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Rijksdienst voor Ondernemend  
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# Best Practice for Risk-Based CUI management



# Best practice for managing the risk associated with corrosion under insulation, using asset management principles and the ISO High-Level structure.

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## **Cover**

Inspection for CUI at critical locations  
within an Industrial installation.  
"The fog lifts"  
Geert Henk Wijnants

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## Introduction

This best practice treats the control of under protection isolation (CUI) by means of a risk-based approach based on asset management principles. This is “Risk Based CUI management” referred to as “Risk Based CUI”, abbreviated by “RB-CUI”.

In addition to this management approach, there is a set of practical tools for practical matters available as shown in Appendix 2:: consisting of a Powerpoint presentation and tools.

This is to systematically practice the risks associated with COI/CUI by means of a program on management level.

The influence of design choices, quality control programs and conditions of use is expressed in the risk that can be controlled, which remains possible for every company despite company differences. What are optimal choices from a management point of view, is for a company from the best practice to trace. The best practice is therefore not intended for use as an instruction.

## 1 Field of application (Scope)

The RB-CUI best practice focuses on the following applications:

Insulated pipes and process equipment made of carbon steel and stainless steel, whether or not coated or provided with a preservation layer such as Thermally Sprayed Aluminum (TSA), whether or not classified as pressure receptacles in use.

This best practice can serve as a basis for setting up a CUI management system or for improving an already operational system. It is therefore intended to be informative; it is no prescription. To align best practice with the set-up of common management systems, it has been given the design of the High Level Structure of the ISO. Where, from that context, the text “should” or “must” or used, that is based on the assumption that the organization has set itself the goal of achieving a level of management in accordance with the ISO HLS principles.

The tools realized during the development of best practice for communication, application and evaluation, are included in the appendices of this best practice and also available to roll out a managerial approach for CUI.

This best practice can be used as a tool to test applied systems by means of an audit.

Aspects that can be tested are recognizable by the following marking in the left margin: [Δ#] where # is the sequence number of the relevant management aspect.

## 2 Normative references

NEN-EN-16991	Risk Based Inspection Framework.
NEN 2767-1	Condition measurement built environment - Part 1: Methodology.
ISO 19.600	Compliance management system, Guidelines.
ISO 31,000	Risk Management, Guidelines.
NRM	Feasibility study NRM, C. Pietersen (SSC), 14 Jul '17 (Assignment I-SZW)

## 3 Terms and definitions

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

### 3.1 Terms:

COF	Consequence Of Failure
CUI	Corrosion Under Insulation
HLS	High Level Structure (standaard opbouw vanuit ISO voor management systemen)
IOW	Integrity Operating Window
POD	Probability Of Detection
POF	Probability Of Failure
RB-CUI	Risk Based CUI Management
RBI	Risk Based Inspectie
TSA	Thermally Sprayed Aluminium

## 3.2 Definitions:

### 3.2.1 Audit

Systematic, independent and documented process (3.2.24) for obtaining audit evidence, and assessing it objectively to determine the extent to which the audit criteria have been met

*NOTE 1 to entry: An audit can be an internal audit (first party) or an external audit (second or third party), and it can be a combined audit (combining two or more disciplines).*

*NOTE 2 to entry: An internal audit is performed by the organization itself, or by an external party on its behalf.*

*NOTE 3 to entry: "Audit evidence" and "audit criteria" are defined in ISO 19011.*

### 3.2.2 Classification

The systematic identification and organization of business processes or actions and/or archive records in categories according to logically structured conventions, methods and rules of procedure as reflected in a classification system.

Within the context of this best practice, this concerns, among other things, the assignment of a service life class to coatings depending on the relevant influencing factors and the assignment of an effectiveness class for applicable NDT methods.

### 3.2.3 Competence

ability to apply knowledge and skills to achieve intended results

### 3.2.4 Condition

(technical) condition or state of a building or installation part (CEN 17385), as determined by means of the condition score in terms of an objective assessment on a six-point scale.

