

IMPLEMENTATION OF PLAN-DO-CHECK-ACT REVIEW OF AN ONSHORE OIL AND GAS OPERATOR'S CORROSION MANAGEMENT POLICY AND ACTIONS

22nd February 2022

Virtual iCorr Presentation



STUDY BACKGROUND AND METHODOLOGY



STUDY BACKGROUND



- Intertek were asked to supply 3rd party expertise for a ***Study To Upgrade the Corrosion Monitoring & Mitigation Activities*** .
- To carry out a detailed study, assess and identify the current employed corrosion management techniques for its effectiveness within the Operators Field
- Identify the gaps in corrosion management techniques within the fields assets
- Provide corrosion management proposals / solutions to ensure world class / excellent asset integrity performance

STUDY BACKGROUND



- Document review which was desktop based, in the UK and the clients offices.
- Site surveys, which were expected to include visits to the facilities listed below (at least one plant from each):
 - Gas Station
 - Degassing Station
 - Gas Recycle Plant
 - PWI Stations
 - Gas Distribution Stations
 - Stripping Plants

PURPOSE OF THE SITE SURVEYS



Gain an understanding of:

- Current integrity management activities
- Corrosion control, monitoring and mitigation programmes
- Repairs, both temporary and permanent

CRITICAL:

Determine:

- Current and projected process conditions, both design and operational
- Fluid compositional data (but not to perform fluid sampling / analyses)
- Chemicals (e.g. those currently being used, such as corrosion and scale inhibitors)
- Materials of construction

Talk to the operators and personnel at site.

