIMAP (Risk-based Inspection and Maintenance Procedures for European Industry) [4]. In this project, the industry independent methodology has been validated for chemical, petrochemical, power and steel industries and summarized in the respective RIMAP Application Workbooks [4].

The main goal of this European Standard and the former RIMAP project is to support the establishment and application of risk-based inspection and maintenance programs in industrial plants in a documented and efficient way, while at the same time maintaining or improving safety, health and environment performance.

The RBIF addresses primarily static pressure equipment (e.g. tanks, piping), but is also applicable to dynamic/rotating equipment (e.g. pumps, turbines, valves) and pressure relief devices, and it can be extended to other types of equipment, if appropriate. It addresses primarily the equipment and/or systems in the in-service phase of the operation, but can also be applied in the design-phase for analysis and/or determination of maintenance/inspection strategies or life extension phases. Application of this RBIF in industry will take into account also the general developments in the industry and maintenance practices (e.g. The Industry 4.0).

1 Scope

This European Standard specifies the Risk-Based Inspection Framework (RBIF) and gives guidelines for Risk-Based Inspection and Maintenance (RBIM) in hydrocarbon and chemical process industries, power generation and other industries where RBI is applicable.

Although RBIF encompasses both inspection and maintenance, this document focuses primarily on Risk-Based Inspection (RBI) and its applicability within the context of RBIM. The RBIF thereby supports optimization of operations and maintenance as well as asset integrity management.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

3.1
risk
combination of the probability of occurrence of harm and the severity of that harm

Note 1 to entry: The probability of occurrence includes the exposure to a hazardous situation, the occurrence of a hazardous event, and the possibility to limit the harm.

Note 2 to entry: Other definitions, e.g. the one from ISO 31000 are recognized, but not used practically in the document.

[SOURCE: ISO/IEC Guide 51:2014, 3.9]

3.2
risk management
coordinated activities to direct and control an organization with regard to risk

Note 1 to entry: Systematic application of management policies, procedures, and practices to the tasks of analysing, evaluating and controlling risk.

[SOURCE: ISO Guide 73:2009, 2.1, ISO 31000:2009, 2.2]

3.3
equipment
individual item that is part of a system, equipment is comprised of an assemblage of components Examples include pressure vessels, pressure relief devices, piping, boilers and heaters.

[SOURCE: API RP 581:2016, 3.1.23]

3.4
inspection
examination for conformity by measuring, observing or testing the relevant characteristics of an item

[SOURCE: EN 13306:2010, 8.1]

3.5
maintenance
combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function

[SOURCE: EN 13306:2010, 2.1]

3.6
integrity operating window
IOW
established limits for process variables (parameters) that can affect the integrity of the equipment if the process operation deviates from the established limits for a predetermined length of time (includes critical, standard and informational IOW's)

[SOURCE: API RP 584, 3.6]

3.7
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

[SOURCE: EN 13306:2010, 7.1]

3.8
corrective maintenance
maintenance carried out after fault recognition and intended to put an item into a state in which it can perform required function

[SOURCE: EN 13306:2010, 7.5]

3.9
reliability centred maintenance
method to identify and select failure management policies to efficiently and effectively achieve the required safety, availability and economical operation

[SOURCE: EN 60300-3-11:2009, 3.1.23]

3.10
risk based inspection
RBI
risk assessment and management process to plan, implement and evaluate inspections in a structured and documented way

3.11
probability of failure
PoF
likelihood of an equipment or component failure due to a single damage mechanism or multiple mechanisms occurring under specific operating conditions

[SOURCE: API RP 581:2016, 3.1.57]

3.12
consequence of failure
CoF
outcome of a failure can be expressed in terms of safety to personnel, economic loss, and/or damage to the environment

[SOURCE: EN 60300-3-11:2009, 3.1.23]

3.13
evergreening
dynamic process of keeping records and analysis updated and relevant for the current situation

3.14
area susceptible to damage/susceptible area
area in a plant where a certain degradation is more probable to occur

[SOURCE: API RP 581:2016, part 2]

3.15
degradation
detrimental change in physical condition, with time, use or external cause

Note 1 to entry: Degradation may lead to a failure.

Note 2 to entry: In a system context, degradation may also be caused by failures within the system.

[SOURCE: EN 13306:2010, 5.6]

3.16
degradation group
group of piping or equipment items exposed to the same internal/external environment and operating conditions, with the same material selection and/or design, thus having the same potential degradation mechanisms.

Note 1 to entry: Degradation grouping can allow the use of inspection data from any equipment in the selection to assess the condition of the entire degradation group. Equipment in a degradation group are normally physically connected to each other.

Note 2 to entry: Corrosion group and/or corrosion circuit and/or corrosion loop is also used if the relevant degradation is corrosion type.