### 3.2.5 Conformity

fulfilment of a **requirement** (3.2.25)

### 3.2.6 nonconformity

non-fulfilment of a **requirement** (3.2.25)

### 3.2.7 Correction

action to eliminate a detected **nonconformity** (3.2.6)

### 3.2.8 Corrective action

action to eliminate the cause of a **nonconformity** (3.2.6) and to prevent recurrence

### 3.2.9 Continuous improvement

recurring activity to enhance **performance** (3.2.22)

### 3.2.10 Deviation

failure to meet a requirement (3.2.25)

### 3.2.11 Documented information

information required to be controlled and maintained by an **organization** (3.2.20) and the medium on which it is contained

*NOTE 1 to entry: Documented information can be in any format and media and from any source.*

*NOTE 2 to entry: Documented information can refer to*

- the **management system** (3.2.16), including related **processes** (3.2.24);
- information created in order for the organization to operate (documentation);
- evidence of results achieved (records).

### 3.2.12 Effectiveness (of NDT)

The extent to which a method is able to perform the specified function. For NDT techniques, this is comparable to the concept of "safety integrity" of security functions, being "the probability that the specified function will be achieved under the determined relevant conditions and within the specified time period" (IEC 61508-4).

*NOTE 1 In the context of this best practice, the effectiveness has three levels of evidence for that effectiveness. Level 1 is experience-based; Level 2 is documented from traceable references; Level 3 is based on calculations (for NDT using the validated POD generator). The effectiveness is determined by the damage mechanism to be investigated, called "damage-typical", and the applied technique and is assessed by means of a score ranging from A to E with decreasing effectiveness.*

### 3.2.13 Integrity

The probability that a system will be able to perform its required functions within the period in time and under all applicable conditions (based on “safety integrity” according to IEC 61508-4; Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations).

### 3.2.14 Interested party (preferred term)

**stakeholder** (admitted term) person or **organization** (3.2.20) that can affect, be affected by, or perceive themselves to be affected by a decision or activity

### 3.2.15 Location

The place where, from the context of condition determination, the condition of the relevant component is determined via one or more measuring points.

### 3.2.16 Management system

set of interrelated or interacting elements of an **organization** (3.2.20) to establish **policies** (3.2.23) and **objectives** (3.2.19) and **processes** (3.2.24) to achieve those objectives

*NOTE 1 to entry: A management system can address a single discipline or several disciplines.*

*NOTE 2 to entry: The system elements include the organization’s structure, roles and responsibilities, planning, operation, etc.*

*NOTE 3 to entry: The scope of a management system may include the whole of the organization, specific and identified functions of the organization, specific and identified sections of the organization, or one or more functions across a group of organizations.*

### 3.2.17 Measurement

**process** (3.2.24) to determine a value

### 3.2.18 Monitoring

determining the status of a system, a **process** (3.2.24) or an activity

*NOTE 1 to entry: To determine the status there may be a need to check, supervise or critically observe.*

### 3.2.19 Objective

result to be achieved

*NOTE 1 to entry: An objective can be strategic, tactical, or operational.*

*NOTE 2 to entry: Objectives can relate to different disciplines (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process (3.2.24)).*

*NOTE 3 to entry: An objective can be expressed in other ways, e.g. as an intended outcome, a purpose, an operational criterion, as an CUI Management objective or by the use of other words with similar meaning (e.g. aim, goal, or target).*

*NOTE 4 to entry: In the context of CUI Management systems CUI Management objectives are set by the organization, consistent with the CUI Management policy, to achieve specific results.*

### 3.2.20 Organization

person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its **objectives** (3.2.19)

*Note 1 to entry: The concept of organization includes, but is not limited to sole-trader, company, corporation, firm, enterprise, authority, partnership, charity or institution, or part or combination thereof, whether incorporated or not, public or private.*

### 3.2.21 Outsource (verb)

make an arrangement where an external **organization** (3.2.20) performs part of an organization’s function or **process** (3.2.24)

*NOTE 1 to entry: An external organization is outside the scope of the management system (3.2.16), although the outsourced function or process is within the scope.*

### 3.2.22 Performance

measurable result

*NOTE 1 to entry: Performance can relate either to quantitative or qualitative findings.*

*NOTE 2 to entry: Performance can relate to the management of activities, processes (3.2.24), products (including services), systems or organizations (3.2.20).*

### 3.2.23 Policy

intentions and direction of an **organization** (3.2.20) as formally expressed by its **top management** (3.2.28)

### 3.2.24 Process

set of interrelated or interacting activities which transforms inputs into outputs