STUDY GUIDE: HSG 65

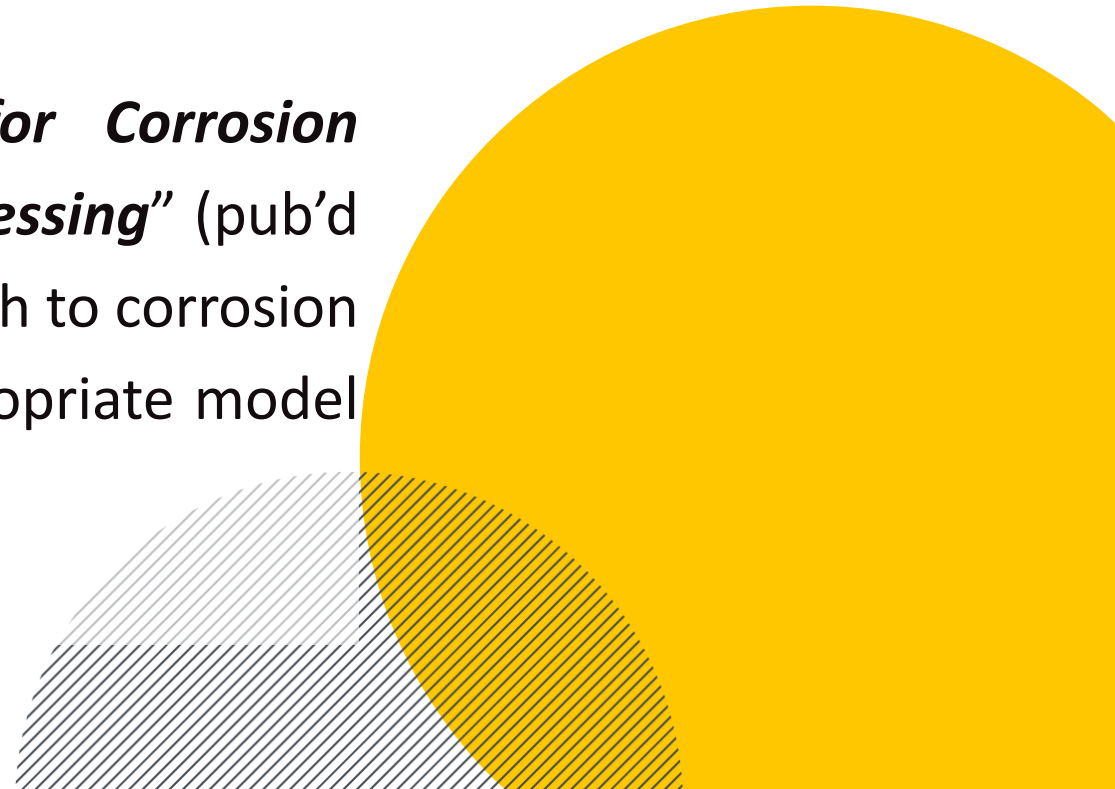


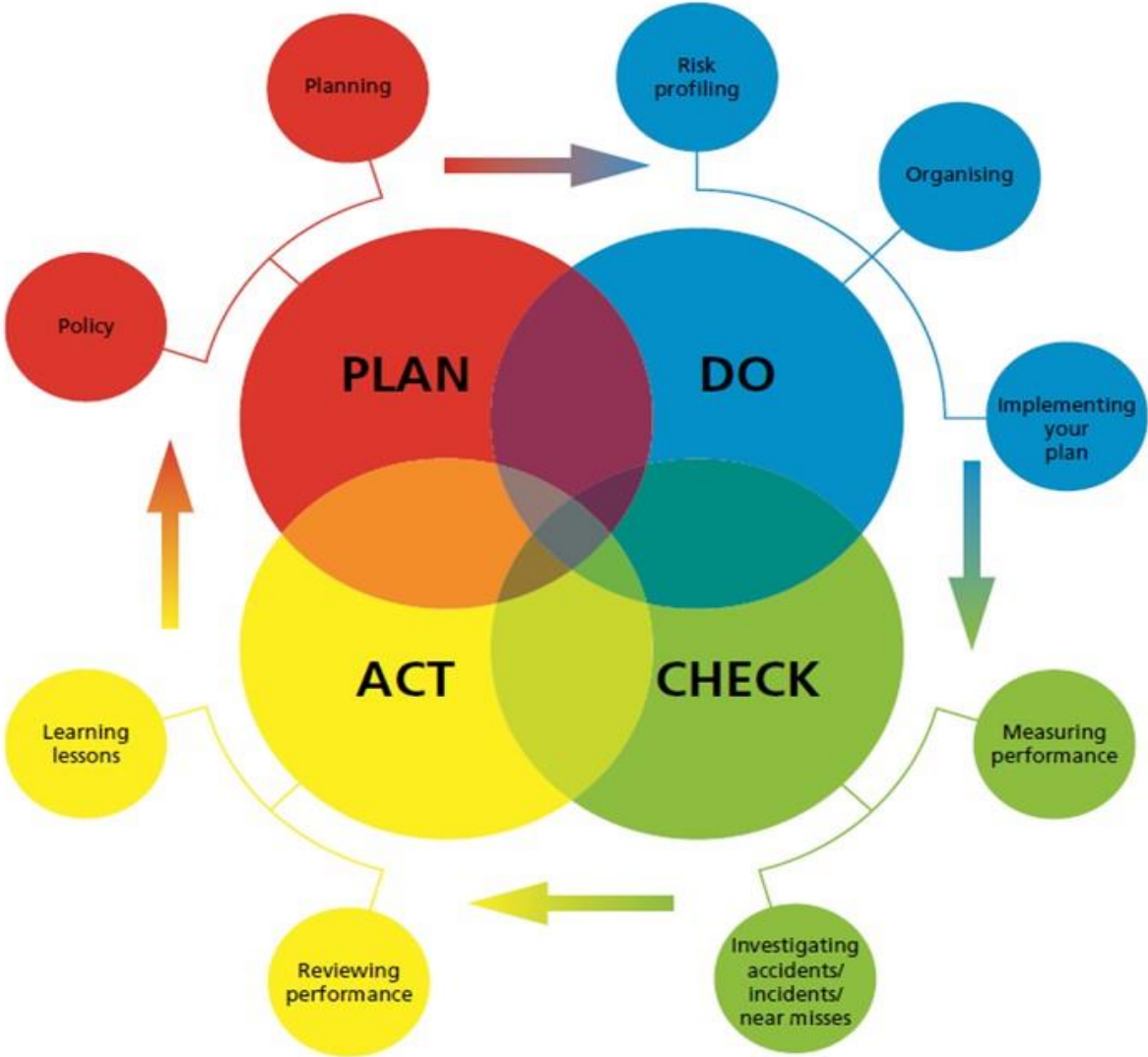
STUDY GUIDE: HSG 65



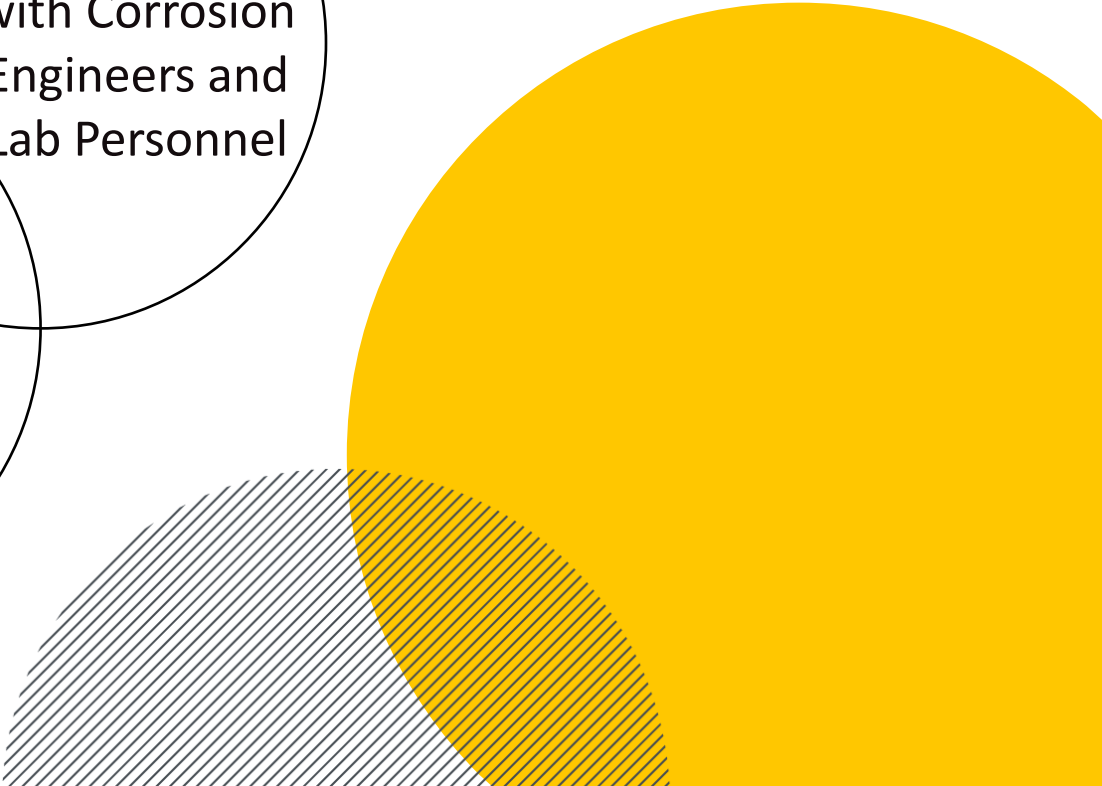
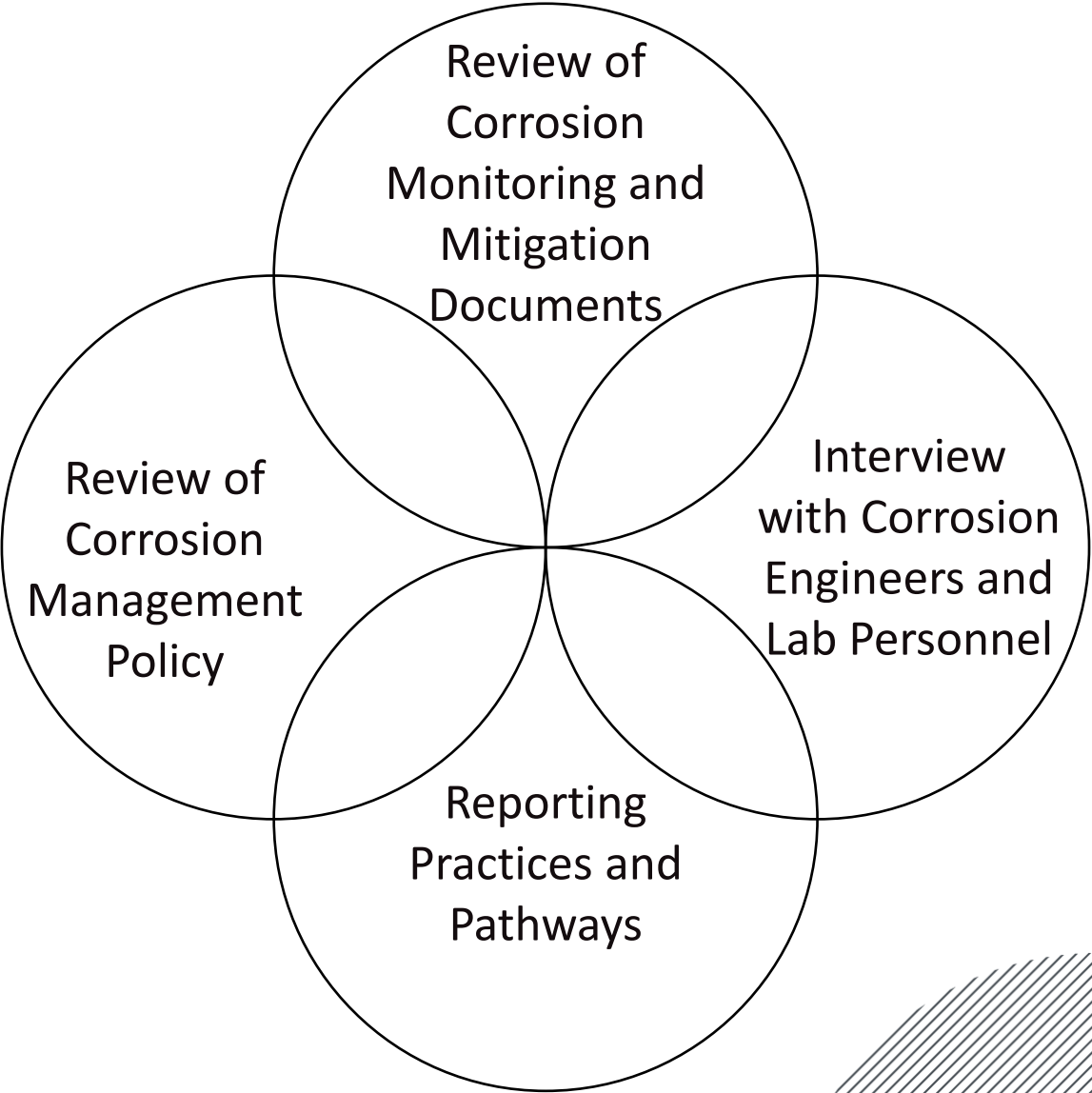
HSG 65 is used to assess the effectiveness of almost any organisation which relies on ***Systems, Procedures, Methodologies*** and Organisations required to operate a company safely and effectively.

The Energy Institute Document: “***Guidance for Corrosion Management in Oil and Gas Production and Processing***” (pub’d 2019), follows the **Plan – Do – Check – Act** approach to corrosion and integrity management, and hence is the appropriate model used for the Operator’s Study

