Engineering 'Lunch & Learn' Series

Pipeline Riser Installation by Stalk-on & Other Methods

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Lunch & Learn Sessions:

1. Installation of Pipelines by Bottom Pull Methods - completed
2. Pipeline Riser Installation by Stalk-on and Other Methods - Present
3. Installation of Floating Facility and Mooring Legs - October
4. Repairs of subsea pipelines – during installation and during operation - November
5. An overview of Seabed Intervention Methodologies – Dec/Jan
6. What are PLETs and how are they installed ?? - Jan/Feb 2020

Agenda:

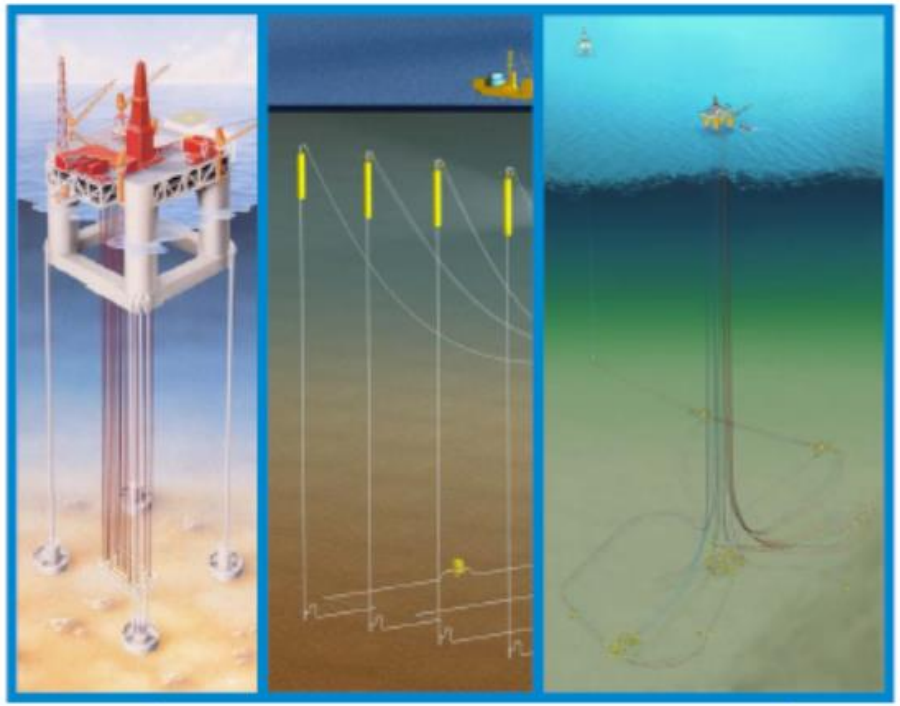
1. Types of Offshore Production Facilities & associated risers
2. Conventional Riser Installation by Stalk-on Method
3. Riser Installation with U-bend Expansion Spool by Stalk-on Method
4. Riser installation through J- or I-tube
5. Steel catenary riser installation
6. Subsea tie-in for pre-installed riser (on jacket) or external riser with flange
7. Typical pre-requisite installation engineering to support riser installation

What is a riser?

Riser is a pipe for transporting oil, gas, water or mud between the seabed and a vessel or platform. Typically:

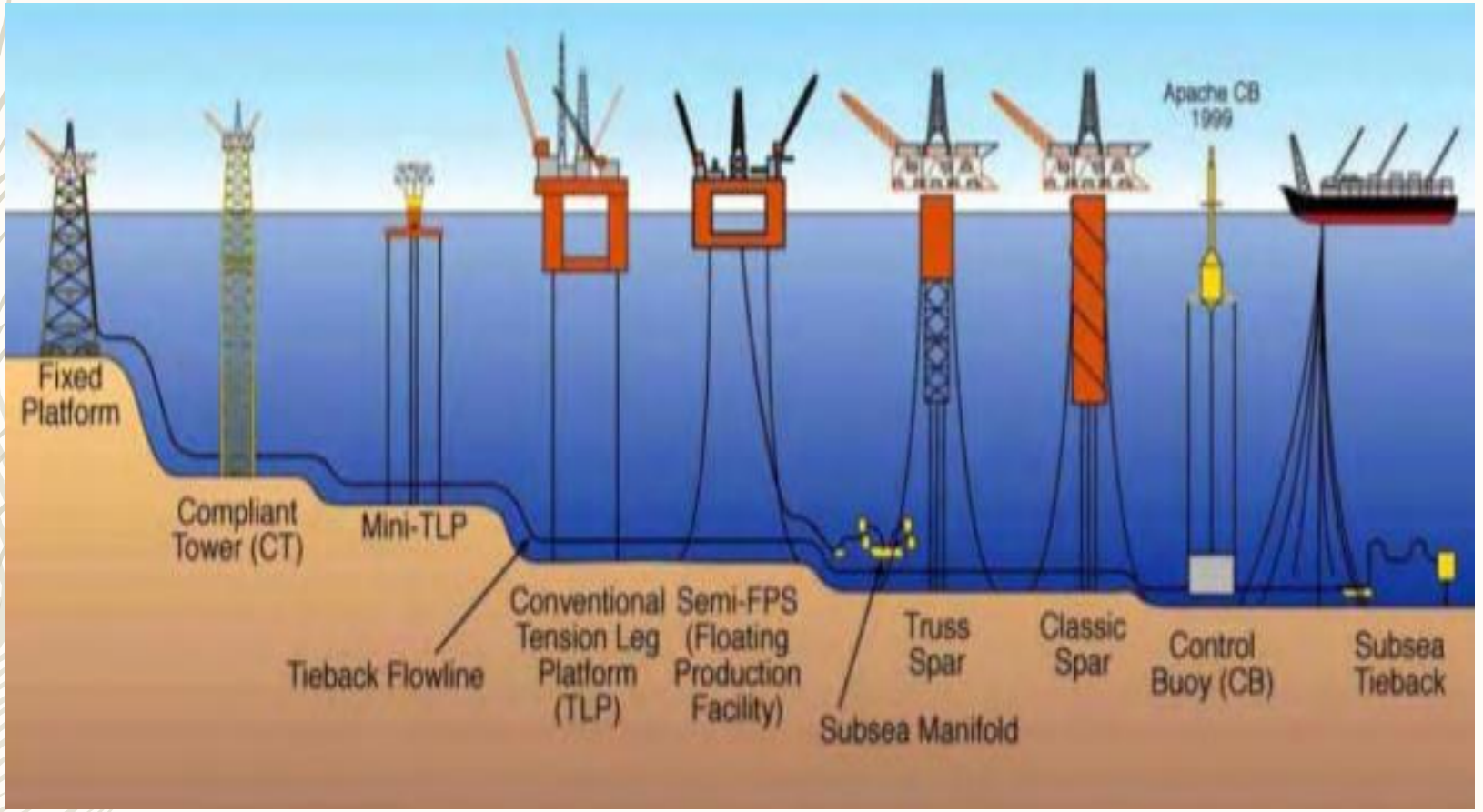
- Rises from seabed to the 'top' – hence, the term 'riser'
- 6-30 inch in diameter
- 200-1100 bar pressure
- Water depth up to 3,000m and beyond

