



Conductor Integrity

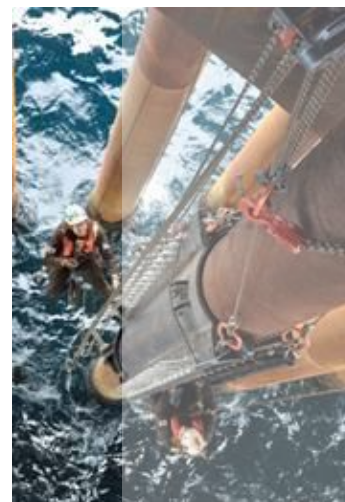
Hidden Risks and Mitigations

*Delivering safe, reliable, cost
effective solutions to the Oil &
Gas Industry.*

sets

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1. What are conductors?
2. When Conductors go bad
3. Damage Examples
4. IM, Inspection & testing
5. Damage Analysis
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1. WHAT ARE CONDUCTORS?

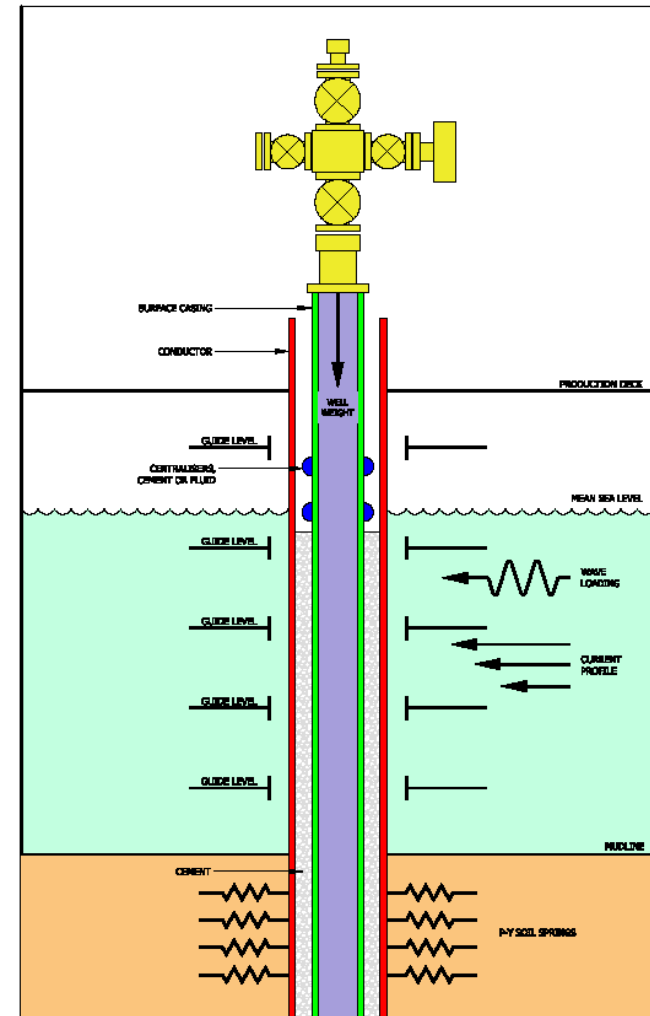
- Asset structural component
 - Well load sharing
- Implications for well integrity management
 - Environmental sheathing for well casings
 - Corrosion protection for surface casing
- Run during early phase operations.
- Robust design has permitted life extensions.
- Not necessarily fit for purpose for late life operations.



Loadings

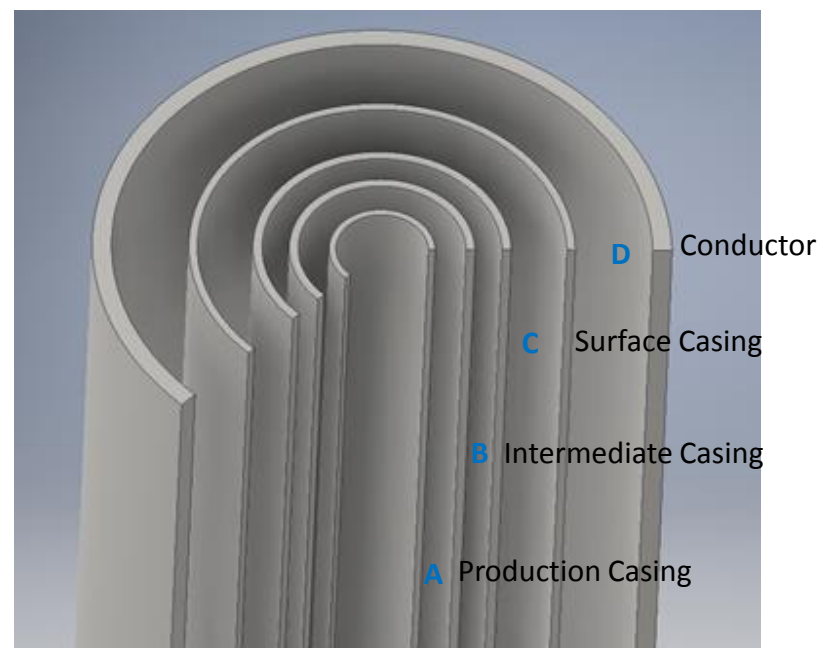
In service, the conductor is subject to:

- Environmental loading due to waves and currents. Dynamic loads greatest at \pm sea surface.
- Impact loads due to contact with conductor guides.
- Operational loads (BOP weight during work-over scenarios).
- Service loads (thermal, tension, pipe properties).
- Corrosive environments.



Internals

- Annuli contents will vary and may not be known, especially in older wells.
- Surface casing (generally) carries well load across underwater zone.
- Load sharing can be complex and affected by deterioration of conductor.
- Casing integrity – implications for well barriers to maintain safe operations.

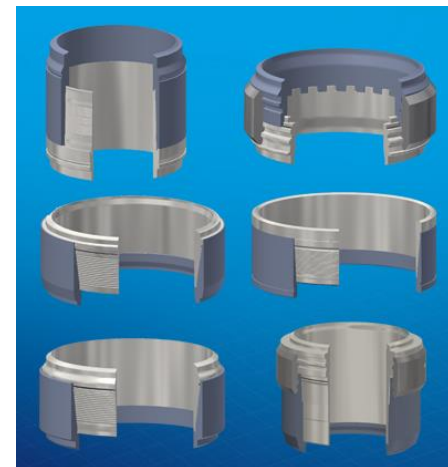
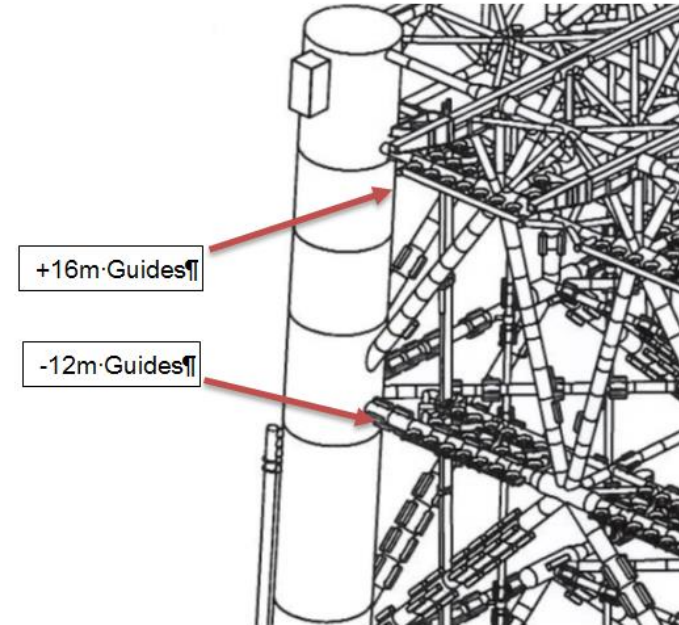


