ROLE OF CORROSION ENGINEERING RELATING TO OFFSHORE AGEING & LIFE EXTENSION, MAXIMISING RECOVERY, AND THE EU DIRECTIVE

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http://www.intertek.com/exploration-production/integrity-assurance/
Overview of role of Corrosion Engineers to long term offshore integrity and safety wrt:

- Oil price fluctuations
- Declining production
- HSE’s KP4
- Wood Review on maximising production
- EU Directive (2013/35/EC) on offshore safety
- Commentary on how perceptions have changed
North Sea oil and gas production since 1970

Million barrels of oil/gas equivalent per day

Source: Oil and Gas UK
Early ‘80s

Recollections of a manager talking to his team:

“Why do we have Corrosion Engineers? They don’t contribute to hydrocarbon production and they spend money for no obvious or immediate benefit”

When the oil price dived late ‘80s/early ‘90s the painters were first to be taken off platforms. We still see the consequences of that decision today.

In 2013 O&GUK made a diametrically opposed comment in their Annual Economic Report.
Early ‘

Quote from Maintenance Engineer at a seawater bromine extraction plant:

“Mr Duncan, we do not have a corrosion problem, we have a maintenance issue”
Institute Of Materials Corrosion Committee

“The original cost of corrosion survey, the "Hoar Report" was commissioned in 1971 and estimated that the cost to the UK economy was between 3-4% of GNP per year…….”

“…..new survey was commissioned in the UK for which the Institute, through the Corrosion Committee…….”

“…..concluded that the cost was still of the order to 2-3% of GNP per year”.

“…..some improvement then…..”
2002: NACE cost of corrosion report for USA

“Results of the study show that the total annual estimated direct cost of corrosion in the U.S. is a staggering **$276 billion** — approximately **3.1%** of the nation’s Gross Domestic Product (GDP)**.

“It reveals that, although corrosion management has improved over the past several decades, the U.S. must find more and better ways to encourage, support, and implement optimal corrosion control practices”.

“.......it has been estimated that **25 to 30%** of annual corrosion costs in the U.S. **could be saved** if optimum corrosion management practices were employed”.

https://www.nace.org/uploadedFiles/Publications/ccsupp.pdf
“…….the production efficiency of existing assets has been in worrying decline, with a number of fields failing to produce as expected”.

“Unit operating costs continued to rise to an average of £13.50 ($21.50) per barrel as production continued to fall and spending on asset integrity and rejuvenation increased”.

“Around £1 billion was spent on asset integrity work in 2012 and the same is expected in 2013. Although this expenditure does not immediately yield additional barrels of oil or gas, companies can expect these assets to be more reliable and, therefore, experience less downtime over the remainder of their productive lives, which may well have been extended as a result”.

<table>
<thead>
<tr>
<th>Aim</th>
<th>Policy</th>
<th>Work Group</th>
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<tr>
<td>Extending the Life of Infrastructure</td>
<td>Infrastructure Code of Practice (ICoP)</td>
<td>PILOT Infrastructure Access Group</td>
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<tr>
<td>Increase Production Efficiency</td>
<td>Asset Stewardship</td>
<td>PILOT Production Efficiency Task Force</td>
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• “After this current wave of investment, it is anticipated that capital investment may fall to around £8-10 billion a year from 2015 (in 2012 money)”.  

• “However, were the rate of investment to be below this, at around £6-8 billion per annum, it would probably be insufficient to sustain current rates of production and the programme of works on asset integrity”.  

• “Keeping operating costs under control is a considerable achievement for the industry, given the need to maintain ageing assets to satisfactory standards (ref KP4 report)”.  

• “If there were to be a fall in commodity prices, the more expensive assets would have to be shut down and could face premature decommissioning”.  

• “Much of the infrastructure is beyond its design life, requiring comprehensive plans to extend its life and increase recovery (note the Health and Safety Executive’s Key Programme 4 on asset integrity”)
OGUK’s predictions may become realised.
Reported May 2014:

- Over half offshore installations older than design life
- KP3 identified serious shortcomings in offshore integrity
- External corrosion project - serious FM issues
- “Major” HCRs increasing against background of reducing HCRs
- AIM and A&LE - HSE priorities
WHAT WAS HSE’s KP4 ABOUT?
AGEING & LIFE EXTENSION PROGRAMME

It was about:

• Raising awareness of A&LE
• Understanding *long term rate of degradation* of work equipment
• Managing obsolescence
• Sustained improvements in offshore health & safety
• Reducing HCRs
• A&LE leadership
AGEING AND ACCIDENTS

HSE report RR823: onshore ageing related accidents:

- European Union Major Accident Reporting System (MARS), 1980 to 2006 (26 years):
  - 96 major accident hazards due to ageing
  - ~28% of loss of containment incidents
  - 11 fatalities, 183 injuries, €170m losses
“AGEING IS NOT ABOUT HOW OLD YOUR EQUIPMENT IS; IT IS ABOUT WHAT YOU KNOW ABOUT ITS CONDITION, AND HOW THAT’S CHANGING OVER TIME”

Just because an item of equipment is old does not necessarily mean that it is significantly deteriorating and damaged.
Studies by Prof Jan Erik Vinnem (Preventor) for PSA Norway found:

- 60% of leaks due to human interventions:
- “It is not possible to demonstrate a correlation between leak frequency and the age of an installation”
- “Technical degradation caused ~21% of HC leaks”


THE BATH TUB CURVE

- Early life failures
- Late life failures
- Ageing phase
- Life extension phase
- Role of the Corrosion Engineer

Time
Additional focus:

- Ensure complete list of SCEs
- Include OEM packages in corrosion risk assessments
- Consider integrating predictive reservoir data with corrosion threats assessments
- Development of advanced NDT for difficult areas: CUPS, CUI, bolts
- Embed ALE into AIM for long-term future
UKCS NORTH SEA LEAK FREQUENCIES

(Up to 2002 – being updated by O&GUK & HSE)

HSE
Energy Division
Offshore
RIDDOR data

Clear evidence of leak frequencies by system and equipment

Leak frequency by system

Leak frequency by equipment
“……the life of fixed offshore installations may be extended providing the **integrity** of the topside equipment, structures and components is properly managed.

The application for consent to life extension provides a point in time for **taking stock of the extent and effects of ageing** on performance, and for planning for the period of anticipated extended operating life.

Leading and lagging integrity indicators and risk factors, combined with fitness-for-service assessment, performance monitoring and effective maintenance provide the basis on which the case for life extension should be made.”
A SINTEF report* for PSA identified 3 key areas to be addressed for effective ageing management:

1. **Materials degradation – understanding the issues**
2. Obsolescence – identifying and managing
3. Organisational issues – suitable for the operation

*Ageing and life extension for offshore facilities in general and for specific systems*
A SINTEF report for PSA identified six main steps in the Life Extension process:

1. Data & information collection to identify & analyse risk factors, & risk reduction measures
2. Criticality screening of: Systems, Structures & Components
3. **Analysis of failures wrt material degradation**
4. Identification and evaluation of potential risk reduction measures
5. Assess overall risk picture based on all aspects of ageing, given the risk reducing measures
6. If risk picture is acceptable, implement LE management plan that ensures integrity throughout the LE period
Announcement: 10th June 2013

“The UK’s ageing North Sea rigs are facing ‘unprecedented challenges’, the secretary of state for energy and climate change said on Monday as he announced a review into how to maximise oil production”.

Ed Davey said:

"Although we have produced a lot of barrels in the North Sea, there is an awful lot there still to be produced as well." He cited falling exploration and production rates, ageing infrastructure, declining efficiency and the risk of premature decommissioning”, and

"All these challenges need to be addressed if we are going to get the maximum economic benefit for the UK."

Davey has appointed Sir Ian Wood, the veteran Aberdeen oilman, to lead a review that will report in early 2014.

Source: bbc.co.uk
Executive Summary:

- “…..some operating assets are more than 30 years old –at or beyond the end of the originally intended design life”.
- “iv. The need for significantly improved asset stewardship”.

Recommendation 4: develop and implement important Sector Strategies:

- Asset Stewardship…..

2.2 Business Environment:

- …. “the need to maintain ageing infrastructure”

2.3 Key Issues:

- iv) Industry stewardship – the rapid fall in production efficiency is an indication of poor asset stewardship…….The consequences of a past lack of investment are also becoming increasingly apparent”.
3.1 MER UK Strategy (MER=Maximising Economic Recovery)

- **Asset stewardship strategy** – to ensure operators are held to account for the proper stewardship of their assets and infrastructure consistent with their obligations to maximise economic recovery”. …………. “…operators should be expected to develop, *maintain* and operate their assets and infrastructure at all times in an *efficient and effective manner* and should share their asset stewardship strategy with the Regulator”.

- V) “The Regulator should also consider **publishing key data on asset stewardship**………..”

- p26 “the current situation where production efficiency has fallen to an average of 60 per cent in 2012 is unacceptable and illustrates the *short comings of existing asset stewardship*”. 
Production Efficiency

Source: DECC, Oil & Gas UK

Definition: Actual Production / Max. Production Potential
(2) ….objective….to reduce as far as possible the occurrence of major accidents relating to offshore oil and gas operations and to limit their consequences……..