Drilling & Completion



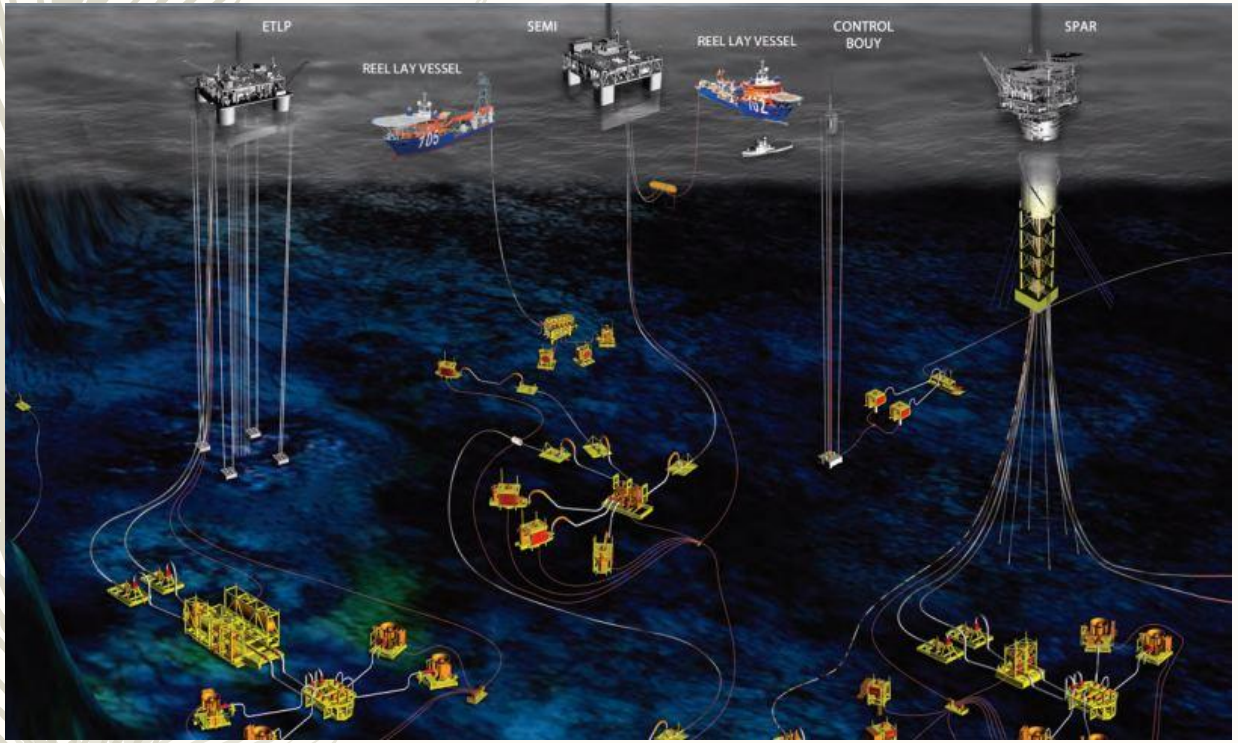
Production, Export and Service

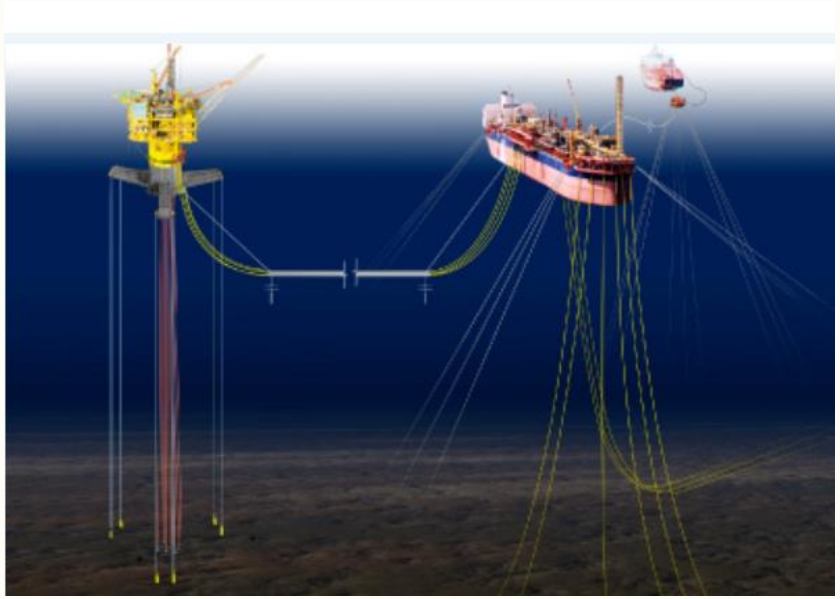
Common types of production facilities - each with unique type of risers



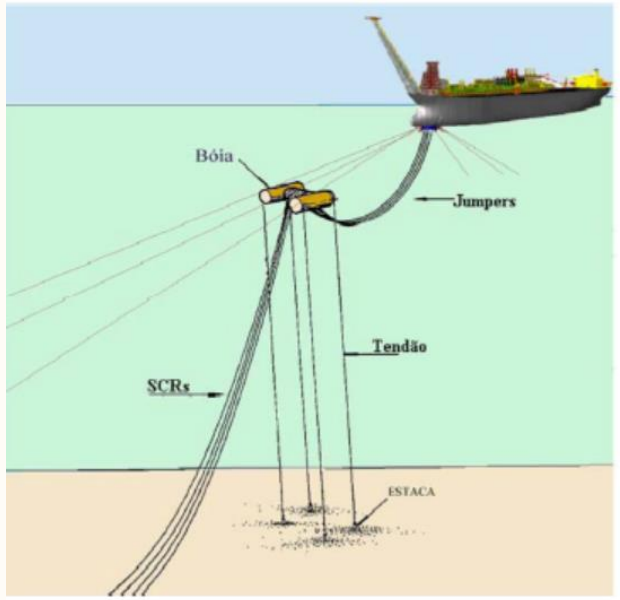
Various types of production system in operation:
1) conventional fixed platform; 2) compliant tower; 3, 4) mini-tension leg and tension leg platform; 5) Semi-Floating Production Platform; 6) Truss Spar; 7) Classis Spar; 8) Control Buoy; 9) Floating Production System and Subsea Tie-back

