Analysis of Material and Corrosion Damage Reports for an Ageing Asset

Part. 2

CED – 26th May 2015
Stephen Tate
Mature Asset - 2

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Stephen Tate
Key Topics to be covered

- What is an MCDR?
- How is an MCDR Raised?
- Initial Ranking Process
- Grouping of Defects / Cumulative Risk
- Erroneous MCDR’s
- Missed MCDR’s
- Suspended MCDR’s
- MCDR Monitors
- Issues with MCDR Monitors
- Resolution of Defects / MCDR Liquidation
- Conclusions
What is an MCDR?

- MCDR = Material Corrosion Damage Report.
- Procedure for the Reporting and Management of Corrosion Damage to Materials and Structures.
- MCDR = The details of an Anomaly.

- MCDR Management Procedure.
- Alternatively called – Anomaly Management Procedure.
How is an MCDR Raised?

• MCDR Raised by OIE – Offshore Inspection Engineer, sometimes called IIE – Installation Inspection Engineer.
• OIE is normally responsible for raising and closing out Anomalies in the Anomaly/MCDR software application.

• OIE – Is the Offshore focal point for all Corrosion and Integrity issues.
• OIE - Makes recommendations as to remediation measures required.
• OIE – Is the Custodian of the Temporary Repair Register.
Who Else Supports the MCDR Process

- **OIE** – Raises MCDR.
- **MTL** - Raises Anomaly Reports (MCDRs) in the OIE’s absence.
- **Senior Inspection Engineer** - Reviews / Advises Offshore if further inspection is required. May also may raise Anomaly Reports Onshore as a part of Inspection Workpack Reviews.
- **Engineering Manager** - Accountable for implementation of MCDR Procedure.
- **Maintenance Manager** – Resp. for all maintenance scopes related to a MCDR.
- **Integrity Manager** – Resp. for ensuring that all Anomalies appear on the Asset plan.
- **Pipespool Co-ordinator** - Liaises with fabricator for the fabrication of pipe.
- **MCDR Co-Ordinator** - Role is normally assumed by the asset Corrosion Engineer.
- **Senior Integrity Engineer** – Reviews all Anomaly Reports for accuracy prior to review.
- **Fabric Maintenance Contractor** - Resp. for scoping, planning and carrying out FM work.
- **ETL** - Offshore focal point for any engineering scopes associated with MCDRs.
- **OSCTL** - Offshore focal point for fabric maintenance teams.
- **Operations Supervisor** - Offshore focal point for raising Anomaly deviations.

- **Technical Authorities (TA’s)** - Corrosion, Structural, Piping, Mechanical, Instrument, Electrical, Drilling and Subsea TA’s are responsible for the technical assessment of all Anomalies within their Discipline and participating in risk ranking individual MCDRs. The TA makes final recommendations on Remedial Actions.
Mature Asset - 2

Initial Ranking Process – Matrix Varies Co. to Co.

<table>
<thead>
<tr>
<th>Barriers / Initiating Factors</th>
<th>Initial and Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of Criticality/Equipment Integrity</td>
<td>Financial Impact Can be Used as a Part of Project Monitoring</td>
</tr>
<tr>
<td>Safety Critical Equipment (SCE)</td>
<td>Personal Health &amp; Safety</td>
</tr>
<tr>
<td>Initial and Residual Risk</td>
<td>Environments</td>
</tr>
<tr>
<td>Level 5</td>
<td>Financial Impacts</td>
</tr>
<tr>
<td>Major incidence; equipment failure due to unforeseen activity by Operator</td>
<td>Minor injury to one person – preventable (offsite exposure)</td>
</tr>
<tr>
<td>Major equipment failure due to unforeseen activity by Operator</td>
<td>Major equipment failure due to unforeseen activity by Operator</td>
</tr>
<tr>
<td>Level 4</td>
<td>Major Systematic Failure of equipment due to unforeseen activity by Operator</td>
</tr>
<tr>
<td>Major equipment failure due to unforeseen activity by Operator</td>
<td>Major equipment failure due to unforeseen activity by Operator</td>
</tr>
<tr>
<td>Level 3</td>
<td>Significant failure of equipment due to unforeseen activity by Operator</td>
</tr>
<tr>
<td>Significant failure of equipment due to unforeseen activity by Operator</td>
<td>Significant failure of equipment due to unforeseen activity by Operator</td>
</tr>
<tr>
<td>Level 2</td>
<td>Minor equipment failure due to unforeseen activity by Operator</td>
</tr>
<tr>
<td>Minor equipment failure due to unforeseen activity by Operator</td>
<td>Minor equipment failure due to unforeseen activity by Operator</td>
</tr>
<tr>
<td>Level 1</td>
<td>Significant equipment failure due to unforeseen activity by Operator</td>
</tr>
<tr>
<td>Significant equipment failure due to unforeseen activity by Operator</td>
<td>Significant equipment failure due to unforeseen activity by Operator</td>
</tr>
</tbody>
</table>

