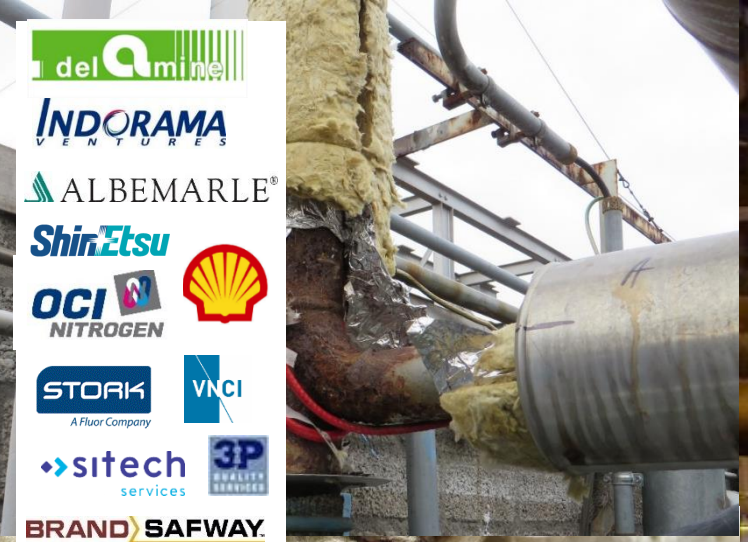


STATUS OVERVIEW.
Results 2023

Corrosion under Insulation

WORLD CLASS MAINTENANCE

Corrosion under Insulation

roadmap

Development CUI Awareness tool

- Self assessment tool.
- Awareness w.r.t. CUI
- Evaluation level of robustness in terms of being prepared for CUI

Development Best Practice

- Modular set of tools for implementation of CUI management
- Risk based approach
- Based on the ISO HLS structure
- Standard based on hands-on experience of involved companies and the current state of the art in this matter.

Innovations project

- Development moisture-sensoring
- Development sustainable coatings with enhanced CUI resistance
- Development Best Practise CUI conscious insulating
- Determination of earning capacity CUI program for the industry.

Knowledge & Validation Project

- Performance of new detecting techniques
- Performance of new coatings
- Performance of improved insulation techniques
- Performance optimised CUI management as per industry branch

Upgrade feasible innovations

- Branch oriented innovations for proven performance blockers as per industry.
- Implementation service concepts for integrated CUI performance management (isolation, coating, inspection, energy efficiency)

Sustainable Control on CUI.

RISC

2018 2019 2020 2021 2022 2023

Call for Action / Business Driver
- Prevention is better than correction.
- Save on failure costs.
- Investing in a cost-effective approach from TCO.
- Recognisability from management structure
- Preventing “trial and error” approach

CUI solution:
- Modular approach based on maintaining what is good, improving what can be improved.
- Using generally proven concepts with regard to predicting corrosion, assessing damage, determining risk, estimating lifespan, controlling costs.
- Transparency through independent approach from WCM; a supplier-independent concept.
- With the involvement of KINT, ION, VNCI, RVO, SDN

Business model:
- Risk-oriented, so investment in those areas where it yields best profits.
- Taking into account the continuation of those concepts which are already doing well.
- Improve together by using each others individual experiences for the better good.

(Potential) partners:
- Asset-owners from “BRZO” sector
- Isolation and coating industry
- Inspection- and service suppliers