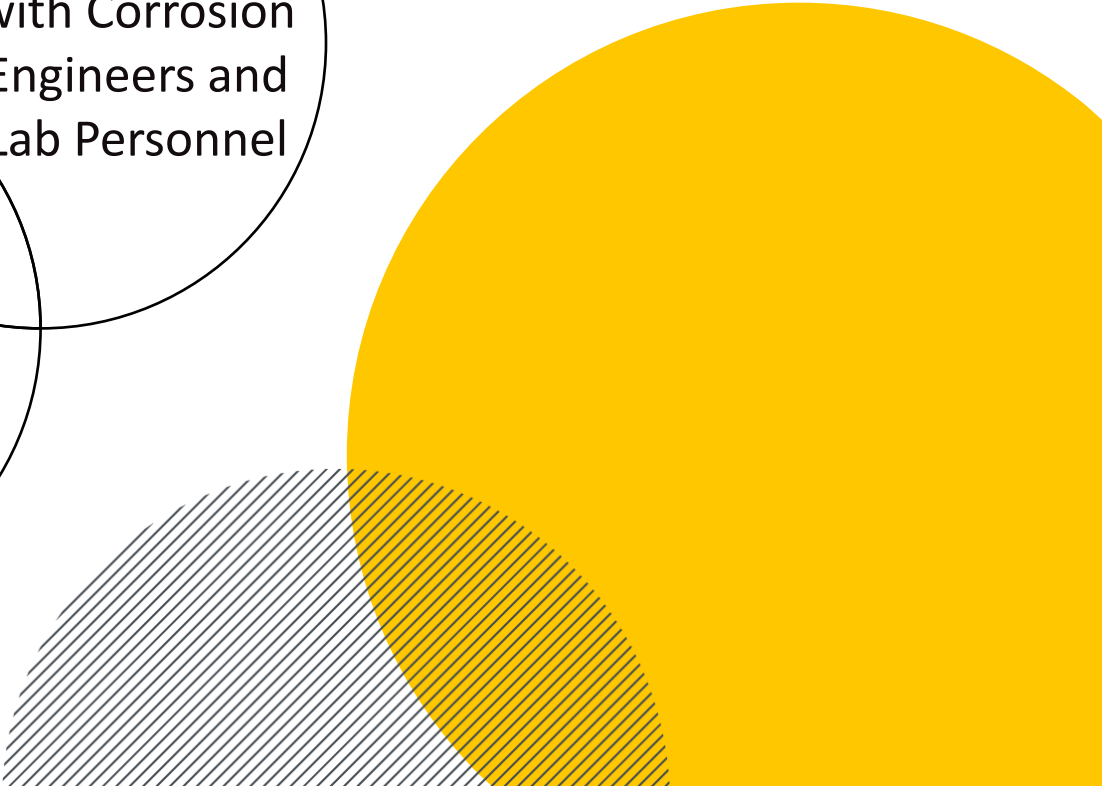
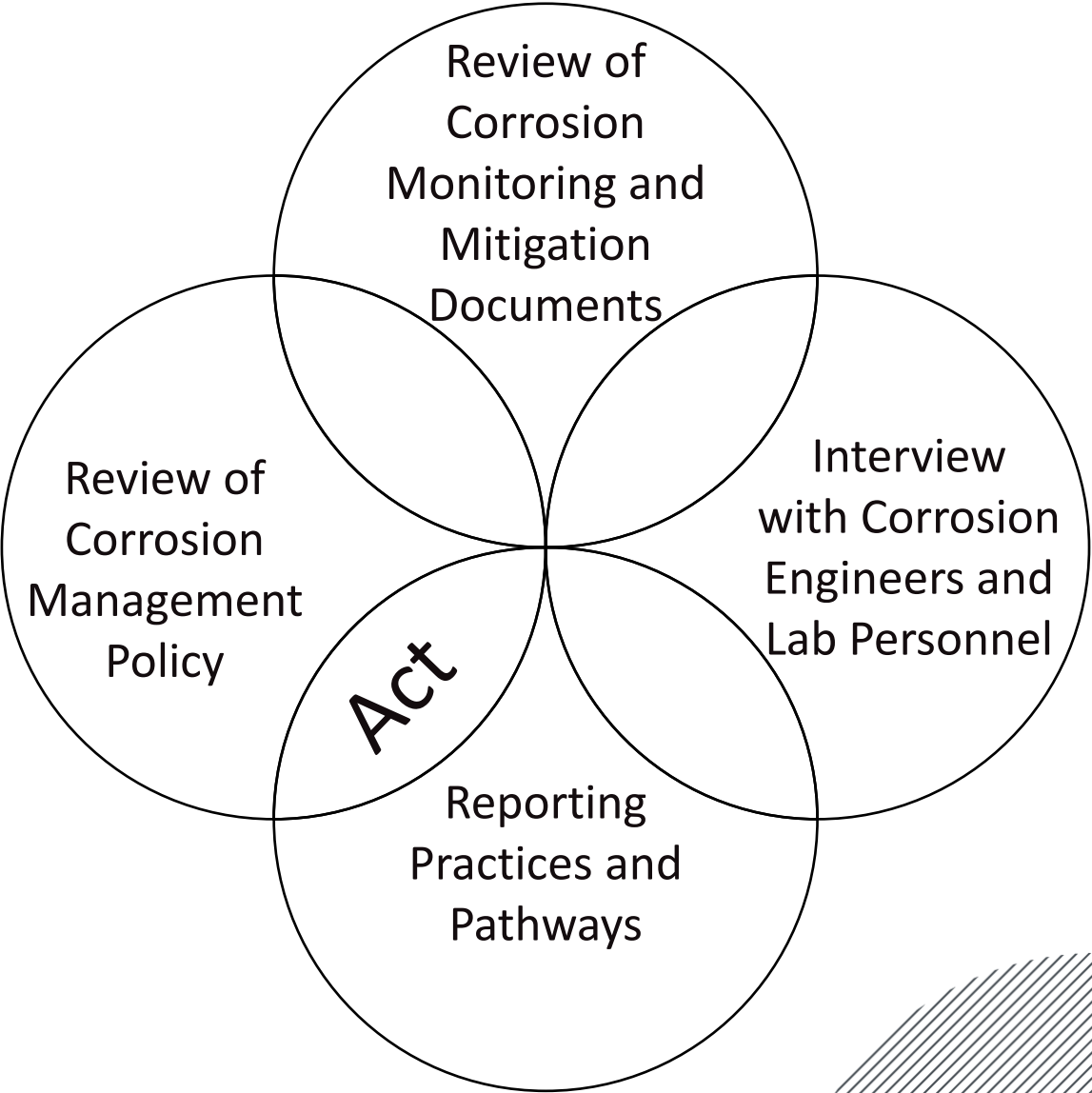