[SOURCE: adapted from DNV RP-G101: 2010]

3.17
condition monitoring locations
CML
designated areas on pressure vessels where periodic examinations are conducted. Previously, they were normally referred to as “thickness monitoring locations (TMLs)”

[SOURCE: API 510:2006]

4 Abbreviated terms

Table 1 — Abbreviated terms

Abbreviated term	Definition
ALARP	As Low As Reasonably Practicable
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CCD	Corrosion Control Document
CMMS	Computerized Maintenance Management System
CML	Condition Monitoring Location
CoF	Consequence of Failure
CUI	Corrosion Under Insulation
ESV	Emergency Shut-off Valves
FME(C)A	Failure Mode, Effects (and Criticality) Analysis
HAZOP	HAZard and OPerability (study/analysis)
HCF/LCF	High Cycle Fatigue/Low Cycle Fatigue
HFF/LFF	High Fluid Flow/Low Fluid Flow
HS(S)E	Health, Safety (Security) and Environment
HSE	Health, Safety and Environment
HT	High Temperature
IOW	Integrity Operating Window
IPF	Instrument Protective Function
KKS	Kraftwerk-Kennzeichensystem, Power Plant Classification System [18]
KPI	Key Performance Indicators
LoF	Likelihood of Failure NOTE: also referred to as Probability of Failure (PoF) in some cases
LoPC	Loss of Primary Containment
MEI	Maintenance Execution Inspection
MOC	Management Of Change
MOTBF	Mean Operating Time Between Failure

Abbreviated term	Definition
NCR	Non Conformity Report
NDT	Non-Destructive Testing/inspection
NII	Non-Intrusive Inspection
PFD	Process Flow Diagrams
P&ID	Piping and Instrumentation Diagram
PHA	Process Hazard Analysis
PoD	Probability of Detection
PoF	Probability of Failure NOTE also referred to as Likelihood of Failure (LoF) in some cases
PRV	Pressure Relief Valve
QA	Quality Assurance
QRA	Quantitative Risk Assessment
QMS	Quality Management System
RBI	Risk Based Inspection
RBIF	Risk Based Inspection Framework
RBIM	Risk Based Inspection and Maintenance
RBWS	Risk Based Work Selection
RCA/RCFA	Root Cause Analysis/Root Cause Failure Analysis
RCM	Reliability Centred Maintenance
RIMAP	Risk based Inspection and Maintenance Procedures

5 The RBI framework

5.1 RBIF principles

The risk-based approach shall apply a multidisciplinary engineering analysis to ensure that targets related to health, safety, business and environment criteria are met. These targets shall be met by implementing optimized inspection, monitoring and maintenance programs based on an appropriate risk-based methodology covering the following items:

— planning of the primary work products of RBI assessments and management approach in such a way that risks at system and/or equipment level are managed, considering risks from the Health, Safety & Environment (HSE) and/or the economic/business perspective;

— defining the RBI framework which meets the requirements of good engineering practices and industrial reference standards in handling hazardous materials and containment;

— complying with applicable legal or normative regulations and guidelines.

5.2 RBIF requirements

5.2.1 General requirements

The general requirements of the RBIF are:

— the objectives and risk criteria shall be clearly defined;

— the assessment and the applied procedure shall comply with the applicable legal and regulatory requirements;

— an adequate level of input information shall be available for the assessment;

— the assessment shall be performed by a multidisciplinary team including personnel with the appropriate required competence and qualifications;

— the integrity and safety assessment and the applied procedures shall provide results, which are:

a) realistic, but with conservative treatment of uncertainties and assumptions;

b) representable in a risk matrix, auditable and consistent with both the objectives and applied risk criteria supporting RBI planning and decision making on the target system or equipment.

— the assessment shall reflect the real conditions in the plant and be kept in "evergreening" status;

— change management shall be made according to an accepted and recognized standard – such as EN ISO 9000 [5];

— in the case when computer models/tools are used, these shall be validated and their decision logic shall be documented and authorized by the risk managers.

The RBI process is divided into the main RBI application level and an inspection and maintenance strategy level. The main RBI application level is shown in Figure 1 and takes into account the following factors:

— the level of risk;

— the opportunity to eliminate failure causes;

— the risk to personnel during execution of inspection and maintenance;

— the risk of introducing new failure causes while trying to eliminate the existing ones.

In cases where change of the inspection and maintenance strategy is not possible, technical (e.g. robotics) or organizational (e.g. training) measures may be introduced to reduce the risk and to avoid introducing any new failures.

The decision tree serves three important purposes:

— to ensure a systematic evaluation of needs for inspection and maintenance activities;

— to ensure consistency of the evaluation between different units, plant systems and similar units at different locations;

— to simplify the documentation of reached conclusions.

