The Challenges (& Opportunities) of Decommissioning Future Offshore Systems

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Challenge or Opportunity?

- A pessimist says the glass is half empty.
- An optimist says the glass is half full.
- The engineer says the glass is too big.
- Glass half empty – we are already talking about decommissioning the new technology.
- Glass half full – further opportunities for technical innovation in decommissioning, and to influence concept selection.
Introduction - Challenges

- We often discuss how new technology will advance the development of future subsea developments.
- The upcoming multi-billion pound requirement to decommission existing subsea developments is also understood.
- Looking further ahead, lies the requirement to decommission the subsea developments of the future.
Introduction - Challenges

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- Focus on subsea oil and gas infrastructure.

- How will new offshore technologies currently being proposed affect decommissioning requirements?

- What new challenges will be faced when decommissioning the subsea facilities of the future?
Current Status of Decommissioning

- Oil & Gas UK report UK offshore expenditure during 2017 of:
  - Capital investment: £5.6 bn
  - Operational expenditure: £7 bn
  - Expenditure likely to increase outside of industry downturn

- Estimated costs of decommissioning in the UK North Sea:
  - £17bn will be spent in the next 10-yrs.
  - Total cost £45bn to £77bn for decommissioning of all assets

- UK North Sea decommissioning programme:
  - Around 80 ageing fixed/floating installations
  - Plugging of approximately 1,200 wells

- Network of 36,000 km of pipelines links ~300 offshore platforms with the UK shoreline.
  - 2x distance from Aberdeen to Adelaide
What do we mean by Decommissioning?

- Well abandonment
- Making safe – facilities and pipelines
  - Remove hydrocarbons: drain, flush, purge and vent
  - Physical isolation
  - Cleaning, flushing, pigging etc.
  - Waste fluid management
- Topside / substructure onshore recycling
  - Not addressed in detail in this presentation
- Subsea infrastructure:
  - End state preparation (remove, trench, rock dump, etc.)
  - Seafastening and transportation
  - Load-in
- Site remediation:
  - Debris clearance
  - Overtrawl surveys
- Monitoring:
  - Surveys to confirm conditions
  - Maintenance and remedial work

Decommissioning can also mean:
- Abandonment
- Relocation

Source: Oil & Gas UK guidelines
Back to the Future

- UK production of oil & gas peaked in 1999
- Focus on **life extension** of ageing assets and transition into **decommissioning**
- Oil & gas expected to provide 2/3 of UK’s total primary energy by 2035
- New field developments are still being sanctioned and installed:
  - Signs of recovery from recent downturn
  - Final Investment Decision for projects in 2018/19
  - Redevelopment of existing fields
- Late life operators
- New field developments will be due for decommissioning in 25 to 40 years.
  - Where were we in the industry 25 years ago?
  - How much further change can be expected in the next 25 years?
Systems Engineering Challenge

- Systems approach: Define > Understand > Integrate > Assure
- Decommissioning must consider factors such as structural integrity and removal loads acting on structures.
- Robust plan for decommissioning must be submitted to regulator.
- Challenges and issues encountered at end of life may not be foreseen or correctly considered during the design phase.
- Lack of early attention increases the cost and the technical challenge.
- Quality and quantity of available data.
- Key part of decommissioning is knowing when to leave the asset in place.
Reduction of Decommissioning Costs

- Influence of decommissioning in the whole asset lifecycle.
- Decommissioning cost estimation:
  - Liabilities appear on operator’s balance sheets.
  - Estimated costs vary between operator, project and region.
- Wells / subsea infrastructure have highest relative cost.
- Use of through-life costing assessments to validate concept selection.
  - Previously assumed 10% of concept cost assigned to decommissioning.
  - Could high decommissioning costs exclude a particular developmental approach?
- OGA Decommissioning Strategy targets >35% reduction in UKCS cost estimates:
  - Economies of scale
  - Greater cooperation
  - Standardisation of methodologies
- Vulnerability to global economic cycles.
Design for Decommissioning

- Design for Decommissioning (D4D) JIP commenced in 2016.
- Now includes 27 member organisations.
- Focus on subsea scope.
- Industry database created to provide practical guidance and make the decommissioning process easier.
- Learn from issues encountered with current decommissioning plans:
  - Improve future efficiency
  - Reduce costs
  - Improve safety
  - Reduce overall decommissioning footprint
- Opportunity to learn lessons from environment and marine science issues associated with decommissioning.
- Develop potential solutions for implementation in future designs.
Design for Decommissioning

- Decommissioning should be incorporated in the design during the Define or FEED stage:
  - Major design criteria defined in the Basis of Design and design specifications.
  - Change control rigorously enforced in the Execute stage.
- Several options for developing the field will be assessed:
  - Cost of decommissioning and removing each option is evaluated to support project cost estimates.
  - Removal options and any issues are evaluated by the regulators and other stakeholders.
- Insufficient definition to consider design for the final decommissioning.
- Decommissioning experience in the project team?
- Standardisation of designs
- Risk associated with engineering decommissioning solutions during Design or at End of Life.
New Frontiers and Challenging Environments

- Future facilities will often be installed in difficult locations.

- Decommissioning challenges associated with facilities installed in increasingly deep water and/or harsh environments:
  - Wells at >3000m water depth
  - Strong currents
  - Year-round storms
  - Ice loading
Deep Water

- Burj Khalifa, Dubai
- 830m (2,722ft) tall
- 163 floors
- Top floor at 585m
Floating Facilities and Subsea Structures

- Floating systems – operating in deep water
- Subsea tiebacks – improved economics
- Bespoke equipment to support recovery from subsea
Lightweight Materials

- Increasing use of lightweight materials and structures:
  - Should simplify offshore handling requirements
  - Enables use of smaller, less costly vessels for decommissioning activities.