STUDY APPROACH



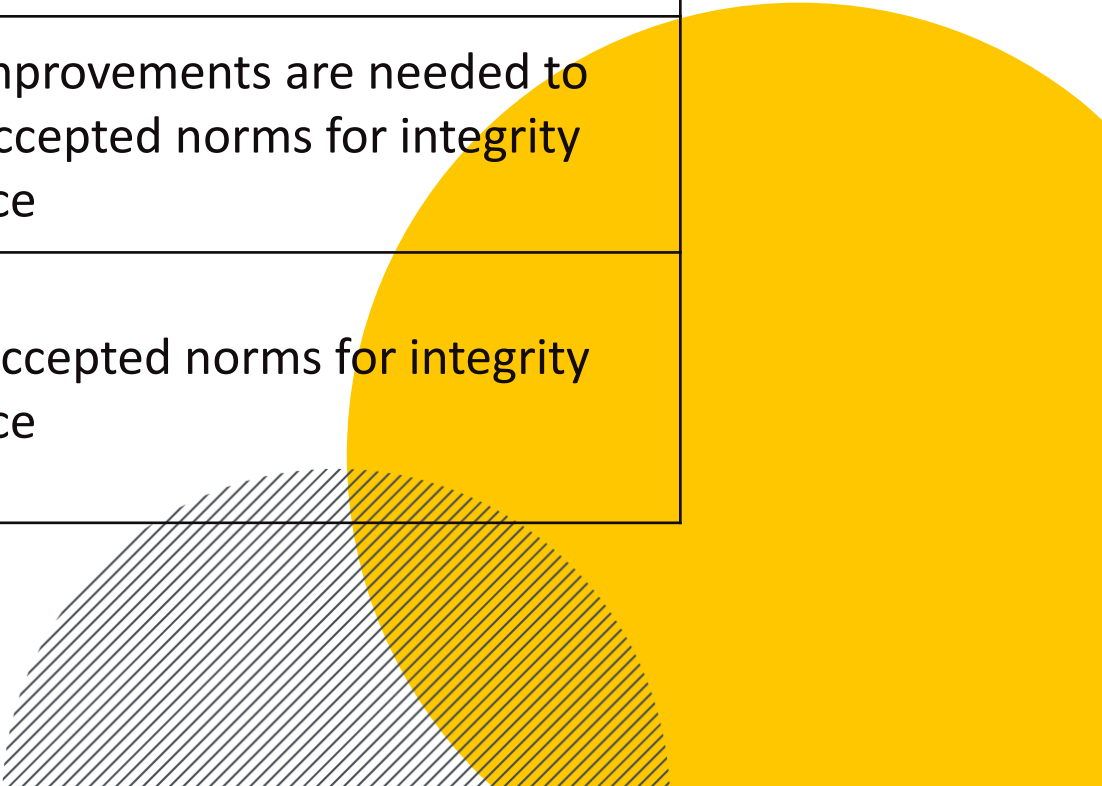
STUDY APPROACH



STUDY APPROACH



| TRAFFIC LIGHT | COMMENT |
|---------------|---|
| RED | In our opinion does not meet internationally accepted norms for integrity management; significant improvements are required to achieve excellence |
| AMBER | In our opinion some improvements are needed to meet internationally accepted norms for integrity management excellence |
| GREEN | In our opinion meets accepted norms for integrity management excellence |



STUDY TOPICS



Technical Basis of the Corrosion Management Policy

• **CORROSION MONITORING**

- Intrusive Corrosion Monitoring
- Deposit Analysis
- Scaling Tendency
- Microbiological Assessment
- Cooling Water Quality Assessments
- Glycol Quality
- External & Internal Coatings Assessments
- Thermal Insulation Inspections
- Review Operator Laboratory Procedures, Documentation, Reporting

• **CORROSION MITIGATION**

- Continuous Corrosion Inhibitor Injection
- Batch Corrosion Inhibitor Pipelines
- Scale Inhibitor for Production
- Biocide Shock Dosing
- Impressed Current Cathodic Protection
- Sacrificial Anode Cathodic Protection – Road Crossings
- Sacrificial Anode Cathodic Protection – Tanks Internal
- Chemical Treatment Cooling Waters
- External & Internal Coatings Specifications – Equipment & Structures
- Permanent & Temporary Repairs