Other examples of production facilities - each with unique type of risers

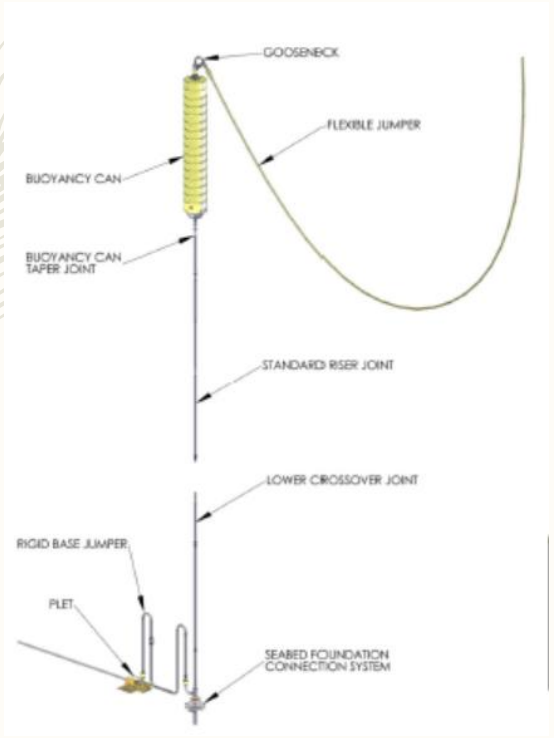




Other examples of production facilities - each with unique type of risers (Cont'd)

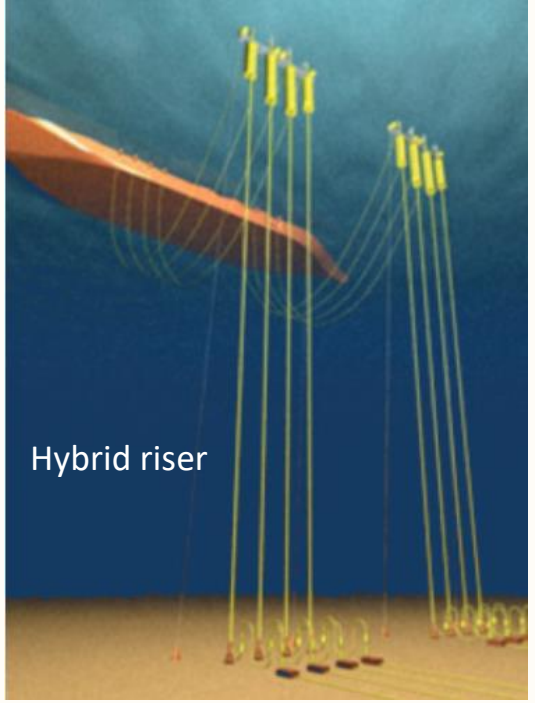


Buoy-supported riser (BSR)

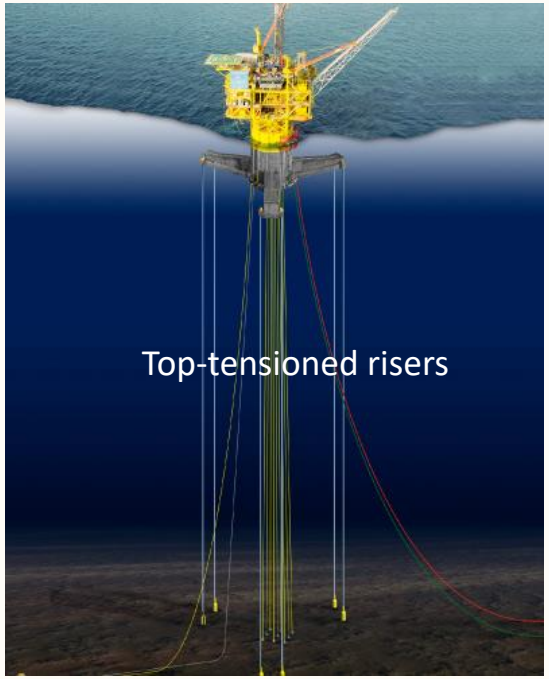


Single line offset riser (SLOR)