### 3.2.25 Requirement

need or expectation that is stated, generally implied or obligatory

*NOTE 1 to entry: “Generally implied” means that it is custom or common practice for the organization and interested parties that the need or expectation under consideration is implied.*

*NOTE 2 to entry: A specified requirement is one that is stated, for example in documented information.*

### 3.2.26 Risk

effect of uncertainty

*NOTE 1 to entry: An effect is a deviation from the expected – positive or negative.*

*NOTE 2 to entry: Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of, an event, its consequence, or likelihood.*

*NOTE 3 to entry: Risk is often characterized by reference to potential **events** (ISO Guide 73, 3.5.1.3) and **consequences** (ISO Guide 73, 3.6.1.3), or a combination of these.*

*NOTE 4 to entry: Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated **likelihood** (ISO Guide 73, 3.6.1.1) of occurrence.*

### 3.2.27 Six-point scale

ordinal measuring scale increasing from 1 to 6 (CEN 17385). This is used, among other things, to classify the condition of insulation.

*NOTE Condition Score 1 represents minimal degradation and 100% original quality. Condition score 6 stands for maximum degradation (CEN 17385).*

*NOTE Fitness score 5 represents a fitness level which is equal to the minimum acceptable fitness level. This is referred to as 'normative failure', whereby a direct control measure is required to ensure integrity. Condition score 6 stands for a condition level at which the set standards are no longer met (“beyond control limits”), so that instantaneous functional failure is possible.*

### 3.2.28 Top management

person or group of people who directs and controls an **organization** (3.2.20) at the highest level

*NOTE 1 to entry: Top management has the power to delegate authority and provide resources within the organization.*

*NOTE 2 to entry: If the scope of the **management system** (3.2.16) covers only part of an organization then top management refers to those who direct and control that part of the organization.*

## 4 Context of the organization

### 4.1 Understanding the organization and its context

[Δ1] The organization shall determine external and internal issues that are relevant to its purpose and that affect its ability to achieve the intended outcome(s) of its CUI Management system.

### 4.2 Understanding the needs and expectations of interested parties

[Δ2] The organization shall determine:

- the interested parties that are relevant to the CUI Management system, and
- the requirements of these interested parties.

[Δ3] Input of the requirements from the relevant stakeholders is ensured by placing the responsibility for this care with Senior Management, who is responsible for the translation into the policy pursued and the provision of the necessary resources, for example in the form of a specific portfolio for CUI management.

[Δ4] The needs are elaborated by means of a business value matrix (see Appendix 2: Tool\_BP...), which has a practical application in the form of a risk matrix for the management of the application area. The

risk profile of an installation indicates to what extent it is necessary to ensure the effectiveness of the management regime used for CUI.

### 4.3 Determining the scope of the CUI management system

[A5] The organization has determined the boundaries and applicability of the RB-CUI management system to determine its scope.

The field of application has been established on insulated process equipment and piping, constructed in C-steel and Stainless Steel 316(L) (1.4401 & 1.4404), aimed at using the installation in practical conditions with or without oscillating temperatures.

When determining this scope, the organization shall consider:

- the external and internal issues referred to in 4.1, and
- the requirements referred to in 4.2.

[A6] This area of application is available as documented information from the applied management regime for RB-CUI management, which is assigned to the maintenance organization within the assigned inspection task and to the operational organization from the concern for reporting deviations and supervising responsible use.

### 4.4 CUI management system

[A7] The organization shall establish, implement, maintain and continually improve an CUI management system, including the processes needed and their interactions, in accordance with the requirements of this International Standard.

## 5 Leadership

### 5.1 Leadership and commitment

[A8] Top management shall demonstrate leadership and commitment with respect to the CUI management system by:

- ensuring that the CUI management policy and CUI management objectives are established and are compatible with the strategic direction of the organization
- ensuring the integration of the CUI Management system requirements into the organization's business processes
- ensuring that the resources needed for the CUI Management system are available
- communicating the importance of effective CUI Management and of conforming to the CUI Management system requirements
- ensuring that the CUI Management system achieves its intended outcome(s)
- directing and supporting persons to contribute to the effectiveness of the CUI Management system
- promoting continual improvement
- supporting other relevant management roles to demonstrate their leadership as it applies to their areas of responsibility.