Typical well cross section

External

Conductors

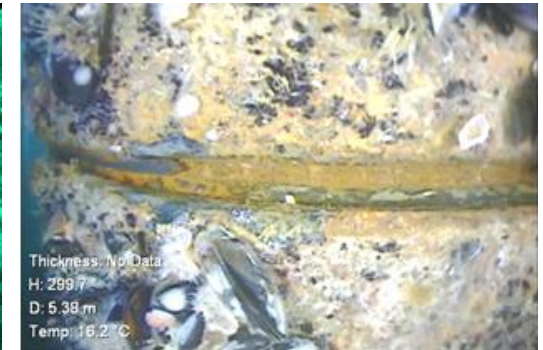
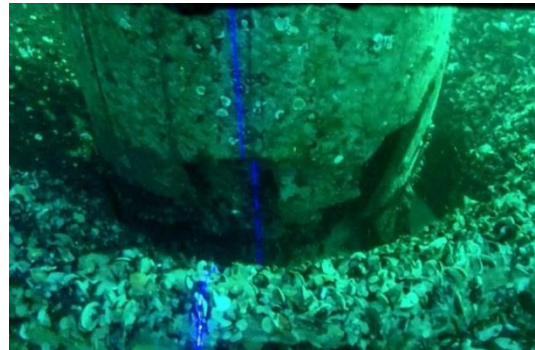
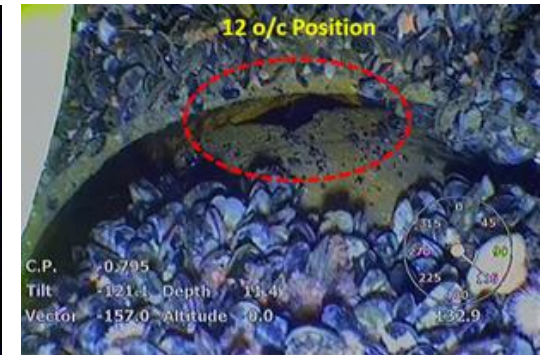
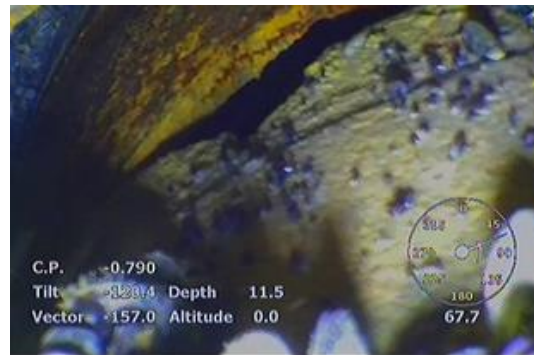
- Standard heavy walled pipe, typically 26" - 32" diameter.
- Spanning between horizontal guide frames.
- Joint connector integrity. Older asset connectors susceptible to corrosion and reduced fatigue life.
- Connector structural capacities of considerable importance.



2. WHEN CONDUCTORS GO BAD

A few UKCS specific corrosion & integrity issues:

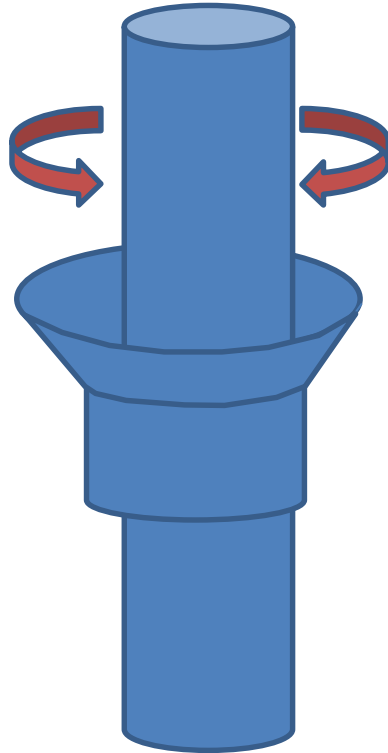
- Fretting at guides
- Internal corrosion (@MSL)
- External corrosion (at connectors)
- Connector integrity
- Casing integrity
- Poor subsea inspection
- Poor data management



Defect Mechanisms

- Fretting
- Dynamic loads - environmental
- Static loads - environmental
- Corrosion

Fretting

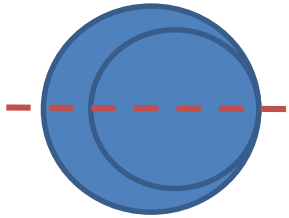


Continual relative movement between conductor and guide, even in benign conditions.

