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INSTITUTE OF CORROSION

Aberdeen Branch

Corrosion Awareness Day 2017

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SHERWIN-WILLIAMS.
Protective & Marine Coatings

Key Sponsor

- M.Sc. Metallurgical Engineering - University of Tehran;
- M.Sc. Corrosion Control Engineering - University of Manchester;
- International Welding Engineer - IIW (International Welding Institute);
- Charter Engineer - IOM3 (Institute materials, minerals, and mining);

- More than 15 years experience in oil and gas industry;
- 4 years in EPC contractor;
- 11 years in third party certification body - Bureau Veritas;
- 3 years in service provider - Oceaneering;
- Work experience in Iran, Abu Dhabi, Malaysia, and the UK;
- Providing service to major operators like:
- NIOC, ADNOC, Total, Saudi Aramco, Petronas, Talisman, and BP.

Corrosion Management Overview / Risk Based Inspection

- Background to Corrosion Management
- Corrosion Management Processes
- Corrosion Management tools
- Corrosion Risk Assessment
- Corrosion Management Systems
- Conclusions

Background to Corrosion Management

To manage has been defined as "to succeed in one's aims"
(often with inadequate materials etc.)

The need for corrosion management

- Catastrophic events due to poor corrosion management / human error
- Legislative requirements (Audits, Policies, etc.)

Corrosion risk → Cost effective mitigation

Corrosion management tools

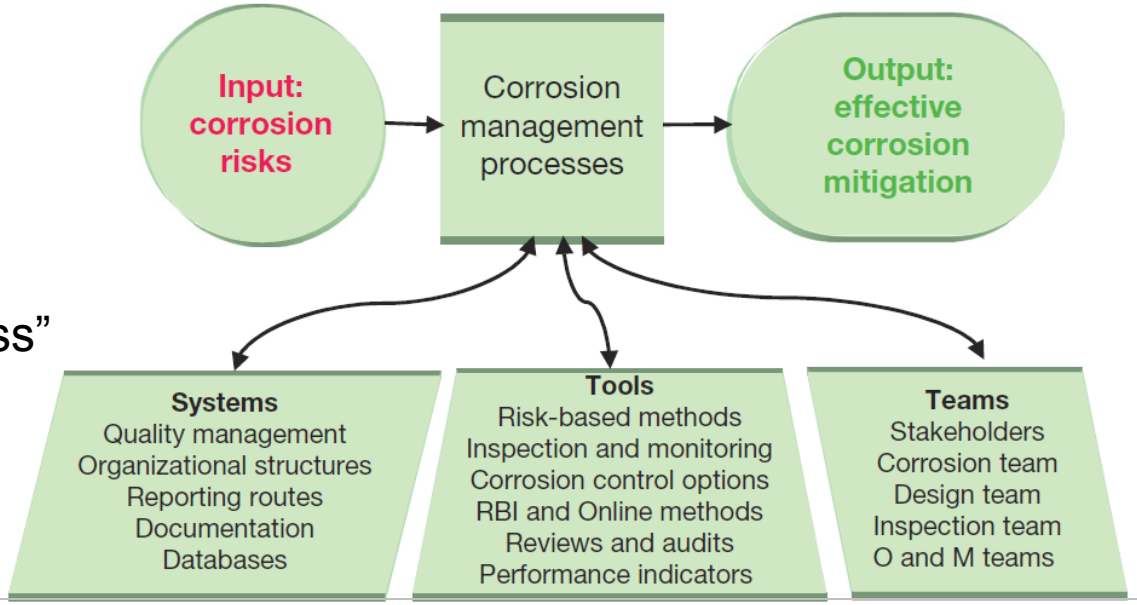
- Quality Management System (QMS)
- Risk Based Inspection
- Management of Change
- Total Quality Management (TQM)
- Written Scheme of Examinations

Basic Concepts

Corrosion control strategy is defined here as the management of available resources, including finance, materials, equipment and manpower, to provide the policies, procedures and organizational systems that are required to mitigate the effects of corrosion

- long-term objectives (Cost, Leaks, etc.)
- standard corrosion control procedures
- Corrosion control tactics (inspection/Monitoring)
- Performance standards/KPI

Based on
"Quality Management Process"