*NOTE Reference to "business" in this International Standard should be interpreted broadly to mean those activities that are core to the purposes of the organization's existence.*

### 5.2 Policy

[A9] Top management shall establish a CUI Management policy:

- a) that is appropriate to the purpose of the organization
- b) provides a framework for setting CUI Management objectives
- c) includes a commitment to satisfy applicable requirements, and
- d) includes a commitment to continual improvement of the CUI Management system.

[A10] The CUI management policy shall:

- be available as documented information
- be communicated within the organization
- be available to interested parties, as appropriate.

### 5.3 Organization roles, responsibilities and authorities

[A11] Top management shall ensure that the responsibilities and authorities for relevant roles are assigned and communicated within the organization.

Top management shall assign the responsibility and authority for:

- a) ensuring that the CUI Management system conforms to the requirements of this International Standard: and
  - b) reporting on the performance of the CUI Management system to top management.
- The distribution of responsibilities is displayed in the next figure:

Senior Management	<ul style="list-style-type: none"> <li>• Demonstrating commitment / culture of continuous attention</li> <li>• Making people &amp; budget available</li> </ul>
Technical Staff/ Engineering	<ul style="list-style-type: none"> <li>• Ensuring correct design of new equipment</li> <li>• Ensuring a representative asset condition representation</li> <li>• Initiate corrective actions where necessary</li> </ul>
Maintenance	<ul style="list-style-type: none"> <li>• Carrying out necessary projects</li> <li>• Ensuring the quality of projects</li> </ul>
Operations	<ul style="list-style-type: none"> <li>• Timely reporting of defects in the insulation and/or steam tracing</li> <li>• Avoiding damage to insulation</li> </ul>
Companies Inspection department	<ul style="list-style-type: none"> <li>• Conducting inspections where necessary</li> <li>• Providing information for the asset condition overview</li> </ul>

Figure 1: Division of responsibilities for the Risk Based CUI Management approach.

**Outsourcing:** The aforementioned responsibilities are assigned within the organization by means of roles. From this role, tasks can be outsourced. This refers to:

Execution of projects, carrying out inspections and generating reports.

If desired, the management of these tasks can also be outsourced if the quality requirements of the own organization are met. This is because the ultimate responsibility for the quality of management rests with the organization itself.

## 6 Planning

### 6.1 Actions to address risks and opportunities

When planning for the CUI Management system, the organization shall consider the issues referred to in 4.1 and the requirements referred to in 4.2 and determine the risks and opportunities that need to be addressed

- to assure the CUI Management system can achieve its intended outcome(s)
- prevent, or reduce, undesired effects
- achieve continuous improvement.

[Δ12] The organization shall plan:

- a) actions to address these risks and opportunities, and
- b) how to
  - integrate and implement the actions into its CUI Management system processes
  - evaluate the effectiveness of these actions.

A method for (a) determining the risks and (b) evaluating the effectiveness of the approach taken is available in the appendix, (a) module [risk assessment] resp. (b) module [Condition Map] in the [Tool BP CUI management] (Xlsx file).

### 6.2 CUI Management objectives and planning to achieve them

[Δ13] The organization shall establish CUI Management objectives at relevant functions and levels. The CUI Management objectives:

- a) shall be consistent with the CUI Management policy
- b) be measurable (if practicable)
- c) take into account applicable requirements

- d) be monitored
- e) be communicated, and
- f) be updated as appropriate.

- [Δ14] The organization shall retain documented information on the CUI Management objectives. When planning how to achieve its CUI Management objectives, the organization shall determine
- what will be done
  - what resources will be required
  - who will be responsible
  - when it will be completed
  - how the results will be evaluated.

The evaluation of the cost-effectiveness of applied methods to control CUI has been elaborated by means of a life cycle analysis method (Costs Based Decision-making; CBD). This can be found in Appendix 2: Tool CBD. The effectiveness of the inspection methods applied is detailed in the Best Practice Tool, Appendix 2:Tool BP, using the table below.