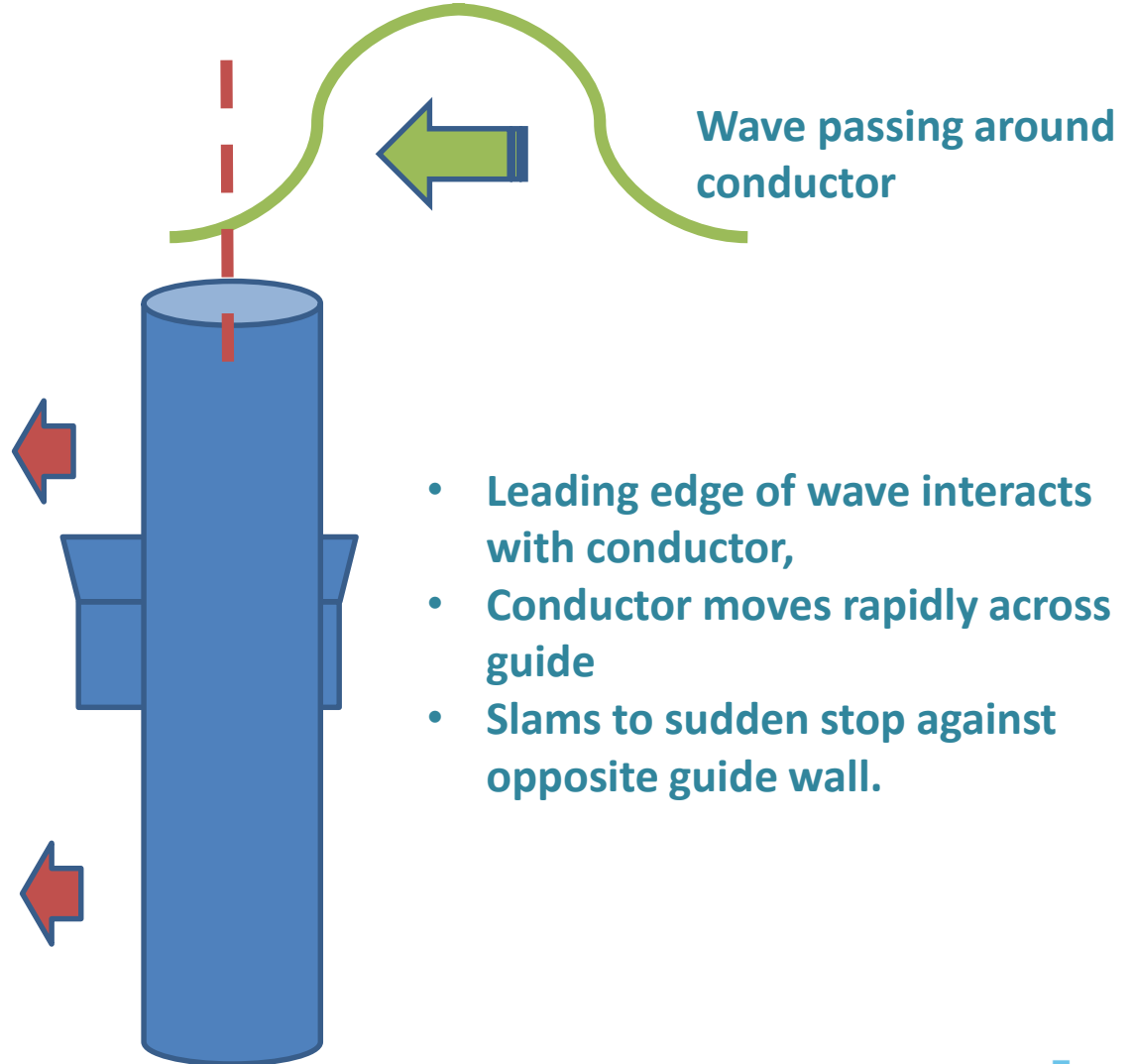


Note corrosion behind where guide would have been.

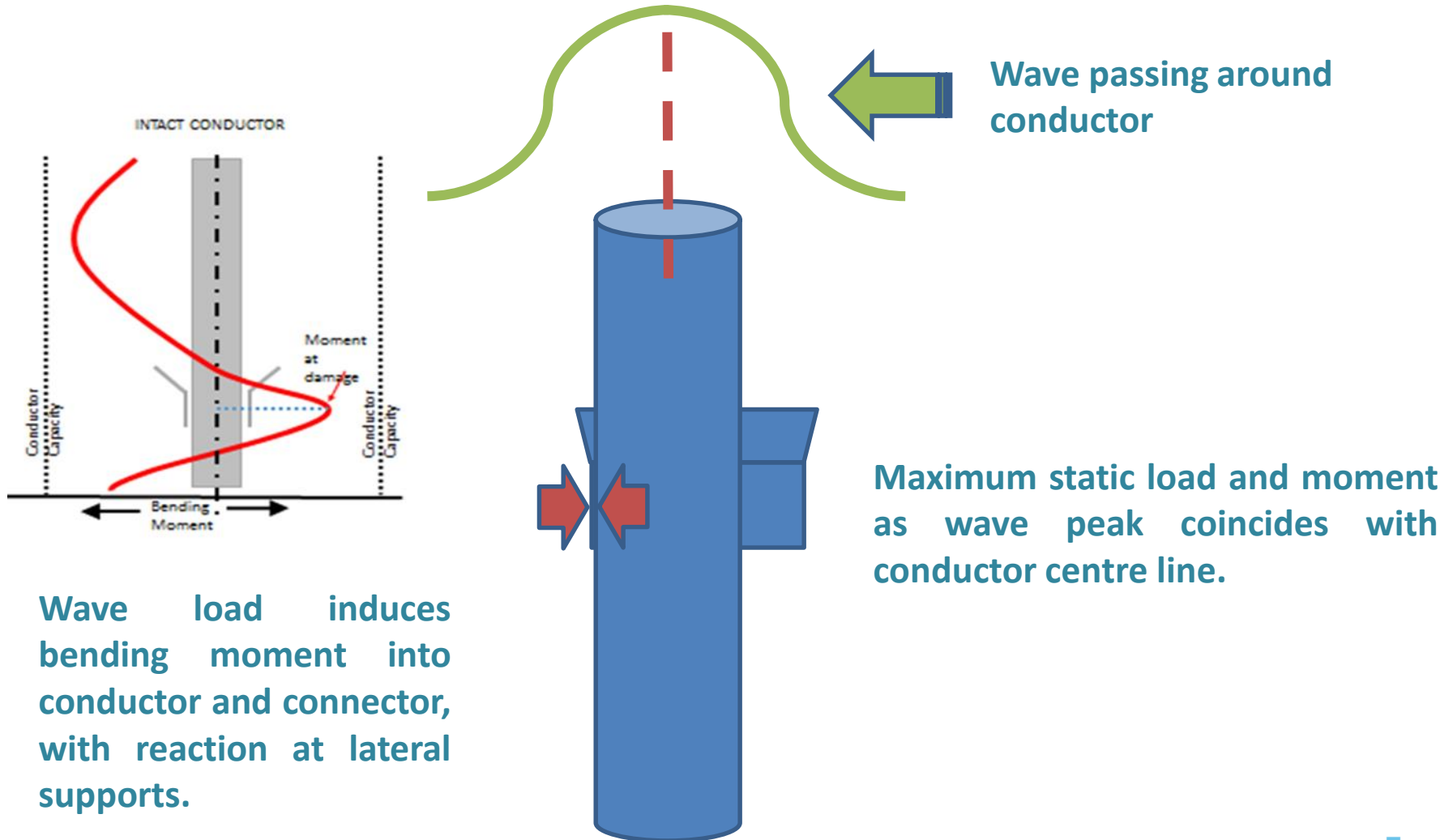
Dynamic loads - environmental



Impact results in a point, or rather vertical line loading.



Static loads - environmental



Wave load induces bending moment into conductor and connector, with reaction at lateral supports.

Maximum static load and moment as wave peak coincides with conductor centre line.