### FAIRFIELD RISK ASSESSMENT MATRIX

<table>
<thead>
<tr>
<th>Level</th>
<th>Risk Assessment</th>
<th>Risk Acceptance</th>
<th>Opportunity Identification</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low Risk</td>
<td>Acceptable</td>
<td>High Priority</td>
<td>Very Low</td>
</tr>
<tr>
<td>2</td>
<td>Moderate Risk</td>
<td>Unacceptable</td>
<td>High Priority</td>
<td>Low Priority</td>
</tr>
<tr>
<td>3</td>
<td>High Risk</td>
<td>Unacceptable</td>
<td>High Priority</td>
<td>Medium Priority</td>
</tr>
<tr>
<td>4</td>
<td>Very High Risk</td>
<td>Unacceptable</td>
<td>High Priority</td>
<td>Low Priority</td>
</tr>
</tbody>
</table>

### Example

**Likelihood**

- **Qualitative**: Very unlikely to happen, Unlikely to happen, Possible, Probable, Very probable
- **Frequency**: Once or appeared in 0 < 10 years, Once or appeared in 10 to 50 years, Once or appeared in 50 to 100 years, Once or appeared in 100 to 1000 years, More than one occurrence per year
- **Personal Injury (Human Factors)**: Unknown/combination of factors required to cause an incident
- **Environmental/Media**: Combination of new factors required to cause an incident
- **Production/Materials**: Incident with additional factors
- **Loss of Containment (Mechanical Integrity)**: Single component or major component of major mechanical plan
- **Complexity for Project Prioritisation**: Very complex

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This matrix is designed to assess and prioritize risks in a project environment. The levels of risk and acceptability are based on industry standards and can vary significantly between companies. The matrix also includes a section for identifying opportunities, which can vary based on the specific project and company culture.
Initial Ranking Process

MCDR Risk Calculator

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Initial Ranking Process

Overall Anomaly Risk Matrix

<table>
<thead>
<tr>
<th>ADD System Ranking</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>18</th>
<th>19</th>
<th>20</th>
<th>22</th>
<th>25</th>
<th>26</th>
<th>30</th>
<th>35</th>
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</thead>
<tbody>
<tr>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>20</td>
<td>23</td>
<td>24</td>
<td>28</td>
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<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
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<td>21</td>
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<tr>
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<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
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<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>14</td>
<td>17</td>
<td>18</td>
<td>22</td>
<td>27</td>
<td></td>
</tr>
</tbody>
</table>

Base

| 1 | 2 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 12 | 15 | 16 | 20 | 25 |

