Annual Corrosion Forum (ACF)

Aberdeen Branch - August 2021

Sponsor: TRAC Oil and Gas

Title: Corrosion Under Insulation (CUI)

A whistle-stop tour of CUI Management…

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Hindsight is 20/20

EI Corrosion Management Guidance defines 'Corrosion under insulation' (CUI) as the external corrosion of insulated piping and vessels that occurs beneath insulation following water ingress.

Regulator Viewpoint

Meeting good practice alone may not be sufficient to comply with the law

CUI Forum - 19th May 2021

HSE

Why is CUI important to the Regulator?

The topic, within the topic of Integrity Management, is so broad that we appreciate a considerable amount of resource and effort is required to develop and establish an effective CUI management scheme.

- Training/competence
- Workforce awareness/engagement/participation
- Quality assurance
- Pipework/vessel materials
- Materials (insulating) and systems/coatings/TSA
- Historical data/evidence
- Current technology
- Future technology
- Research/studies
- Information and learnings out of sector (Nuclear/onshore/chemical)
- Inspection (techniques/capabilities)
- Prediction/RBI/Corrosion Assessment
- Regulation (PSA/HSE and others)
- Process/operations review/support to optimise removal and understand actual conditions
- Design

Regulator Viewpoint

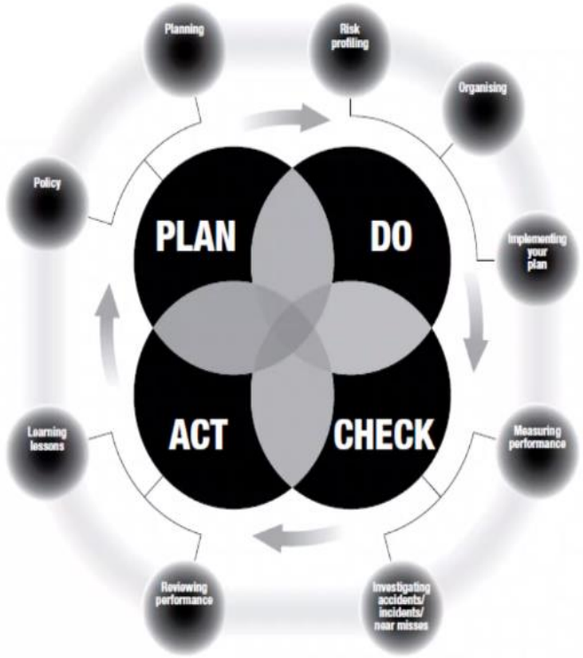
Do what you say you're going to do
Be clear about progress and priorities

CUI Forum - 19th May 2021

HSE

What are we looking for?

Onshore element of inspection; we are looking for evidence that the CUI management activity has been/is being carried out effectively. This, like other integrity or risk management activities, should follow a cycle of planning, implementation, measurement and review/action, or…



…as described in HSG 65 and referred to in the EI Corrosion Management Guidance

Regulator Viewpoint

Suitable inspection at a frequency to permit detection and remediation of deterioration in good time

CUI Forum - 19th May 2021

HSE

Inspection – Stripping and NII

It is widely acknowledged that insulation stripping and inspection is still the most effective way to mitigate against CUI.

…in combination with PUWER…

(2) Every employer shall ensure that work equipment exposed to conditions causing deterioration which is liable to result in dangerous situations is inspected –

1. (a) at suitable intervals; and
2. (b) each time that exceptional circumstances which are liable to jeopardise the safety of the work equipment have occurred,

to ensure that health and safety conditions are maintained and that any deterioration can be detected and remedied in good time.

…means we expect insulation stripping to form the basis of any CUI management scheme (at a frequency to permit the detection and remediation of any deterioration in good time).

Roadmap Anyone?