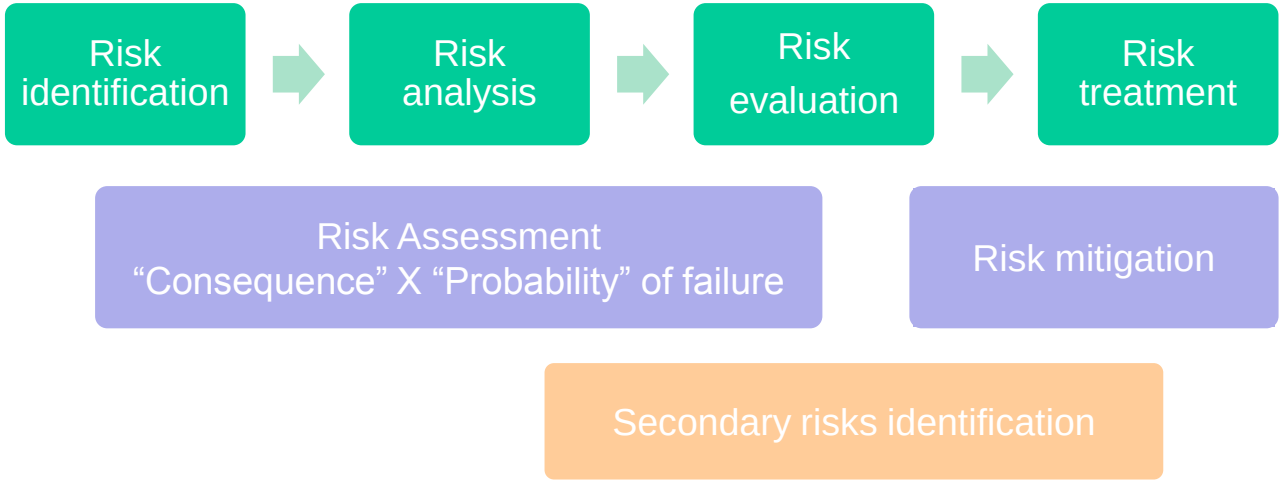


Basic Concepts

Risk Management Processes

- Strategic decisions
- Tactical decisions
- Operational decisions

1. Significant undesired or unexpected outcomes can be identified, and
2. Opportunities for improvement can be considered.

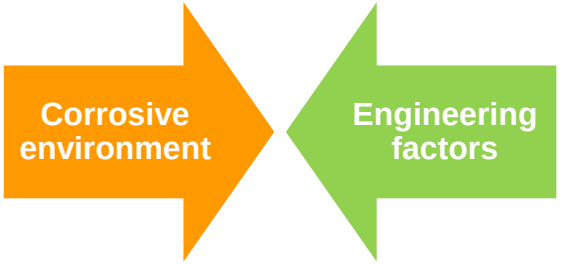


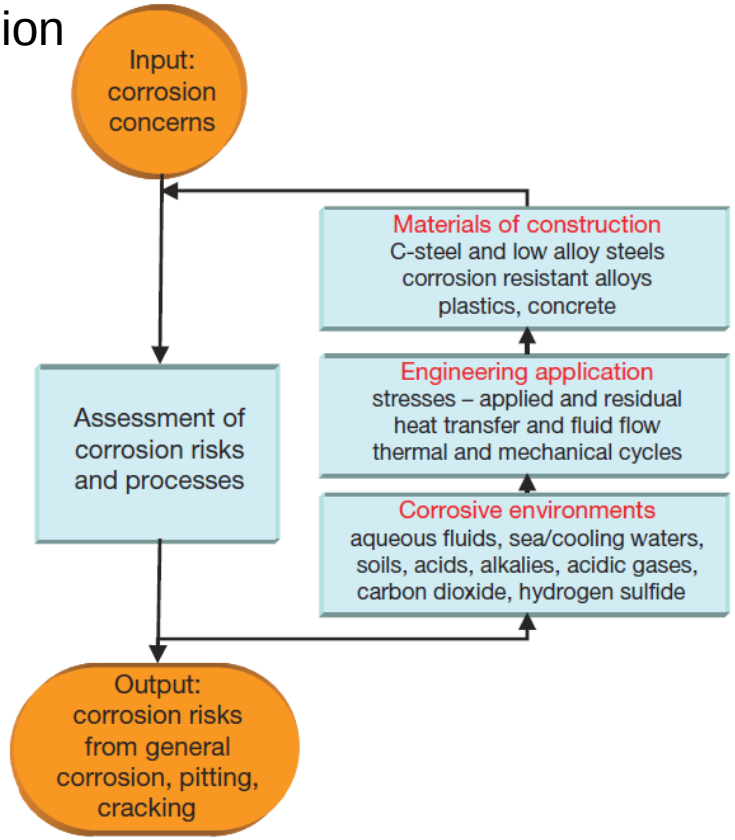
Identification of Corrosion Risks

Corrosion damage and failure modes

- Uniform corrosion
- Galvanic corrosion
- Localized attack – pitting and crevice corrosion
- Flow induced corrosion – erosion corrosion
- Environmentally assisted cracking
- Corrosion fatigue