Multi-lines free standing risers

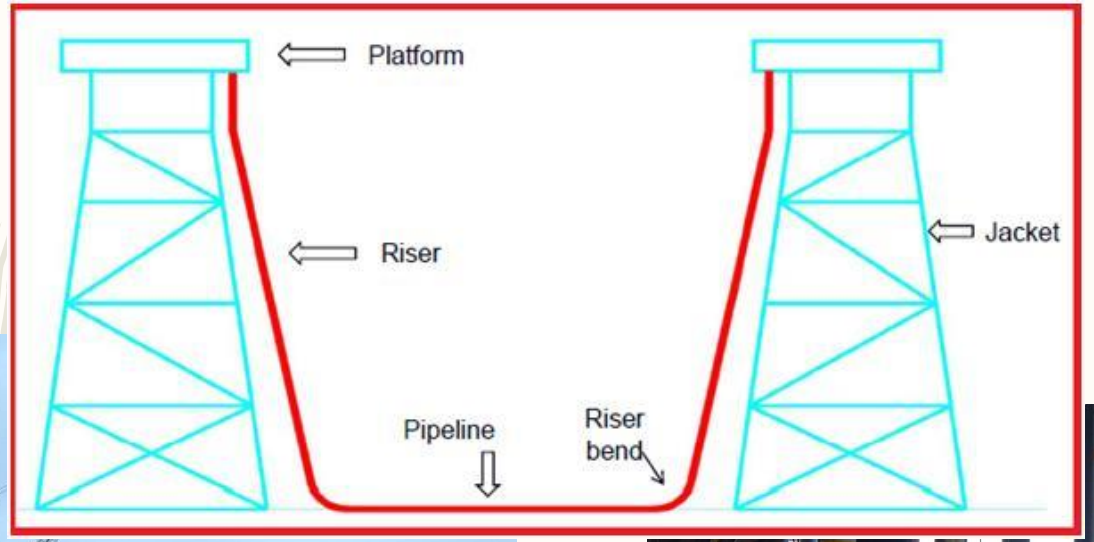


Hybrid riser

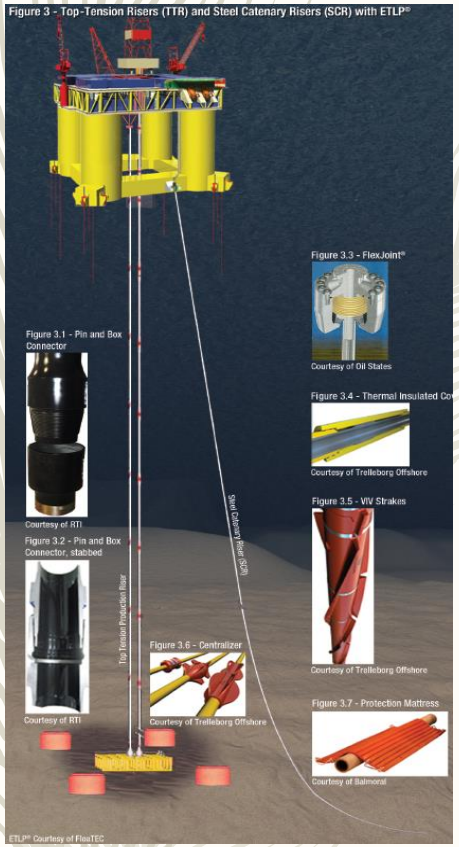


Top-tensioned risers

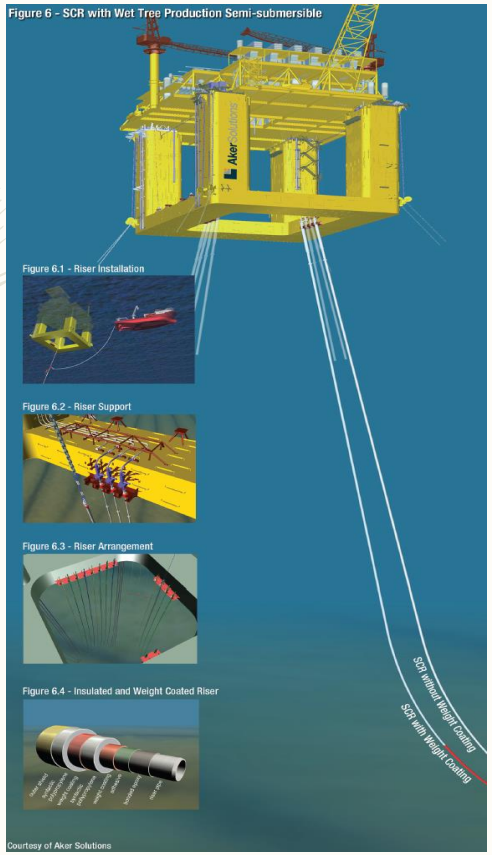
Main topic of this Lesson : Installation of risers for fixed platforms (with or without expansion spool)



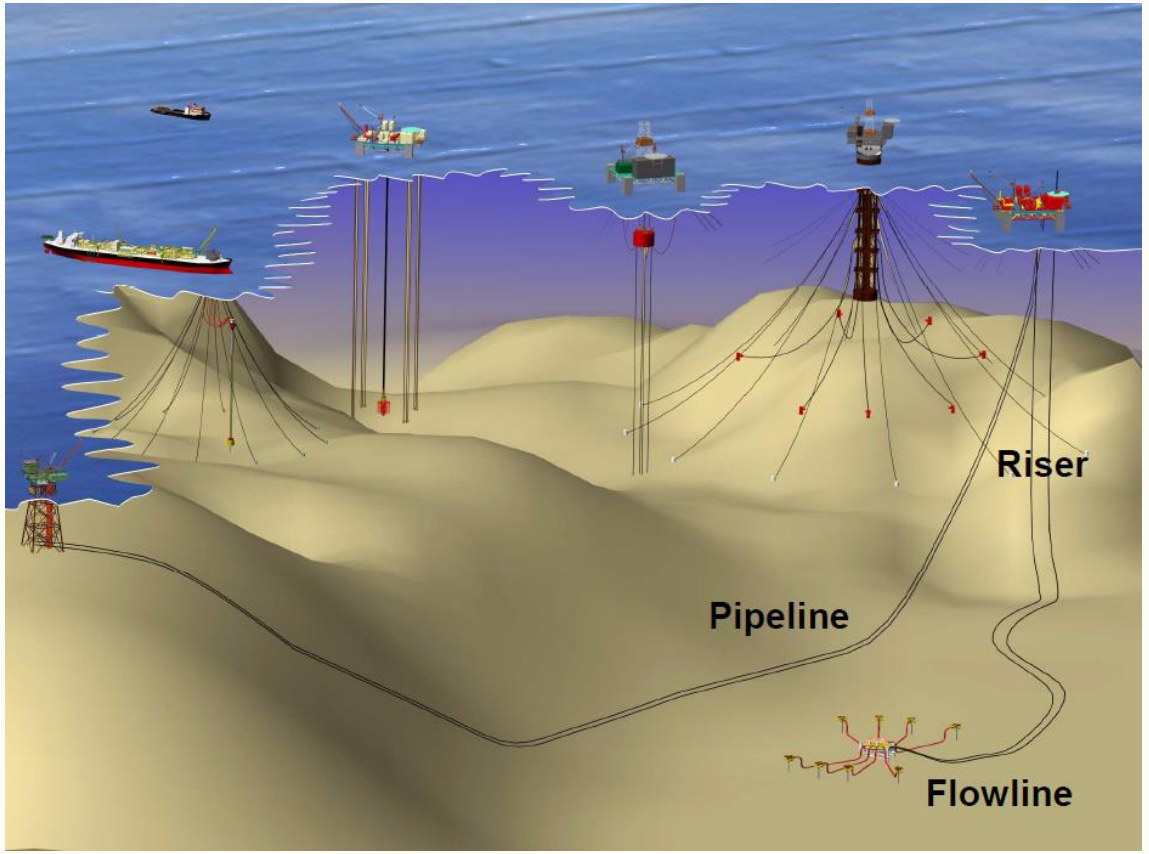
Supplementary topic of this Lesson : Installation of steel catenary risers



Steel Catenary Riser
to
Tension Leg Platform



Steel Catenary
Riser to
Semi- Submersible



Typical Stalk-on Method of Riser Installation

Stalk-on method for riser installation is relatively common for shallow water platforms under one or more of the following circumstances:

- Client does not allow flanged connection;
- The riser is designed to be installed after the jacket has been installed (i.e. jacket does not come be a pre-installed riser);

Riser installation by stalk-on method normally requires a barge with multiple davits. This method of riser installation normally encompasses the following sequences:

- Divers are sent to do metrology, i.e. to take measurement so that the bottom section of the riser assembly can be accurately made so that the final assembly can be slotted into the riser clamps on the jacket when the pipeline cum riser assembly is lowered to seabed.
- The final riser assembly is then fabricated on the barge while the davits are being attached to the pipeline.