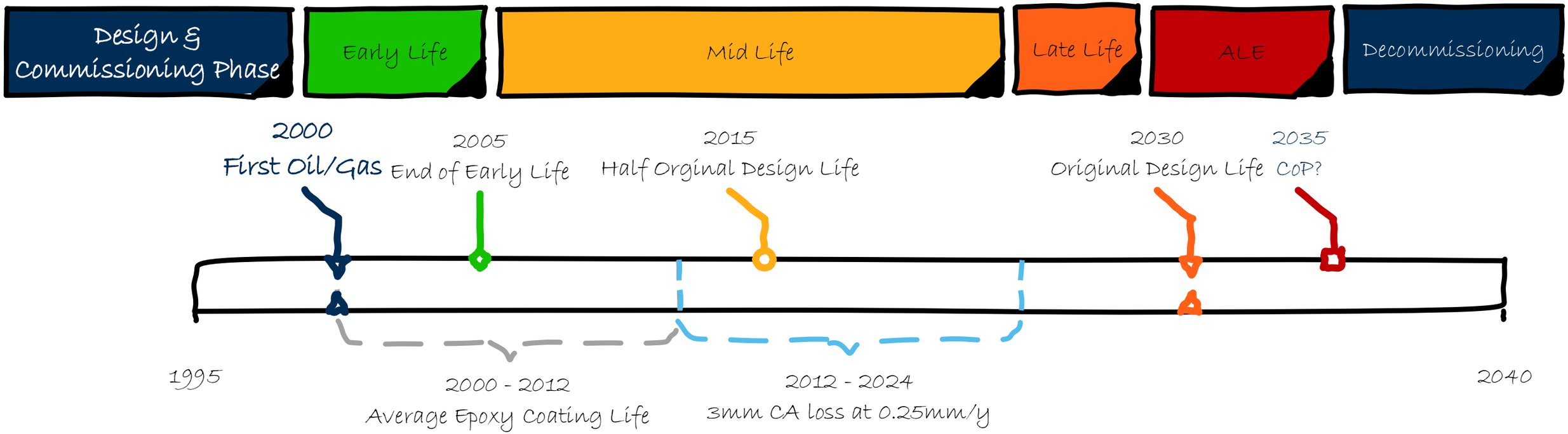
CUI Management Scheme

In relation to Major Inspections & Fabric Maintenance

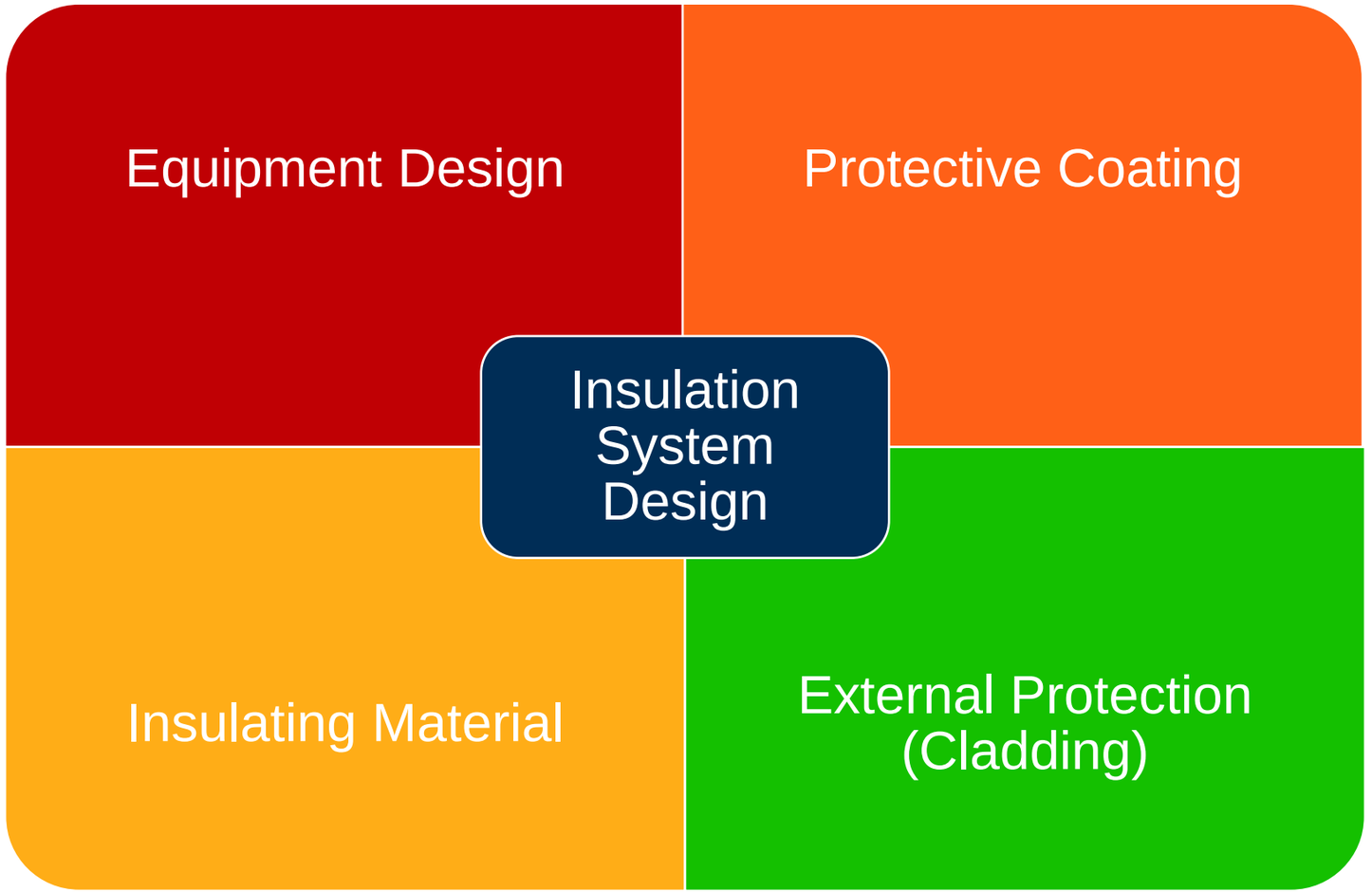
CUI Management Scheme

CUI Strategy

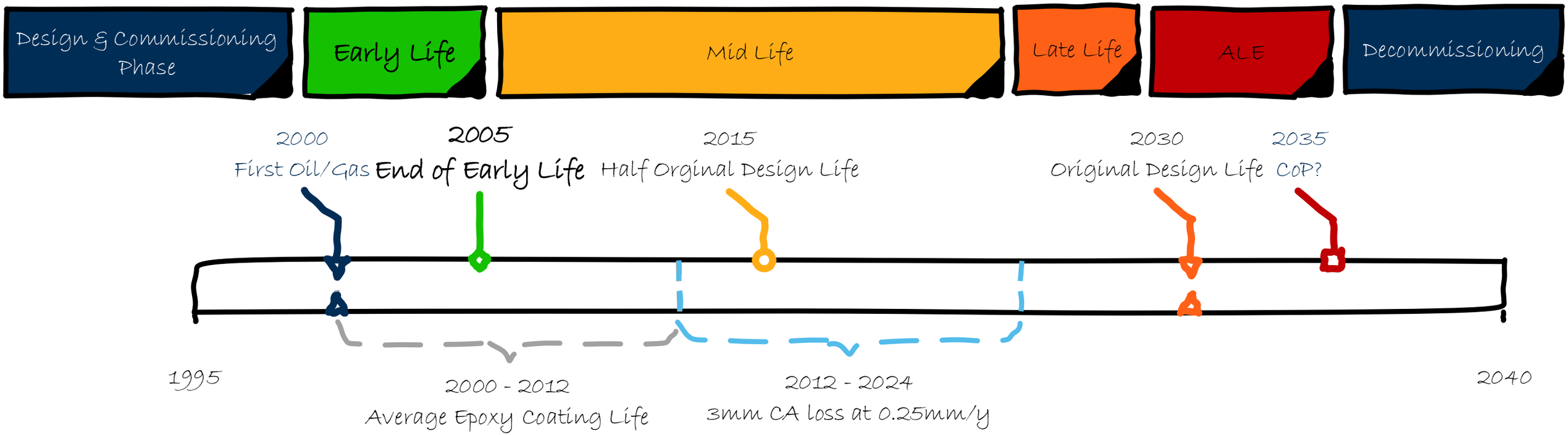
CUI Strategies
Design



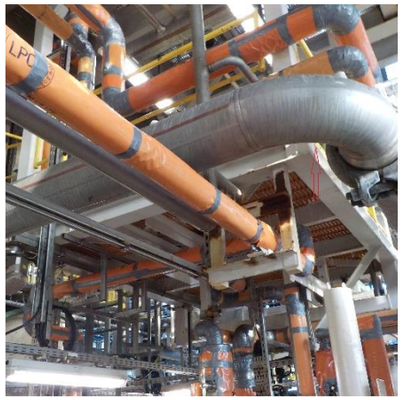
Design Considerations



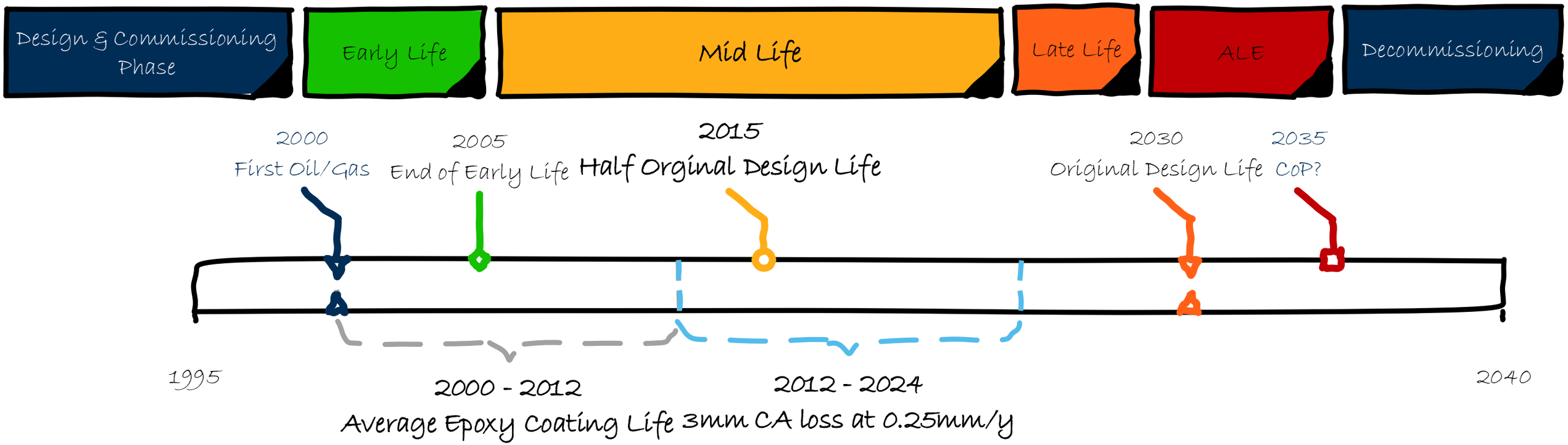
CUI Strategies
Early Life



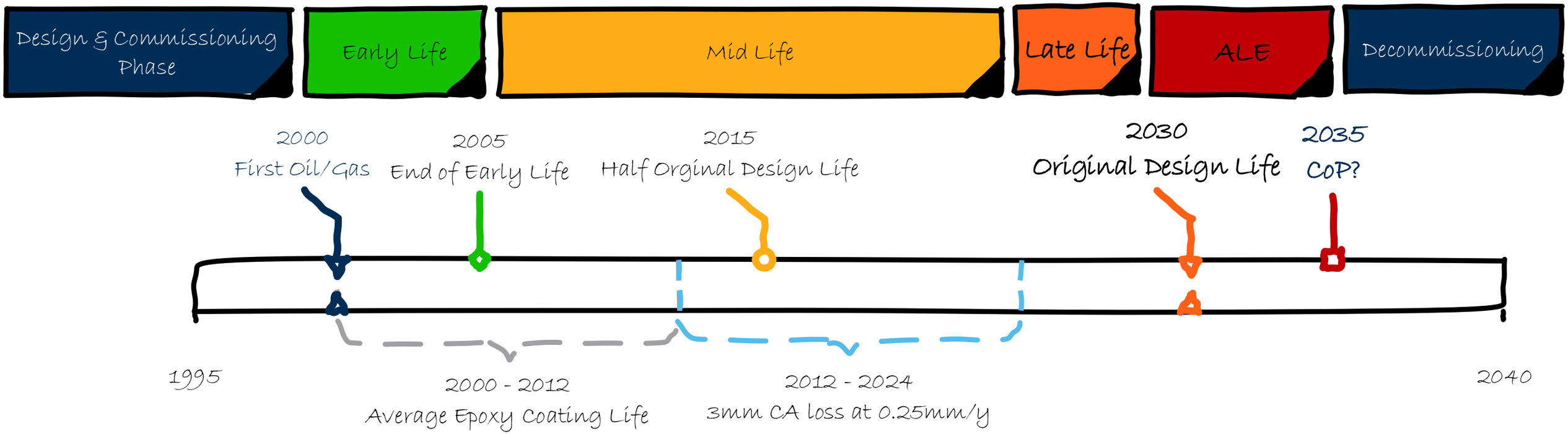