Highest Priority

Lowest Priority
## Initial Ranking Process – Further Reviews

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Anomaly Risk Assessment Methodology for Pressure Containment</th>
<th>Review Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme</td>
<td>Shutdown and replace or repair. Fitness-for-purpose assessment. Add to plan</td>
<td>1 month</td>
</tr>
<tr>
<td>Very High</td>
<td>Fitness-for-purpose assessment, apply temporary repair, monitor 2 weekly, raise PMR, add to plan</td>
<td>3 months</td>
</tr>
<tr>
<td>High</td>
<td>Fitness-for-purpose assessment, apply temporary repair, monitor monthly, raise PMR, add to plan</td>
<td>6 months</td>
</tr>
<tr>
<td>Medium</td>
<td>Monitor wall thickness monthly, PMR in WorkMate</td>
<td>12 months</td>
</tr>
<tr>
<td>Low</td>
<td>Monitor wall thickness 6 monthly, PMR in WorkMate</td>
<td>18 months</td>
</tr>
<tr>
<td>Very Low</td>
<td>Monitor wall thickness 12 monthly, PMR in WorkMate</td>
<td>24 months</td>
</tr>
<tr>
<td>Negligible</td>
<td>No further work needed</td>
<td>Suspend MCDR</td>
</tr>
<tr>
<td>MCDR No</td>
<td>Title</td>
<td>Date Completed</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
<td>----------------</td>
</tr>
<tr>
<td>DA-0-02091</td>
<td>DESIGNER'S - Correcting four gape in burred base at drilling package E2 - Approach area</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02095</td>
<td>SINGLE MONITOR SCOPE - 2 out of 3 COMPLETE</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02099</td>
<td>Squatting to mount in building</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02101</td>
<td>SINGLE MONITOR SCOPE - REQUIRE SCALING BEFORE EXAMINATE Gear</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02103</td>
<td>Internal corrosion to access ladder</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02104</td>
<td>Drilling of Ovend filling equipment</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02105</td>
<td>Painting of fire pipe</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02106</td>
<td>Paint corrosion and disconnection of valves in areas</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02107</td>
<td>Inspection of fire pipes</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02108</td>
<td>Paint corrosion and disconnection of valves in areas</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02109</td>
<td>Inspection of fire pipes</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02110</td>
<td>Potential complete - TA Action</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02111</td>
<td>Potential complete - TA Action</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02112</td>
<td>Expanded Scale of a balance E1 to meet</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02113</td>
<td>Single Monitor Support - Requires</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02114</td>
<td>Single Monitor Support - Requires</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02115</td>
<td>Single Monitor Support - Requires</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02116</td>
<td>Single Monitor Support - Requires</td>
<td>2011-02-01</td>
</tr>
<tr>
<td>DA-0-02117</td>
<td>Single Monitor Support - Requires</td>
<td>2011-02-01</td>
</tr>
</tbody>
</table>

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**Initial Ranking Process – Overall DB**

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**MCDR Risk Assessment**

- **System Risk:** 4
- **Consequence Risk:** 2
- **Risk Level:** 4
- **Review Period:** 2

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**Risk Assessment Outcome**

- **Pressure Container:** Yes
- **Fabric Maintenance:** No
- **Negligible:** Leave

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**Notes:**

- Updated inspection required to validate risk assessment score.
- Could you request that a specialist take some updated pictures of this tank so we can assess the MCDR?
Grouping of Defects / Cumulative’ Risk

- Grouping of Defects / Cumulative’ Risk.
- The Total Area Risk must also be Considered.
Grouping of Defects / Cumulative’ Risk

Consider - Total Area Risk

CED – 26th May 2015

Stephen Tate
MCDR Liquidation / Tracking – Weekly Status

- Ready to Install: 6
- Workpacks Prepared: 7
- Materials Available: 34
- Engineering Complete: 14
- Score 18 and Over: 195

The chart shows the status of different tasks in the process, with a focus on the number of items completed and pending at various stages.
MCDR Liquidation / Tracking – Weekly Status

Estimates (Score ≥ 18)

- Estimates Allocated (Hard): 43
- Hours Allocated (Hard): 53
- Estimates Allocated (Soft): 166
- Hours Allocated (Soft): 166
- Score 18 and Over: 195

[Graph showing the distribution of completed and pending tasks.]
Erroneous MCDR’s – DB Population Errors

- An MCDR is raised by Inspector at **Alarm Level 3** for rem. W.T
- Sometimes Alarm is **False**.
- MCDR Unnecessary.
- Inspection Database may have PMC – Pipe Material Class Value only. This can greatly affect Min. Thickness Alarm. **19 bar v. 3 bar**