Corrosion

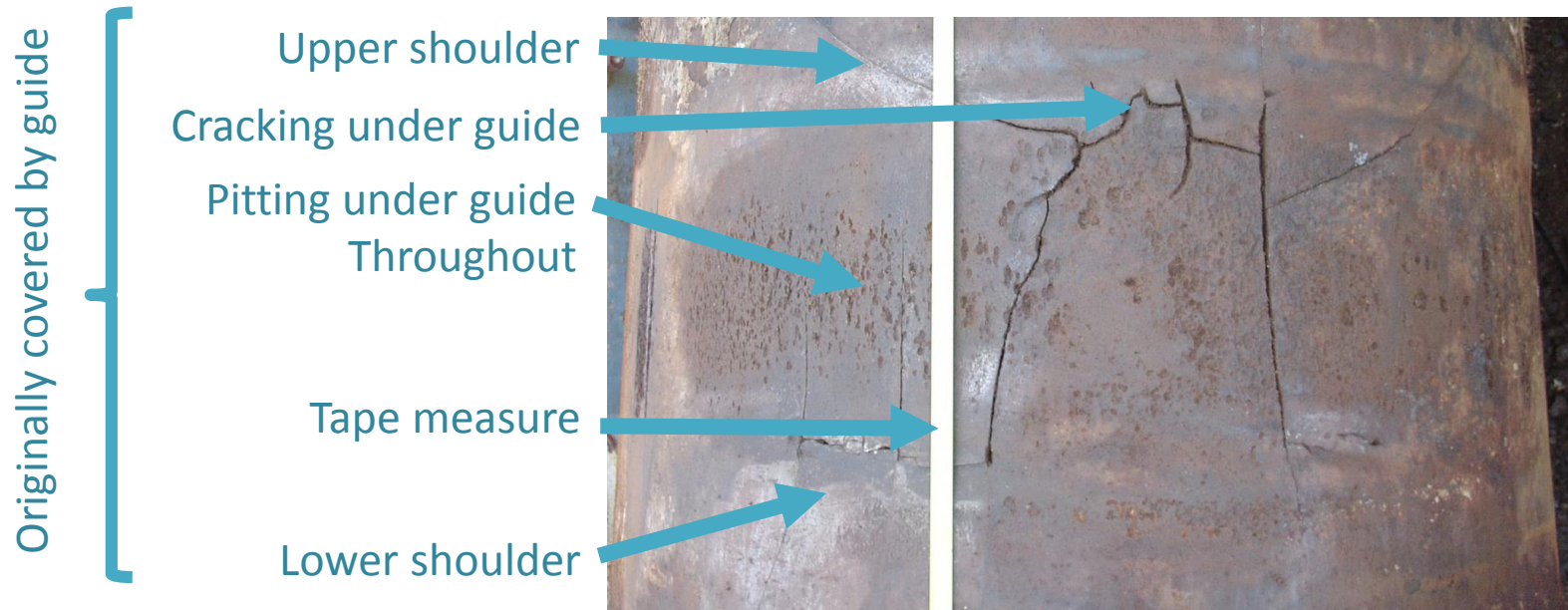
Not a primary cause in UKCS. Contributory factor to damage.

Low CP across conductors and CGF and CP 'shadow' area within guides. Pitting may be crack initiation site.

Current inspections do not provide corrosion rates.

Internal / casing rates may be greater and more of a risk to well.

Recovered Conductor showing where guide sat



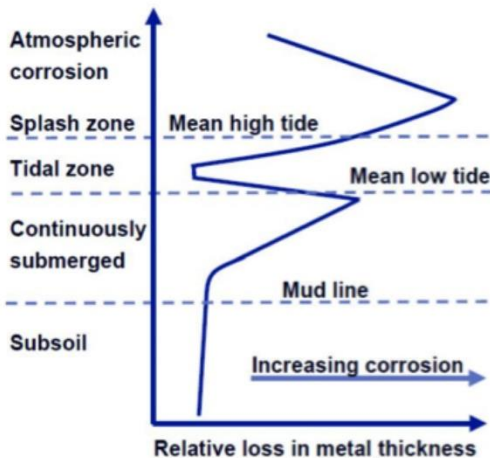
Corrosion

Warmer climates corrosion across MSL primary defect mechanism.

Linked to atmospheric temperatures.

Damage through movement not so prevalent.

Salinity relevant but not driver – e.g. Caspian 1/3 sea water salinity.



Example of surface corrosion
 El-3 m to +3 m in Caspian:
 through wall corrosion and
 threat to well; this well was
 plugged.



Components

Conductor components can cause issues.

Often through inadequate design or fabrication details or component failure.

Common components are:

- Tie-back conductor centralisers
- Retrofit chocks



DAMAGE EXAMPLES

Connector Failure – Air Gap

Connector Failure

Early signs can be an opening of the gap between the pin and box and is generally progressive.

Connector in air gap, easily found and assessed.



Connector Failure – Subsea

Connector Failure

Flush connector's location subsea or degree of separation cannot be ascertained without marine growth removal, unless defect progression is advanced.

Failed connector subsea – after cleaning by ROV.

Difficult to find in marine growth.



Connector Damage

Connector Failure

Grossly failed connector – pin and box square cut threads have been ground smooth.

This well was P&A'd, photo taken during recovery.



Fretting & Random Cracking

Fretting within Guide

Failed conductor.

TWD and circumferential cracking within guide.

Photo taken whilst conductor and well string being recovered.



Conductor & Guide Damage

Guide damage

Failed guide – support web missing, section of guide cone missing.

TWD to conductor.

Marine growth removed by diver.



Guide Damage

Broken guide down stand

Through wall defect running circumferentially between the 4o/c to the 6o/c position.



Fretting & Random Cracking

Significant crack positioned on the 11o/c position.

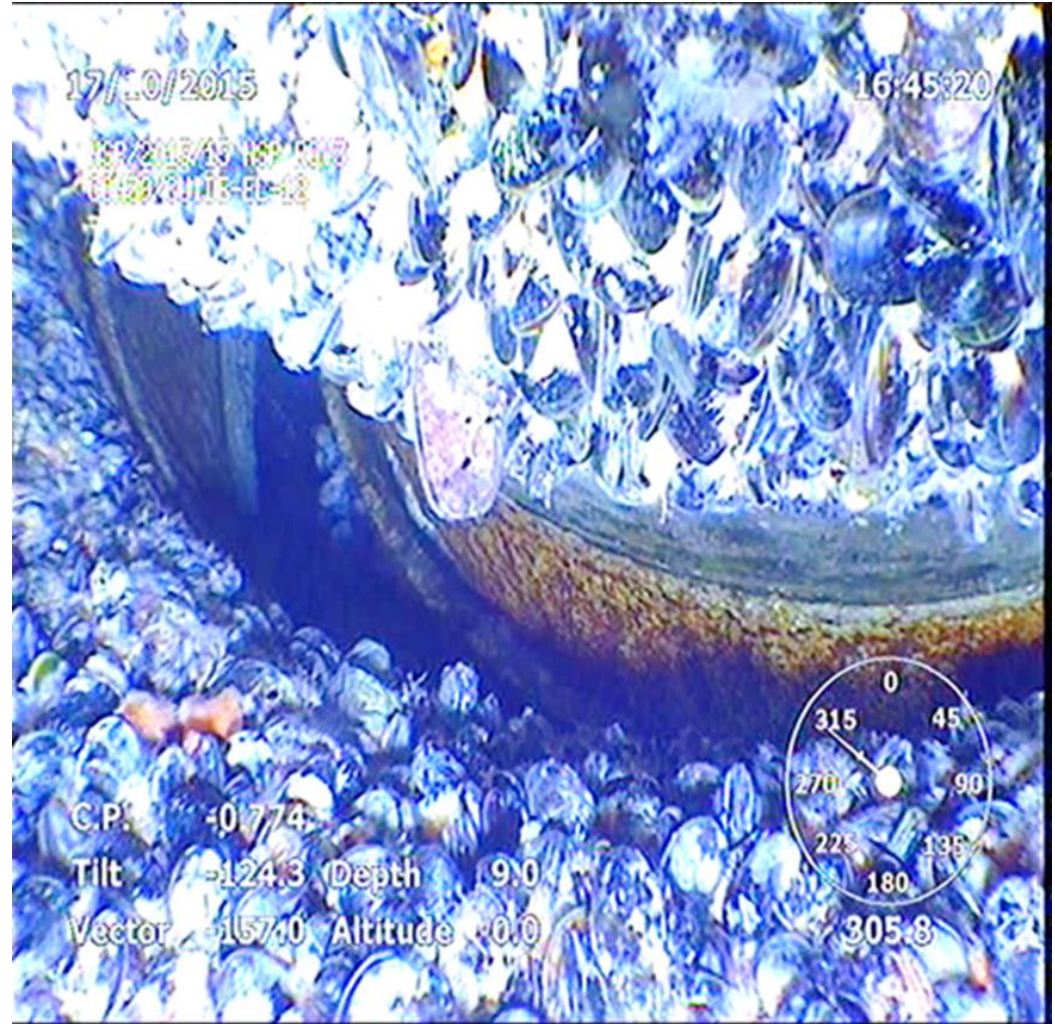
The defect has a Z-shaped appearance with the surface casing clearly visible beneath.