Early Life Problems



CUI Strategies
Mid Life



CUI Strategies
Late Life & Decommissioning



Late Life & Decommissioning

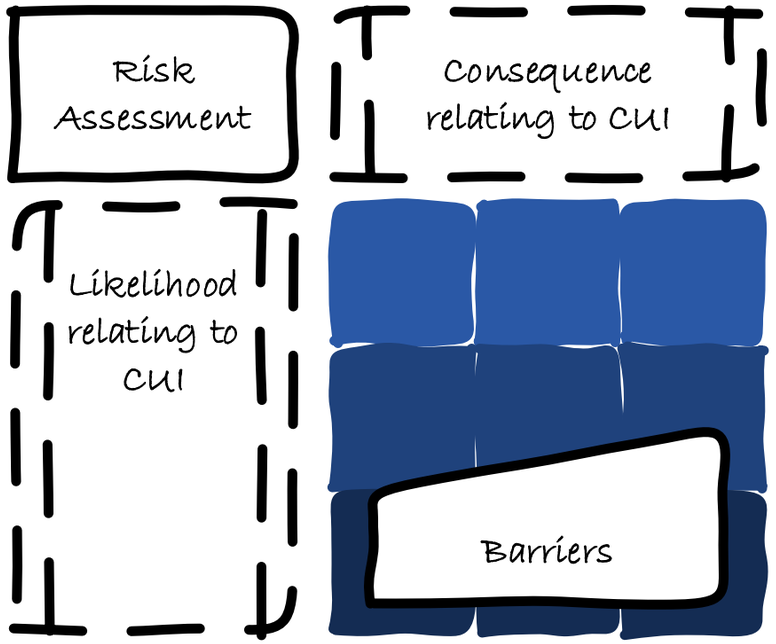
CUI Management Scheme

RBI Methods

CUI Risk Assessment

Key Factors

- Materials of Construction
- Water Ingress and Exposure
- Service Temperature & Heat Tracing
- Insulation Condition & Type
- Coating Condition & Lifespan
- Asset Age
- Inspection Methods, Extent and Frequency of Inspection

