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FINAL
DRAFT

INTERNATIONAL STANDARD

ISO/FDIS 23222

ISO/TC **156**/SC **1**

Secretariat: SAC

Voting begins on:
2020-09-07

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2020-11-02

Corrosion control engineering life cycle — Risk assessment

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys,* Subcommittee SC 1, *Corrosion control engineering life cycle*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Corrosion control engineering life cycle — Risk assessment

1 Scope

This document specifies the general requirements for risk assessment in the life cycle of corrosion control engineering.

This document is applicable to a risk assessment of all types of corrosion control engineering programmes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 23123[1)], *Corrosion control engineering life cycle — General requirements*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
risk assessment
overall process of *risk identification* (3.2), *risk analysis* (3.3) and *risk evaluation* (3.4)

3.2
risk identification
process of finding, recognizing and describing the corrosion risk of all elements in the corrosion control engineering life cycle

3.3
risk analysis
process to understand the nature of the corrosion risk and the degree of damage

Note 1 to entry: Risk analysis is the basis of *risk assessment* (3.1).

3.4
risk evaluation
process of comparing the results of the *risk analysis* (3.3) and summarizing the traceability and supporting documents to determine whether the corrosion risk of all elements in the corrosion control engineering life cycle and/or its magnitude is acceptable or tolerable

1) Under preparation.

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3.5
consequence
outcome of an event affecting objectives

Note 1 to entry: A consequence can be certain or uncertain and can have positive or negative direct or indirect effects on objectives.

Note 2 to entry: Consequences can be expressed qualitatively or quantitatively.

Note 3 to entry: Any consequence can escalate through cascading and cumulative effects.

[SOURCE: ISO 31000:2018, 3.6]

4 General principles

4.1 Objectives

The purpose of risk assessment is to:

a) improve the integration, systematization, mutual coordination and optimization of all elements of the corrosion control engineering life cycle;

b) create and protect the benefits of human health and safety, cost-effectiveness, long-term operation and environmental protection.

4.2 Principles

For risk assessment to be effective, an organization should, at all levels, conform to the following principals:

a) risk assessment should be based on ISO 23123 or other risk criteria, and should be performed on all elements of the corrosion control engineering life cycle;

b) risk assessment is transparent and inclusive;

c) risk assessment is dynamic, iterative and responsive to change;

d) risk assessment takes human factors into account;

e) risk assessment is systematic, structured and timely.

5 Risk assessment procedure

5.1 General

The risk assessment process of a corrosion control engineering life cycle includes the following steps.

a) Identify the corresponding actual risk of all elements in the corrosion control engineering life cycle.

b) Research and analyse whether all elements are implemented in accordance with ISO 23123.

c) Analyse the evaluation result and submit the identified assessment report.

5.2 Risk identification

The risk of all elements of the corrosion control engineering life cycle should be identified collectively and accurately in accordance with the actual situation of the main programme.

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5.3 Risk analysis

5.3.1 Objectives

The objectives should be analysed as follows.

a) Whether the corrosion control engineering is implemented in accordance with the principles given in Clause 4.

b) Whether the objectives are implemented into the risk analysis of all elements of the corrosion control engineering life cycle, and communicated, and maintained in all aspects of the life cycle. In addition, whether the objectives adapt the corrosion control engineering life cycle and the protected main programme life cycle. The corrosion control engineering life cycle depends on, serves and assists the main programme. In some cases, it is also restricted to the main programme.

5.3.2 Corrosion sources

The corrosion sources should be analysed as follows.

a) Whether the internal and external corrosion sources are identified comprehensively and accurately.

b) Whether new corrosion sources generated in the implementation process are identified comprehensively and accurately.

c) Whether the conditions of the main programme and the influence of the corrosion control engineering body are taken into account.

d) Whether an established procedure has been identified.

e) How the corrosion and its sources are monitored and mitigated, which shall be analysed during the lifetime of the assessment.

5.3.3 Design

The design should be analysed as follows.

a) Whether the design takes into account all elements, links and nodes throughout the entire life cycle of the corrosion control process.

b) Whether the design takes into account the integration, systematization, mutual coordination and optimization during the entire life cycle of corrosion control engineering.

c) Whether a green plan has been made.

d) Whether the design system is constantly improved to meet the requirements of the main programme.

e) Whether the design documents are subject to the acceptance of established procedures, and whether they are to be documented and archived.