STUDY OUTCOMES



STUDY OUTCOMES



Meets Expected Standards

Needs some improvement

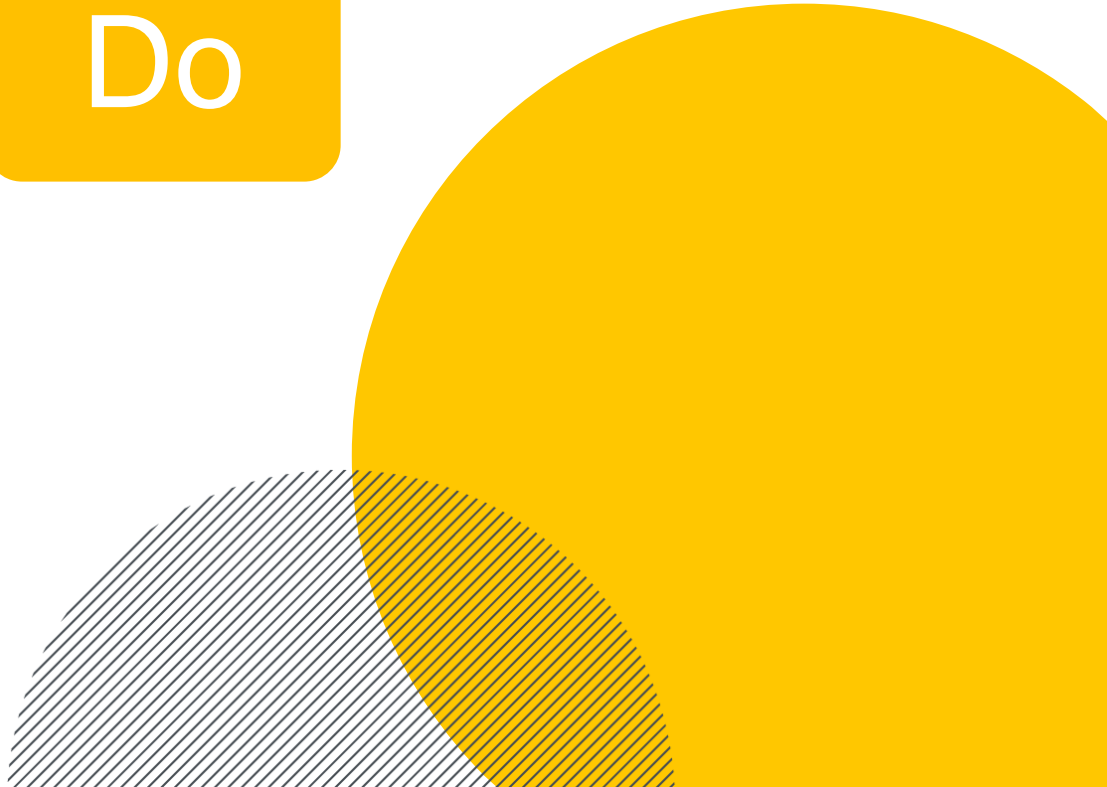
Step Change for Improvement

Plan

Act

Do

Check



STUDY OUTCOMES



| PLAN-DO-CHECK-ACT | INDIVIDUAL TRAFFIC LIGHTS | OVERALL TRAFFIC LIGHT |
|-------------------|-------------------------------------|--|
| PLAN | Policy | <ul style="list-style-type: none"> Operator has policies and procedures, but most need review and updating. Operator has an existing approach to monitoring & mitigation which it endeavours to fulfil in a professional manner. |
| | Planning | |
| DO | Risk profiling | <ul style="list-style-type: none"> Operator does not use risk assessment to drive its monitoring & mitigation programmes – it is recommended it does. The Operator team endeavour to meet the current approach to organising and implementing the plan as best as it is able to – it is recommended additional subject matter specialists are brought in to help with the workload. |
| | Organising | |
| | Implementing the plan | |
| CHECK | Measuring performance | <ul style="list-style-type: none"> Operator needs a formal system in place which is well resourced to measure the performance of its monitoring & mitigation programmes. Operator should take the opportunity to investigate deficiencies in the monitoring & mitigation programmes to achieve continuous improvement. At present only significant issues are subject to detailed scrutiny – these are usually the culmination of numerous smaller systemic failures |
| | Investigating accidents & incidents | |
| ACT | Reviewing performance | <ul style="list-style-type: none"> Operator needs a formal system in place to review monitoring & mitigation programme performance. Operator should broaden its approach to lessons learned from RCA's to lower level incidents so as to prevent the major incidents occurring. |
| | Learning lessons | |

STUDY TOPICS



• **CORROSION MONITORING**

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- Scaling Tendency
- Microbiological Assessment
- Cooling Water Quality Assessments
- Glycol Quality
- External & Internal Coatings Assessments
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• **CORROSION MITIGATION**

- Continuous Corrosion Inhibitor Injection
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- Impressed Current Cathodic Protection
- Sacrificial Anode Cathodic Protection – Road Crossings
- Sacrificial Anode Cathodic Protection – Tanks Internal
- Chemical Treatment Cooling Waters
- External & Internal Coatings Specifications – Equipment & Structures
- Permanent & Temporary Repairs

STUDY FINDINGS – CORROSION MONITORING



INTRUSIVE CORROSION MONITORING (ICM) TRAFFIC LIGHTS



| PLAN- DO- CHECK- ACT | INDIVIDUAL TRAFFIC LIGHTS | OVERALL TRAFFIC LIGHT |
|-------------------------------|-------------------------------------|---|
| PLAN | Policy | Well written standard but overdue for review. Some technical errors in the ICM standard. Retrievals & ER probe readings appear well planned. No tag numbers on ICM's in the field. Use >1500 spreadsheets – need corrosion management software. |
| | Planning | |
| DO | Risk profiling | Opportunity to further optimise ICM retrievals and ER probe readings. Organisation is very effective. Implementing the existing plan is very effective. Need a centralised support function to look long term. |
| | Organising | |
| | Implementing the plan | |
| CHECK | Measuring performance | No centralised system to link CI injection rates & corrosivity. No evidence of data trending to forecast future risks. Opportunity to use traffic lights to inform management. |
| | Investigating accidents & incidents | |
| ACT | Reviewing performance | Need a centralised function to help assess all corrosion related information, e.g. linking ICM data CI performance; reasons why corrosion rates are higher or lower than anticipated. |
| | Learning lessons | |



INTRUSIVE CORROSION MONITORING (ICM) TRAFFIC LIGHTS

Introduce software to manage the huge amount of data & trend the information

- This trending recommendation applies to all data collected for all topics
- ICM retrievals and ER probe readings will then be readily based on corrosion risk
- Link ICM data to CI injection rates & performance & NDT data
- ICM fittings on high risk hazardous duties should have pressure containing caps with bleed valve and pressure gauge
- Review and update the ICM standard
- The retrieval procedure should be followed at all times
- Responsibilities for ICM should be clearly stated using a **RACI** chart:
Responsible – Accountable – Consulted - Informed

RACI CHARTS



RACI CHARTS



Responsible – Accountable – Consulted - Informed

| Designation | Role |
|-------------|--|
| Responsible | Who actual does the action: who collects the corrosion measurements; who conducts the analysis; who updates. |
| Accountable | The person who is job it is to ensure the task is completed. |
| Consulted | Person or people who can input to the task. Technical specialist, external consultants. |
| Informed | Person who has overview and checks with the accountable person the task is done |