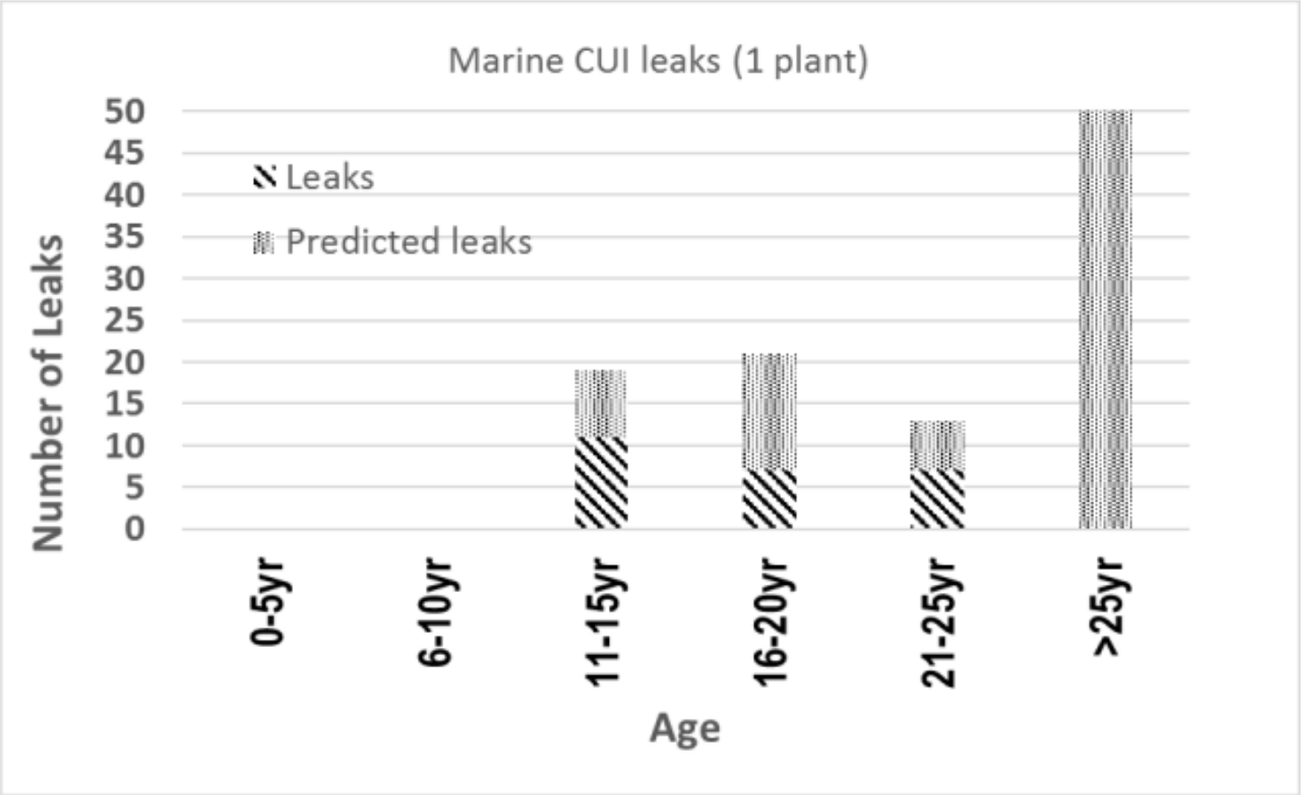


Acknowledge there are a variety of approaches, but identify key contributing factors that must be considered

CUI Risk Assessment
Inspection Programmes

RBI Methods allow prioritisation of inspection resource by adjusting timing and/or inspection coverage and technique

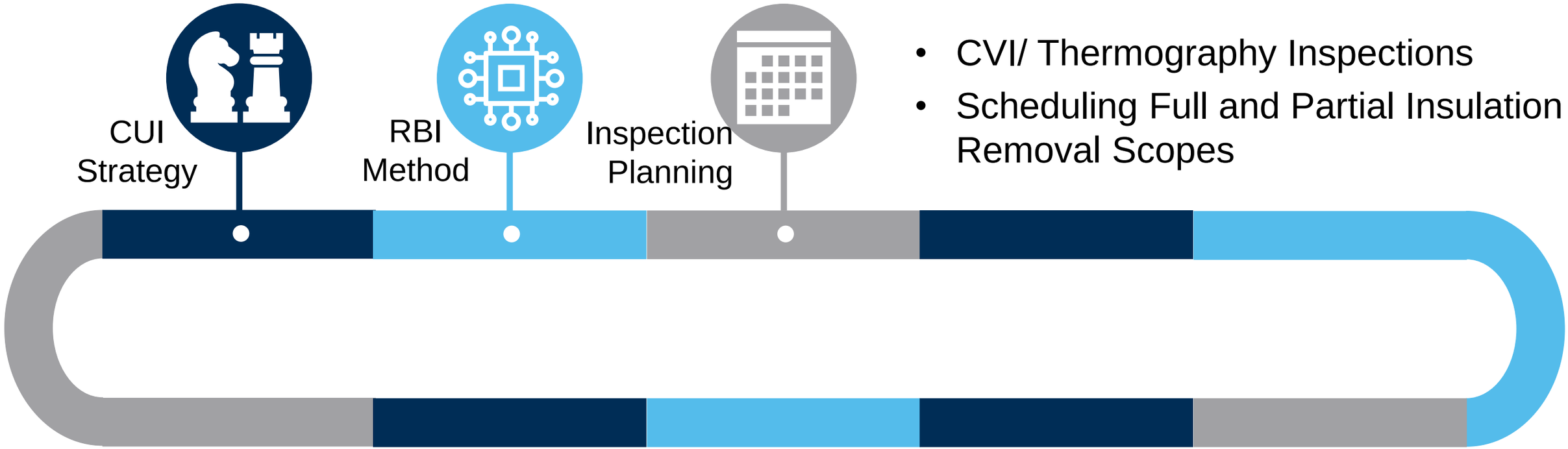
CUI corrosion rate data vary significantly for individual plants and locations



Using industry data to compare performance of different risk-based methods for the management of corrosion under insulation
Dr. Clare Watt, Dr Chi-Ming Lee, Steve Paterson, Mr Antony Jopen

CUI Management Scheme

Major Inspection Planning & Interim Inspections



- CVI/ Thermography Inspections
- Scheduling Full and Partial Insulation Removal Scopes

Interim Inspections
Insulation Anomalies

GREEN
No Additional Action Required

- Insulation present and good condition
- No defects
- Well-sealed and no tears or ill-fitting sections
- No evidence of water ingress, seams are all fully sealed

YELLOW
Follow-up Inspection Required

- Minor Damage / Area missing
- No seal / no overlap / sprung seal meaning seams are not all fully sealed but with no evidence of water ingress
- Note – Follow-up inspection (e.g. thermography) may be performed to help determine whether there is any water present. Thermography inspection results may lead to a different Condition Classification.