![Diagram](image-url)
Erroneous MCDR’s – NDT Errors

- The limitations of NDT may mean that some MCDR Spools are removed unnecessarily.
- There may also be obstructions and/or inclusions that affect NDT reading, giving lower rem. W.T than is actually the case.
- Special care must be taken around Pipe Supports.
- There is increased NDT error when testing thin materials.
- Testing below 3mm is not reliable.
Erroneous MCDR’s – NDT Errors – Met. Lab Checks

UT – Reported Values, 2.2 / 2.4 mm Rem W.T.  
**Actual** Rem. Thickness 5.5mm
## Erroneous MCDR’s – NDT Errors

<table>
<thead>
<tr>
<th>Feature ID</th>
<th>Feature Type</th>
<th>Nominal WT (mm)</th>
<th>Alarms</th>
<th>Alarms</th>
<th>MAWT (Struct. Overide)</th>
<th>MAWT (Pres. Retent.)</th>
<th>Pres. Rate</th>
<th>Pres. Retal</th>
<th>Hist Rate</th>
<th>Hist Retal</th>
<th>Inspection History Pre-Shut-In</th>
<th>Background Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-01-47-W050</td>
<td>WELD</td>
<td>279.00</td>
<td>15.50</td>
<td>11.70</td>
<td>6.7</td>
<td>1.30</td>
<td>2.30</td>
<td>3.31</td>
<td>2.30</td>
<td>0.63</td>
<td>20/04/2018</td>
<td>UT Reported Values, 2.2 / 2.4 mm Rem W.T</td>
</tr>
<tr>
<td>P-01-47-W057</td>
<td>WELD</td>
<td>279.00</td>
<td>15.50</td>
<td>11.70</td>
<td>6.7</td>
<td>1.30</td>
<td>2.30</td>
<td>3.31</td>
<td>2.30</td>
<td>0.63</td>
<td>20/04/2018</td>
<td>UT Reported Values, 2.2 / 2.4 mm Rem W.T</td>
</tr>
<tr>
<td>P-01-47-W067</td>
<td>WELD</td>
<td>279.00</td>
<td>15.50</td>
<td>11.70</td>
<td>6.7</td>
<td>1.30</td>
<td>2.30</td>
<td>3.31</td>
<td>2.30</td>
<td>0.63</td>
<td>20/04/2018</td>
<td>UT Reported Values, 2.2 / 2.4 mm Rem W.T</td>
</tr>
<tr>
<td>P-01-47-W061</td>
<td>WELD</td>
<td>279.00</td>
<td>15.50</td>
<td>11.70</td>
<td>6.7</td>
<td>1.30</td>
<td>2.30</td>
<td>3.31</td>
<td>2.30</td>
<td>0.63</td>
<td>20/04/2018</td>
<td>UT Reported Values, 2.2 / 2.4 mm Rem W.T</td>
</tr>
</tbody>
</table>

**Background Notes:**
- **UT Reported Values, 2.2 / 2.4 mm Rem W.T**
- **Mature Asset - 2**

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**Injection History Pre-Shut-In:**
- **UT Reported Values, 2.2 / 2.4 mm Rem W.T**

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**UT – Reported Values:**
2.2 / 2.4 mm Rem W.T
Erroneous MCDR’s – NDT Errors

Nominal 15.09mm

Min. Section 5.25mm

Bore Damage – Large Circular Pits Joining Up to form Larger Pitted Sites. X = NDT Site.
Missed MCDR’s

- Some MCDR’s are driven by the Onshore Team.
- Additional Observations at Returned WP Review.
- MCDR’s may also occur when IIE off duty / Nightshift.
Suspended MCDR’S

- Suspended MCDR’S
- Occur when a Monitor Requirement is Proven False.
  - NDT Results not Repeatable.
  - NDT Results show no further Deterioration.
## Suspended MCDR’S - Examples