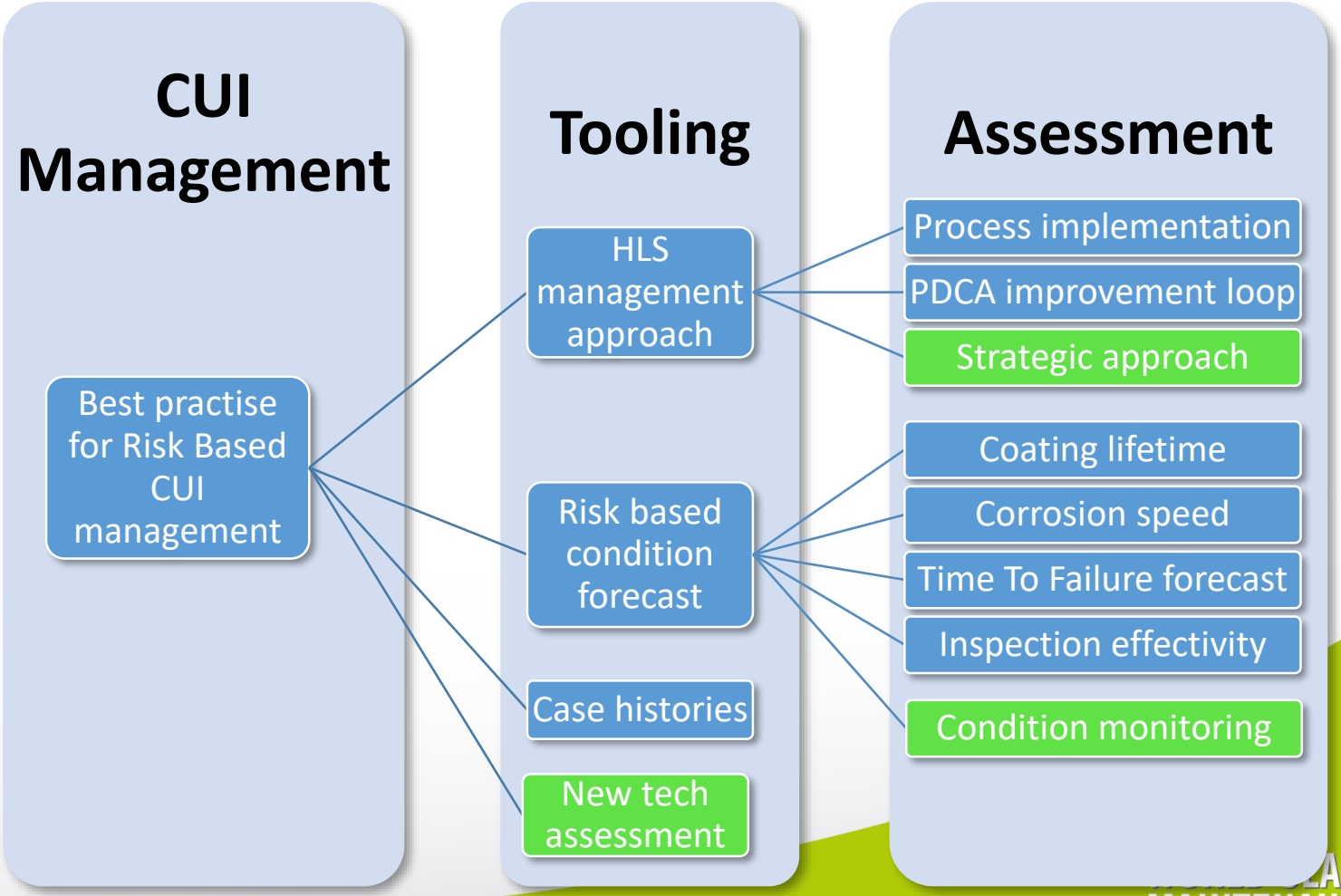
WORLD CLASS MAINTENANCE

Corrosion under Insulation

WCM CUI-approach 2023:

Related activities:

- Positioning EFC BP



Corrosion under Insulation

Strategic approach

- Generic setup, using ISO HLS.
- Template available for “kick-start”.
- Adapted to company vision.
- Based on PDCA improvement.
- Aligns with compliance req.’s.

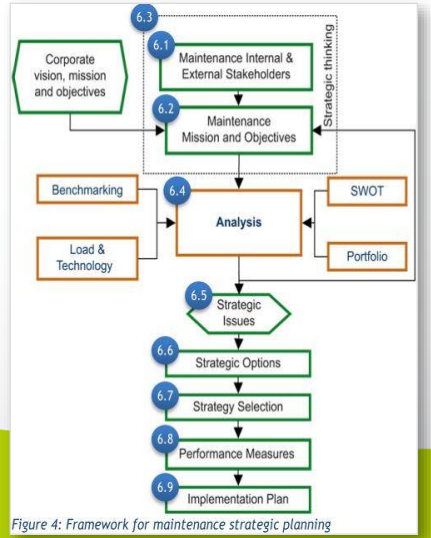
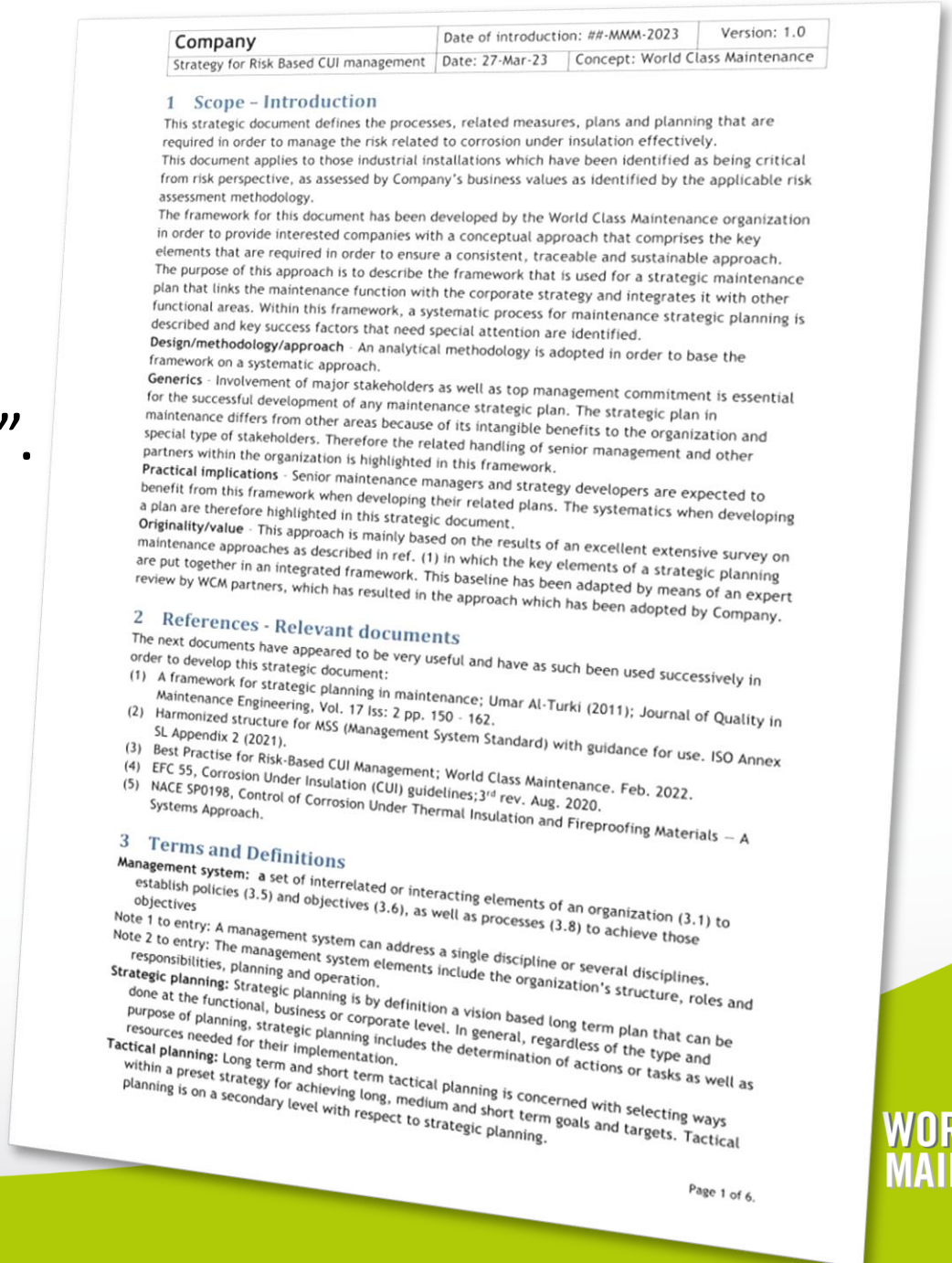