5.3.4 Research and development

The research and development should be analysed as follows.

a) Whether all elements, links and nodes during the entire life cycle of corrosion control engineering are continuously studied, improved and developed in the implementation process and achieve the optimum benefits of safety, cost-effectiveness, long-term operation and environmental protection.

b) Whether the entire research and development process is carried out in accordance with established procedures.

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c) Whether new materials and new technologies have been developed when existing materials and technologies fail to meet the corrosion control requirements, so that they can meet the requirements for material selection and technical application.

d) Whether the data documentation for research and development is built for traceability.

5.3.5 Materials, technology, manufacturing, construction, storage and transportation, installation and commissioning, and repair

Each of these elements should be analysed as follows.

a) Whether the selected element is corrosion-resistant and can achieve the optimum benefits of safety, cost-effectiveness, long-term operation and environmental protection.

b) Whether the selected element is based on the relevant inspection standards.

c) Whether the selected element has corresponding specific performance and supporting implementation cases.

d) Whether the selected element is coordinated, optimized and supported with other elements.

e) Whether the selected element has been identified by established procedures, and whether it is to be documented and archived.

5.3.6 Acceptance inspection

The acceptance inspection should be analysed as to whether it has been implemented in accordance with ISO 23123 before operation.

5.3.7 Operation

The operation should be analysed as to whether to increase monitoring during the operation of the corrosion control engineering life cycle on the basis of the acceptance inspection to ensure a real-time forewarning.

5.3.8 Maintenance

The maintenance should be analysed as to whether to carry it out in accordance with the corresponding maintenance manual, and whether to maintain the monitoring equipment in good condition.

5.3.9 Scrap and disposal

The scrap and disposal should be analysed as follows.

a) Whether scrap and disposal are carried out in accordance with the green plan formulated at the design stage.

b) Whether the recyclable equipment is recycled.

c) Whether the social responsibility for the equipment to be scrapped and disposed is clearly defined to prevent environmental pollution.

d) Whether scrap and disposal are subject to the acceptance of the established procedures, and whether they are to be documented and archived.

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5.3.10 Documents and records

The documents and records should be analysed as follows.

a) Whether the documents and records established for all elements of the corrosion control engineering life cycle are reasonable, scientific and traceable.

b) Whether the documents and records are audited regularly to ensure the corrosion control information has been completed.

5.3.11 Resource management

The resource management should be analysed as follows.

a) Whether each element, link and node has relevant requirements for corresponding and appropriate personnel, process tooling, testing equipment, work site and supervision, etc.

b) Whether the human resources, equipment, materials, technology, methods, environment and other resources have been managed in an overall way to meet the principles given in Clause 4.

5.3.12 Comprehensive assessment

The comprehensive assessment should be analysed as follows.

a) Whether all elements of the corrosion control engineering life cycle have a comprehensive assessment in accordance with the specified requirements.

b) Whether to provide assessment reports, which can be used to guide the improvement of the engineering design of the life cycle of corrosion control engineering.

5.4 Risk evaluation

5.4.1 Evaluation principle

In order to achieve the objectives given in 4.1, ensure that the risk assessment of the integration, cost-effectiveness, effectiveness and remedial measures of the corrosion control engineering life cycle is conducted in accordance with ISO 23123.

5.4.2 Evaluation method

5.4.2.1 The risk evaluation should be carried out in accordance with the actual situation of the main programme. The corrosion control engineering should be carried out in accordance with ISO 23123.

5.4.2.2 The risk evaluation method should be carried out and analysed as follows.

a) Whether its implementation has the corresponding basis.

b) Whether it has traceable and supporting documents.

c) A spot check and trace should be carried out.

d) The data quality, completeness, sensitivity and consistency of the conclusion should be checked during the process of risk evaluation.

e) The conclusion of the risk evaluation should be subject to the acceptance of the corresponding procedures and should be completely transparent.

f) The assessment records can be carried out item by item in accordance with the risk assessment form provided in Annex A.

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5.4.3 Risk assessment report

5.4.3.1 A risk assessment report should be issued.

5.4.3.2 The risk assessment report should provide clear conclusions on whether all elements in the corrosion control engineering life cycle have been implemented in accordance with ISO 23123, and should offer suggestions and new supplements.