ORANGE
Insulation Removal Required

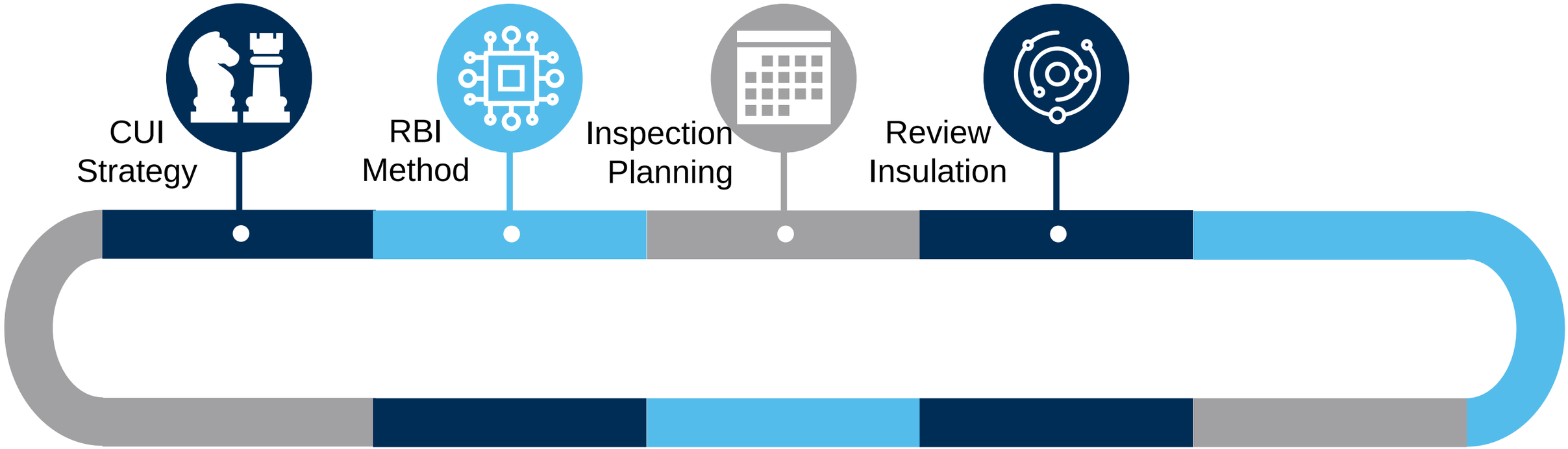
- Major Deterioration / Tearing / Damage
- Damaged seals and 'watershed' going in wrong direction with evidence of water ingress / wet insulation and evidence of CUI (corrosion scale / staining) to substrate
- Any areas where thermography indicates the potential presence of water under the insulation, including any areas confirmed visually to meet the GREEN or YELLOW criteria

SUBSTRATE AND/OR COATING DAMAGE
Repair Required

- Areas of coating or substrate damage identified during Major Inspections require rectification prior to insulation reinstatement
- Refer to External Corrosion Anomaly Criteria as required

CUI Management Scheme

Reviewing Insulation Reinstatement Requirements



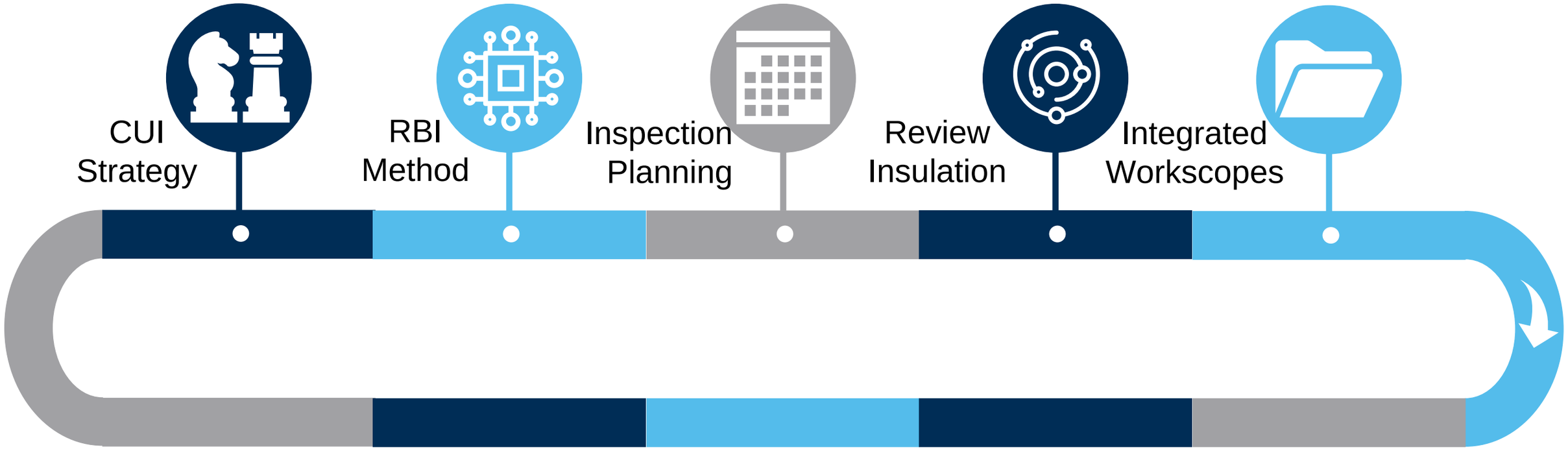
Insulation Reviews

Technical Safety and Process Requirements

- Heat Conservation
- Cold Insulation
- Personnel Protection
- Acoustic Insulation
- Fireproofing and Passive Fire Protection (PFP)

CUI Management Scheme

Integrated Workscopes for Major Inspections and Fabric Maintenance



Many hands make light work
Too many cooks spoil the broth

Cross-discipline activities may be considered complex, although the individual trade activities may be routine