Basic corrosion risk assessment steps





Corrosion Risk Assessment Processes

Hazards and risks

A hazard has the potential to cause harm or damage; often defined as a physical condition or release of hazardous material as a result of component failure that can cause human injury or death, loss or damage, or environmental degradation.

Risk is the combination of the severity of the effect (the consequences) and the likelihood of it happening (damage mode and probable frequency).

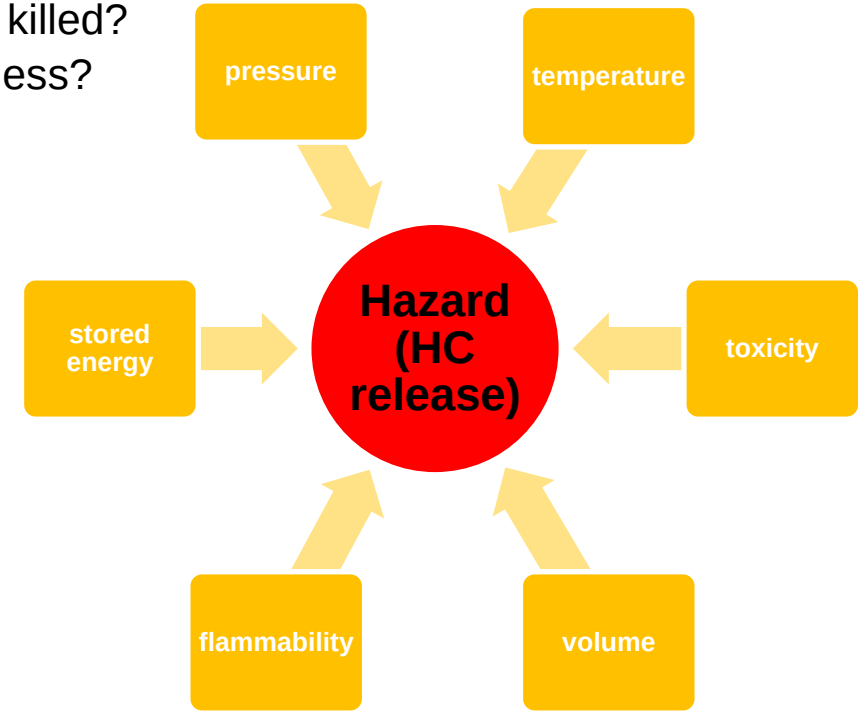
information needed for corrosion assessment

- asset register (structures/vessels/pipework/storage tanks, etc.),
- historical data (inspection/monitoring/maintenance),
- theoretical analysis (new systems based on published data/models),
- opinions and concerns of stakeholders
- field data where available.

Corrosion Risk Assessment Processes

Risk assessment:

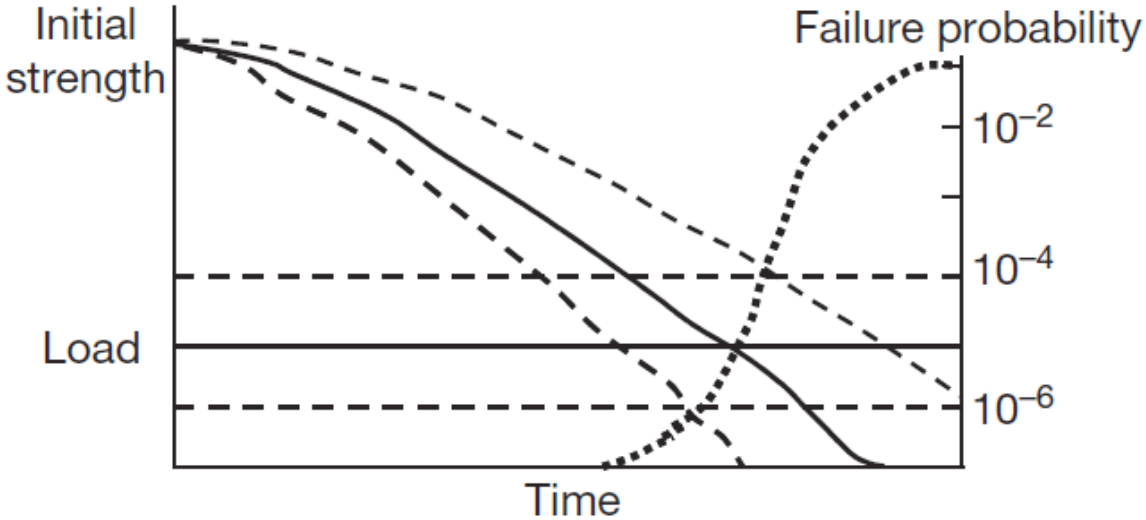
1. What would be the worst case scenarios?
2. How likely are they to occur?
3. What would be the damage?
4. How many people could be injured or killed?
5. How will these events affect the business?