5.4.3.3 The risk assessment report should provide clear conclusions and recommendations on whether all elements are optimized and coordinated.

5.4.3.4 The risk assessment report should be identified in accordance with established procedures.

5.4.3.5 The risk assessment should emphasize whether the report involves safety issues. If safety is involved, solutions to the corresponding issues should be established.

5.4.3.6 A duty system for the risk assessment should be established, in order to identify the liability subjects in cases where there are safety-related issues.

5.4.3.7 The risk assessment report should be used as a traceable and supporting document to improve and supplement ISO 23123.

6 Quantitative analysis of risk

This document does not give the quantitative analysis of risk. For information, Annex B provides a basic principle about a quantitative analysis of risk.

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Annex A
(informative)

Corrosion control engineering life cycle risk assessment form

A corrosion control engineering life cycle risk assessment should be conducted systematically, iteratively and collaboratively, drawing on the knowledge and views of stakeholders. Table A.1 can be referenced in the process of a corrosion control engineering life cycle risk assessment

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Table A.1 — Corrosion control engineering life cycle risk assessment form

<table>
<tr><th>Assessment object:</th><th></th><th colspan="2">Project name:
No.:</th><th colspan="5">Assessment date:</th></tr>
<tr><th rowspan="2">Assessment item</th><th rowspan="2">Assessment content</th><th rowspan="2">Internal assessment of the assessed object</th><th rowspan="2">Third-party assessment record</th><th colspan="4">Assessment result</th></tr>
<tr><th>Compliance</th><th>Basic compliance</th><th>Non-conformity</th><th>Not applicable</th></tr>
<tr><td rowspan="4">1. General principles</td><td rowspan="2">1.1 Basis
This document is based on ISO 23123 and other relevant International Standards.</td><td>It is based on ISO 23123.
Yes ☐ No ☐</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>It is based on other relevant International Standards
Yes ☐ No ☐</td></tr>
<tr><td rowspan="2">1.2 Objectives
The purpose of risk assessment is to:
a) improve the integration, systematization, mutual coordination and optimization of all elements of the corrosion control engineering life cycle;
b) create and protect the benefits of human health and safety, cost-effectiveness, long-term operation and environmental protection.</td><td>It is the correct objective.
Yes ☐ No ☐</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>There is a risk assessment of all the elements specified in ISO 23123.
Yes ☐ No ☐</td></tr>
<tr><td>2. Risk element analysis programme</td><td>2.1 General
a) Identify the corresponding actual risk of all elements in the corrosion control engineering life cycle.
b) Research and analyse whether all elements are implemented in accordance with ISO 23123.
c) Analyse the evaluation result and submit the identified assessment report.</td><td>The entire evaluation process is complete.
Yes ☐ No ☐</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

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Table A.1 *(continued)*

Assessment object:		**Project name:** **No.:**	**Assessment date:**					
Assessment item	**Assessment content**	**Internal assessment of the assessed object**	**Third-party assessment record**	**Assessment result**				
				Compliance	**Basic compliance**	**Non-conformity**	**Not applicable**	
2. Risk element analysis programme	2.2 Risk identification Whether all elements that affect the entire process chain of the corrosion control engineering life cycle are scientifically identified. Whether they are complete and accurate. Whether there is supportive and traceable documentation.	All elements that affect the entire process chain of the corrosion control engineering life cycle are scientifically identified. Yes ☐ No ☐						
		The identified elements are complete and accurate. Yes ☐ No ☐						
		There is supportive and traceable documentation. Yes ☐ No ☐						

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Table A.1 *(continued)*

Assessment object:		**Project name:** **No.:**	**Assessment date:**					
Assessment item	**Assessment content**	**Internal assessment of the assessed object**		**Third-party assessment record**	**Assessment result**			
					Compliance	**Basic compliance**	**Non-conformity**	**Not applicable**
2. Risk element analysis programme	2.3 Risk analysis of various elements 2.3.1 Objectives a) Analyse whether the corrosion control engineering follows the holistic, systematic and comprehensive control principles and accords with the optimal benefits of cost-effectiveness, long-term operation and green environmental protection.	The objectives are the optimal benefits of cost-effectiveness, long-term operation and green environmental protection. Yes ☐ No ☐						
		The control follows the holistic, systematic and comprehensive control principles. Yes ☐ No ☐						
	b) Analyse whether the objective is implemented in the risk analysis of various elements, and communicated, implemented and maintained in all aspects of the life cycle, so that corrosion control life cycle engineering and the life cycle of the protected subject project are adapted to each other. (The corrosion control engineering life cycle depends on, serves and assists the main programme. In some cases, it is also restricted to the main programme.)	The risk control of all elements involved is based on the optimal benefits of safety, cost-effectiveness, long-term operation and environmental protection. Yes ☐ No ☐						
		Corrosion control life cycle engineering and the life cycle of the main programme are adapted to each other. Yes ☐ No ☐						

