



Integrity Management and Life Extension of Ageing FPSOs

FPSO Training Course, Paris.

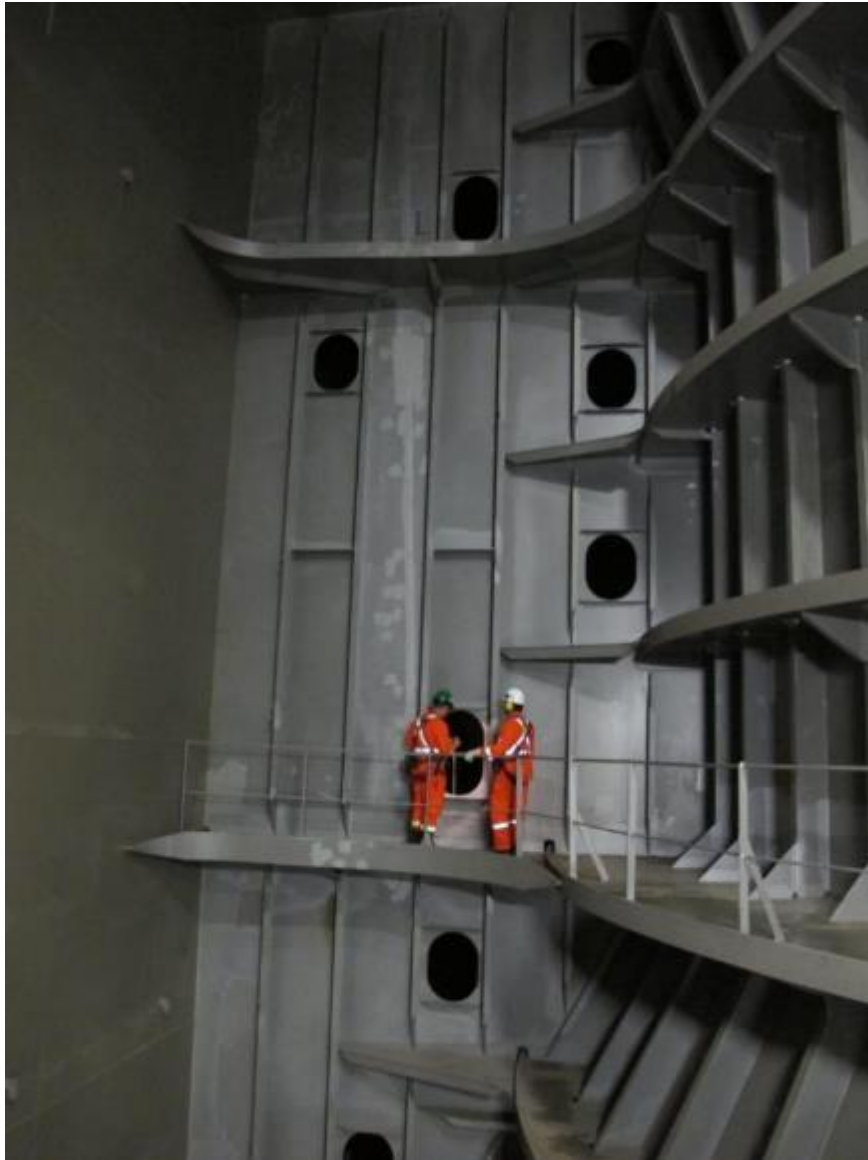
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Background



- Marine Technical Limits specialise in FPSO hull integrity management and on-station repair.
- MTL have been supervising teams of 2 to 30 people working in FPSO tanks almost continuously since 2007.
- Our work has covered shipyard and offshore locations in the UK, West Africa, Canada, Norway and Singapore.
- MTL developed the FPSO Ageing and Life Extension (ALE) Guidance for Oil and Gas UK.