Corrosion Risk Assessment Processes

Probability of Failure assessment

1. Failure mode – what could go wrong?
2. Failure effect – how will it affect the project/plant integrity/operations?
3. Failure criticality – how likely is it?



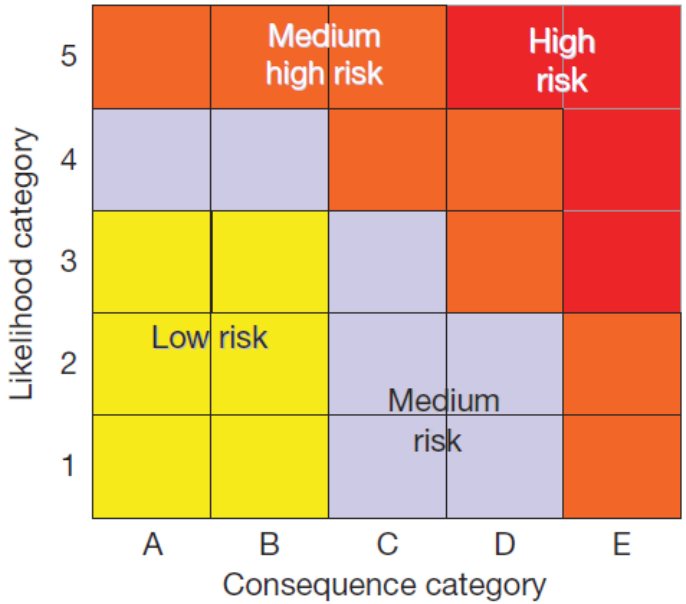
Corrosion Risk Assessment Processes

Matrix analysis Criticality = Likelihood of failure X Effect of failure

Level 1 – Qualitative risk analysis, a simple ranking of equipment
Level 2 – Semi-quantitative risk analysis, a more accurate prioritization that retains vital inputs of a Level 3 analysis but simplifying assumptions
Level 3 – Quantitative risk analysis, an in-depth study including assessment of reliability, financial and limited environmental issues

Criticality ranking, 1–5

Effect of failure	Low	1	2	3
	Medium	2	3	4
	High	3	4	5
		Low	Medium	High
		Likelihood of failure		