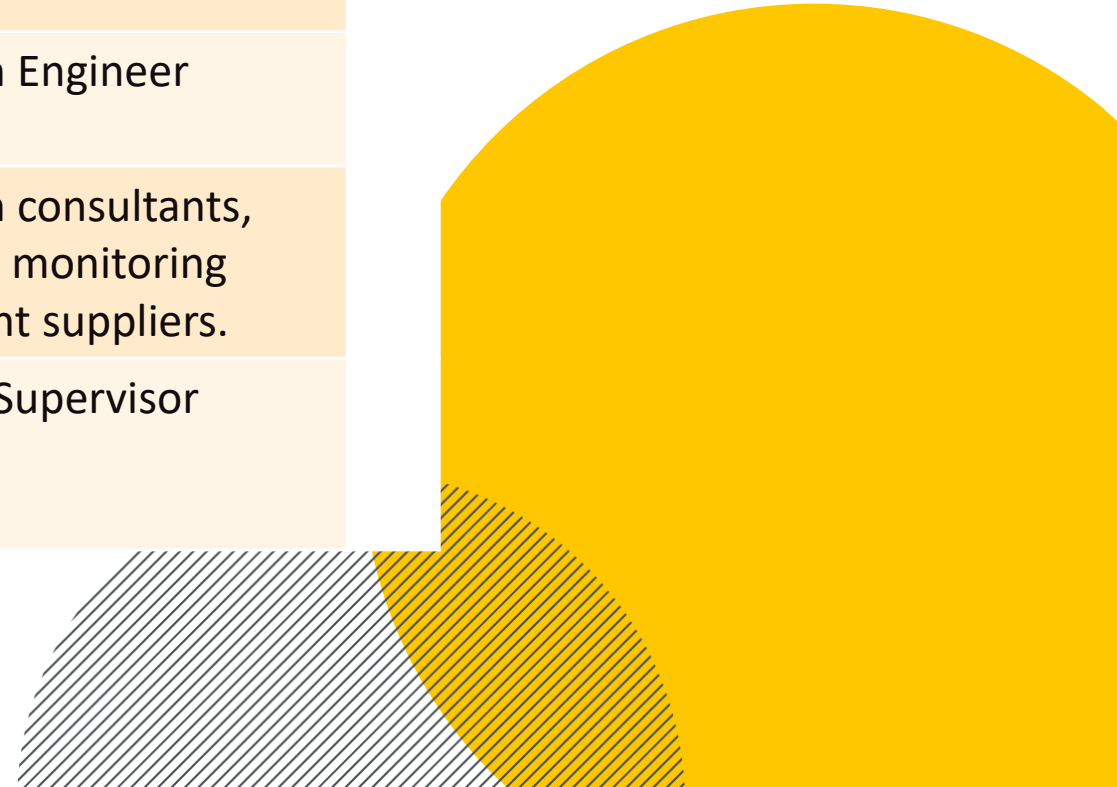
RACI CHARTS



Responsible – Accountable – Consulted - Informed

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| Example – Corrosion Coupon Retrieval |
|--|
| Coupon Retrieval Team |
| Corrosion Engineer |
| Corrosion consultants, corrosion monitoring equipment suppliers. |
| Integrity Supervisor |



RACI CHARTS



Responsible – Accountable – Consulted - Informed

| Designation | Role |
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| Example – Corrosion Coupon Retrieval |
|--|
| Coupon Retrieval Team |
| Corrosion Engineer |
| Corrosion consultants, corrosion monitoring equipment suppliers. |
| Integrity Supervisor |

| Corrosion Coupon Examination |
|---|
| Corrosion laboratory technician |
| Corrosion laboratory supervisor |
| Corrosion Engineer, corrosion monitoring equipment suppliers. |
| Corrosion Engineer |



EXTERNAL AND INTERNAL COATINGS TRAFFIC LIGHTS



| PLAN-DO-CHECK-ACT | INDIVIDUAL TRAFFIC LIGHTS | OVERALL TRAFFIC LIGHT |
|-------------------|-------------------------------------|---|
| PLAN | Policy | One Operator Specification is overdue review. Operator Specifications refer to outdated standards. Need more technical detail. Need more detail on inspection methods, criteria & acceptance levels. |
| | Planning | |
| DO | Risk profiling | No evidence of risk based assessments for coating inspections; time or opportunistic based. Coatings Team appear well organised and effective. Coatings Team appear to respond in a timely manner to Asset requests. |
| | Organising | |
| | Implementing the plan | |
| CHECK | Measuring performance | No evidence performance of coatings was being measured and fed back into the procedure. No evidence of coating failures being formally investigated, as opposed to being just repaired. However – the coatings we observed appear in very good condition. |
| | Investigating accidents & incidents | |
| ACT | Reviewing performance | No evidence of a formal system to assess the performance of coatings and learning the lessons of the output for future improvements. |
| | Learning lessons | |



EXTERNAL AND INTERNAL COATINGS RECOMMENDATIONS

- Update, revise and expand coatings & inspection documents
- Consider separating out new builds from maintenance of existing assets
- Expand information on pipe wrapping
- Simplify references to international standards to minimise potential confusion
- Inspections should be based on risk and the specific anticipated degradation mechanisms, e.g. CUPS & FUPS
- Need to trend coating inspection data to forecast likelihood of future non-conformances & to help optimise future inspection frequencies
- Consider creating a RACI chart to clarify activity responsibilities

