

Integrity Engineering/Management Services

Overview

Z-Subsea provides Integrity Engineering and Integrity Management services to the oil and gas industry amongst other established services such as Subsea Design, Advanced Analyses and Project Management. We believe in benefit of engaging our experienced integrity engineers with our client project team right from the start (conceptual phase), then design and fabrication to operation. That is why we call our Integrity Engineering services "Full-Life Cycle" service (Figure 1).

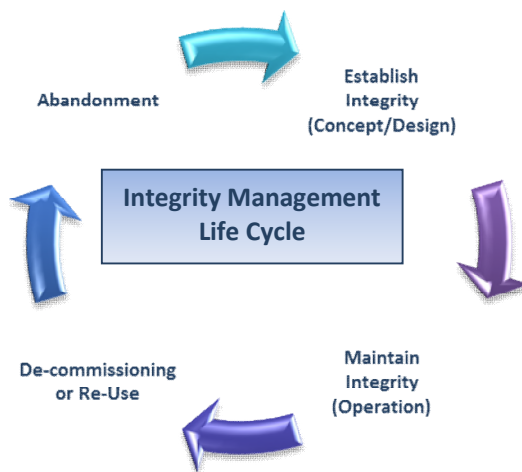


Figure 1. Integrity Management Life Cycle

Integrity management is usually established during the concept/design phase of a project and is maintained during the operation until the end of design life. Z-Subsea's services continue beyond this stage by either de-commissioning or re-use of the pipeline as well as life extension studies before moving to Abandonment. During all these steps, integrity of the pipeline/riser should be managed similar to the pipeline in operation.

Integrity Management Activities

We in Z-Subsea assist our clients by providing expertise, knowledge and flexibility on the following main areas:

- Qualitative and Quantitative Risk assessments.
- Integrity management planning at the design stage.
- Developing and implementing of the Inspection and Monitoring methodologies.

- Performing and implementing intelligent Piggging feasibility studies for piggable and difficult to pig pipeline systems.

Probability category	5	M	H	VH	VH	VH
	4	L	M	H	VH	VH
	3	VL	L	M	H	VH
	2	VL	VL	L	M	H
	1	VL	VL	VL	L	M
		A	B	C	D	E
		Consequences				

Figure 2. A qualitative risk assessment matrix

- Review, audit and modification of existing integrity management systems.
- Management of change.
- Fitness for Service (FFS) assessment of existing assets to ASME-FFS-1/API 579-1, ASME B31G and/or DNV RP-F101 procedures at presence of Dents, Metal loss, Buckles, Lamination, etc.
- Engineering Criticality Assessment (ECA) (Figure 3) of subsea systems at presence of crack-like weld flaws at extreme loading or environmental conditions such as Reeling installations, High Temperature and High Pressure operations and exposure to the hostile environments such as sour (high level of H₂S) and sweet corrosion (CO₂ corrosion).
- Remaining life calculation of existing assets and determination of inspection intervals for the most dominating damage mechanism.
- Development and implementation of intrusive/non-intrusive repair systems and associated procedures.

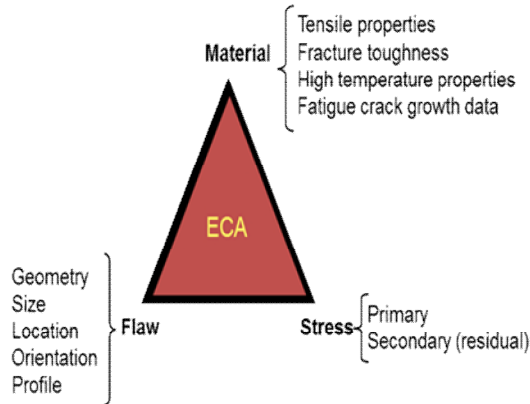


Figure 3. ECA triangle and associated input data

- Life extension of existing assets to standards such as NORSOK N-001, ISO 19900/19902, ISO13822 and API RP2A-WSD.
- Subsea pipeline/risers numerical stress analysis (Figure 4).

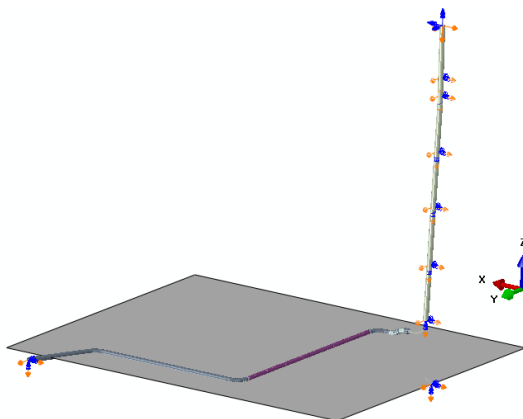


Figure 4. Riser global stress analysis

- Advanced finite element analyses of the Corroded and un-corroded subsea pipelines/risers under extreme loading condition such as cyclic loading (free-span), permanent deformation (lateral or upheaval buckling), third party damages (anchor drag, trawling/fishing activities, etc.) and low cycle fatigue loading during the start-up/shut-down. Figures 5 & 6 show a case of subsea pipeline dragged drastically with an anchor and the corresponding FE model developed by Z-Subsea advanced analysis team to assess the integrity of the pipeline for further safe operation



Figure 5. A subsea pipeline dragged by anchor

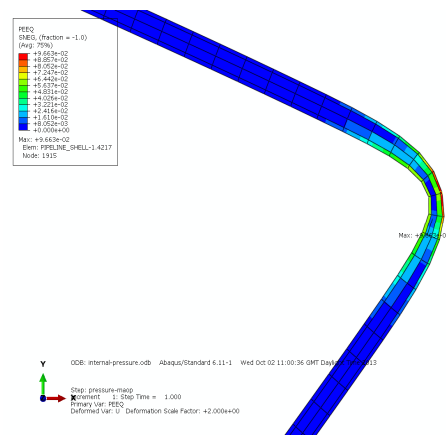


Figure 6. Finite Element modelling of the anchor-dragged pipeline shown above

- Management of standard and specialised mechanical tests such as tensile tests (at low and high temperatures), fracture toughness (SENT, SENB, curved wide plate, etc.) tests and full-scale tests. These will be performed in collaboration with Z-Subsea's testing partners.

Other services (training courses)

Z-Subsea Integrity management team has extensive experience on delivering standard or specialised tailor-made training courses on integrity engineering (assessment) and integrity management of Pipelines/risers, topside facilities, onshore plants.