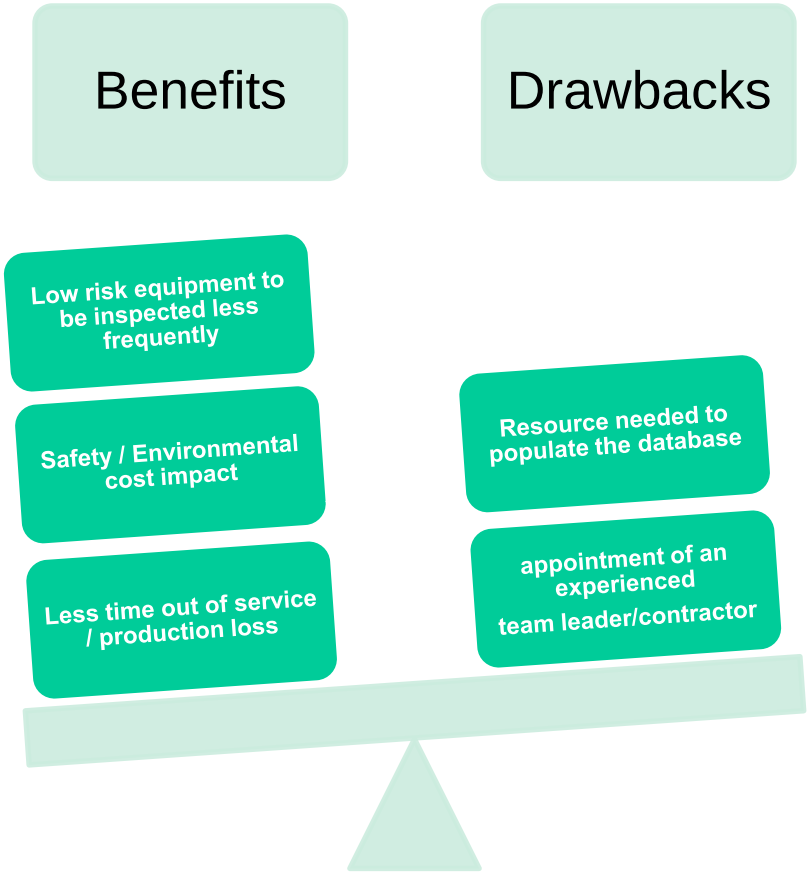


Corrosion Risk Assessment Processes

Corrosion Risk Assessment Outcome:

1. A minimal inspection plan.
2. The current level of inspection.
3. An optimized level of inspection.

- Inspection frequency can be adjusted
- the methods and tools used for the test and inspection (T&I) schedule can be changed.
- The scope, quality, and extent of the inspection and data collection / interpretation can also be modified.



Corrosion Risk Assessment Processes

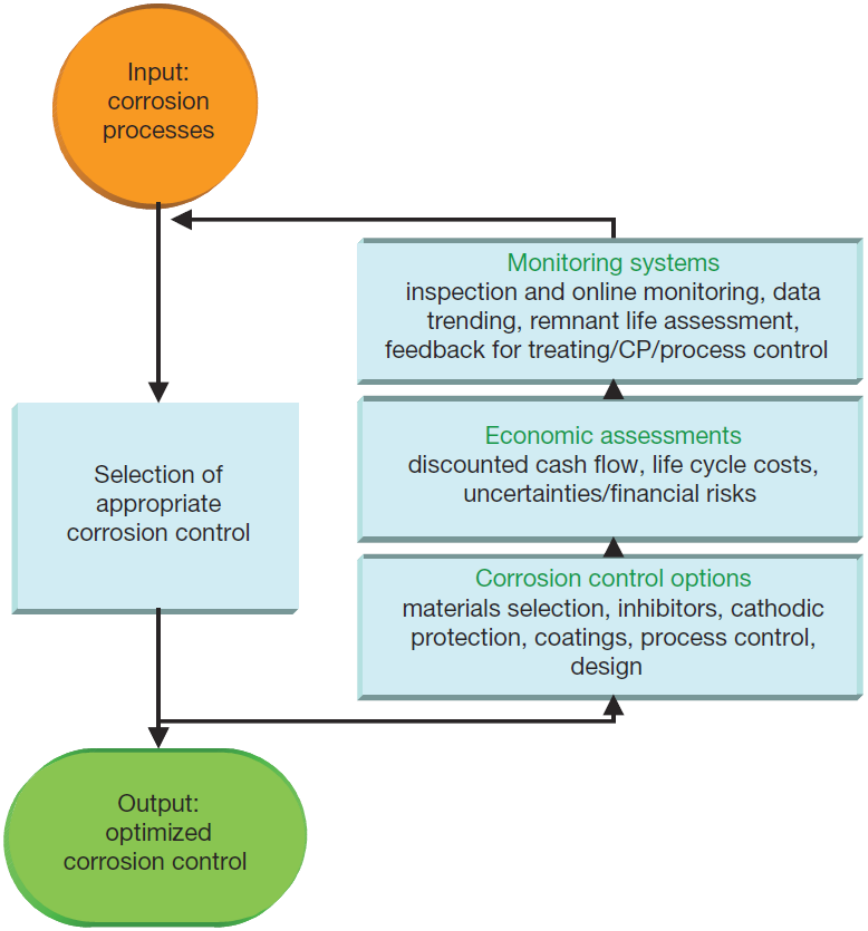
<u>Unacceptable high risks</u>
requiring a redesign in more corrosion resistant materials or alternative processing routes to be employed.

<u>Medium–high risks</u>
Could be assessed to see if increased inspection frequencies would allow continuing operation but obviously with a limited life (a predictive maintenance strategy) or if improved corrosion control measures would be effective at decreasing the likelihood of failure and moving the item into a medium risk level and also extending the life.