Figure 4: Framework for maintenance strategic planning



Company	Date of introduction: ##-MMM-2023	Version: 1.0
Strategy for Risk Based CUI management	Date: 27-Mar-23	Concept: World Class Maintenance

1 Scope – Introduction

This strategic document defines the processes, related measures, plans and planning that are required in order to manage the risk related to corrosion under insulation effectively.
This document applies to those industrial installations which have been identified as being critical from risk perspective, as assessed by Company’s business values as identified by the applicable risk assessment methodology.
The framework for this document has been developed by the World Class Maintenance organization in order to provide interested companies with a conceptual approach that comprises the key elements that are required in order to ensure a consistent, traceable and sustainable approach.
The purpose of this approach is to describe the framework that is used for a strategic maintenance plan that links the maintenance function with the corporate strategy and integrates it with other functional areas. Within this framework, a systematic process for maintenance strategic planning is described and key success factors that need special attention are identified.
Design/methodology/approach - An analytical methodology is adopted in order to base the framework on a systematic approach.
Generics - Involvement of major stakeholders as well as top management commitment is essential for the successful development of any maintenance strategic plan. The strategic plan in maintenance differs from other areas because of its intangible benefits to the organization and special type of stakeholders. Therefore the related handling of senior management and other partners within the organization is highlighted in this framework.
Practical implications - Senior maintenance managers and strategy developers are expected to benefit from this framework when developing their related plans. The systematics when developing a plan are therefore highlighted in this strategic document.
Originality/value - This approach is mainly based on the results of an excellent extensive survey on maintenance approaches as described in ref. (1) in which the key elements of a strategic planning are put together in an integrated framework. This baseline has been adapted by means of an expert review by WCM partners, which has resulted in the approach which has been adopted by Company.

2 References - Relevant documents

The next documents have appeared to be very useful and have as such been used successively in order to develop this strategic document:
(1) A framework for strategic planning in maintenance; Umar Al-Turki (2011); Journal of Quality in Maintenance Engineering, Vol. 17 Iss: 2 pp. 150 - 162.
(2) Harmonized structure for MSS (Management System Standard) with guidance for use. ISO Annex SL Appendix 2 (2021).
(3) Best Practise for Risk-Based CUI Management; World Class Maintenance. Feb. 2022.
(4) EFC 55, Corrosion Under Insulation (CUI) guidelines;3rd rev. Aug. 2020.
(5) NACE SP0198, Control of Corrosion Under Thermal Insulation and Fireproofing Materials – A Systems Approach.

3 Terms and Definitions

Management system: a set of interrelated or interacting elements of an organization (3.1) to establish policies (3.5) and objectives (3.6), as well as processes (3.8) to achieve those objectives
Note 1 to entry: A management system can address a single discipline or several disciplines.
Note 2 to entry: The management system elements include the organization’s structure, roles and responsibilities, planning and operation.
Strategic planning: Strategic planning is by definition a vision based long term plan that can be done at the functional, business or corporate level. In general, regardless of the type and purpose of planning, strategic planning includes the determination of actions or tasks as well as resources needed for their implementation.
Tactical planning: Long term and short term tactical planning is concerned with selecting ways within a preset strategy for achieving long, medium and short term goals and targets. Tactical planning is on a secondary level with respect to strategic planning.

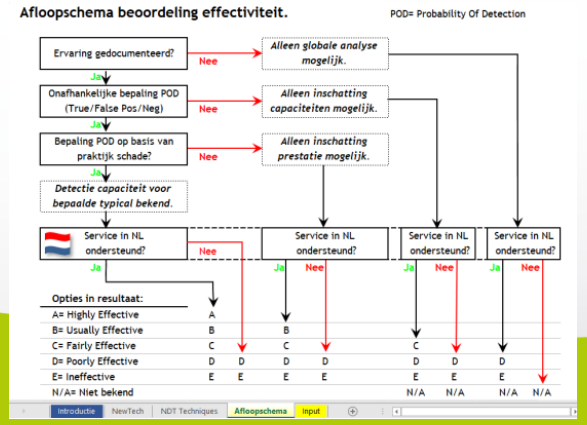
Page 1 of 6.