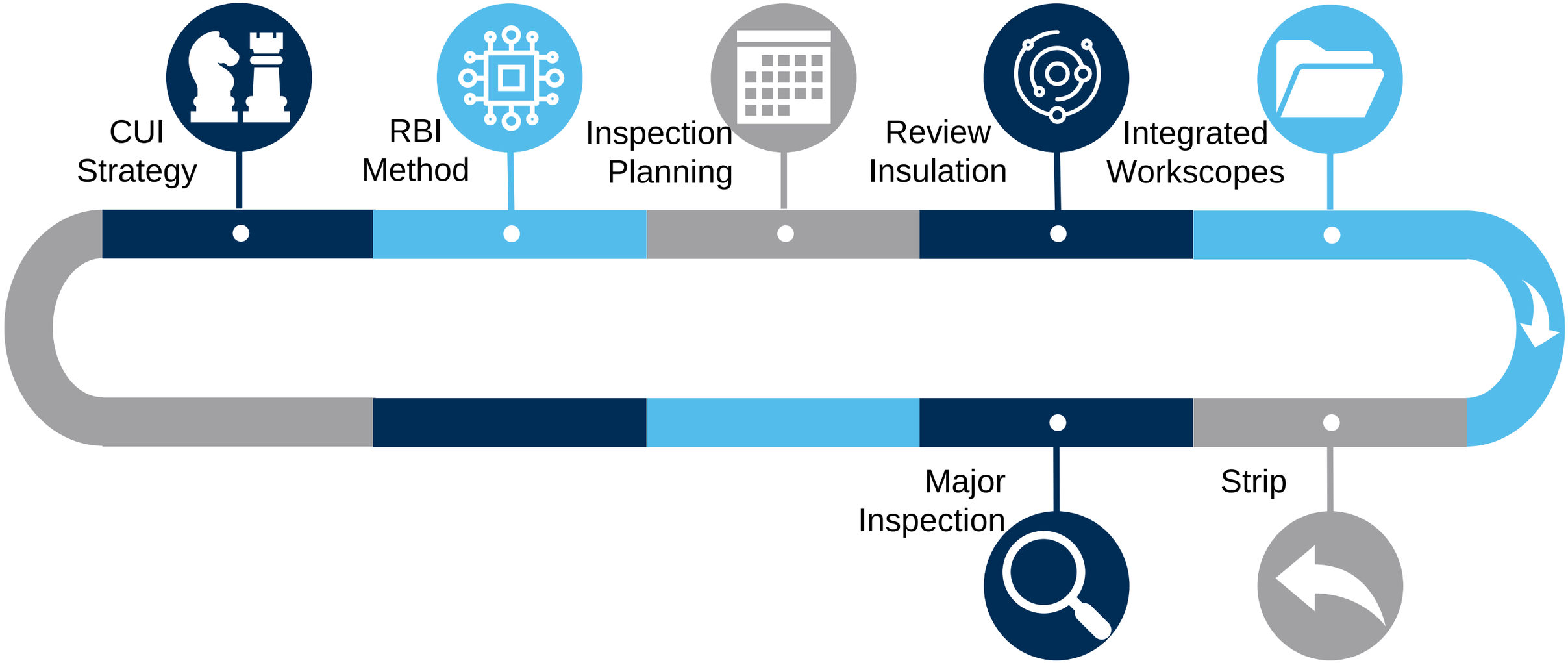
Ownership and Strategic Planning by a suitably competent and senior individual at the outset will ensure maximum value is achieved

Integrated Workscopes for Major Inspection

- Equipment Unique Identifiers (Tag, Line Number, etc.)
- Description of Item(s) to be inspected
- Item Location (Asset, System, Area)
- Priority
- Design and Operating Conditions (heat tracing, temperatures, pressures) to facilitate planning for trades, TAR and identify low pressure lines
- Reference to Work Management System (MMS) Work Order Number and/or Planned Maintenance Routine
- Integrated-Job Considerations (access, safety, trades etc.)
- Inspection requirements (scope of coverage, test point/features etc.) and basis of requirements (RBA, WSE, Anomaly Management)
- Drawings and other attachments (listed with references and revisions)
- Major Inspection and/or Fabric Maintenance (Anomalies) Due Date(s)
- Degradation Threats and History (previous condition statement, expected defect types, locations and existing anomalies or DLRs)

CUI Roadmap

Stripping and Major Inspection



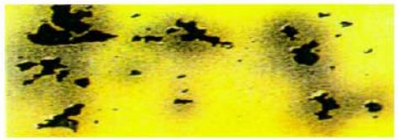
Insulation Removal and Major Inspections

HM Line Case Study

Defects on high pressure pipework are more likely to overpressure and burst during service.

Small isolated defects in low pressure lines are often only apparent as a weep or seep after corrosion product is disturbed by insulation removal, inspection or blast cleaning.

Inspection
Coating and Substrate Condition

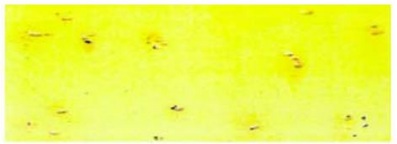
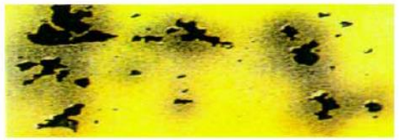
ISO No	Pictorial reference	Description
Ri 0		0% breakdown; newly painted
Ri 2		0.5% coating breakdown
Ri 3		1% coating breakdown. Recommended intervention level for structural steelwork and piping re-coating
Ri 4		8 – 39% coating breakdown
Ri 5		40% - 50% coating breakdown

Coating Damage at or greater than **Ri3** requires insulation removal scope increase and fabric maintenance

Corr./pit category	Description		Substrate Example
	General description	Estimated scale thickness	
CAT A	▶ Light Scale	1 – 2 mm	
CAT B	▶ Moderate scale	4 - 6 mm	
CAT C	▶ Severe scale ▶ Pitting visible	6 mm	
CAT D	▶ Deformation & holes		

Inspection
Coating and Substrate Condition

Substrate Damage **≥Cat A** requires insulation removal scope increase where partial stripping has been recommended and fabric maintenance

Ri 0		surfaces
Ri 1		0.05% coating breakdown
Ri 2		0.5% coating breakdown
Ri 3		1% coating breakdown. Recommended intervention level for structural steelwork and piping re-coating
Ri 4		8 – 39% coating breakdown
Ri 5		40% - 50% coating breakdown

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Inspection
Coating and Substrate Condition

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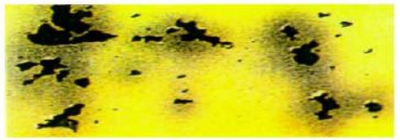
Ri 4		8 – 39% coating breakdown
Ri 5		40% - 50% coating breakdown