<table>
<thead>
<tr>
<th>MCDR Number</th>
<th>Tag</th>
<th>Title</th>
<th>System</th>
<th>Reason for Suspension</th>
</tr>
</thead>
<tbody>
<tr>
<td>2825</td>
<td>Drilling Derrick Wind Wall</td>
<td>Loose corrugated wind wall sheeting to drill floor West wall</td>
<td>Drilling/Structural</td>
<td>This MCDR is being suspended until when the drilling campaign finishes, then it will be re-inspected and placed in the temporary repair register to be monitored on an annual basis.</td>
</tr>
<tr>
<td>2775</td>
<td>8”-D-006-1105 Leg A</td>
<td>Piping perforation to open drains piping in Leg A @ 101m level.</td>
<td>Drains (Open)</td>
<td>This line is out of service, suspension status to remain,</td>
</tr>
<tr>
<td>2321</td>
<td>3”-D-055-1105</td>
<td>Pitting corrosion to flange face</td>
<td>Drains (Open)</td>
<td>Suspension to be maintained until the pumps are brought back into system.</td>
</tr>
<tr>
<td>596</td>
<td>6”-WS-035-1803</td>
<td>Internal Corrosion / Erosion and Vibration</td>
<td>Service Water</td>
<td>Long term wrap given five years, will be due for review at the end of January 2015, Deviation number 100</td>
</tr>
<tr>
<td>903-10</td>
<td>A-3221</td>
<td>Murchison Pig Receiver door opening gearbox damage (Top lid damage &amp; base plate support feet)</td>
<td>Oil Export</td>
<td>Murchison is reported as being decommissioned. Instructed not to carry out remedial repairs. MCDR to remain suspended until decommissioned. To review in six months time.</td>
</tr>
<tr>
<td>732-10</td>
<td>8”-G-073-1106X</td>
<td>REDUNDANT - SMB 1 anomalies</td>
<td>Ventilation</td>
<td>Redundant line. To verify the lines has been removed/replaced as part of the flare drains upgrade as started in September 2011</td>
</tr>
<tr>
<td>723-09</td>
<td>DA-T-6210-B</td>
<td>External tank support structure moderately corroded</td>
<td>Chemical injection</td>
<td>Tank is empty and currently not in use. Tank has not been positively isolated. Recommend isolate from the process until way forward is agreed</td>
</tr>
</tbody>
</table>
MCDR Monitors

- Temporary Wraps – OIE / IIE will perform Monthly Inspection.
- Low W.T – Inter Med. RAD / UT performed according to W.T Severity.

Non-Destructive Testing – Monitoring Frequency according to CR
Issues with MCDR Monitors

• NDT is not always reliable / sufficiently accurate.
• Monitoring at too close frequency may only exacerbate errors / give misleading trends.
MCDR Extremes - Low

24" Produced Water to Overboard Line – Single Scab.

24" Produced Water to Overboard Line – Localised Internal Irathane' Rubber Lining Breakdown. CLOSE UP.
MCDR Extremes - High

Down Leg 36” Service Water Supply – Severely Corroded Pipe Support.

Down Leg 36” Service Water Supply – Severely Corroded Pipe Support. CLOSE UP
Resolution of Defects / MCDR Liquidation

Repair – Active Leak Site

- Temporary Repairs (Wraps and Clamps) – METALYTE’
Resolution of Defects / MCDR Liquidation

Repair – Active Leak Site

• Temporary Repairs (Wraps and Clamps) – METALYTE’

Stage 1 – Geometry of clamp and patch fared into line with epoxy and coated in 1mm of Kevlar reinforced Sub Sea LV Epoxy

Stage 2 – 12 Layers of Syntho Glass XT to initially reinforce repair areas.

Stage 3 – Additional Syntho Braid High tensile composite installed over Original repair. (Remainder of Elbow coated in Sub Sea LV).

Stage 4 – Completed repair on outside of elbow showing extra reinforcement.

Metalyte’ – Stages of a Twin Service Water Leak Repair
Resolution of Defects / MCDR Liquidation

- Temporary Repairs (Wraps and Clamps) - TEEKAY

Temporary Repair (Drilling Service Water Line) – Leak shown as initially reported prior to isolation for inspection and installation of Teekay clamp.

Fitted Teekay – Minor weep Post Fit due to Surface Condition.
Resolution of Defects / MCDR Liquidation

- Temporary Repairs (Wraps and Clamps) – Walker Techno-wrap

Temporary Repair (Gas Turbine Cooling Water Return) – Jubilee clip secured rubber patch, Overwrapped with Techno-wrap bandage.