- Composites are seeing growing consideration for pipeline and riser applications as an alternative to traditional materials

- Composite materials offer a range of potential benefits:
  - Light weight
  - High strength
  - Complex shapes
  - Good fatigue resistance
  - High corrosion resistance
  - Low maintenance
  - Low bending stiffness (allowing reeled installation/retrieval)

- Use of non-metallic materials will change handling of recovered materials.
  - Different opportunities for re-use and recycling.

Image courtesy Magma Global
Composite Materials

- Composite pipeline market developed by organisations such as Airborne Oil & Gas and Magma Global.

- No composite pipe installations are near end of life.
  - There has been no serious consideration of decommissioning.

- Magma’s m-pipe is guaranteed for a lifespan of 50 years.
  - Lack of corrosion due to use of inert materials means it could continue in service for much longer.

- Airborne’s TCP can be recovered and re-used.
  - Particular advantages for the application of small fields with limited service life.

Image courtesy Magma Global
Composite Materials

- Retrieval:
  - Magma’s ‘m-pipe’ can be taken up in the reverse way to installation over the Integrated Deployment Package (IDP), and coiled onto a reel.
  - The pipe can be taken ashore for inspection and re-use.

- Re-use:
  - m-pipe is a standard product, always made from the same materials. Only the diameter and pressure rating change.
  - Hence the pipe can be repurposed “as is” for different applications.

- Recycling:
  - Composites are sometimes perceived to be ‘non-recyclable’.
  - If no further use is identified m-pipe can be shredded into short carbon fibre PEEK ready for re-melting.
    - A short fibre PEEK material is an existing commercial Victrex product.

Image courtesy Magma Global
Structural Integrity

- Integrity of ageing subsea structures is often uncertain
  - Effect of corrosion and marine growth
- Enhanced simulation to understand the asset condition
  - Optimisation of Cathodic Protection systems prior to installation
  - Assessment of likely corroded regions
Digitalisation

- Simulation
- Virtual and augmented reality
- 3D photogrammetry
  - Determines exact positions of surface points from visual images
  - Already suitable for subsea use and accurate to within a few millimetres.
  - Technology developing at a faster rate than laser technology.
  - Data replaces live streaming of video – providing natural compression.
- Enhanced asset management – digital inventory
- Development of ‘big data’ management and analysis methodologies
- Machine learning
- Digital twin
- Data sharing within industry:
  - Greater understanding of system behaviour, including dynamic response and degradation.
- Removal of the asset becomes more predictable:
  - Improved safety
  - Reduced cost

Image courtesy ROVCO
Autonomous Operations

- Increased use of autonomous operations will make removal of the asset safer.
  - Mechanical operations – removes diver requirement
  - Mobile structural / environmental monitoring
  - Data collection – supports decision-making
  - Reduce number of personnel offshore
  - Condition monitoring of decommissioned structures

- Energy supply and consumption.
- Criticality of control and cyber security.
Environmental Impact

- Impact on the local marine environment:
  - Marine Protected Areas
  - Commercial fishing

- Trends evolve fast in today’s society:
  - Changing attitudes towards single-use plastics.
  - Typical approaches today may soon become unacceptable.
  - “Equipment is unlikely to be removed from deep-sea environments.”

- Abandonment vs. Removal
  - What happens if you leave it there?
  - What happens if you remove it?

- Eco-engineering of structures
  - Who retains long-term liability?
  - Safety, cost and feasibility.
Evolving Safety and Environmental Regulations

- Strict legal framework of national & international regulations.
- Recommendations, regulations and directives to protect the environment are enshrined in UK legislation.
  - Environmental Impact Assessments
- Regulatory requirements vary in different regions.
  - BSEE reviewing regulations for decommissioning in deep water in the Gulf of Mexico
- Regulation can be perceived as an obstacle to innovation.
- Increasing body of good practice being gathered.
- Increasing safety and environmental controls may result in more onerous legislation.
- Opportunity to identify and relax areas of over-conservatism:
  - Greater understanding and experience
  - Greater standardisation across regions
Vessels

- Use of smaller vessels to reduce costs
  - E.g. recovery of flexible flowlines by AHV

- Existing vessel designs:
  - Installation vessels can also be used for decommissioning roles.
  - Similar roles are performed in ‘reverse motion’.

- New concepts for specialist decommissioning vessels:
  - Many different activities within the decommissioning sector.
  - Fixed and temporary cranes of varying sizes and lifting capacities.
  - Keep vessel size small.
  - Ensure sufficient deck space is available.

- Allseas Pioneering Spirit
  - Single lift installation / removal of entire platforms
  - Platform topsides up to 48,000 Te; jackets up to 20,000 Te
Summary - Opportunities

We cannot solve our problems with the same thinking we used when we created them.

ALBERT EINSTEIN

- Design of new facilities can be optimised:
  - Minimise through-life costs.
  - Reduce environmental impact and decommissioning footprint.
  - Ensure that safe and cost-effective decommissioning will be feasible.

- Continued evolution necessary to meet changing demands and incorporate the latest technology.

- Innovation and disruption from new entrants.

- Opportunity to make changes now in anticipation of decommissioning.

- BUT it is hard to predict which factors will be critical in > 30-yrs.

- Decommissioning does not have to mean retrieval.

- Lessons apply equally to other subsea infrastructure:
  - E.g. offshore renewables and subsea mining

- Rise of decommissioning specialists:
  - Opportunity to develop an efficient, low cost and exportable industry