Method:	Technique: (For details see API 581 Annex 2-C)											← Update 13 November 2019.
	1)	2)	3)	4)	5)	6)	7)	8)	9)	10)	11)	Note (regarding typical for technique):
A technique has a certain chance of detecting damage. After assessment, if there is reason to do so, a second assessment follows, in which the condition is assessed by means of wall thickness measurements. The reliability of that (follow-up) assessment is not included here, since in that case the insulation has already been removed locally; the effectiveness of "seeing through the insulation" is then no longer an issue.												
<b>Typical:</b>												
Branches on pipes > DN250 and on vessel walls	A	B	B	B	C	C	B	A	B	D	D	
Branches on pipes ≤ DN250	A	A	A	B	C	C	B	A	A	D	D	
Fire-resistant cladding in general	A	A	A	B	D	B	E	E	A	E	D	
Imposition/Support (*)	D	B	A	C	C	E	A	E	E	D	E	
Straight pipes > DN250 and vessel walls	A	B	B	B	A	B	A	A	A	C	D	1): by means of corrosion product on support (assumed ↑)
Straight pipes ≤ DN250	A	A	A	A	A	B	A	A	A	C	D	
(*): the valuation strongly depends on the type of support	Note (regarding technique in relation to typical(s))											

Table 1: Overview of the effectivity of NDT techniques for inspecting damage-typicals.

## 7 Support

### 7.1 Resources

[Δ15] The organization shall determine and provide the resources needed for the establishment, implementation, maintenance and continual improvement of the CUI Management system.

For:	Department:	Means:	See:
Existing equipment	Operations & Maintenance	Prevention & elimination of CUI causes	Appendix 2:Tool CBD
		Inspection of CUI	Appendix 2:Tool CBD
		Damage control (NDT Effectivity)	Appendix 2:Tool CBD
		Selection inspection method (NDT Effectivity)	Appendix 2:Tool CBD
		Prioritizing approach for COI programming	Appendix 2:Tool CBD
		Surface protection / coating	Appendix 2:Tool CBD
		Installation of isolation (Condition assessment)	Appendix 2:Tool CBD
	Shutdowns & renovation	Evaluation of experiences / lessons learned	
		Mechanical modifications	
		Costs-effective maintenance scenario determination	Appendix 2:Tool CBD
		Awareness / Training	Appendix 2: Presentation
New equipment	Design & Engineering	The need to dispute the necessity of isolation	
		Specific factors of the location	
		Mechanical design	
		Selection of isolation materials	
	Manufacture & Construction	Rules for construction & Installation	
		Communication with contractors	
		Inspection of applied paint + isolation	

*Abbreviations used: CBD: Costs Based Decision-Making BP: Best Practice.*

Table 2: Available means for CUI management.

### 7.2 Competence

[Δ16] The organization shall:

- determine the necessary competence of person(s) doing work under its control that affects its CUI Management performance, and
- ensure that these persons are competent on the basis of appropriate education, training, or experience;
- where applicable, take actions to acquire the necessary competence, and evaluate the effectiveness of the actions taken, and
- retain appropriate documented information as evidence of competence.

*NOTE Applicable actions may include, for example: the provision of training to, the mentoring of, or the reassignment of currently employed persons; or the hiring or contracting of competent persons.*

### 7.3 Awareness

[Δ17] Persons doing work under the organization's control shall be aware of:

- the CUI Management policy
- their contribution to the effectiveness of the CUI Management system, including the benefits of improved CUI Management performance
- the implications of not conforming with the CUI Management system requirements.

### 7.4 Communication

[Δ18] The organization shall determine the need for internal and external communications relevant to the CUI Management system including

- on what it will communicate
- when to communicate
- with whom to communicate
- how to communicate

## 7.5 Documented information

### 7.5.1 General

- [Δ19] The organization's CUI Management system shall include
- documented information required by this International Standard
  - documented information determined by the organization as being necessary for the effectiveness of the CUI Management system.

*NOTE The extent of documented information for a CUI Management system can differ from one organization to another due to*

- the size of organization and its type of activities, processes, products and services,*
- the complexity of processes and their interactions, and*
- the competence of persons.*

### 7.5.2 Creating and updating

- [Δ20] When creating and updating documented information the organization shall ensure appropriate:
- identification and description (e.g. a title, date, author, or reference number)
  - format (e.g. language, software version, graphics) and media (e.g. paper, electronic)
  - review and approval for suitability and adequacy.

### 7.5.3 Control of documented information

- [Δ21] Documented information required by the CUI Management system and by this International HLS Standard shall be controlled to ensure

- it is available and suitable for use, where and when it is needed
- it is adequately protected (e.g. from loss of confidentiality, improper use, or loss of integrity).