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Table A.1 *(continued)*

Assessment object:		**Project name:** **No.:**	**Assessment date:**				
Assessment item	**Assessment content**	**Internal assessment of the assessed object**	**Third-party assessment record**	**Assessment result**			
				Compliance	**Basic compliance**	**Non-conformity**	**Not applicable**
2.Risk element analysis programme	2.3.2 Corrosion sources a) What are the sources of corrosion? What are the working conditions, including temperature, surface treatment, etc.? b) The corrosion sources are identified comprehensively and accurately. c) There is supportive and traceable documentation. d) There is a procedure for identifying the sources of corrosion.	The corrosion source identifies completely and accurately. Yes ☐ No ☐ There is a procedure for identifying the source of corrosion. Yes ☐ No ☐ There is supportive and traceable documentation. Yes ☐ No ☐					

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Table A.1 *(continued)*

Assessment object:		**Project name:** **No.:**	**Assessment date:**				
Assessment item	**Assessment content**	**Internal assessment of the assessed object**	**Third-party assessment record**	**Assessment result**			
				Compliance	**Basic compliance**	**Non-conformity**	**Not applicable**
2. Risk element analysis programme	2.3.3 Design a) The design includes all the elements that affect the entire corrosion control engineering life cycle.	The design includes all the elements in the project that affect the entire life cycle chain of the corrosion control project. Yes ☐ No ☐					
	b) The design enables all elements to link up with each other, optimize with each other, coordinate with each other, support each other, and form a holistic, systematic, comprehensive design to achieve the optimal benefits of safety, cost-effectiveness, long-term operation and environmental protection.	The design meets the holistic, systematic and coordinated optimization principles. Yes ☐ No ☐					
	c) There is a green plan.	There is a green plan. Yes ☐ No ☐					
	d) The design system has been evaluated for suitability to meet the requirements of the main programme.	The main programme is applicable. Yes ☐ No ☐					
	e) It should be analysed whether the design documents are reviewed and approved in accordance with the procedures and documented and recorded.	There are design documents and records in accordance with the procedures reviewed and approved. Yes ☐ No ☐					

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Table A.1 *(continued)*

Assessment object:		**Project name:** **No.:**	**Assessment date:**				
Assessment item	**Assessment content**	**Internal assessment of the assessed object**	**Third-party assessment record**	**Assessment result**			
				Compliance	**Basic compliance**	**Non-conformity**	**Not applicable**
2. Risk element analysis programme	2.3.4 Research and development a) Whether research and development are needed.	Research and development are needed. Yes ☐ No ☐					
	b) Whether the entire research and development process is carried out in accordance with procedures and maintains the principles of science, technology and cost-effectiveness.	If needed, there is a procedure for research and development that guarantees the principles of science, technology and cost-effectiveness. Yes ☐ No ☐					
	c) In cases where existing materials and technologies fail to meet corrosion control requirements, whether new materials and new technologies have been developed to meet the requirements for material selection and technical application.	There are new materials and new technologies developed. Yes ☐ No ☐					
		If so, there is an experimental verification and evaluation. Yes ☐ No ☐					
	d) Whether all research and development projects have established data documents to make them traceable.	A data document for the research and development process has been established. Yes ☐ No ☐					