Circumferential Cracking

Circumferential crack on 30" conductor body.

Differential movement between crack halves indicating severance.



Air Gap Fretting & Puncture

Poor chock design, poor inspection and poor maintenance regime.

Leading to:
Guide damage

Chock damage and subsequent
conductor puncture.

Conductor fretting within guide.

Reduction in movement between
conductor and chock prevented cracking
but engendered punctures.



Air Gap Fretting & Puncture

Chock fretting and subsequent conductor TWD

Better choke design but poor inspection and maintenance regime.



Air Gap Fretting & Puncture

All of the above

Chock fretting and subsequent conductor TWD.



INTEGRITY MANAGEMENT

RBI Scheme Flawed?

Were the above defect mechanisms recognised whilst compiling RBI?

If not, RBI is fatally flawed.

The inspection schemes could be inspecting:

- Wrong things
- In wrong place
- Using wrong techniques
- At wrong frequencies

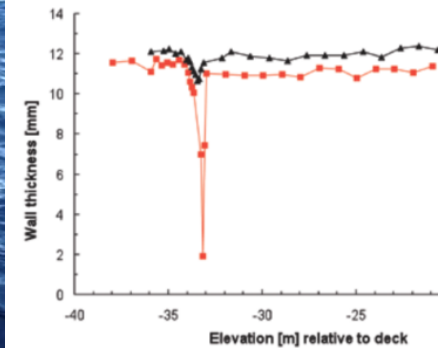
Inspection Components

INTERNAL

Surface Casing
Contents
Cement levels

EXTERNAL

Conductor,
Connectors,
Guides,
Centralisers
CGF,
Coating/sheathing,
CP system,
Previous repairs.



What to Inspect, How?

Inspection to confirm actual condition across conductors:

- Internal: Casing static head testing C&D annuli integrity.
- Internal: Well testing A&B annuli integrity.
- Internal: Topside conductor annulus pressure testing.
- External: Topside wellhead drop monitoring.
- External Rope access air gap inspection: Conductor, connectors, guides, coating/sheathing, previous repairs using visual and dimensional methods.
- External subsea: Conductor, connectors, guides, centralisers, CGF, CP system, previous repairs using visual, laser profile methods.
- External splash zone: above components but more difficult.

Inspection - Methods

- **Internal inspection**
 - casing PT, D-PEC, contents (fluids), cement levels
- **Air gap external inspection**
 - eddy current, UT, visual, metrology.
- **Subsea external inspection**
 - eddy current (MEC), UT, visual, laser profile & CP.

Inspection Issues - Topsides

- **Internal inspection**
 - Access to surface casing/conductor annuli
 - Annuli contents (liquid, centralisers)
 - Cement level uncertainty
 - Corrosion presence and rates
- **Air gap external inspection**
 - Access
 - Weather

Inspection Issues - Subsea

ROV: shallow, weather, cameras, ROV control, inspection, anomaly appreciation, no MG cleaning

Average ROV inspection image without cleaning EL-31 m

To maximise the information recovered, ideally the following should be required:

- **Marine growth removed: to identify defects**
- **Steady video images: to identify defects**
- **Ability to measure: quantify damage for analysis**
- **Repeatable: damage progression, rate of progression**
- **Inexpensive: inspect frequently**

Inspection Interpretation - Subsea

- Damage present but not recognised, in some cases for years.
- New damage not highlighted by inspection contractor.
- ROV surveys often inadequate at guides and shallow elevations.
- No marine growth cleaning undertaken; defects obscured.

Subsea Inspection - Illustration

Damaged Conductor?

Generally conductor inspection is undertaken by ROV.

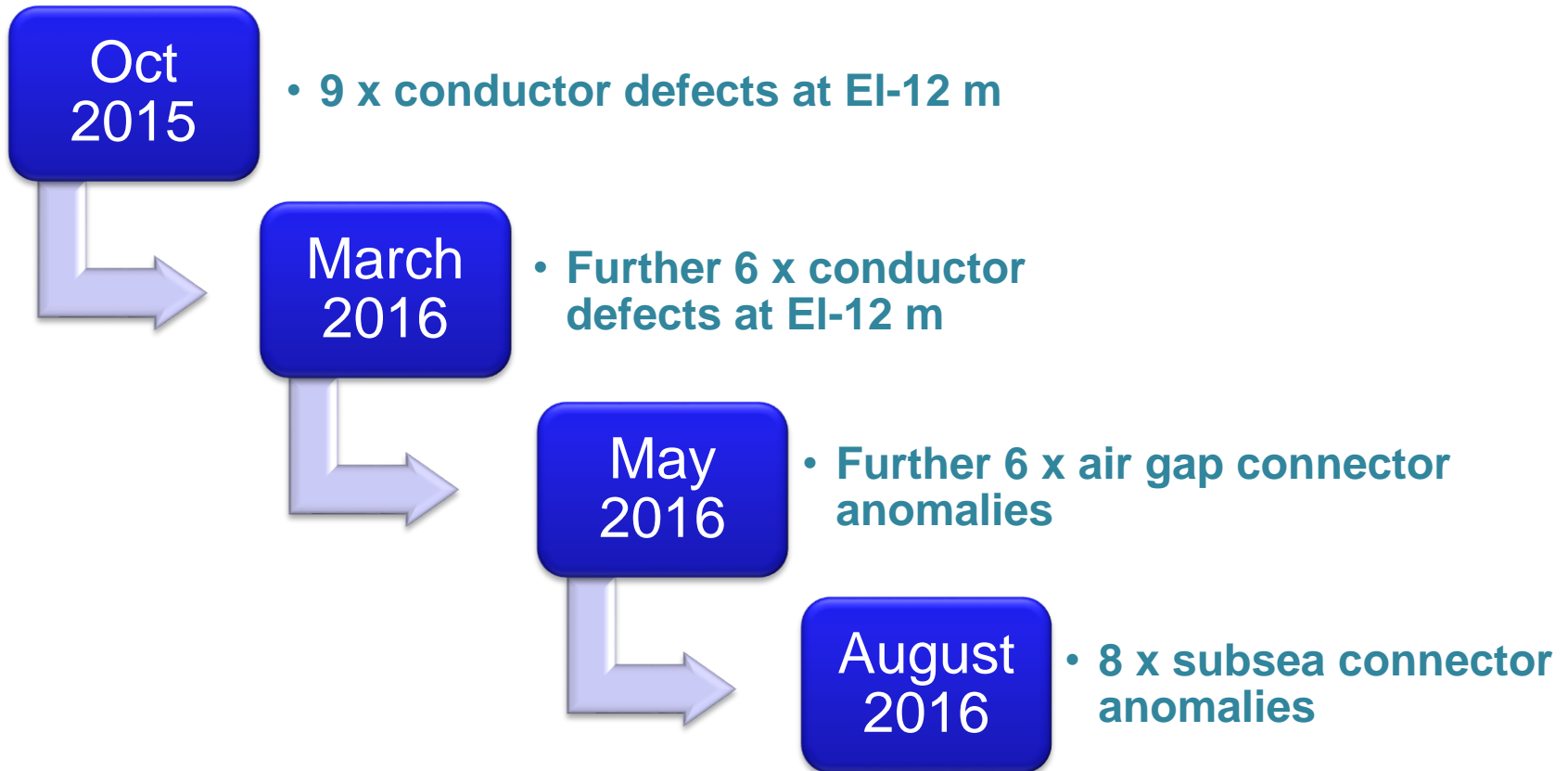
The upper elevations most susceptible to damage.