STUDY FINDINGS – CORROSION MITIGATION



CONTINUOUS CORROSION INHIBITOR INJECTION TRAFFIC LIGHTS



| PLAN-DO-CHECK-ACT | INDIVIDUAL TRAFFIC LIGHTS | OVERALL TRAFFIC LIGHT |
|-------------------|-------------------------------------|---|
| PLAN | Policy | Excessive reliance on vendors for testing, dosage, performance. No data on independent CI test performance or dose rates. Field trial testing conditions not defined. No evidence CI's have been tested against pipeline conditions. Oil soluble CI's for gas lines & low water conditions – basis? |
| | Planning | |
| DO | Risk profiling | No evidence of risk profiling the pipelines. Chemical dosing generally satisfactory, but some omissions. One pipe line had extended periods without CI dosing or low dosing. Dosing rates often did not match the vendor recommendations. |
| | Organising | |
| | Implementing the plan | |
| CHECK | Measuring performance | Corrosion monitoring extensive, but not usually directly related to CI injection rates against the prescribed dosages. Residual CI analyses generally inappropriate. |
| | Investigating accidents & incidents | |
| ACT | Reviewing performance | No clear procedures for reviewing performance: dosing rates, residual concentrations, monitoring records and inspection data. |
| | Learning lessons | |

CONTINUOUS CORROSION INHIBITOR INJECTION RECOMMENDATIONS



- Review basis for current CI injection across the assets
 - Vendors to supply basis for selecting CI's and specifying dosing rates to Operator for review
 - Review whether the original basis for selecting CI is still relevant to the current fluid flow conditions
- Independent performance testing and dosing optimisation of all corrosion inhibitors
 - Operator had a standard but not used
 - As a minimum requirement the vendors must demonstrate they are testing to simulated pipeline conditions
- Need to review ICM data against CI injection rates
- CI injection rates to be adjusted to flow rates
- Review the CI residual testing methodologies to ensure they are suitable and accurate
- Match CI performance to NDT and ILI data to verify suitability
- Clearer responsibilities for all related activities create a RACI chart

BATCH CORROSION INHIBITOR GAS PIPELINES TRAFFIC LIGHTS



| PLAN-DO-CHECK-ACT | INDIVIDUAL TRAFFIC LIGHTS | OVERALL TRAFFIC LIGHT |
|-------------------|-------------------------------------|---|
| PLAN | Policy | New procedure & contract in place for planning batch CI treatment. |
| | Planning | |
| DO | Risk profiling | Revised system in place considers historic corrosion and debris data and adjusts batch CI treatments accordingly. |
| | Organising | |
| | Implementing the plan | |
| CHECK | Measuring performance | ICM & ILI data plus deposits and CI residuals. No significant internal corrosion issues, so not applicable. |
| | Investigating accidents & incidents | |
| ACT | Reviewing performance | Corrosion Team review batch CI treatment performance and feedback into the planning |
| | Learning lessons | |

RECOMMENDATIONS

- Batch CI performance should be independently verified, including persistency

OVERVIEW TRAFFIC LIGHTS FOR CORROSION MONITORING



| TOPIC | PLAN | DO | CHECK | ACT |
|---|--------|--------|--------|-----|
| Intrusive Corrosion Monitoring | Green | Yellow | Yellow | Red |
| Scale Deposit / Corrosion Product Assessments | Yellow | Yellow | Red | Red |
| PW Scaling Tendency | Yellow | Yellow | Red | Red |
| PWRI Microbiological Assessments | Yellow | Green | # | # |
| Cooling Water Quality (FSP) | Yellow | Yellow | Red | Red |
| Glycol Quality (Degassing Stations) | Yellow | Yellow | Red | Red |
| Residual Corrosion Inhibitor Concentration | Yellow | Yellow | Red | Red |
| External & Internal Protective Coatings Integrity Inspections | Yellow | Yellow | Red | Red |
| Thermal Insulation Inspections | Yellow | Yellow | Red | Red |

#Deliberately left blank as it does not apply.

OVERVIEW TRAFFIC LIGHTS FOR CORROSION MITIGATION



| TOPIC | PLAN | DO | CHECK | ACT |
|---|--------|--------|--------|--------|
| Continuous corrosion inhibitor injection | Red | Yellow | Yellow | Red |
| Batch corrosion inhibitor gas pipelines | Green | Green | Green | Green |
| Scale inhibitor for production and produced water | Red | Red | Red | Red |
| Biocide shock dosing | Red | Red | Red | Red |
| Impressed Current Cathodic Protection (ICCP) | Yellow | Green | Green | Yellow |
| Sacrificial Anode Cathodic Protection (SACP) road crossings | Yellow | Red | Red | Green |
| Tanks (Internals ICCP and SACP) | Green | Yellow | Green | Green |
| Chemical treatment of cooling waters | Red | Yellow | Red | Red |
| External & internal coatings specifications equipment & structures | Yellow | Yellow | Red | Red |
| Temporary defined life repairs | Red | Red | Red | Red |

FUTURE APPLICATION OF P-D-C-A FOR CORROSION MITIGATION





FUTURE APPLICATION OF P-D-C-A

- The world has changed dramatically over the last two years
- Significant change in working patterns and project delivery
- Move towards remote and automated inspection and monitoring – reduce POB

What does this mean for P-D-C-A and Corrosion Monitoring

- If the PLANNING Stage is not done properly then automation is pointless:
 - With any automated system **G**arbage **I**n **G**arbage **O**ut (GIGO)
 - Placement of sensors/monitoring equipment must be planned and review:
 - Sensors in correct place – low points, 6 o'clocks locations, high risk areas
- Automation will make the DO stage easier and quicker.
- Automation may result in complacency for CHECK and ACT – an automated system is NOT automatic.
- Sensors need to be calibrated, locations confirmed (has the sensor been moved/knocked), applicability of location re-confirmed (has the system changed?).
- Data CHECKED and reviewed.
- ACT will have double impact – ACT on what the data has shown and ACT on how the data was gathered.



THANK YOU FOR YOUR ATTENDANCE

ANY QUESTIONS?

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