Corrosion Mitigation Requirements

Corrosion risk mitigation:

1. Materials selection
2. Chemical treatments
3. Use of coatings
4. Cathodic and anodic protection
5. Process and environmental control
6. Design
7. Inspection and monitoring



Corrosion Mitigation Requirements

<u>Corrosion risk mitigation by Inspection:</u>

1. condition of equipment
2. requirements for repair
3. rates of localized corrosion or cracking

<u>Corrosion risk mitigation by monitoring</u>

Changes in fluid corrosivity due to

i. damaging excursions in composition
ii. chemical treatments.

<u>Location of Inspection/monitoring</u>

Inspection Conventional
- UT, RAD, MPI, DPI, AE, …

Inspection Advanced/Specialised
- Computerised Rad, intelligent pigging, …

Inspection Permanently installed/on-line
- UT mat, piezoelectric sensors

Monitoring Conventional
- coupons, ER probes, electrochemical measurements, LPR, …

Monitoring Advanced/Specialised
- field signature method (FSM), sand probes, …

Monitoring Data handling
- supervisory control and data acquisition (SCADA) systems

INSERT SLIDE TITLE

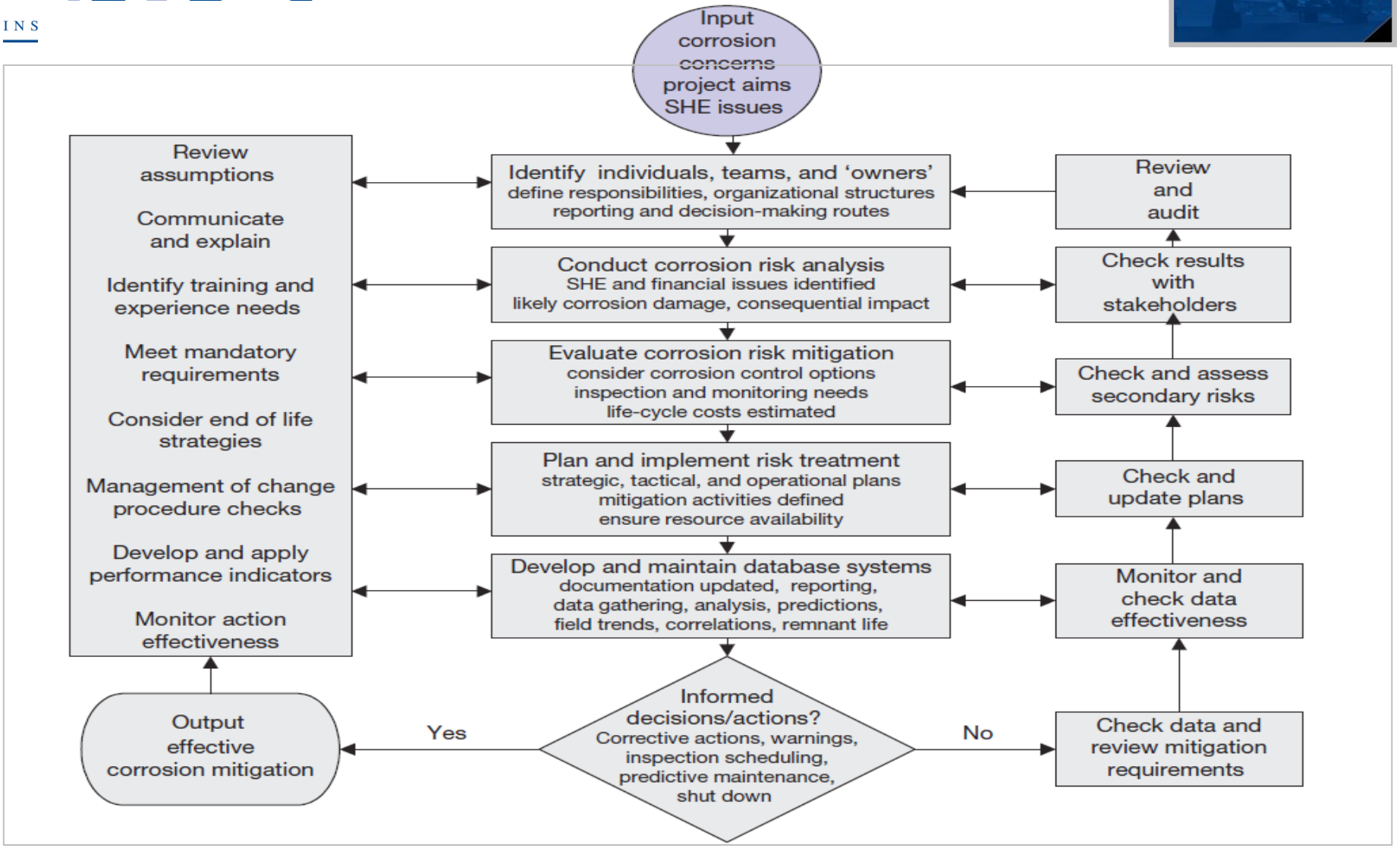
The effectiveness of inspection programs in finding and monitoring identified damage mechanisms.
Ranking typical inspection methods for various forms of damage modes