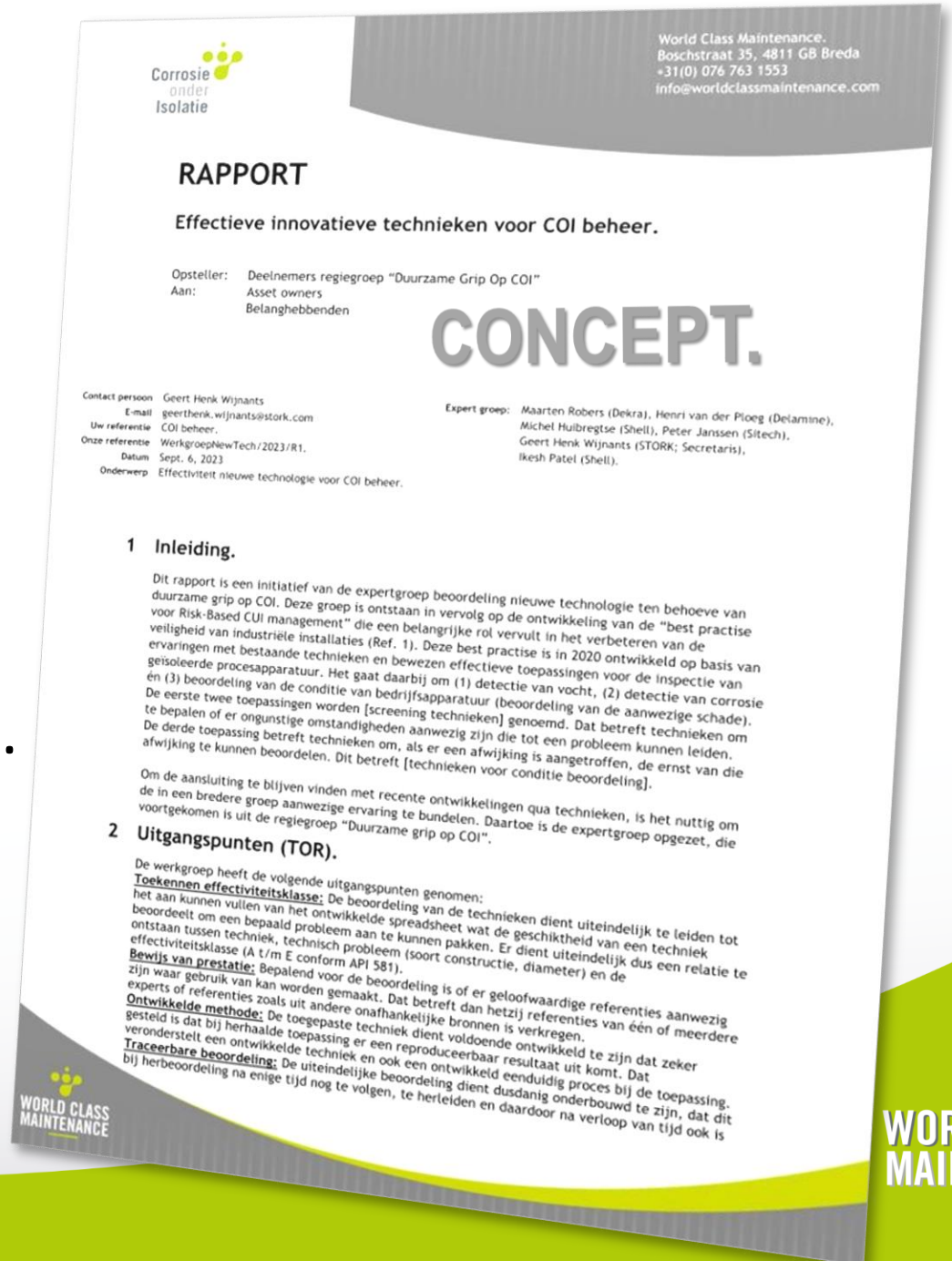
WORLD CLASS MAINTENANCE

Corrosion under Insulation

New tech assessment.

- Overviews various innovations.
- Preselected matured tech.
- Based on proof from practise.
- Based on expert reviews.
- Effectivity using API 581 eff.score.
- Guidance by decision scheme




Corrosie onder Isolatie

World Class Maintenance.
Boschstraat 35, 4811 GB Breda
+31(0) 076 763 1553
info@worldclassmaintenance.com

RAPPORT

Effectieve innovatieve technieken voor COI beheer.

Opsteller: Deelnemers regiegroep "Duurzame Grip Op COI"
Aan: Asset owners
Belanghebbenden

CONCEPT.

Contact persoon Geert Henk Wijnants
E-mail geerthenk.wijnants@stork.com
Uw referentie COI beheer.
Onze referentie WerkgroepNewTech/2023/R1.
Datum Sept. 6, 2023
Onderwerp Effectiviteit nieuwe technologie voor COI beheer.

Expert groep: Maarten Robers (Dekra), Henri van der Ploeg (Delamine), Michel Huibregtse (Shell), Peter Janssen (Siltech), Geert Henk Wijnants (STORK; Secretaris), Ikesh Patel (Shell).

1 Inleiding.

Dit rapport is een initiatief van de expertgroep beoordeling nieuwe technologie ten behoeve van duurzame grip op COI. Deze groep is ontstaan in vervolg op de ontwikkeling van de "best practise voor Risk-Based CUI management" die een belangrijke rol vervult in het verbeteren van de veiligheid van industriële installaties (Ref. 1). Deze best practise is in 2020 ontwikkeld op basis van ervaringen met bestaande technieken en bewezen effectieve toepassingen voor de inspectie van geïsoleerde procesapparatuur. Het gaat daarbij om (1) detectie van vocht, (2) detectie van corrosie én (3) beoordeling van de conditie van bedrijfsapparatuur (beoordeling van de aanwezige schade). De eerste twee toepassingen worden [screening technieken] genoemd. Dat betreft technieken om te bepalen of er ongunstige omstandigheden aanwezig zijn die tot een probleem kunnen leiden. De derde toepassing betreft technieken om, als er een afwijking is aangetroffen, de ernst van die afwijking te kunnen beoordelen. Dit betreft [technieken voor conditie beoordeling].

Om de aansluiting te blijven vinden met recente ontwikkelingen qua technieken, is het nuttig om de in een bredere groep aanwezige ervaring te bundelen. Daartoe is de expertgroep opgezet, die voortgekomen is uit de regiegroep "Duurzame grip op COI".