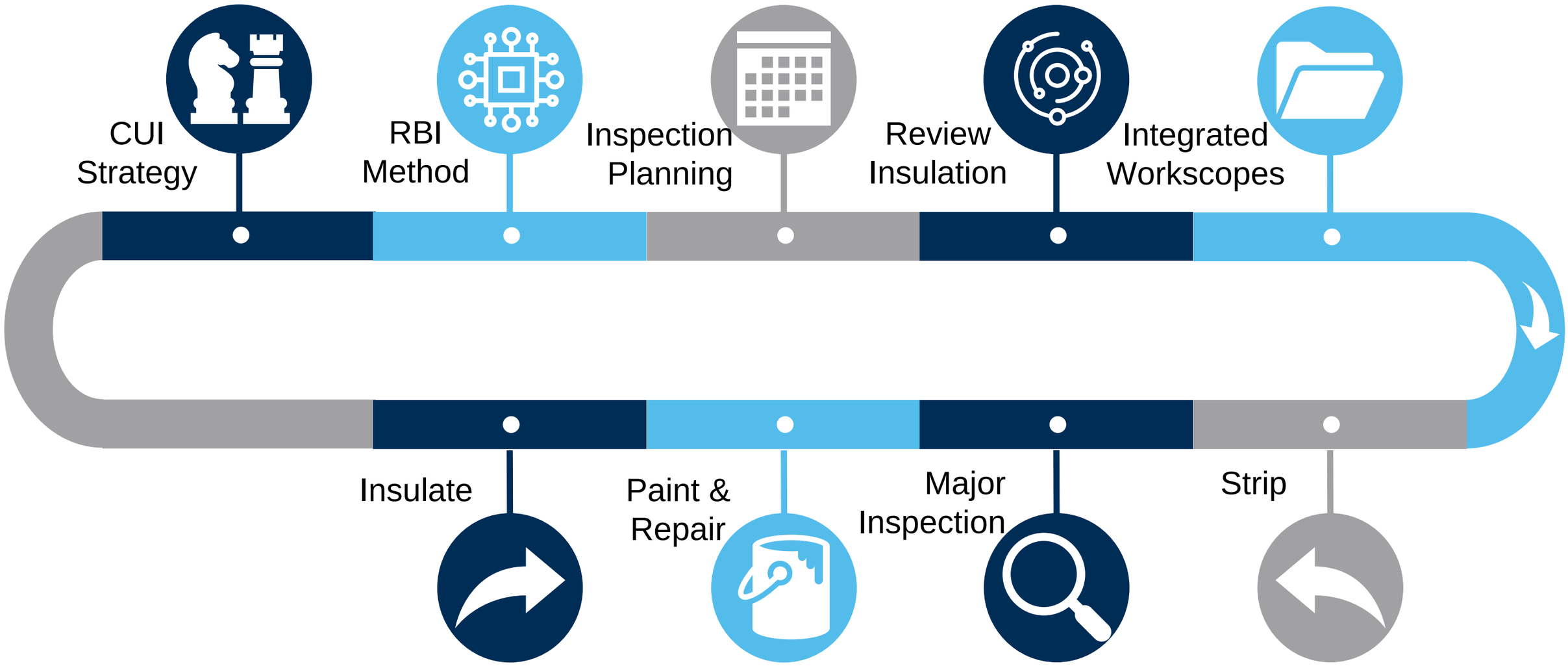
Integrity Engineer confirms the extent of Fabric Maintenance required, i.e. ‘spot repairs’ or 100% re-coat and if the insulation removal scope should be increased i.e. critical defects detected.

The FMC Fabric Maintenance Coordinator is responsible for updating the tactical plan and Integrated Workpacks accordingly.

Corr./pit category	Description		Substrate Example
	General description	Estimated scale thickness	
CAT C	▶ Severe scale ▶ Pitting visible	6 mm	
CAT D	▶ Deformation & holes		

CUI Management Scheme

Paint & Repair



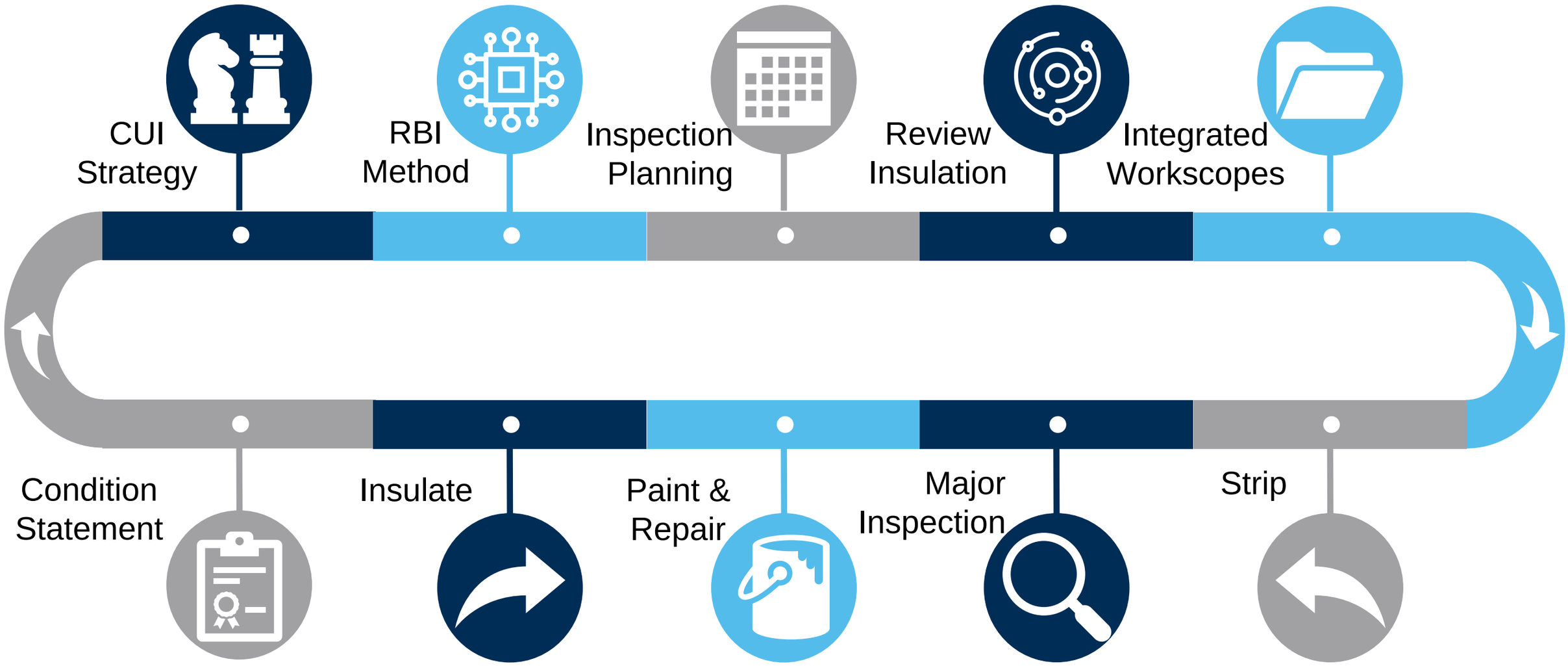
Fabric Maintenance and Insulation Reinstatement QA/QC