Ageing

Any aspect which over time adversely affects the ability of the asset, or elements of the asset, to perform the desired function

Examples: corrosion, fatigue, obsolescence

Life Extension

Period beyond the originally defined period for which a facility is to operate while still maintaining acceptable standards of operational and technical integrity

Integrity Management

The process for understanding the level and rate of deterioration and deciding the actions to be taken.

Scope of Session

This presentation covers aspects unique to FPSOs:





- Hull Structure and appendages
- Marine Systems

The following aspects are not covered:

- Process topsides and control systems
- Subsea infrastructure and control systems
- Moorings



Typical Operator Expectations

- Maintaining Class through inspection assures hull integrity for field life 
- Maintenance of the hull and coatings won't be required during field life (no POB allocation) 
- Tank inspections won't affect storage capacity 
- Hot work repairs can be avoided 

Realistic Expectations

- The Owner is responsible for hull integrity (not the Classification society)
- Inspections will increase with time and storage will be affected
- Steelwork and coating repairs will be necessary
- If a drydock opportunity arises, there will always be hull inspection and repair scope to be executed.
- At some point, too much work may accumulate to execute on-station.

Being realistic about repair

FPSO hull built to similar standards as trading tankers.

Tankers dry-dock every 2½ – 5 yrs.

Tankers routinely require increasing quantity of steel renewals at each dry docking.

FPSOs typically expected to remain on-station 15+ years.



Classification – is it enough ?

- Proven approach for shipping since 1760
- Established rules and guidance
- Defined inspection schedule with scope increasing as the vessel ages
- Qualified inspectors and surveyors available worldwide from multiple classification societies

BUT, Class Rules:

- Are based on a 5 year renewal (drydock) cycle
- Are not necessarily aligned with business needs
- Are not a guarantee

The International Association of Classification Societies (IACS) document ***“Classification Societies – What, Why and How?”***

A certificate of classification:

“....does not imply, and should not be construed as, a warranty of safety, fitness for purpose or seaworthiness of the ship.

It is an attestation only that the vessel is in compliance with the Rules that have been developed and published by the Society issuing the classification certificate.”

- Managing integrity by understanding the risk from first principles:
 - How could this element fail ?
 - What would the consequences be ?
 - How likely is it to fail ?
- Use these inputs to determine inspection frequency and maintenance strategy
- Note that some inspections may be justified as less frequent than Class minimum, but some could be more frequent and more rigorous.



Life Extension Assessment

Hull Structural
Integrity

Hull Watertight
Integrity

Station Keeping

Turret and Swivels

Marine Systems

Hull Structural Integrity

LOF Structural Capability

- Fatigue Analysis
- Strength Analysis
- Structural Inspections

Hull Structure

- Upper Deck
- Cargo Tanks
- Slops Tanks
- Ballast Tanks
- Other Tanks (Aft)
- Pump Room
- Void Spaces
- Bilge Keels
- Caissons

Corrosion Protection: Internal Hull

- Cargo Tanks
- Ballast Tanks
- Void Spaces
- Machinery Spaces

Corrosion Protection: External Hull

- Upper Deck
- Bottom to Waterline
- Waterline to Upper Deck
- Turret
- Moonpool
- Rudders
- ICCP System
- Sea Chests

Hull Watertight Integrity

Sea Chests

- Sea Chests
- Stub Pieces
- Ship side valves

Overboards

- Pipe penetrations
- Connecting pipework

Other Structures

- Process Module Structures
- Crane Foundations & Integration with Hull Structure
- Helideck Structure
- Moonpool Structure
- Turret Shield/Swivel Support Structure
- Ground Flare/Flare Tower Structure
- Towing and Mooring Arrangement
- Offloading

Corrosion Protection: Other Structures

- Helideck
- Flare Tower
- Crane Foundations
- Process Module Structures
- Accommodation