- [Δ22] For the control of documented information, the organization shall address the following activities, as applicable:

- distribution, access, retrieval and use,
- storage and preservation, including preservation of legibility
- control of changes (e.g. version control)
- retention and disposition

- [Δ23] Documented information of external origin determined by the organization to be necessary for the planning and operation of the CUI Management system shall be identified as appropriate, and controlled.

*NOTE Access implies a decision regarding the permission to view the documented information only, or the permission and authority to view and change the documented information, etc.*

## 8 Operation

### 8.1 Operational planning and control

- [Δ24] The organization shall plan, implement and control the processes needed to meet requirements, and to implement the actions determined in 6.1, by:

- establishing criteria for the processes
- implementing control of the processes in accordance with the criteria
- keeping documented information to the extent necessary to have confidence that the processes have been carried out as planned.

- [Δ25] The organization shall control planned changes and review the consequences of unintended changes, taking action to mitigate any adverse effects, as necessary.

- [Δ26] The organization shall ensure that outsourced processes are controlled by testing the quality of those processes against the requirements set by the organization.

In order to ensure that the required reliability of the installation is achieved through the implementation of control measures, pre-inspections are carried out prior to inspections to take into account any limitations and obstacles present.

## 9 Performance evaluation

### 9.1 Monitoring, measurement, analysis and evaluation

[A27] The organization shall determine:

- what needs to be monitored and measured
- the methods for monitoring, measurement, analysis and evaluation, as applicable, to ensure valid results
- when the monitoring and measuring shall be performed
- when the results from monitoring and measurement shall be analysed and evaluated.

[A28] The organization shall retain appropriate documented information as evidence of the results. For applied NDT methods, the performance is monitored by monitoring the effectiveness for detecting and assessing damage typicals. That assessment includes the likelihood of false perceptions (“false calls/false positives” and risky “undetected/false negatives”).

[A29] The organization shall evaluate the RB-CUI Management performance and the effectiveness and efficiency of the RB-CUI management system. See as an example of this the elaboration of the effectiveness of the applied methods to manage the risks present on the [Installation] tab in the [ToolBP\_CuiManagement.xlsx] as a result of the lifespan of applied coatings, management of the condition of insulation and the applied management through inspection and maintenance.

### 9.2 Internal audit

#### 9.2.1 Control effectiveness of approach

[A30] The organization shall conduct internal audits at planned intervals to provide information on whether the CUI Management system;

- a) conforms to
  - the organization’s own requirements for its CUI Management system
  - the requirements of this International HLS Standard;
- b) is effectively implemented and maintained.

#### 9.2.2 Planned implementation

[A31] The organization shall:

- a) plan, establish, implement and maintain an audit programme(s), including the frequency, methods, responsibilities, planning requirements and reporting. The audit programme(s) shall take into consideration the importance of the processes concerned and the results of previous audits;
- b) define the audit criteria and scope for each audit;
- c) select auditors and conduct audits to ensure objectivity and the impartiality of the audit process;
- d) ensure that the results of the audits are reported to relevant management, and
- e) retain documented information as evidence of the implementation of the audit programme and the audit results.

### 9.3 Management review

[A32] Top management shall review the organization’s CUI Management system, at planned intervals, to ensure its continuing suitability, adequacy and effectiveness.

The management review shall include consideration of:

- a) the status of actions from previous management reviews;
- b) changes in external and internal issues that are relevant to the CUI Management system;
- c) information on the CUI Management performance, including trends in:
  - nonconformities and corrective actions
  - monitoring and measurement results, and
  - audit results;
- d) opportunities for continual improvement.

[A33] The outputs of the management review shall include decisions related to continual improvement opportunities and any need for changes to the CUI Management system. The organization shall retain documented information as evidence of the results of management reviews.

## 10 Improvement

### 10.1 Nonconformity and corrective action

[Δ34] When a nonconformity occurs, the organization shall:

- a) react to the nonconformity, and as applicable
  - take action to control and correct it, and
  - deal with the consequences;
- b) evaluate the need for action to eliminate the causes of the nonconformity, in order that it does not recur or occur elsewhere, by
  - reviewing the nonconformity
  - determining the causes of the nonconformity, and
  - determining if similar nonconformities exist, or could potentially occur;
- c) implement any action needed;
- d) review the effectiveness of any corrective action taken; and
- e) make changes to the CUI Management system, if necessary.

Corrective actions shall be appropriate to the effects of the nonconformities encountered.