Example for General thinning:

Effectiveness	Inspection method/coverage
Highly effective (90%)	complete internal visual examination plus ultrasonic thickness testing (UT).
Usually effective (80%)	partial internal visual examination plus UT
Fairly effective (50%)	external spot UT
Poorly effective (40%)	hammer testing/telltale holes
Ineffective (33%)	external visual examination

Increase in the number of effective inspections → Increase in the confidence in the outcome

Corrosion Management Systems



Setting Performance Measures

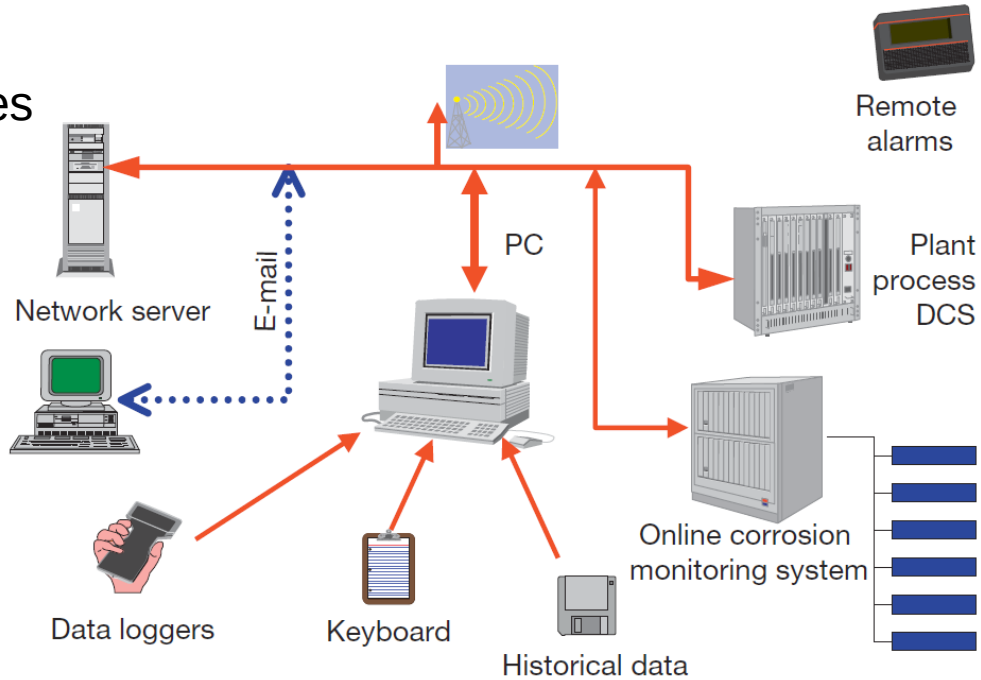
UK pressure system regulations require asset owners to record / inform the regulatory authorities of any delay to a scheduled inspection.

1. Corporate level
   - written policy statements
2. Strategic level
   - CRA studies / Competencies / Legislations / Objectives / …
3. Tactical level
   - Annual audits/ team allocation / guidelines, codes, standards / …
4. Operational/corrosion team level
   - On time reporting failures / collect monitoring data / …
5. Corrosion team leader
   - Review conformance of records / Specific procedures / …