Cargo System

Cargo Pumps

- Motors
- Hydraulics
- Control System

Systems in Cargo Tanks

- Pipework
- Valves
- Hydraulics
- Control System
- Level Sensors/Gauges

Slops Tank

- Pipework
- Valves
- Hydraulics
- Control System
- Level Sensors/Gauges

Stripping Pump

- Motor
- Control System

Crude Oil Washing

- COW Heaters
- Deck Pipework
- Valves
- COW Guns

Offloading System

- Hoses
- Hawser
- Deck Pipework
- Valves
- Hydraulics

Marine Systems

Ballast System

Ballast Pumps

- Motors
- Hydraulics
- Control System

Systems in Main Tanks

- Pipework
- Valves
- Hydraulics
- Control System
- Levels Sensors/Gauges

Systems in Pump Room

- Pipework
- Valves
- Hydraulics
- Control System

Control Systems

Load Control

- Stability
- Longitudinal Strength

Flood Detection & Bilge Systems

- Telemetry

Marine Utilities

- Fire Pumps
- Emergency Generator
- Black Start Generator
- Pumps
- Sewerage System
- Fresh Water Generation
- Power Distribution
- Air Compressors
- Boiler/Steam System
- Fuel Oil Separators
- Fuel Oil/Fresh Water Bunkering Hose

Inert Gas

- IG Generator
- IG Scrubber
- Deck Seal
- Pipework
- Valves
- Vent Headers

Station Keeping

Moored Systems

- Fairleads
- Chain Stopper
- Chain Tensioned System
- Mooring Chains
- Mooring Winches

Heading Control & Mooring Assist

Diesel Power Generation

Main Propulsion Train

- Seals
- Bearings
- Shafting
- Propellers

Thrusters

- Electric Motor
- Propellers
- Hydraulics
- Control System

Rudders

- Rudder Structure
- Steering Gear
- Bearings
- Shafts

Turret and Swivels

Turret

- Driver Motor & Gear System
- Bearings
- Mooring Winches
- Mooring Lines
- Turret Structure
- Fairleads
- Risers and Umbilicals
- Bend Stiffeners