2 Uitgangspunten (TOR).

De werkgroep heeft de volgende uitgangspunten genomen:
Toekennen effectiviteitsklasse: De beoordeling van de technieken dient uiteindelijk te leiden tot het aan kunnen vullen van het ontwikkelde spreadsheet wat de geschiktheid van een techniek beoordeelt om een bepaald probleem aan te kunnen pakken. Er dient uiteindelijk dus een relatie te ontstaan tussen techniek, technisch probleem (soort constructie, diameter) en de effectiviteitsklasse (A t/m E conform API 581).
Bewijs van prestatie: Bepalend voor de beoordeling is of er geloofwaardige referenties aanwezig zijn waar gebruik van kan worden gemaakt. Dat betreft dan hetzij referenties van één of meerdere experts of referenties zoals uit andere onafhankelijke bronnen is verkregen.
Ontwikkelde methode: De toegepaste techniek dient voldoende ontwikkeld te zijn dat zeker gesteld is dat bij herhaalde toepassing er een reproduceerbaar resultaat uit komt. Dat veronderstelt een ontwikkelde techniek en ook een ontwikkeld eenduidig proces bij de toepassing.
Traceerbare beoordeling: De uiteindelijke beoordeling dient dusdanig onderbouwd te zijn, dat dit bij herbeoordeling na enige tijd nog te volgen, te herleiden en daardoor na verloop van tijd ook is

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Status wrt the expert group New Technologies:

Currently 5 experts from div. background involved; NDT; Asset owner(2); Corrosion; Asset management

List with new technologies prepared. Pre selection TRL_BRL / Classification / Review / Final.

New CUI screening detection technology.

Toelichting op header (regel hieronder):

SELECTIE:	Technologie:	Leverancier:	Meet methode:	Data acquisitie:	Website:	Atex proof:	Praktijkcase:	Screening / Detectie-Evaluatie:	True positives:	False calls:	False negatives:	Toepassing	Onder- of op de isolatie.	Data verversing.	Eigen gebruik / data as a service (huur)	Onderhouds-gevoeligheid	Communicatie (data	Kosten (indicatief):	Conclusie:	Klas
J	Signaal absorbtie & corrosie draad	CorrosionRadar	Fuse wire; Electromagnetic waves through wire; Aanbrengen draad onder de isolatie.	Wifi/Cellular/WirelessHART/LoRa	https://www.corrosionradar.com/	Ja; Zone 1 (II 3 GD cert.)	Ntb	Screening; vochtdetectie via radar reflectie & corrosiemeting via corrosie van de	Ntb	Ntb	Ntb									
J	Optische draad die per meter verschil qua uitzetting meet.	Fluves	Optical fibre moisture measurement; Aanbrengen draad OP de isolatie.		www.fluves.com.	?	manager BASF; blijkt bij afpellen een student te zijn die 4 jr. als IAEer bij	Screening middels vergelijking en AI.	Ntb	Ntb	Ntb								Suggereer klasse E; neigt nogal gevoelig te zijn voor div. invloedsfactoren.	
J	Combinatie meting vochtgehalte (RH) én watersensor (DWP). Fusion 310 sensor.	Trisense	Batterij gedreven sensor (ca. 10 jr. levensduur) die meet via perforatie in de	4G/5G network met cloud solution Cirrusense	https://trisense.no/	Ja; Zone 0	TRL7 qualificatie test door Equinor verkregen.	Screening	Ntb	Ntb	Ntb							########	Potentieel klasse B; betreft tamelijk rechttoe-rechtaan techniek waarbij de combinatie de kans op false-calls sterk beperkt.	
		3-Sci																		
		Bartec																		
		Beniax	Water accumulation sensor																	
		C-Cube	ER/LPR																	
		ClampOn																		
		Corr Instruments LLC																		
		COSASCO	Fuse wire																	
		CUI Spotter	Fuse wire																	
		Eddyfi	PEC																	
		Eddyfi	Guided wave/UT																	
		E-Globaledge																		
		Equinor																		
		Equans	Thermografie																	
		Hempel																		
		H2O Obvious	Water accumulation sensor																	
		Inducenz	Air humidity sensor																	
		Integrity Diagnostics																		
		iSensPro	Capacitive moisture measurement																	
		IRC Inspect	X-Ray backscatter																	
		Kaefer Bla																		
		Metal Samples Company																		
		Oceaneering/Acuren	Neutron/X-ray																	
		Oceaneering/Spetr	Focussed Stress Concentration																	
		Haner Ltd																		
		Permasens (Emerson)																		
		Percosens	Percolation sensor																	
		Previse																		
		REPCO CORROTEX	Pop-out fuse wire																	
		Resensys																		
		Rohrback Cosasco																		
		Senergetics	Optical fibre moisture measurement																	
		Sensuron																		
		Senemat Ltd.	ENAT Guided wave																	
		Structural Monitoring Systems Plc																		
		Sabbera Fi NDT	Sub-Terahertz sensing technology																	
		WaveScan																		
		Wi-Corr proximity	Radio wave antenna(s); Air humidity sensor																	
		Wisense (Draper; Yokogawa)	Array of low cost magnetic sensors																	

File / Tab: NewTechnologyRating.xlsx / NewTech

Print date: 8-3-2023

Rating based upon:

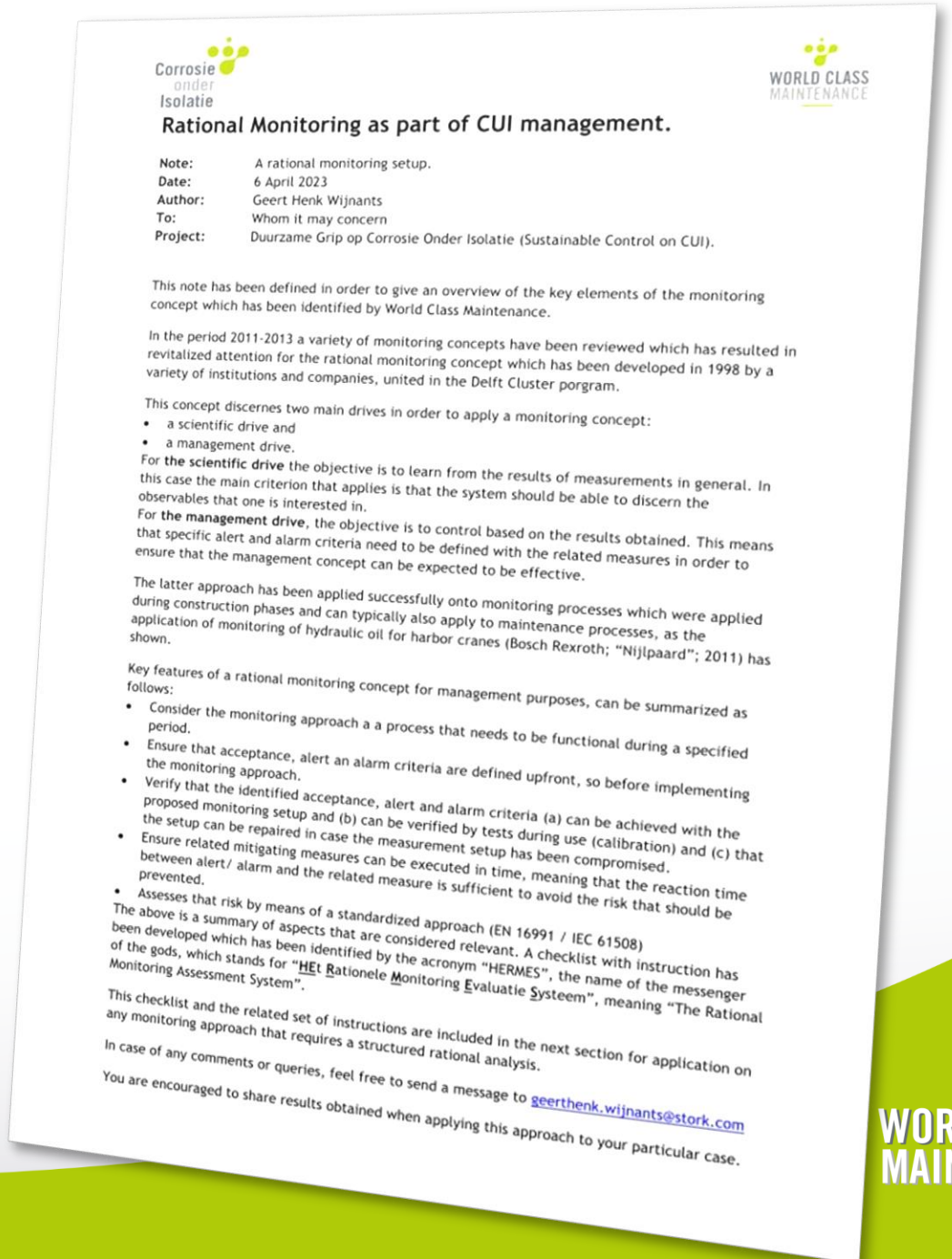
- ✓ True positives
- ✓ False positives
- ✓ False negatives

➔ Add-on to BP RB CUI management.

Corrosion under Insulation

Rational monitoring

- Application note.
- Instruction.
- Aspect checklist (completeness)
- References.



Corrosie onder Isolatie

WORLD CLASS MAINTENANCE

Rational Monitoring as part of CUI management.

Note: A rational monitoring setup.
Date: 6 April 2023
Author: Geert Henk Wijnants
To: Whom it may concern
Project: Duurzame Grip op Corrosie Onder Isolatie (Sustainable Control on CUI).

This note has been defined in order to give an overview of the key elements of the monitoring concept which has been identified by World Class Maintenance.

In the period 2011-2013 a variety of monitoring concepts have been reviewed which has resulted in revitalized attention for the rational monitoring concept which has been developed in 1998 by a variety of institutions and companies, united in the Delft Cluster porgram.

This concept discernes two main drives in order to apply a monitoring concept:

- a scientific drive and
- a management drive.

For **the scientific drive** the objective is to learn from the results of measurements in general. In this case the main criterion that applies is that the system should be able to discern the observables that one is interested in.
For **the management drive**, the objective is to control based on the results obtained. This means that specific alert and alarm criteria need to be defined with the related measures in order to ensure that the management concept can be expected to be effective.

The latter approach has been applied successfully onto monitoring processes which were applied during construction phases and can typically also apply to maintenance processes, as the application of monitoring of hydraulic oil for harbor cranes (Bosch Rexroth; "Nijlpaard"; 2011) has shown.

Key features of a rational monitoring concept for management purposes, can be summarized as follows:

- Consider the monitoring approach a a process that needs to be functional during a specified period.
- Ensure that acceptance, alert an alarm criteria are defined upfront, so before implementing the monitoring approach.
- Verify that the identified acceptance, alert and alarm criteria (a) can be achieved with the proposed monitoring setup and (b) can be verified by tests during use (calibration) and (c) that the setup can be repaired in case the measurement setup has been compromised.
- Ensure related mitigating measures can be executed in time, meaning that the reaction time between alert/ alarm and the related measure is sufficient to avoid the risk that should be prevented.
- Assesses that risk by means of a standardized approach (EN 16991 / IEC 61508)

The above is a summary of aspects that are considered relevant. A checklist with instruction has been developed which has been identified by the acronym "HERMES", the name of the messenger of the gods, which stands for "**HE**t **R**ationele **M**onitoring **E**valuatie **S**ysteem", meaning "The Rational Monitoring Assessment System".

This checklist and the related set of instructions are included in the next section for application on any monitoring approach that requires a structured rational analysis.

In case of any comments or queries, feel free to send a message to geerthenk.wijnants@stork.com

You are encouraged to share results obtained when applying this approach to your particular case.