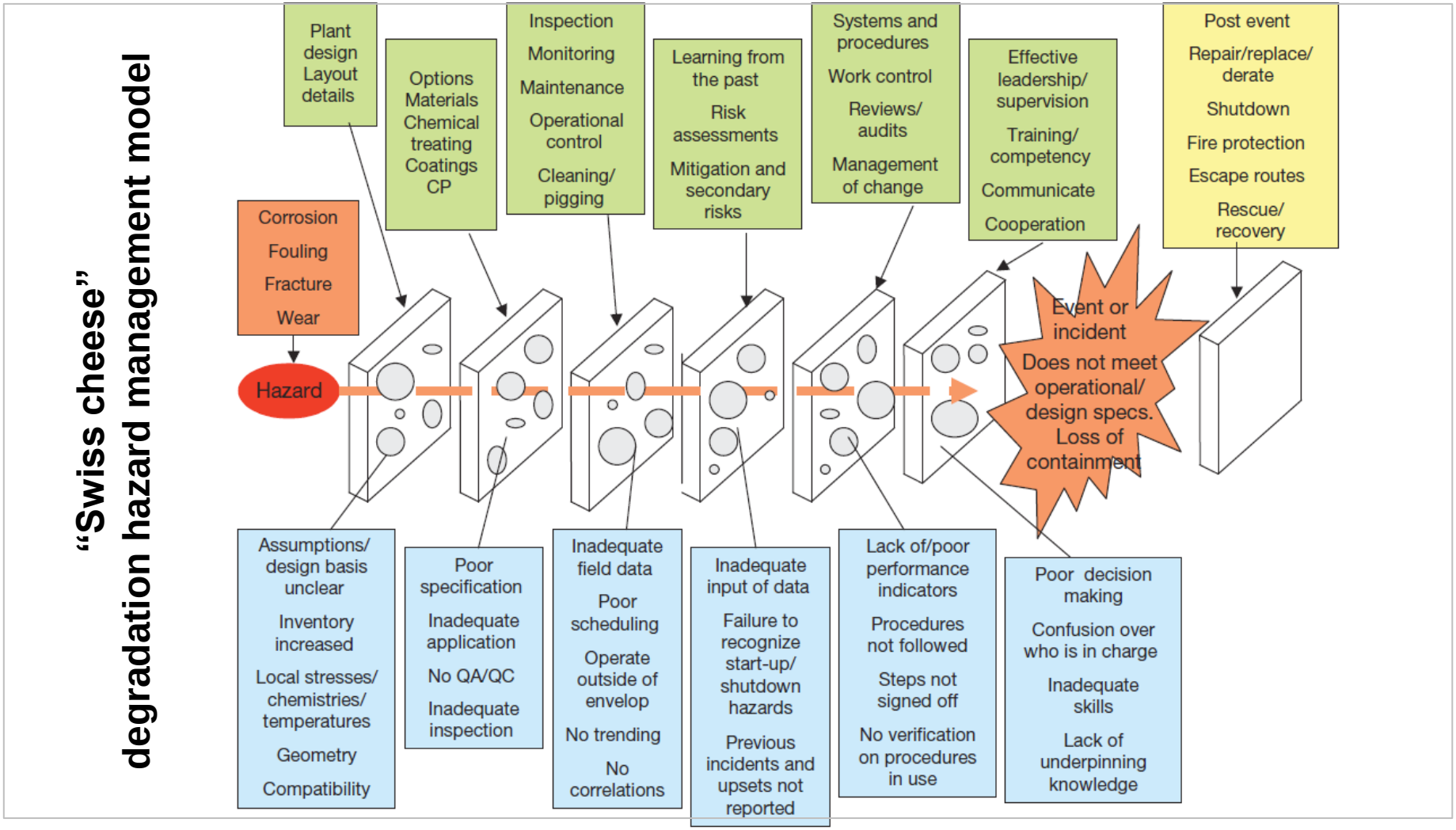
Data Management Systems

The choice will depend on the size of the project/operation.

1. An asset register
2. A documentation system
3. Data collection input and interfaces
4. Data analysis capability
5. Planning/work control
6. Reporting
7. Functionality enhancement



Corrosion Management Systems



Further studies

- Review of Corrosion Management for Offshore Oil and Gas Processing. Offshore Technology Report 2001/044, UK Health and Safety Executive, 2001
- The Offshore Installations (Safety Case) Regulations, SI 1992/2885
- The Pipelines Safety Regulations, SI 1996/825
- The Control of Major Accident Hazard Regulations, SI 1999/743
- Pressure Systems Safety Regulations, SI 2000/128
- API Recommended Practice RP580, Risk Based Inspection; American Petroleum Institute, 2000.
- API Publication 581, Risk Based Inspection Resource Document; American Petroleum Institute, 2002.
- DnV RP G101 Risk Based Inspection of Offshore Topsides Static Mechanical Equipment; DnV, 2002.
- Guidance for Corrosion Management in Oil and Gas Production and Processing; Energy Institute: London, May 2008.

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THANK YOU FOR YOUR ATTENTION
ANY QUESTIONS?