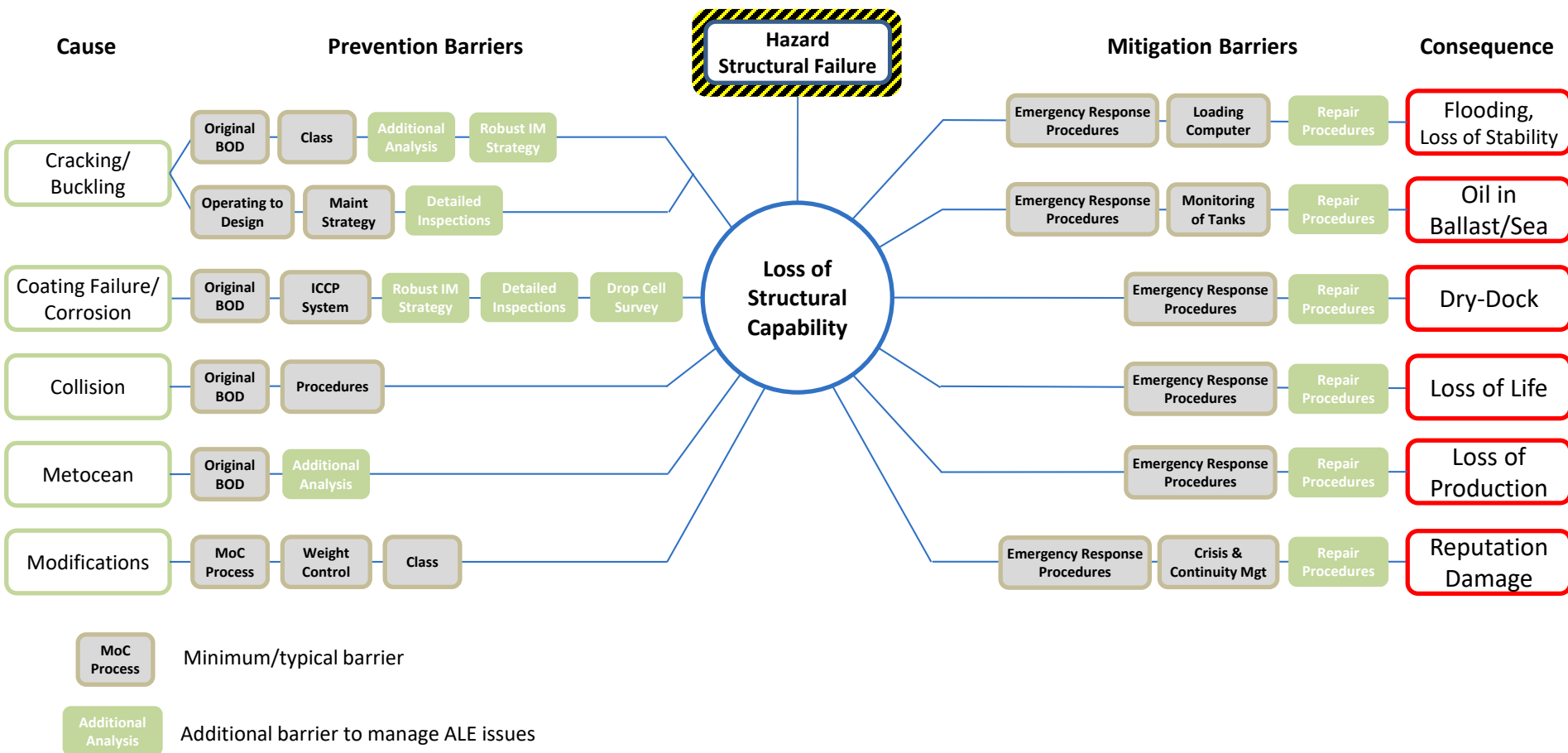
Swivel

- Seals
- Hoses
- Silt Barriers
- Main Bearing

- Understand the **system function**
- Identify the **failure modes**
- Identify the **consequences** of failure
- Identify the **barriers** to prevent failure
- Identify the mitigation barriers to limit the consequences of failure