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Corrosion under Insulation

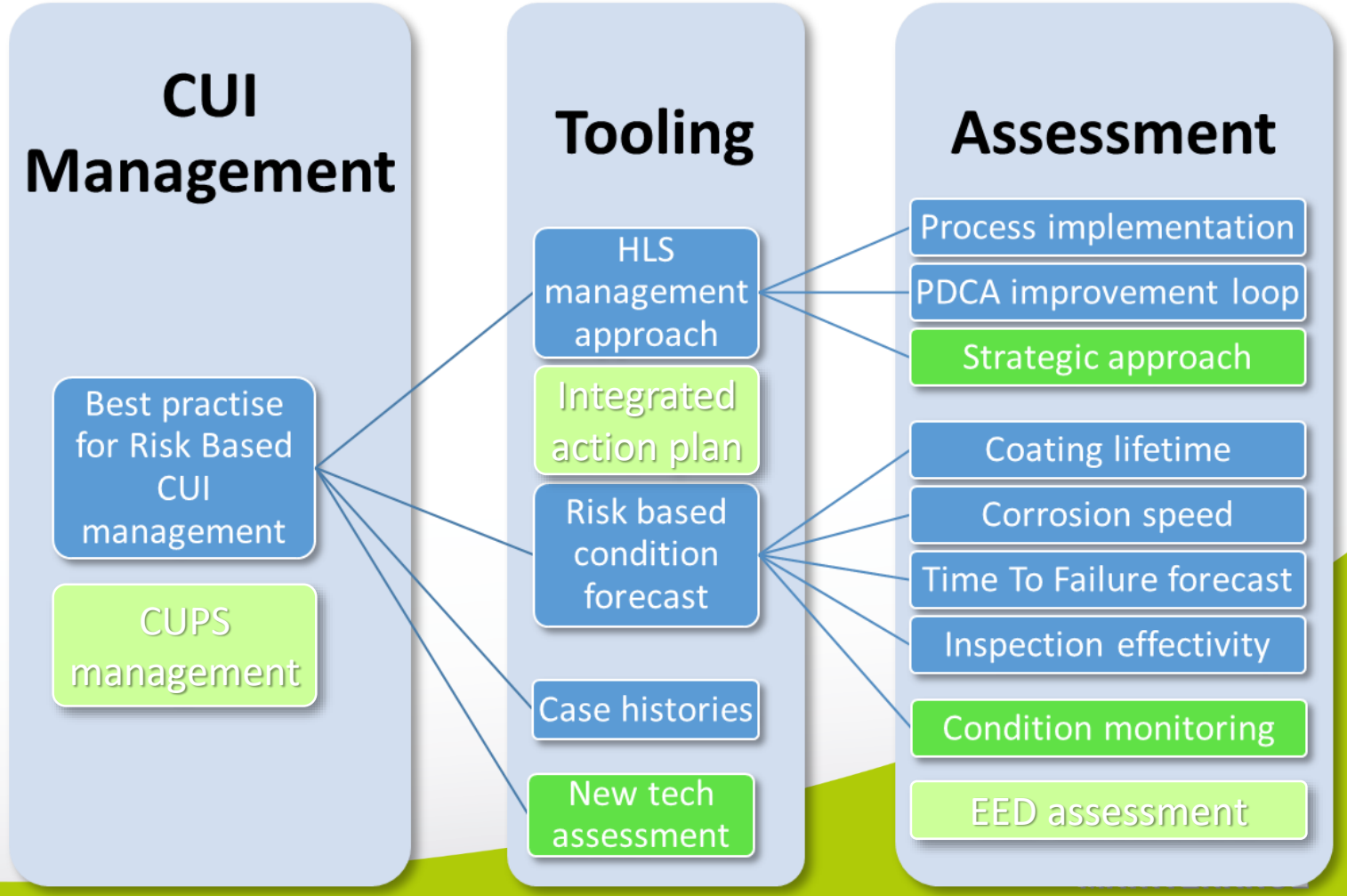
WCM CUI ecosystem 2024:

On 2024's menu:

- CUPS management
- Energy Efficiency Scan
- Integrated action plan
- New tech effectivity scan
- Standardized approach

Certified approach?

Easy-EED reporting (xml)?



The tools; as a reminder:

General access: https://www.wcmvector.com/

Demo Beta tool: https://www.wcm-cuiassesment.com/

Live tool: https://wcm-cuiassessment.com (4 S's).

Beta tool, new role: Available for training purposes.

WCM VECTOR Corrosion under Insulation

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Questions?

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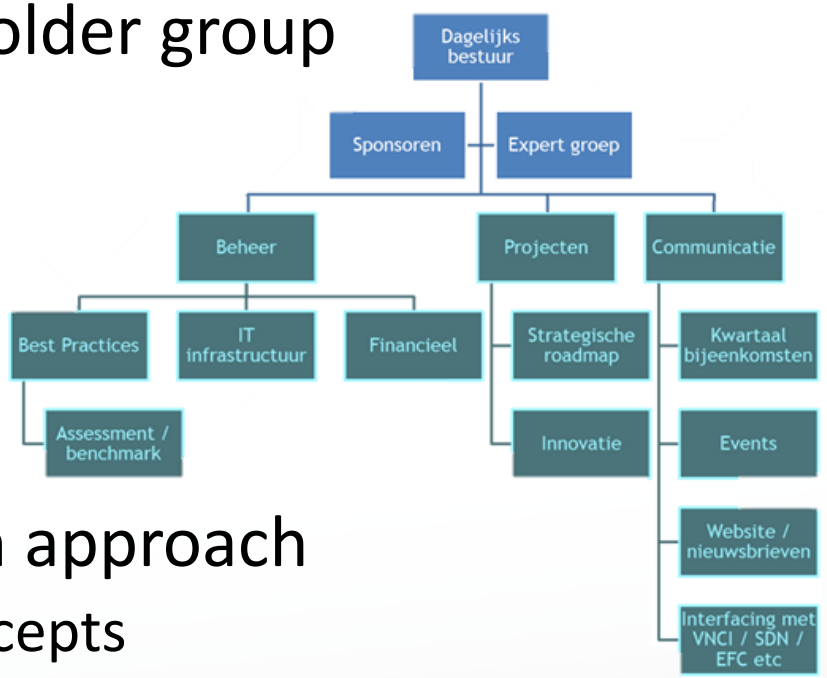
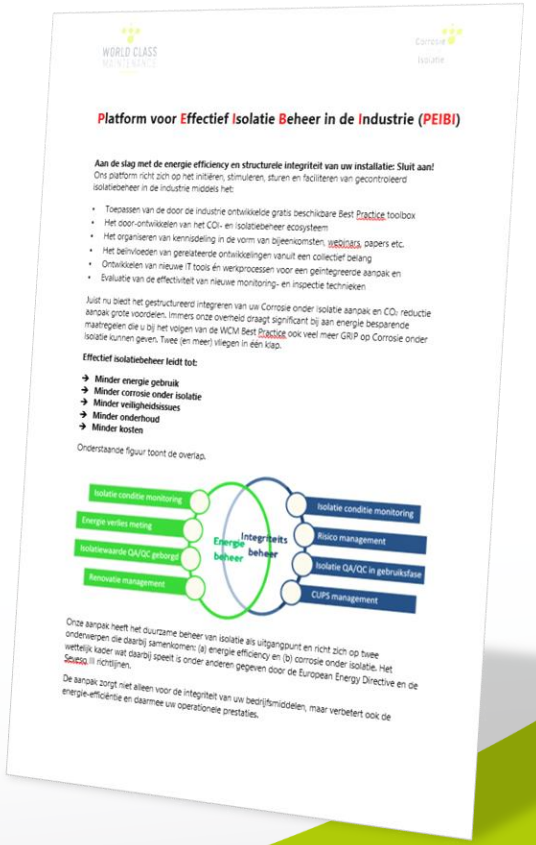
Foreseen developments WCM CUI ecosystem 2024+:

- Develop dedicated stakeholder group
  - PEIBI – initiative
- Create organization
- Maintain products
- Support innovation
- Support standardization in approach
  - Facilitate asset service concepts
- CUI support center (tools, knowledge; NDT, coating)



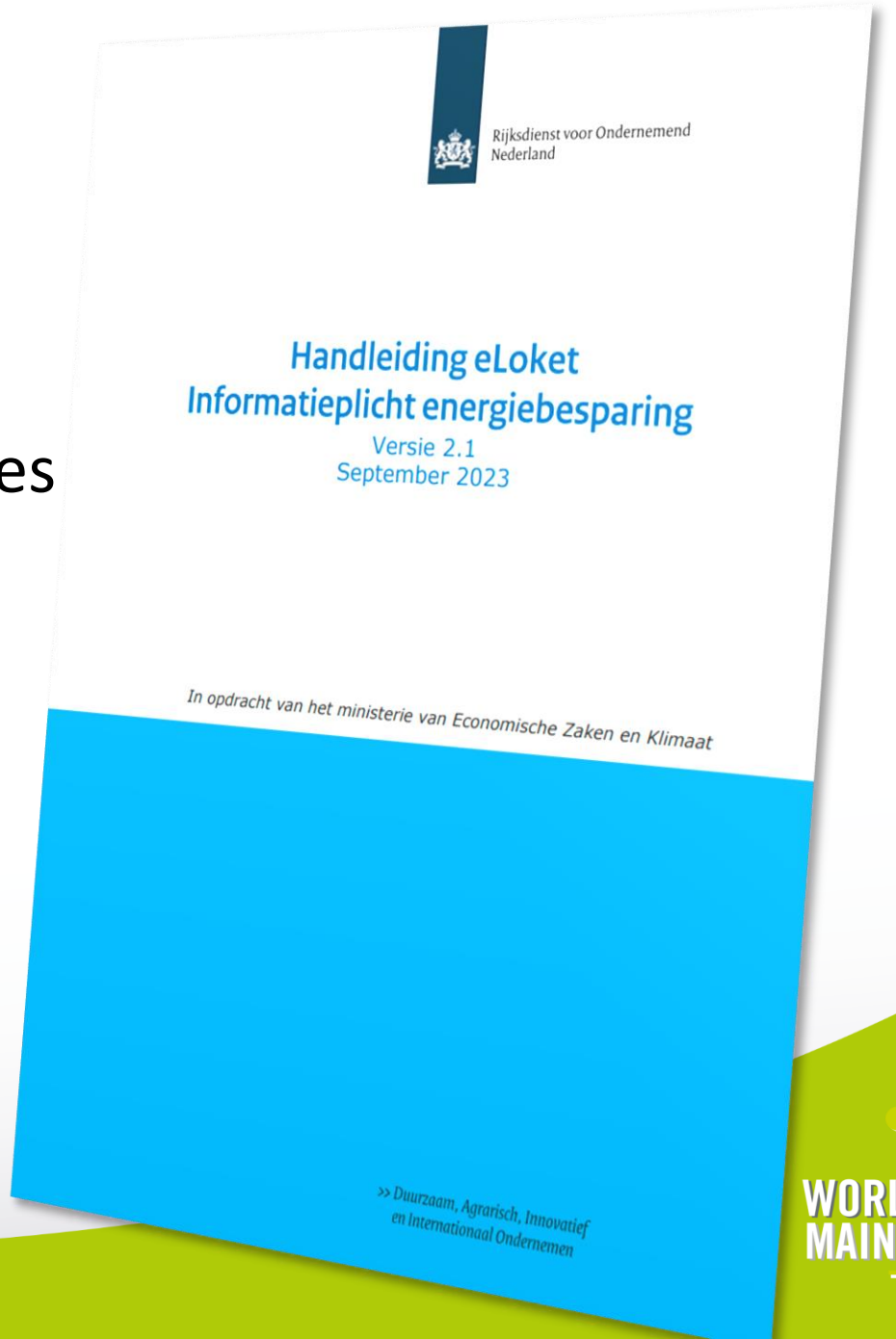

Platform voor Effectief Isolatie Beheer in de Industrie (PEIBI)

Aan de slag met de energie efficiency en structurele integriteit van uw installatie: Sluit aan!

Corrosion under Insulation

Issues of interest:

- Administrative reporting load ↑
- Lack of personnel & variability of services
- Transparency in compliance
- Ensure future proof approach
  - Build upon solid concepts



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