Other issues are poor inspection quality, poor anomaly appreciation, no MG cleaning.

Image illustrates typical video quality

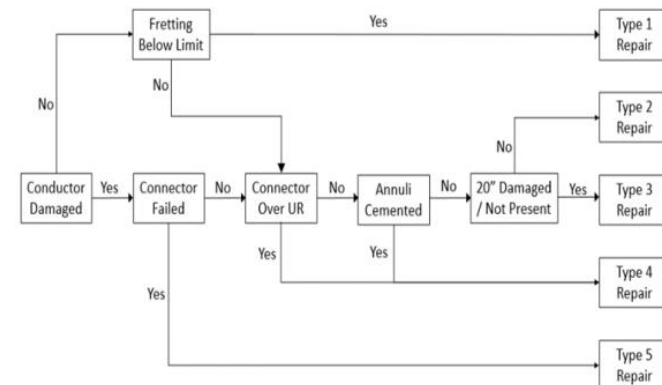
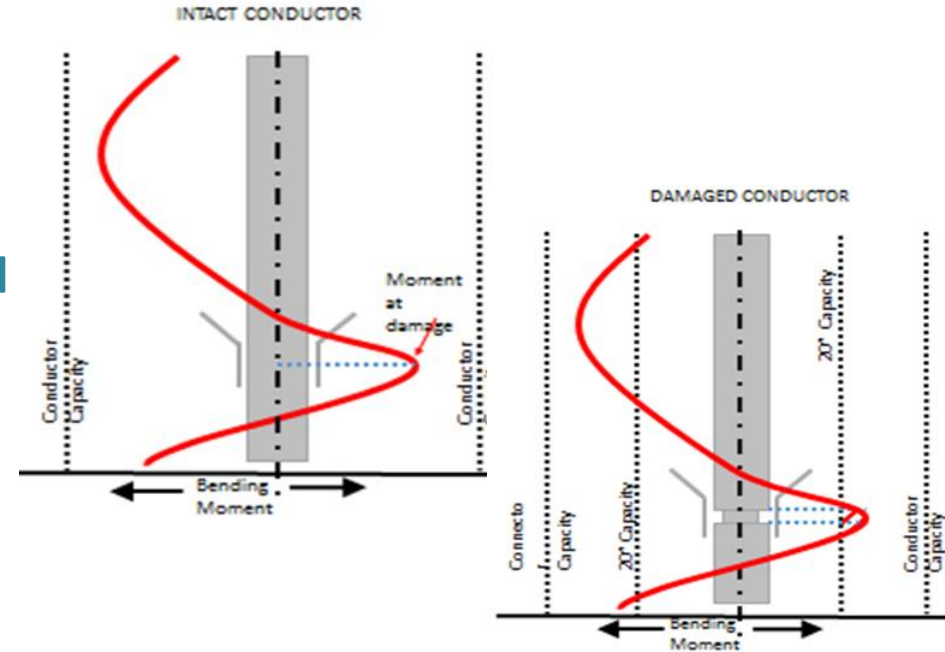


Defect – Progress or Inspection



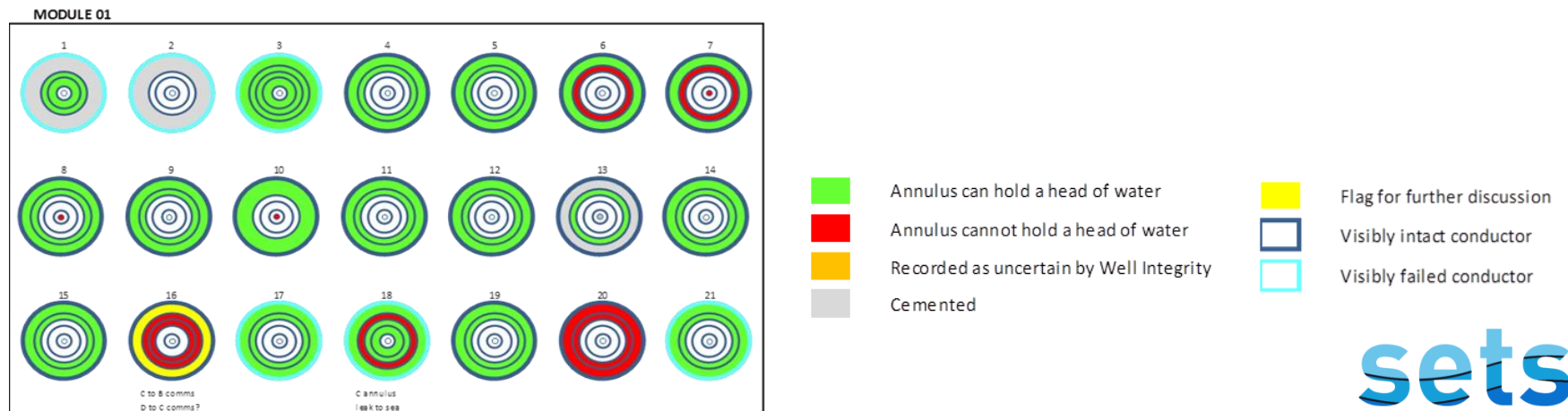
5. REPAIR ANALYSIS

- Understand current condition & determine implications of damage.
- Build model across all conductors based on current condition and loadings.
- Further analysis required for legacy components.
- Analyse for trends and defect mechanisms.
- Consideration of unique defect situations: separation at guide & connector above.



Analysis

- Over laid conductor inspection results with well integrity data with structural analysis to build overview of integrity.
- Line-up integrity overview with well economics to inform repair strategy.
- Conductors can support a single item of damage, either connector or fretting damage.
- Double failure – conductor unstable – mechanism.