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Table A.1 *(continued)*

Assessment object:		**Project name:** **No.:**	**Assessment date:**				
Assessment item	**Assessment content**	**Internal assessment of the assessed object**	**Third-party assessment record**	**Assessment result**			
				Compliance	**Basic compliance**	**Non-conformity**	**Not applicable**
2. Risk element analysis programme	2.3.5 Risk analysis of materials, technology, manufacturing, storage and transportation, construction and installation, commissioning and repair. a) It should be analysed whether the selected element is corrosion-resistant and achieves the optimum benefits of safety, cost-effectiveness, long-term operation and environmental protection.	The selected element is corrosion-resistant and achieves the optimum benefits of safety, cost-effectiveness, long-term operation and environmental protection. Yes ☐ No ☐					
	b) It should be analysed whether the selected element is based on the relevant inspection standards or not.	It is based on relevant inspection standards. Yes ☐ No ☐					
	c) It should be analysed whether the selected element has corresponding specific performance and supporting implementation cases.	There are corresponding specific performance and supporting implementation cases. Yes ☐ No ☐					
	d) It should be analysed whether the selected element is coordinated, optimized and supported with other elements.	The selected element is coordinated, optimized and supported with other elements. Yes ☐ No ☐					
	e) It should be analysed whether the selected element has been identified by certain procedures, and whether it is to be documented and archived.	There are certain identifying procedures, and traceable documents and records. Yes ☐ No ☐					

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Table A.1 *(continued)*

Assessment object:		**Project name:** **No.:**	**Assessment date:**				
Assessment item	**Assessment content**	**Internal assessment of the assessed object**	**Third-party assessment record**	**Assessment result**			
				Compliance	**Basic compliance**	**Non-conformity**	**Not applicable**
2. Risk element analysis programme	2.3.6 Acceptance inspection An acceptance inspection is performed prior to operation in accordance with the procedures specified in ISO 23123. There are supporting documents and records.	There is an acceptance condition. Yes ☐ No ☐					
		There is a clear acceptance content. Yes ☐ No ☐					
		There is a specific acceptance procedure. Yes ☐ No ☐					
		There is a standard for acceptance. Yes ☐ No ☐					
		The acceptance inspection is performed in accordance with ISO 23123. Yes ☐ No ☐					
		There are documents and records regarding the acceptance of the project's corrosion control engineering life cycle. Yes ☐ No ☐					

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Table A.1 *(continued)*

Assessment object:		Project name: No.:	Assessment date:					
Assessment item	**Assessment content**	**Internal assessment of the assessed object**	**Third-party assessment record**	**Assessment result**				
				Compliance	**Basic compliance**	**Non-conformity**	**Not applicable**	
2. Risk element analysis programme	2.3.7 Operation It should be analysed as to whether to increase monitoring for the life cycle operation of the corrosion control engineering to ensure a real-time forewarning, including what measures have been taken, and what documents and records are available.	There are enough monitoring equipment and early warning procedures to ensure real-time monitoring. Yes ☐ No ☐						
		The operation meets the requirements of the running programme. Yes ☐ No ☐						
		There are supporting and traceable documents and records. Yes ☐ No ☐						
2. Risk element analysis programme	2.3.8 Maintenance Maintenance is carried out in accordance with the corresponding maintenance manual, and the monitoring equipment, devices, instruments, etc. throughout the entire corrosion control life cycle are maintained in a normal and intact state. There are documents and records for maintenance and maintenance data.	There is a maintenance manual and maintenance in accordance with the maintenance procedures. Yes ☐ No ☐						
		There is a documented maintenance for the monitoring equipment, facilities, meters and their status of use. Yes ☐ No ☐						

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Assessment object:		**Project name:** **No.:**	**Assessment date:**				
Assessment item	**Assessment content**	**Internal assessment of the assessed object**	**Third-party assessment record**	**Assessment result**			
				Compliance	**Basic compliance**	**Non-conformity**	**Not applicable**
2. Risk element analysis programme	2.3.9 Scrap and disposal a) Scrap is disposed of in accordance with the established green plan. b) The recyclable equipment that has been scrapped is recycled. c) Social responsibility is clarified to prevent environmental pollution. d) The results of the scrap have been reviewed by established procedures to form a traceable and supportive document to prove the completion of the procedure.	Scrap and disposal are needed. Yes ☐ No ☐					
		The process is green and environmental-friendly, and it is in accordance with the green plan. Yes ☐ No ☐					
		There is a recyclable device that is looped. Yes ☐ No ☐					
		There are supporting and traceable documents and records to demonstrate the entire scrap and disposal process. Yes ☐ No ☐					
2. Risk element analysis programme	2.3.10 Documents and records a) There are traceable supporting documents and records for all elements. b) Periodic reviews are conducted to obtain the latest corrosion control information.	There are some supporting and traceable documents and records for the elements in the chain of the corrosion control engineering life cycle. Yes ☐ No ☐					
		An internal periodic review has been conducted. Yes ☐ No ☐					