The organization shall retain documented information as evidence of

- the nature of the nonconformities and any subsequent actions taken, and
- the results of any corrective action.

The improvements to be made include the effectiveness of NDT techniques.

[Δ35] If this does not correspond to the specifications, appropriate techniques such as Root-Cause analysis are used to determine where deviations have resulted from. If no cause can be determined, the specification of the effectiveness is adjusted on the basis of the recorded practical experience.

### 10.2 Continual improvement

[Δ36] The organization shall continually improve the suitability, adequacy and effectiveness of the CUI Management system.

## REFERENCES.

In the elaboration of this best practice, personal expertise has been used (see Appendix 1:), the project results from the 3 working groups mentioned there, the normative references as mentioned under § 2 and the following sources:

- Ref. 1. CINI Relation between process temperatures and corrosion under insulation. CINI 1.2.04 (1 Jan '16)
- Ref. 2. Corrosion-Under-Insulation (CUI) Guidelines, European Federation of Corrosion Publications, Number 55 (2016)
- Ref. 3. Roadmap to Managing Corrosion-Under-Insulation (CUI); EEPCCUI Issue Group (2011)
- Ref. 4. HOIS Guidance for in-situ inspection of corrosion under insulation (CUI); HOIS(16)R2 Issue 1; S.F.Burch (Nov. '16).
- Ref. 5. API 581; Risk-Based Inspection methodology (April 2016); API Recommended Practice, 3rd Edition.
- Ref. 6. API 583; Corrosion Under Insulation and Fireproofing; 1st edition, May 2014.

## APPENDICES

### Appendix 1:

List of companies and persons who have attributed to the development of this best practise:

<b>Working group:</b>	<b>Company:</b>	<b>Participant:</b>	
Coatings	Vereniging ION	E. Stremmelaar*	(chairman)
	Bjond	J. van Montfort*	(secretary)
	Fluor	R. Spier	
	Projectcontrole	E. Scheper	
	Venko	O. Smale	
	Sitech	B. Wolfs	
	Iris	J. Neefs	
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	VNCI	P. Bareman	
	KIC / DOW	A. Balt	
	KIC / MPI	P. Raes	
	BASF	M. Schoonacker	

\* Persons marked by \* in a specific group, have also participated in the steering group.

## Appendix 2:



Presentation: Risk Based “Corrosion Under Insulation” (CUI) Management.



Tool BP\_Prio (Xlsx): [Tool BP CUI Management Prioritization] the tool to manage risk based CUI. This contains the following modules:

- Overview installation. (tab: [Installation])
- Display asset status. (tab: [View])
- Plan of attack with clustering by area / risk or combination (Tab: [Installation])



Tool BP (Xlsx): [Tool BP CUI Management] which is the elaboration of the developed method to assess the present risk. Parts of the [Tool BP Prio] are detailed therein. It thus enables the user to reduce the approach followed, down to the level of detail, to the expertise-related insights. It contains the following modules:

- Risk assessment module (derived from NEN-EN 16991)
- Module Failure probability due to corrosion
- Module Insulation Condition Classification
- Module coating remaining life assessment
- Effectiveness Inspection Module



Tool CBD (Xlsx): Cost-based decision support “inspection, renovation or value creation” based on life cycle analysis. This tool supports the decision-making process between maintenance strategies such as “investing in inspection” or “inspecting in renovation”. This tool contains the following components:

- Upgrade module costs/benefits CUI proof (scenario case CUI “engineering out”)
- Module “Inspect or renovate” (cost-based consideration - height dependent).



Tool NDT Selection (Xlsx) [Tool Suitability NDT techniques]: Tool to determine the associated inspection method based on typical, construction data and required effectiveness.

## Appendix 3:

Working group reports:



Workgroup Risk Based CUI Management: This report and management summary; Memo number: WG-RB-CUI-16Okt19 (file: ProjectSummaryWCM\_CUI\_12Nov19.pdf) .

Working group NDT Effectiveness: CUI NDT Project report; Prevention and detection of corrosion under insulation. Selection of NDT. Final report. Nov. '19. (file: 08 Final report WG-NDT 14-11-2019.pdf)

Working Group Lifetime of coatings: Corrosion under Insulation (COI), guideline for the use of coating systems. Final report. March '20. Report No. R230320.01\_WCm.



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