Analysis Required

- Conductor's utilisation including drilling loads.
- Conductor's stability.
- Criteria for repair selection; extent of fretting.
- Repair type design loads.
- Fretting loss; Overload, Fatigue.
- Wellhead drop.
- Strength of wellhead support structure.
- GE connector load limit criteria study.
- Connector capacity significantly lower than anticipated.
- Connector exclusion bands defined.




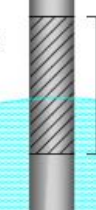
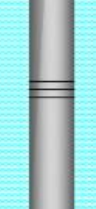

Analysis Issues

- Incomplete data sets: annular cement, modifications, as-built data, service histories.
- Different department, different data sets, same system.
- Wells; understanding of well integrity & responsibility.
- Structural; where integrity responsibility sits in organisation.
- Legacy equipment: connector capacities.
- Lack of reliable data points to project time-to-failure or progression rates.
- Lack of inspection data; images rather than measurements.
- Individual well value and plans.

MITIGATIONS

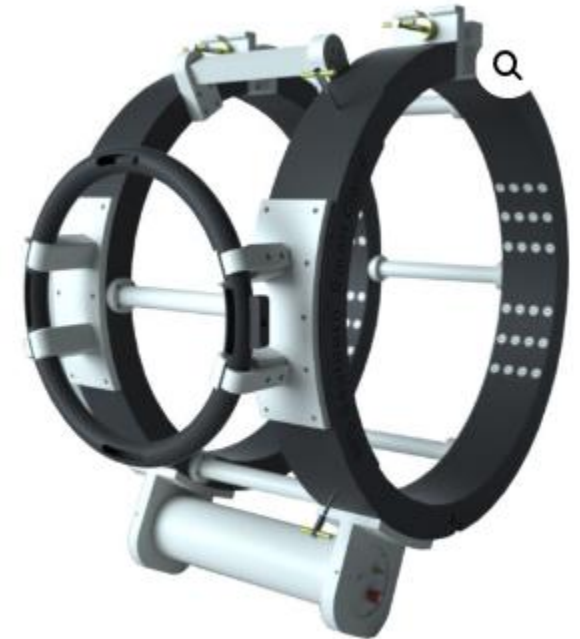
Across MSL Guide to Guide

- Most damage sustained across MSL from guide immediately above to guide immediately below sea level.
- This illustrates common issues, inspection and repair methods.

CONDUCTOR FEATURES		COMMON DEFECTS	STANDARD INSPECTION OPTIONS (SEE DOC. SK-MKT-110)	STANDARD REPAIR OPTIONS (SEE DOC. SK-MKT-107)
GUIDE & CFG		WALL THICKNESS, CEMENT LEVELS, CONDITION THROUGHOUT CONDUCTOR LENGTH	RAT VISUAL INSPECTION RAT NDT	STRUCTURAL REPAIR SETS TYPE 5 CLAMP PS POURED OR CAST
GUIDE & CFG		PUNCTURES FROM CHOCKS FRETTING WITHIN GUIDE, COATING BREAKDOWN, CRACKING	RAT VISUAL INSPECTION LASER METROLOGY	TYPE 1, 2 & 3/4 CLAMPS MANUAL OR CUT-OUT CGF & REBUILD
CONNECTOR		FATIGUE LIFE RELATIVE MOVEMENT INTERNAL DAMAGE	RAT VISUAL INSPECTION NDT INTERNAL CONNECTOR INSPECTION	TYPE 5 MANUAL
WRAP/SHEATHING		DAMAGE CORROSION BENEATH WRAP OR SHEATHING	RAT VISUAL INSPECTION SETS INSPECTION TOOL	RE-WRAP, STRUCTURAL REPAIR ENCASEMENT
CONNECTOR		FATIGUE LIFE RELATIVE MOVEMENT INTERNAL DAMAGE	SETS INSPECTION TOOL LASER (EXTERNAL) NDT INTERNAL X-RAY (INTERNAL)	TYPE 5 REMOTELY INSTALLED
GUIDE & CGF		FRETTING WITHIN GUIDE, CRACKING	VISUAL INSPECTION LASER METROLOGY GUIDED ULTRASONICS	PS CAST TYPE 1, 2 & 3/4 CLAMPS REMOVEDLY INSTALLED

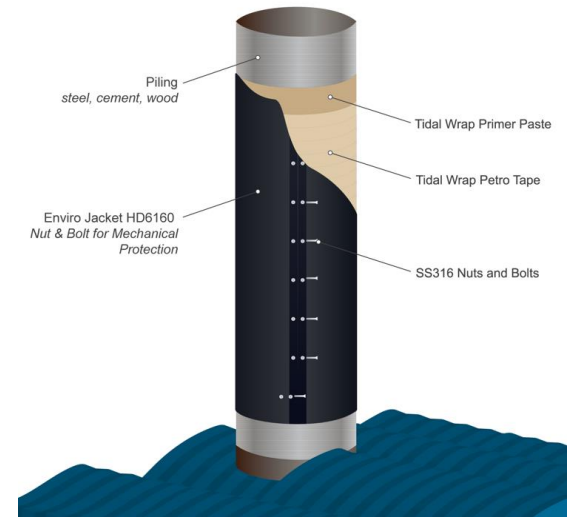
Mitigation - Monitoring

- Integrated strain, acceleration, pressure and temperature monitoring sensors to generate real-time fatigue/load/movement data.
- Structural Monitoring System, providing real-time movement/fatigue analysis of difficult to access assets.
- Installed to create a wireless network, transmitting to the topside receiver.