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Table A.1 *(continued)*

Assessment object:		**Project name:** **No.:**	**Assessment date:**					
Assessment item	**Assessment content**	**Internal assessment of the assessed object**	**Third-party assessment record**	**Assessment result**				
				Compliance	**Basic compliance**	**Non-conformity**	**Not applicable**	
2. Risk element analysis programme	2.3.11 Resource management Each element, link, etc. has appropriate personnel, process tooling, testing equipment, work sites and supervision.	The management of resources meets the holistic, systematic, coordinated and optimized principles, and achieves the optimal benefits of safety, cost-effectiveness, long-term operation and environmental protection. Yes ☐ No ☐						
	It should be analysed whether the human resources, equipment, materials, technology, methods, environment and other resources have been managed in an integrated manner to meet the principles of integration, system, coordination and optimization, achieving the optimal benefit of safety, cost-effectiveness, long-term operation and environmental protection.	There are corresponding and appropriate personnel qualification conditions, process tooling conditions, equipment levels and workplaces. Yes ☐ No ☐						
		The entire management of resources such as the human resources, equipment, materials, technology, methods and environment are compatible with the project. Yes ☐ No ☐						
		There are supporting and traceable documents and records to demonstrate the management of resources. Yes ☐ No ☐						

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Table A.1 *(continued)*

Assessment object:		**Project name: No.:**	**Assessment date:**				
Assessment item	**Assessment content**	**Internal assessment of the assessed object**	**Third-party assessment record**	**Assessment result**			
				Compliance	**Basic compliance**	**Non-conformity**	**Not applicable**
2. Risk element analysis programme	2.3.12 Comprehensive assessment a) There is a comprehensive assessment for each element.	There is a comprehensive assessment of each element in the design of the corrosion control engineering life cycle. Yes ☐ No ☐					
	b) It should be analysed whether there is a comprehensive assessment of the integration, systematization, coordination and optimization of various elements to achieve the optimal benefits of safety, cost-effectiveness, long-term operation and environmental protection for corrosion control engineering.	There is a comprehensive assessment of the integration, systematization, coordination and optimization of various elements. Yes ☐ No ☐					
	c) Analyse whether a written assessment report is issued and provide continuous improvement and improvement guidance for the engineering design of the corrosion control engineering life cycle.	There is a written assessment report. Yes ☐ No ☐					
Assessment conclusion							

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Annex B
(informative)

Quantitative analysis of risk

The traditional risk equation is risk = probability × consequence, where the failure probability refers to the probability that a failure event will occur, and the failure consequence refers to the consequences of the failure event.

Table B.1 describes how a risk severity index can be apportioned to different elements of the corrosion control engineering life cycle. Compared to the traditional failure consequence, Table B.1 includes two other consequence values: long-term operation and environmental protection.

The severity index, I, is calculated by multiplying the failure potential, F, by the sum of four consequence values, expressed as shown in Formula (1):

$$I = F \times (S + C + L + P) \tag{1}$$

where

F is the failure potential;

S is the failure consequence of safety;

C is the failure consequence of cost-effectiveness;

L is the failure consequence of long-term operation;

P is the failure consequence of environmental protection.

The recommended values of F, S, C, L, P are given in Table B.1.

Table B.1 — Failure potential and consequence evaluation

Failure potential F **(assigned by an inspector)**	**Failure consequence (assigned by operations)**				**Severity index** I
	Safety S	**Cost-effectiveness** C	**Long-term operation** L	**Environmental protection** P	
4: Item could fail in an unpredictable manner 3: Failure could occur within 1 year but not in an unpredictable manner 2: Item could fail within 1 to 5 years 1: Item could fail within 5 to 10 years	3: High concern that failure will result in serious consequences and effects of personal injury and death 2: Moderate concern 1: Low concern 0: No concern	3: High impact on economics if the failure occurs 2: Moderate concern 1: Low concern 0: No concern	3: High impact on the long-term operation if the failure occurs 2: Moderate concern 1: Low concern 0: No concern	3: High impact on the environment if the failure occurs 2: Moderate concern 1: Low concern 0: No concern	$F \times (S + C + L + P)$

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Bibliography

[1] ISO 31000:2018, *Risk management — Guidelines*

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