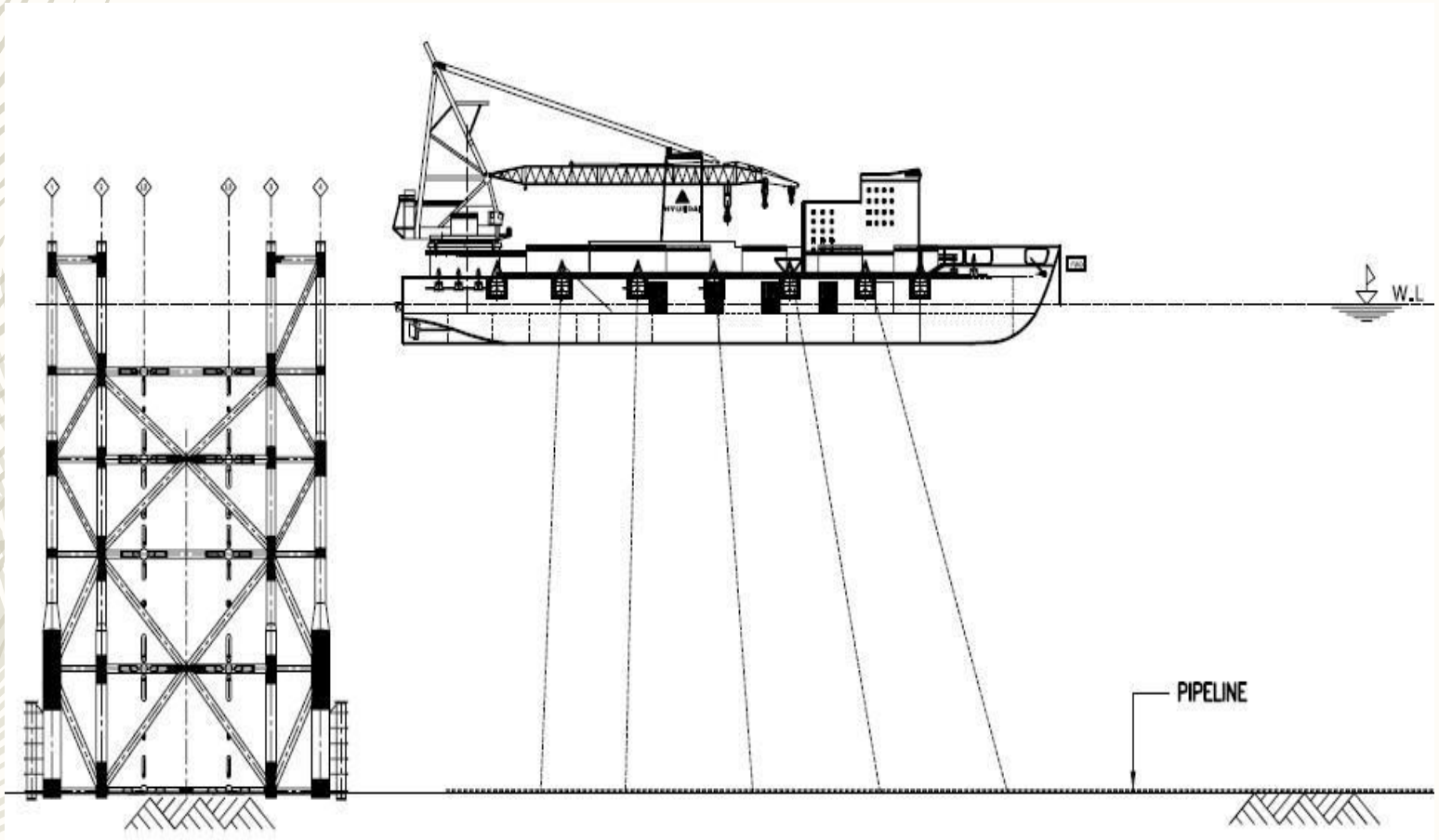
- The barge is positioned with the davits directly over the pipeline.
- Davit lines are lowered to the seabed and divers are deployed to attach the davit lines on the pipeline with the specified offset at the designated locations (in practice, the pipeline is ‘choked’, i.e. wrapped with wire rope at designed locations and attached with shackle each, as the pipeline is being abandoned so that the task of attaching a wire sling around the pipe on the seabed is avoided)
- The pipeline is then lifted up in stages in accordance with the lifting procedures developed based on appropriate engineering.
- The pipeline is lifted till the pull head of the pipeline is above deck level, and then the pipeline is secured to the barge.
- The pull head is cut and removed, and the pipe end bevelled.
- The riser (cum spool) assembly is lifted up by the barge crane and the riser bottom is aligned with the lifted pipeline end.

- The riser is welded to the pipeline, followed by cleaning and non-destructively testing of the field joint.
- The field joint is then wrapped with a corrosion wrap, followed by application of a steel or polyurethane sheet wrap to create a mould around the field joint, and then the annulus is filled with high density foam or quick setting concrete.
- With the weight of the riser (and spool) assembly supported by the barge crane, the pipeline is then slowly lowered to seabed by releasing the davit lines in a pre-determined sequence.
- The lowering process is typically the direct opposite of the lifting process.
- As the riser (and spool) assembly is being lowered, it is guided into the riser clamps on the jacket.
- Once the riser (and spool) assembly has been lowered to seabed and onto the riser clamps, the clamps are closed and secured.
- The crane lines to the riser and the davit line attachments to pipeline are removed.