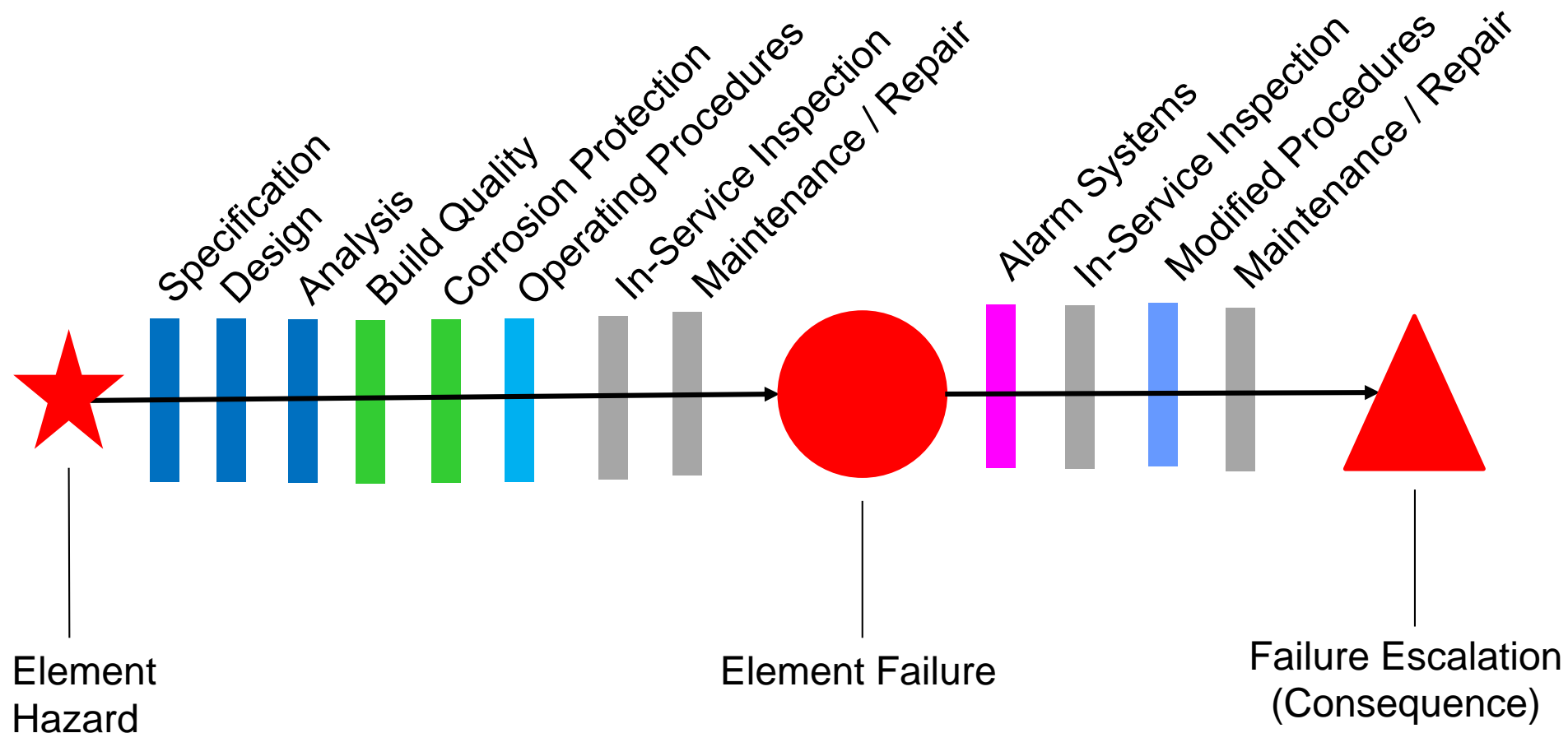


Bow-Tie Diagram





Barrier Model



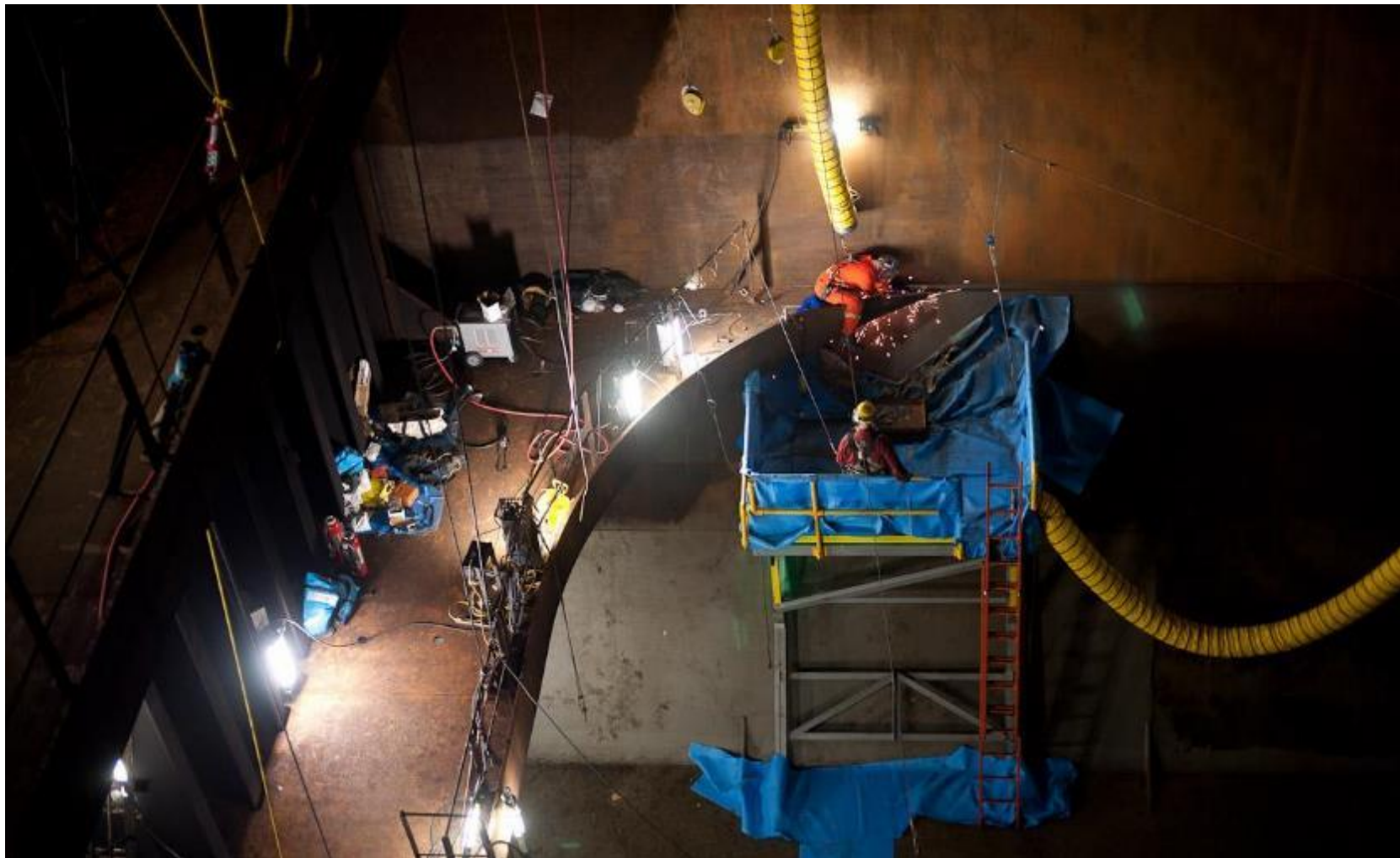


Structural inspections



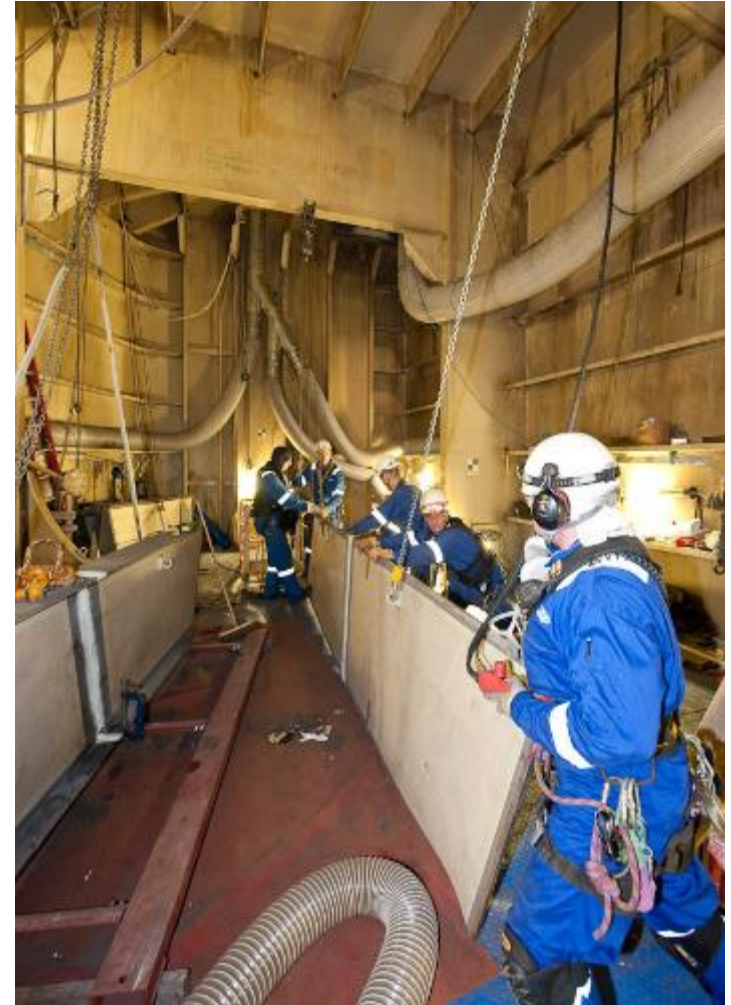


Mitigation - Repairs





Major Projects





Corrosion Assessment Methods



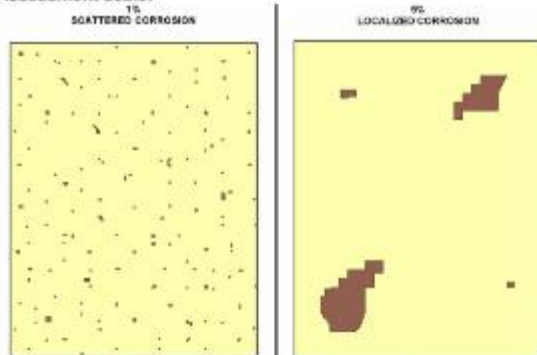


Example Assessments



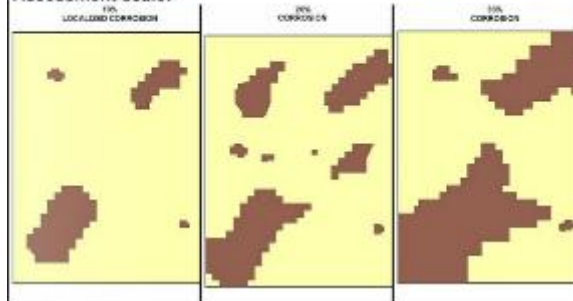
Notes: Condition: **GOOD**
spot rusting: scattered 1%
spot rusting on edges or weld lines: localised less than 5%

Assessment scale:



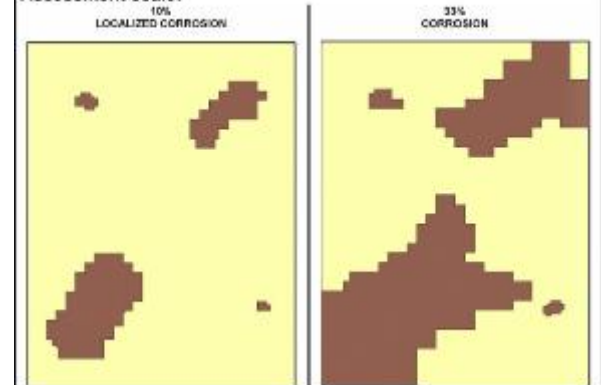
Notes: Condition: **FAIR**
Breakdown of coating/area rusted: localised 15-20%
Area of hard rust scale: Less than 10% of the area rusted
Local breakdown of coating or rust on edges or weld lines: 30-40%
Remarks: **FAIR** for longitudinal close to bottom, remaining surface; **GOOD**

Assessment scale:



Notes: Condition: **POOR**
Breakdown of coating/area rusted: approx. 30%
Area of hard rust scale: More than 10% of the area rusted
Local breakdown of coating or rust on edges or weld lines: 30-40%

Assessment scale:





Coating Defect Examples



Chemical Damage



Chemical Damage



Produced Water

Coating Defect Examples



Slops tank

Excessive corrosion spreading from point of coating system breakdown



Ballast tank

Breakdown is likely to start from edges or welds.

Thermal effects of hot cargo in adjacent tank (> 60 deg C) can cause rapid coating system failure.



Piping Defects



Pipe Supports



Pipework replacement



Fatigue



Ballast pipe – failure of internal coating

Ageing/Deterioration starts at Day 1.

It is essential:

- To understand the structure and systems
- To understand failure modes and consequences of failure
- To put in place barriers to prevent failures
- To have contingency plans to limit the consequences of failure.



Acknowledgements / Thank You / Questions



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