- protection of the marine environment and coastal economies against pollution,
- establishing minimum conditions for safe offshore exploration and exploitation of oil and gas…
- limiting possible disruptions to Union indigenous energy production….

(3) This Directive should apply not only to future offshore oil and gas installations and operations but, subject to transitional arrangements, also to existing installations.

(14) Operators should reduce the risk of a major accident as low as reasonably practicable, to the point where the cost of further risk reduction would be grossly disproportionate to the benefits of such reduction.

- The reasonable practicability of risk reduction measures should be kept under review in the light of new knowledge and technology developments.
- In assessing whether the time, cost and effort would be grossly disproportionate to the benefits of further reducing the risk, regard should be had to best practice risk levels compatible with the operations being conducted.
(22) Specific legislation is needed to address the major hazards relating to the offshore oil and gas industry, specifically in process safety, **safe containment of hydrocarbons**, structural integrity, prevention of fire and explosion, evacuation, escape and rescue, and limiting environmental impact following a major accident.

(45) ………The Commission should publish reports periodically on levels of Union activity and trends in the safety and environmental performance of the offshore oil and gas sector. Member States should, without delay, inform the Commission, and any other Member State whose territory or offshore waters are affected, as well as the public concerned, of a major accident.
ANNEX III: 2. Provisions relating to the functioning of the competent authority

(1) For the purposes of carrying out its duties pursuant to Article 9 effectively, the competent authority shall prepare:

(a) a written strategy that describes its duties, priorities for action i.e. in design and operation of installations, integrity management and in emergency preparedness and response, and how it is organised;

ANNEX IV: Provisions by operators and owners for prevention of major accidents pursuant to Article 19:

1. Member States shall ensure that operators and owners:

(a) pay particular attention to evaluation of the reliability and integrity requirements of all safety and environmental critical systems and base their inspection and maintenance systems on achieving the required level of safety and environmental integrity;

(b) take appropriate measures to ensure as far as reasonably practicable that there is no unplanned escape of hazardous substances from pipelines, vessels and systems intended for their safe confinement. In addition, operators and owners shall ensure that no single failure of a containment barrier can lead to a major accident;

(c) prepare an inventory of available equipment, its ownership, location, transport to and mode of deployment at the installation and any entities relevant to the implementation of the internal emergency response plan. The inventory shall identify measures in place to ensure equipment and procedures are maintained in operable condition;
UK HSE law and the EU Directive require operators:

- To assess the risks
- To have integrity management policies and strategies
- Have organisation suitable for preventative and protective measures
- Maintain plant effectively
- Inspect plant at suitable intervals
- Detect and remedy deterioration in good time
- Keep risks As Low As Reasonably Practicable (ALARP)
CONSEQUENCES OF NOT MANAGING INTEGRITY
<table>
<thead>
<tr>
<th>LAW NUMBER</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>1</td>
<td>Anything that can go wrong will</td>
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<tr>
<td>2</td>
<td>Things will go wrong at the worst possible time</td>
</tr>
<tr>
<td>3</td>
<td>If there is a possibility of several things going wrong, the one that will go wrong is the one that will do most damage.</td>
</tr>
<tr>
<td>4</td>
<td>Left to themselves, things will go from bad to worse</td>
</tr>
<tr>
<td>5</td>
<td>Nature always sides with the hidden flaw</td>
</tr>
<tr>
<td>6</td>
<td>If everything seems to be going well, you have obviously overlooked something.</td>
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CONSEQUENCES OF THE GENERAL LAWS OF CORROSION

Coating disbondment

Pit in stainless steel resulting from microbial corrosion after hydrotest

Hydrogen induced cracking

Corrosion under insulation

Coating disbondment
CONCLUSIONS

- Degradation of offshore work equipment is potentially a serious risk to health and safety
- UK & EU require risks to be ALARP
- Importance of integrity management and hence role of Corrosion Engineer recognised by:
  - HSE’s KP4 programme
  - PSA Norway’s report on ageing
  - Wood Review
  - O&GUK Economic reports
  - EU Directive on Offshore Safety
WHAT CAN THE CORROSION ENGINEERING FRATERNITY DO TO HELP?

• Greater collaboration?:
  ➢ Between ourselves?
  ➢ Between companies?
  ➢ Between Learned Bodies?
    ▪ IOMMM IMechE
    ▪ IChemE EI
    ▪ EEMUA ETC

• Can we modularise approaches?
• Should ICorr lead the way in developing guidelines? Or are we content to work through EI, EEMUA, ETC?