Laybarge Manouvred for Riser installation by Stalk-on Method

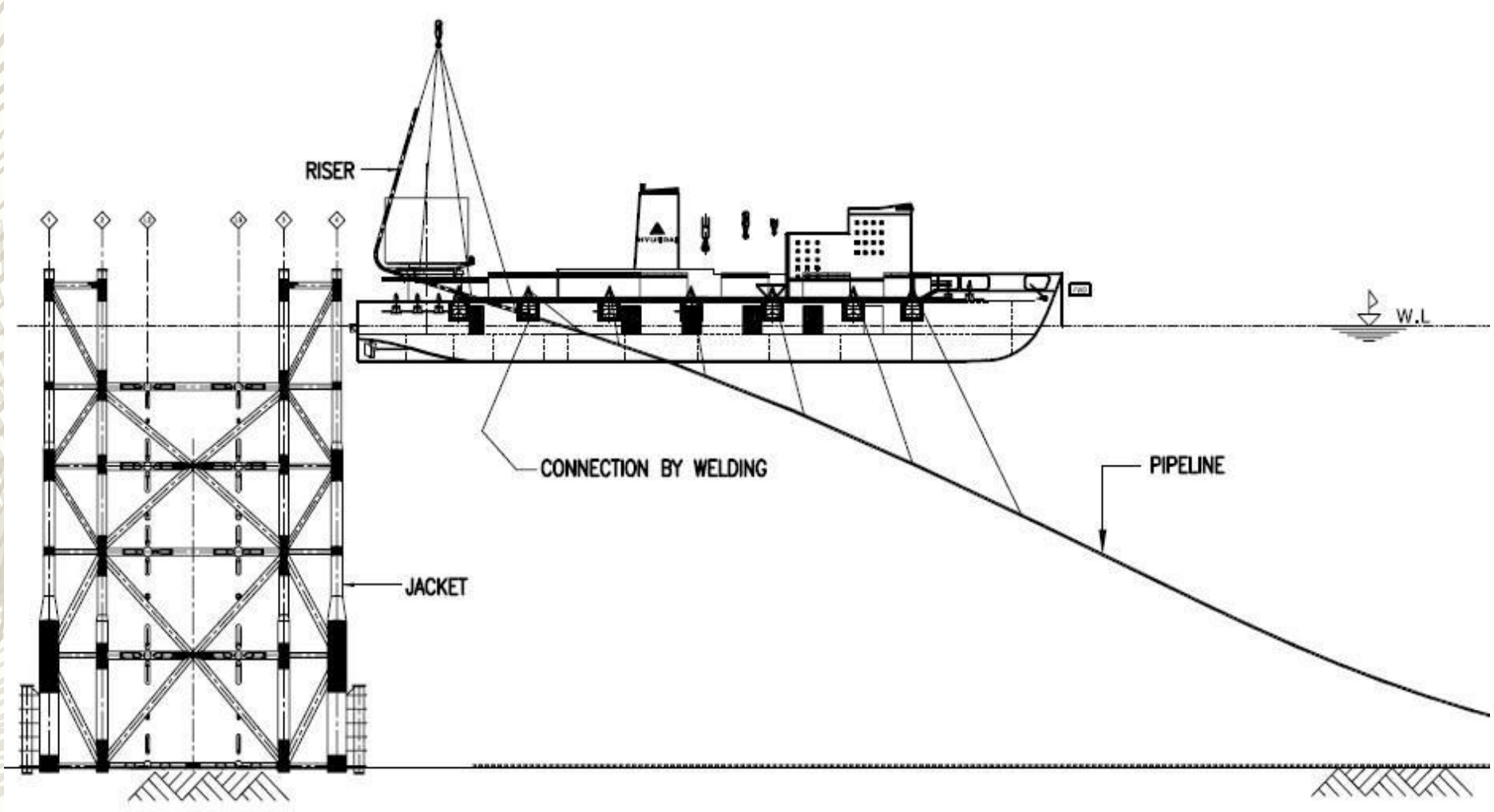
Typical laybarge, with material barge containing spares is moored alongside & riser cum spool assembly (if any) is fabricated on the barge deck

Initial barge and davit line set up for davit lift



Note offset of davit lines to obtain maximum horizontal pull to minimise pipeline sagbend stresses during davit lift

Final lift configuration of the pipeline and davit lines for stalk-on of riser (and spool) assembly

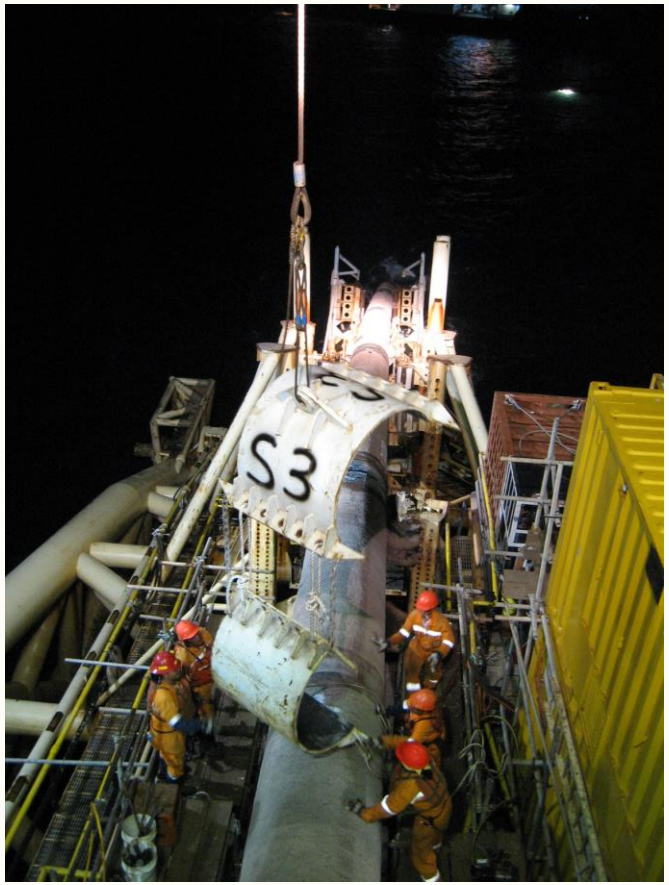


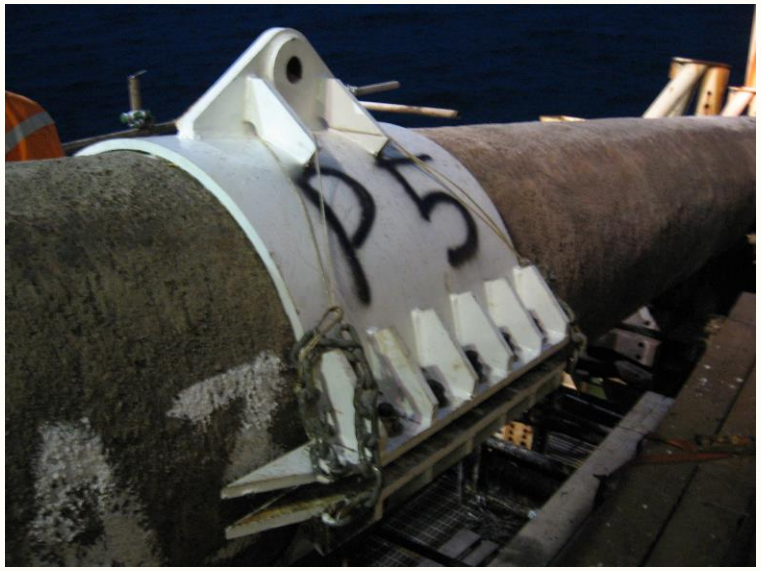
Picking up of pipeline using davits & removal of pipe pullhead for riser stalk-on

Above: pipeline is 'choked' with slings at planned davit attachment point.