When the inspection and maintenance strategy has been determined, the method, intervals, and extent of inspection shall be determined so that risks remain acceptable and costs are optimized (ALARP). This needs to be aligned to the organization's asset management strategy and kept up-to-date. This is achieved by establishing risk reduction measures for the items that exceed the acceptance limits and, where possible, by mitigating measures like inspections and maintenance for items that remain below these limits for the period of assessment. The risk reduction effect of alternative measures as well as the costs of these measures shall also be determined.

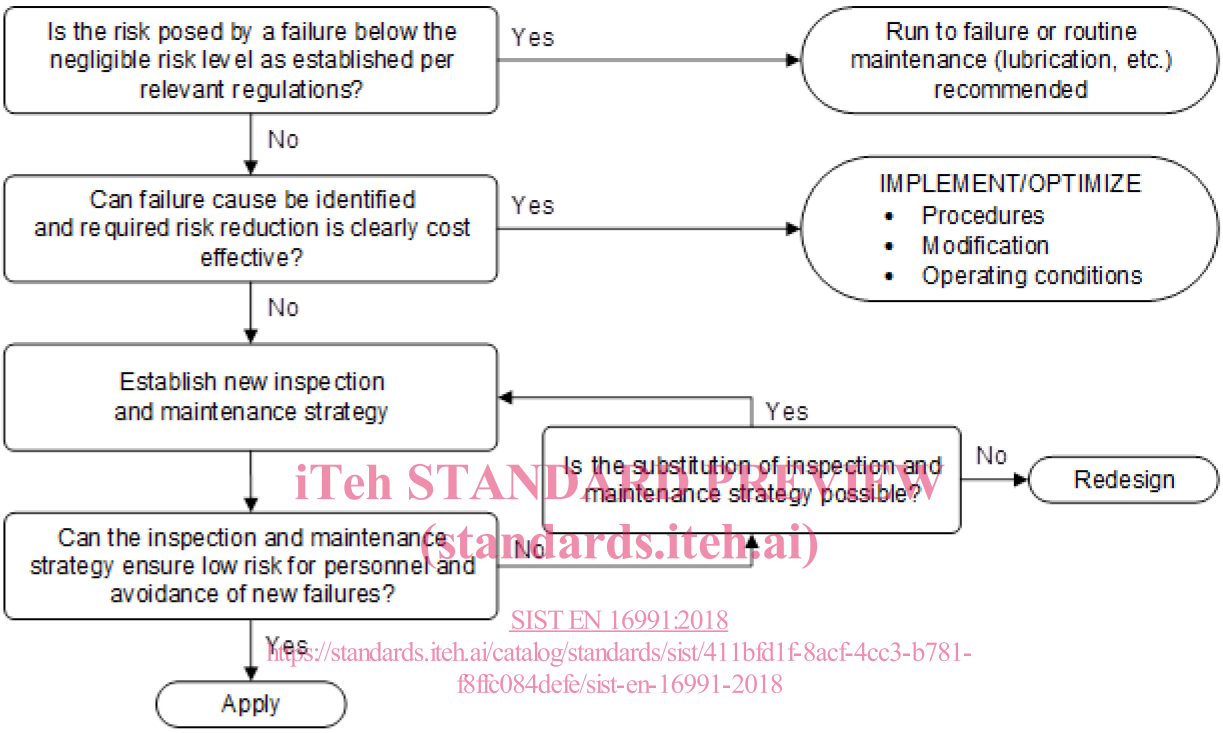

Figure 1 — Main RBI application level and decision tree

The approaches and methodologies used in RBIF can be compatible with the generic requirements resulting from basic ISO Standards such as EN ISO 9000-series[5], EN ISO 14000-series [6], ISO 55000 [7] and in-particular, ISO 31000-series [8] (IEC/ISO 31010 [9], ISO/IEC Guide 51 [10], ISO Guide 73 [11]). Other standards with which RBIF can also be compatible are EN 13306 [12], ISO/DIS 45001, ISO 22301 [13], IEC 61508/ IEC 61511 [14] [15] and ISO/IEC 17020 [16].

5.2.2 Plant and process documentation

The development of a Risk-Based Inspection plan for different equipment items shall follow a well-defined, rigorous, and logical process to ensure that all pertinent information has been considered, and no critical factors are overlooked.

The RBI process shall be clearly documented in a written procedure. This documented procedure shall be referenced, approved and controlled. The procedure shall define each step to be taken during the risk assessment process including the data journey and data quality needs of all data sets used for the risk assessment. The procedure shall explain in detail how PoF and CoF are established, and how this is used to determine the risk level and inspection plans.