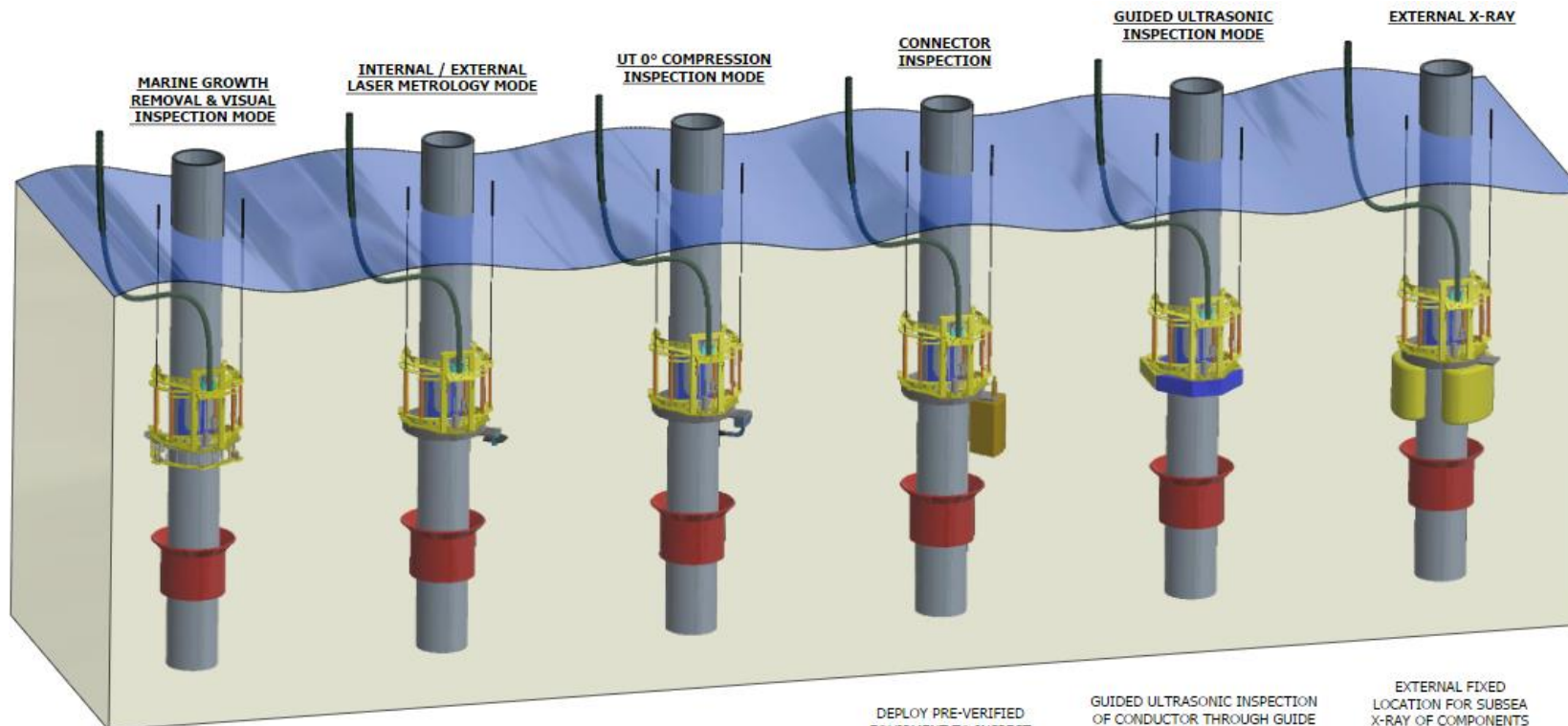


Mitigation – Wrapping/Cladding

- A means of excluding seawater from conductor surface to mitigate corrosion.
- Monel – not retro fit but effective.
- Painting – underwater paints.
- Wrapping – well understood topside more challenging across splash zone.
- All options present challenging application across splash zone and subsea.



Mitigation - Inspection



MARINE GROWTH REMOVAL & VISUAL INSPECTION OF CONDUCTOR SURFACE DOWN TO GUIDE, VIEW INTO ANNULAR GAP



HIGH ACCURACY METROLOGY OF CONDUCTOR SURFACE, CONDUCTOR GUIDE, ANNULUS AND ANY OBSTRUCTIONS



CONDUCTOR WALL THICKNESS READING



DEPLOY PRE-VERIFIED EQUIPMENT TO INSPECT CONNECTORS EXTERNALLY FOR EARLY SIGN OF DEFECTS



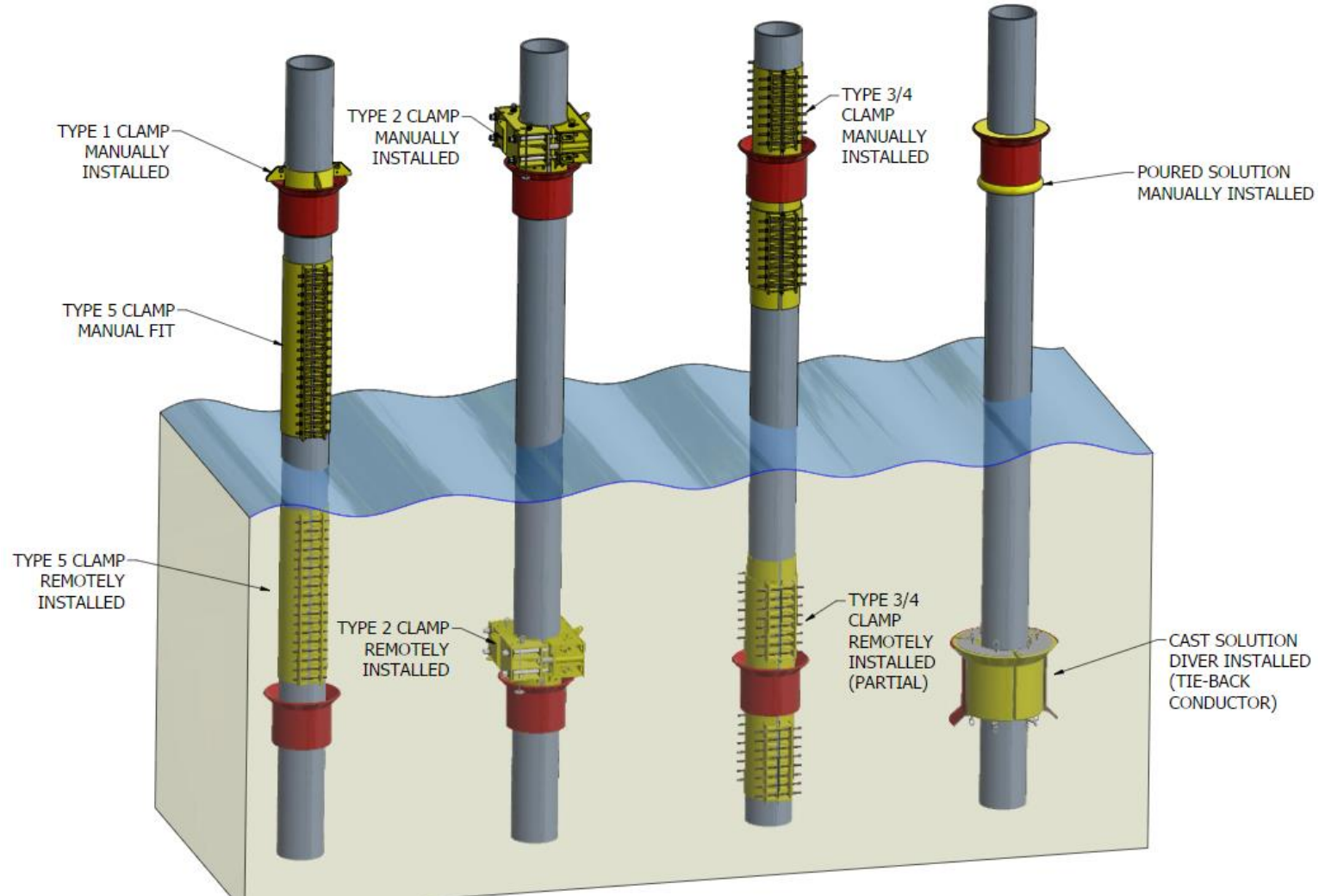
GUIDED ULTRASONIC INSPECTION OF CONDUCTOR THROUGH GUIDE AREA OR OTHER OBSTRUCTIONS



EXTERNAL FIXED LOCATION FOR SUBSEA X-RAY OF COMPONENTS



Mitigation - Repair



Animation

The logo for 'sets' is displayed in a stylized, lowercase, blue font. The letters are bold and have a slight shadow effect. The background of the entire slide is a dark blue gradient with a subtle diagonal line.

CONDUCTOR MANAGEMENT SOLUTIONS

The 'sets' logo is repeated in the bottom right corner of the slide, rendered in the same blue, stylized font as seen in the main content area.



Early engagement. Disruptive thinking.



sets

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