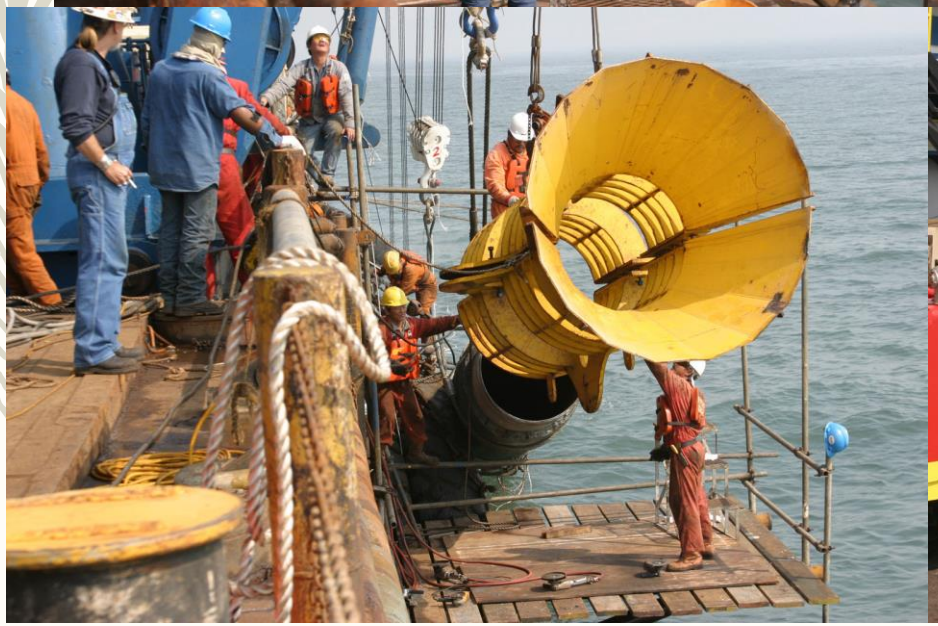
Purpose: to minimize diving support & facilitate attachment of davit line

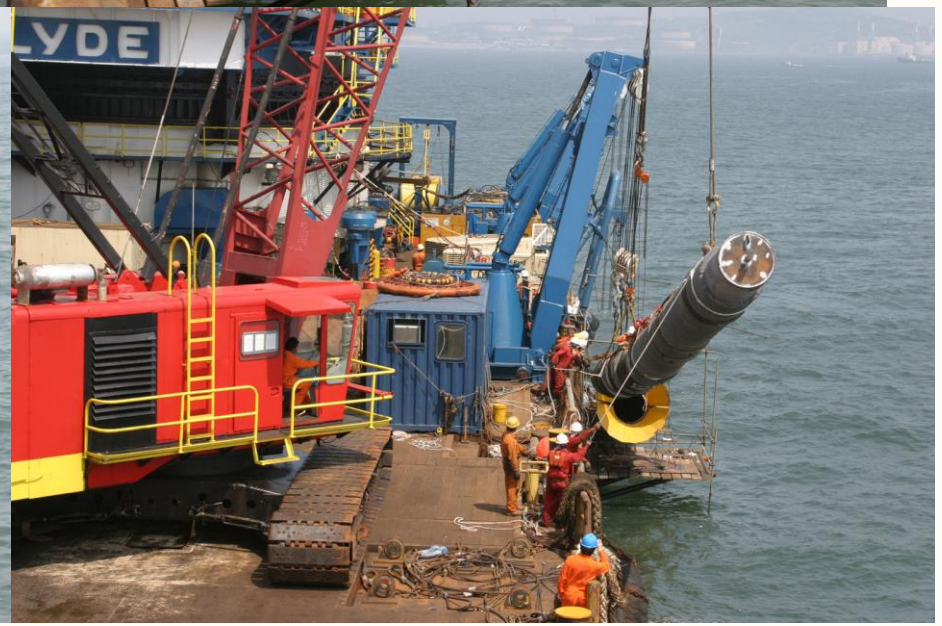
Instead of choking with slings, special lifting clamps could instead be installed on pipeline prior to laydown





Preparing pipe end for riser add-on; stabbing guide attach to assist with riser spool/riser bend alignment & subsequent welding