If the coating is not applied under controlled and correct conditions, it can be fully degraded after just a few years. It is recommended to have a good quality assurance system in place to ensure the proper quality of the coating and insulation reinstatement work.

- Humidity/Dewpoint
- Temperature
- Salt content of substrate
- Surface profile (as per painting specification requirements)
- Surface cleanliness (Sa 2.5)
- Wet film thickness
- Dry film thickness

CUI Management Scheme

Condition Statements



Providing Clients with an understanding of Asset Condition and Lifespan

Green
No immediate concerns, item considered suitable for field life

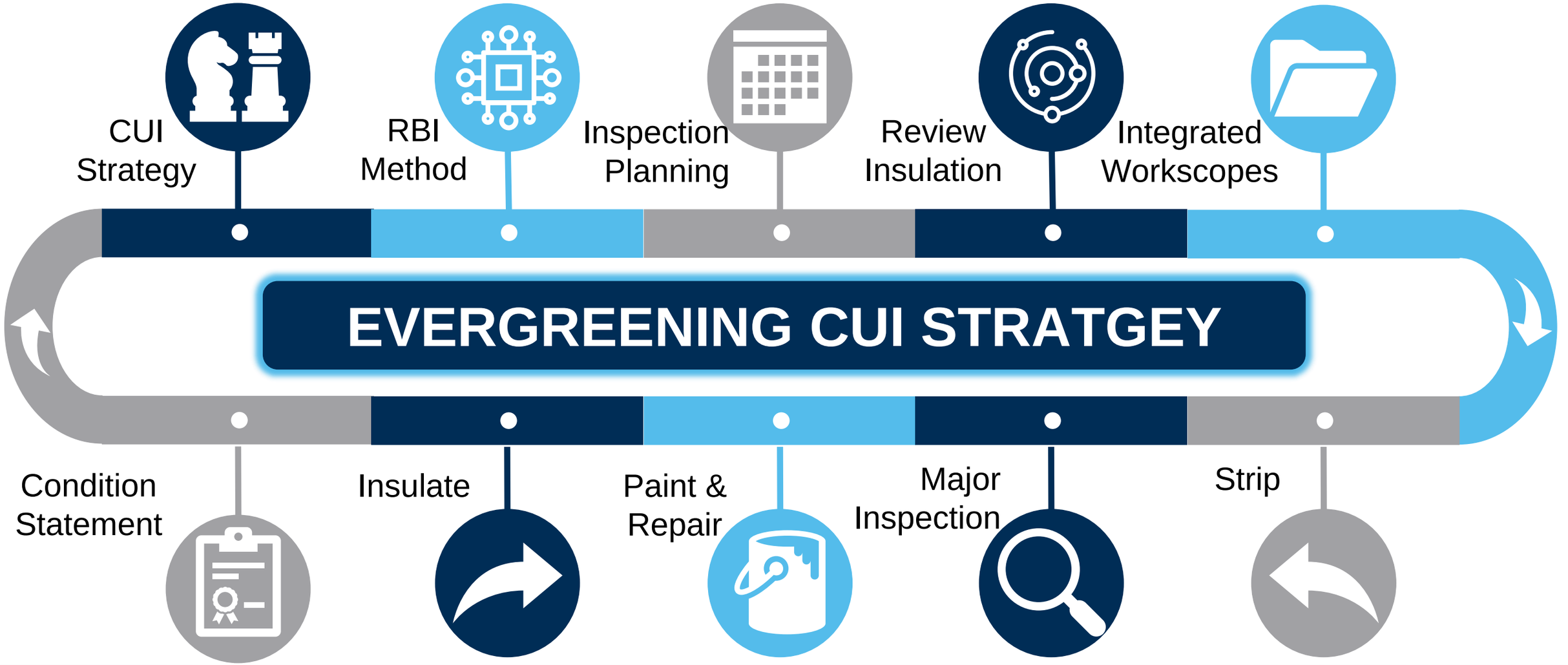
Yellow
Degradation has occurred, however, no immediate concerns, but unless action is taken item may not be able to meet remaining field life

Orange
Degradation has occurred and possible threat of failure if action not taken, however, condition stable to allow repair to be planned within 2 years

Red
Performance standard failure, urgent action required to mitigate risk

CUI Management Scheme

In relation to Major Inspections & Fabric Maintenance



CUI Strategy References

Applicable Regulations

- Health & safety at Work Act 1974
- Management of Health and Safety at Work Regulations 1999
- Prevention of Fire, Explosion and Emergency Response (PFEER) Regulations 1995
- Offshore Installations (Offshore Safety Directive) Regulations 2015 – Safety Case
- Provision and Use of Work Equipment Regulations 1998

Asset Specific Knowledge

- Evaluation of inspection results and adjustment of probability/likelihood for inspection cycles after the first inspections
- Key guidance all recommends the use of plant data to form the basis of CUI prioritisation methods, but not what to do if there is no data

Industry CUI Management Guidance

- Energy Institute Guidelines for Corrosion Management in Oil and Gas Production
- HSE SPC/TECH/GEN/18 Corrosion under insulation of plant and pipework
- HOIS-G-023 Guidelines for In-Situ Inspection of Corrosion Under Insulation (CUI)
- EFC 55 Corrosion under insulation (CUI) guidelines
- API 583 Corrosion Under Insulation and Fireproofing
- DNV RP G109 Risk-based management of corrosion under insulation
- DNV RP G101 Risk based inspection of offshore topsides static mechanical equipment
- API 581 Risk-Based Inspection Technology

End of Presentation – Your Questions Please