Compare – Ships Way.
Resolution of Defects / MCDR Liquidation

- Temporary Repairs (Flanges)

4” Monel Cooling Water Line – Associated with Gas Turbine Generator. The corrosion covers the full circumference of the face and approximately 33 – 50% of the face width. The pitting was noted between 2 & 3mm in depth at the worst area.

FRG - A flange rescue gasket has been fitted along with the new valve and logged under a temporary repair number.
Resolution of Defects / MCDR Liquidation

- Temporary Repairs (Flanges)

FRG and Temporary Repair Tagged
Resolution of Defects / MCDR Liquidation

- Permanent Repairs
- Typically 1-2 Weeks to Process / Review / Rank MCDR.
- Typically Further 1-2 Weeks to Fabricate / Spool.
- Typically Further 3-6M Waiting on Isolations or S/D.

- Quicker Process of Course, if Platform already S/D because of Leak and a Temporary Repair cannot be effected.
Difficulties of Achieving Isolations

- Isolations
- May not be achievable outwith a S/D if adjoining valves are passing.
MCDR Summary

Av. MCDR's Raised Per Year (2008-2014)
Bow Wave New MCDR’s Raised, Inspections – New Owner

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. MCDR's Raised Post Acquisition</td>
<td>44</td>
<td>100</td>
<td>130</td>
<td>145</td>
<td>161</td>
<td>99</td>
<td>96</td>
</tr>
</tbody>
</table>
### MCDR Profile - Closed Drain System

<table>
<thead>
<tr>
<th>Failure Type</th>
<th>Crevice Corrosion</th>
<th>Crevice Corrosion (%)</th>
<th>CUI</th>
<th>CUI (%)</th>
<th>External Corrosion / Poor FM</th>
<th>External Corrosion / Poor FM (%)</th>
<th>Galvanic Corrosion</th>
<th>Galvanic Corrosion (%)</th>
<th>Internal Corrosion / Erosion</th>
<th>Internal Corrosion / Erosion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recorded Failures</td>
<td>3</td>
<td>17.65</td>
<td>1</td>
<td>5.88</td>
<td>10</td>
<td>58.82</td>
<td>2</td>
<td>11.76</td>
<td>1</td>
<td>5.88</td>
</tr>
</tbody>
</table>

### MCDR Profile - Produced Water System

<table>
<thead>
<tr>
<th>Failure Type</th>
<th>Crevice Corrosion</th>
<th>Crevice Corrosion (%)</th>
<th>CUI</th>
<th>CUI (%)</th>
<th>External Corrosion / Poor FM</th>
<th>External Corrosion / Poor FM (%)</th>
<th>Galvanic Corrosion</th>
<th>Galvanic Corrosion (%)</th>
<th>Internal Corrosion / Erosion</th>
<th>Internal Corrosion / Erosion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recorded Failures</td>
<td>2</td>
<td>15.38</td>
<td>2</td>
<td>15.38</td>
<td>6</td>
<td>46.15</td>
<td>2</td>
<td>15.38</td>
<td>1</td>
<td>7.69</td>
</tr>
</tbody>
</table>
CONCLUSIONS – Ageing Asset / MCDR’s

- Approx. 100 MCDR’s raised per year on Pressure Systems.
- Many more raised on Non-Pressurised Plant / Structures.

- Expect a Bow Wave of Additional MCDR’s Post Transfer of Ownership.
- Expect to Liquidate 2/3 MCDR’s, by Repair / Replacement. 60 + per Year.
- Remaining 1/3, will go to Monitor or are Suspended if no Further Deterioration.

- Some MCDR’s raised are False Alarms – Parameters not correctly set in DB.
- No. of MCDR’s raised varies with Inspector / Inspector Interpretation.

- FM Campaigns are very difficult to implement, Very high POB req.
- FM MCDR’s may need to alternate with Drilling / Well Work-over Campaigns.

- Non HC Water Systems have a big Impact on Plant Uptime – Biggest Group of MCDR’s normally. Often most difficult to Fix / Achieve Isolations on.
- Increasing use of Defined Life / Engineered Wraps Offshore.
Presentation

End Part 2.