Lifting of riser assembly and stalking-on to pipe end for welding

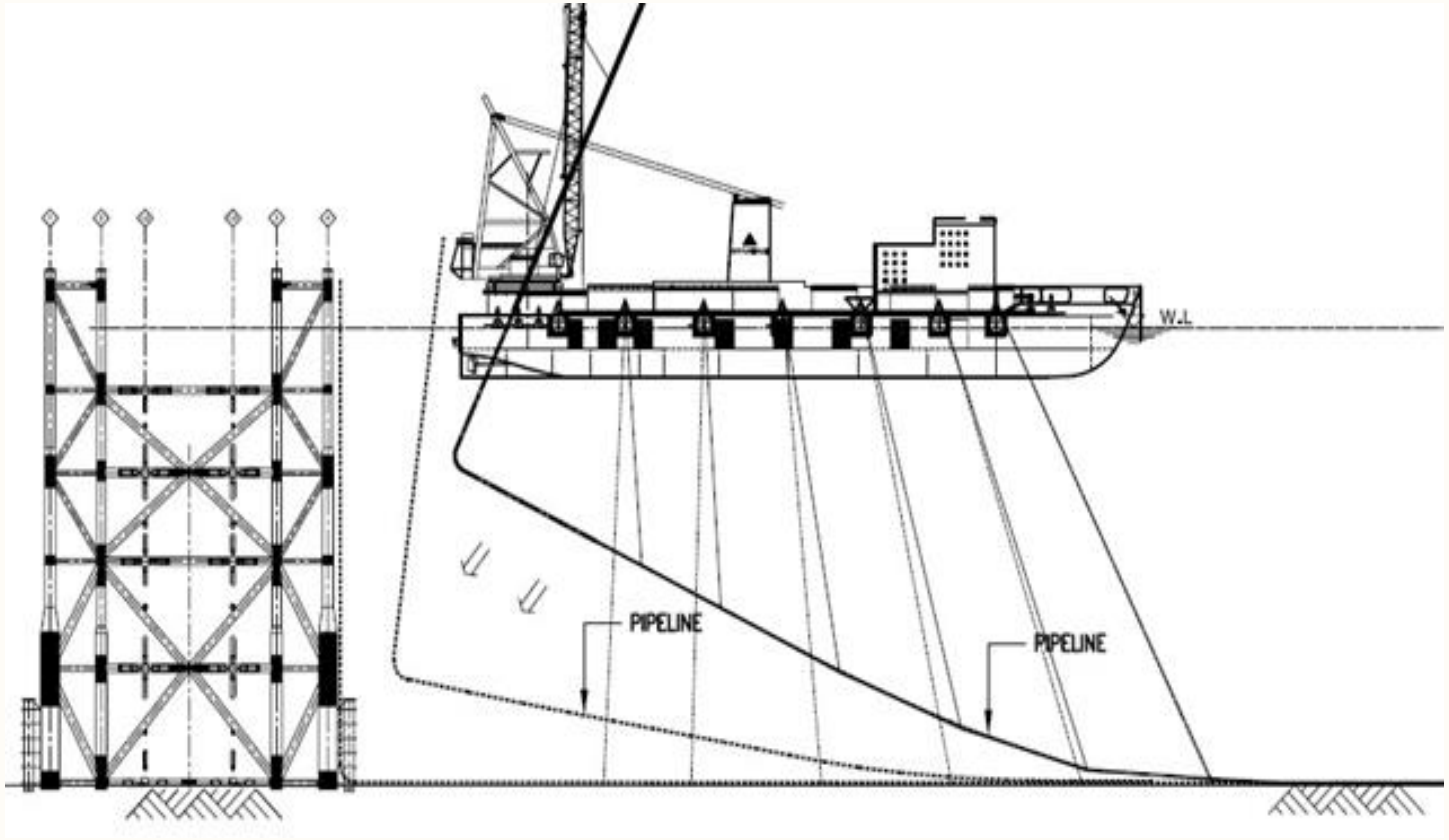
Lifting of riser assembly with dog-leg being stalked-on to lifted pipe end

Welding of riser assembly to the pipeline end – note stabbing guide now functions as tie-in clamp used to hold both ends in position and steady for welding

Another type of tie-in clamp – more elaborate (Saipem)
(it is purely a tie-in clamp and does not function as stabbing guide)

Wrapping of field joint after successful welding & NDT

Lowering of pipeline and riser assembly after the riser has been successfully stalked on and welded to the pipeline



Examples of Riser Installation with U-Bend Expansion Loop by Stalk-on Method


HYUNDAI- 2500

FIG. 3.3A

ATTACHMENT CONFIGURATION FOR LIFT

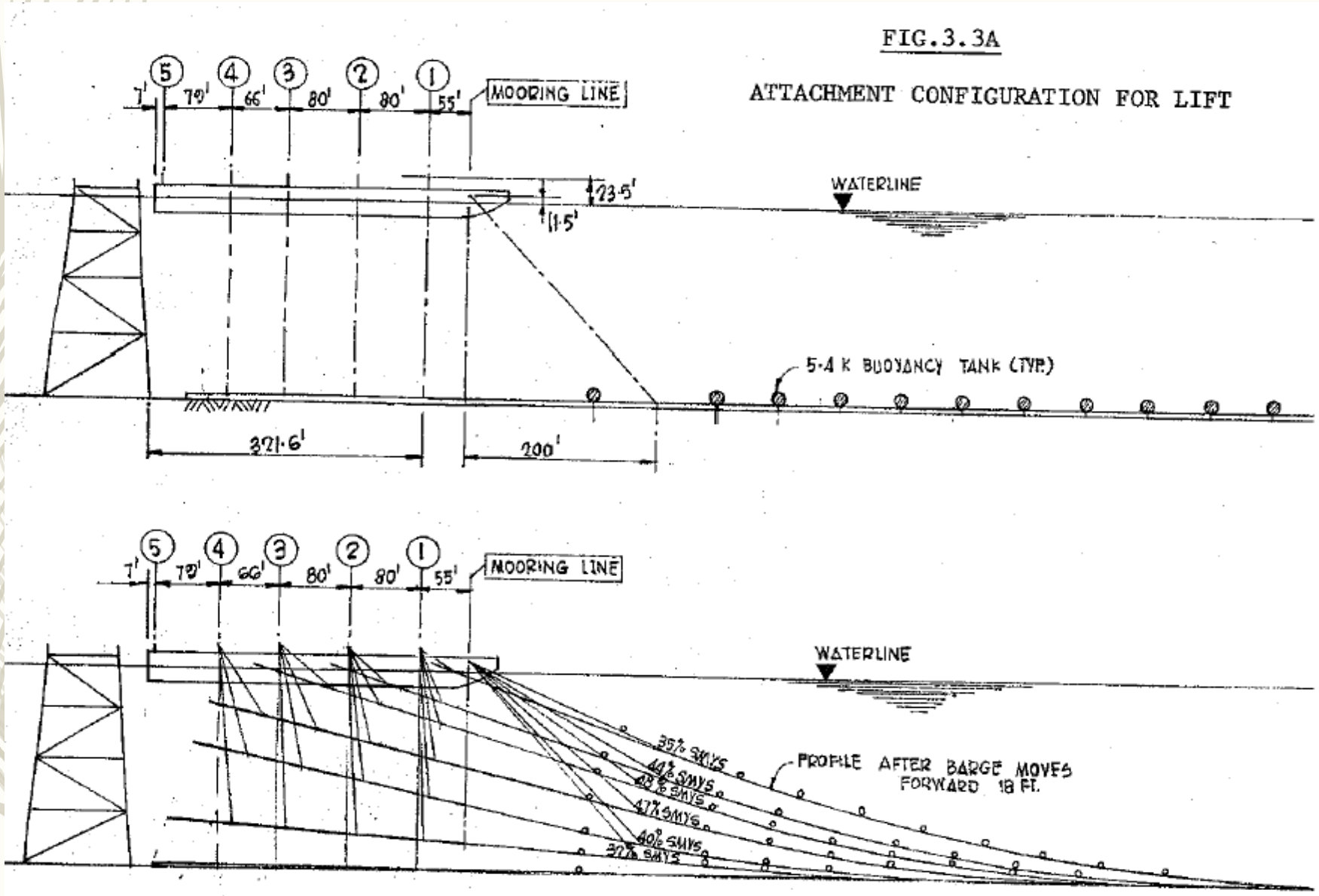
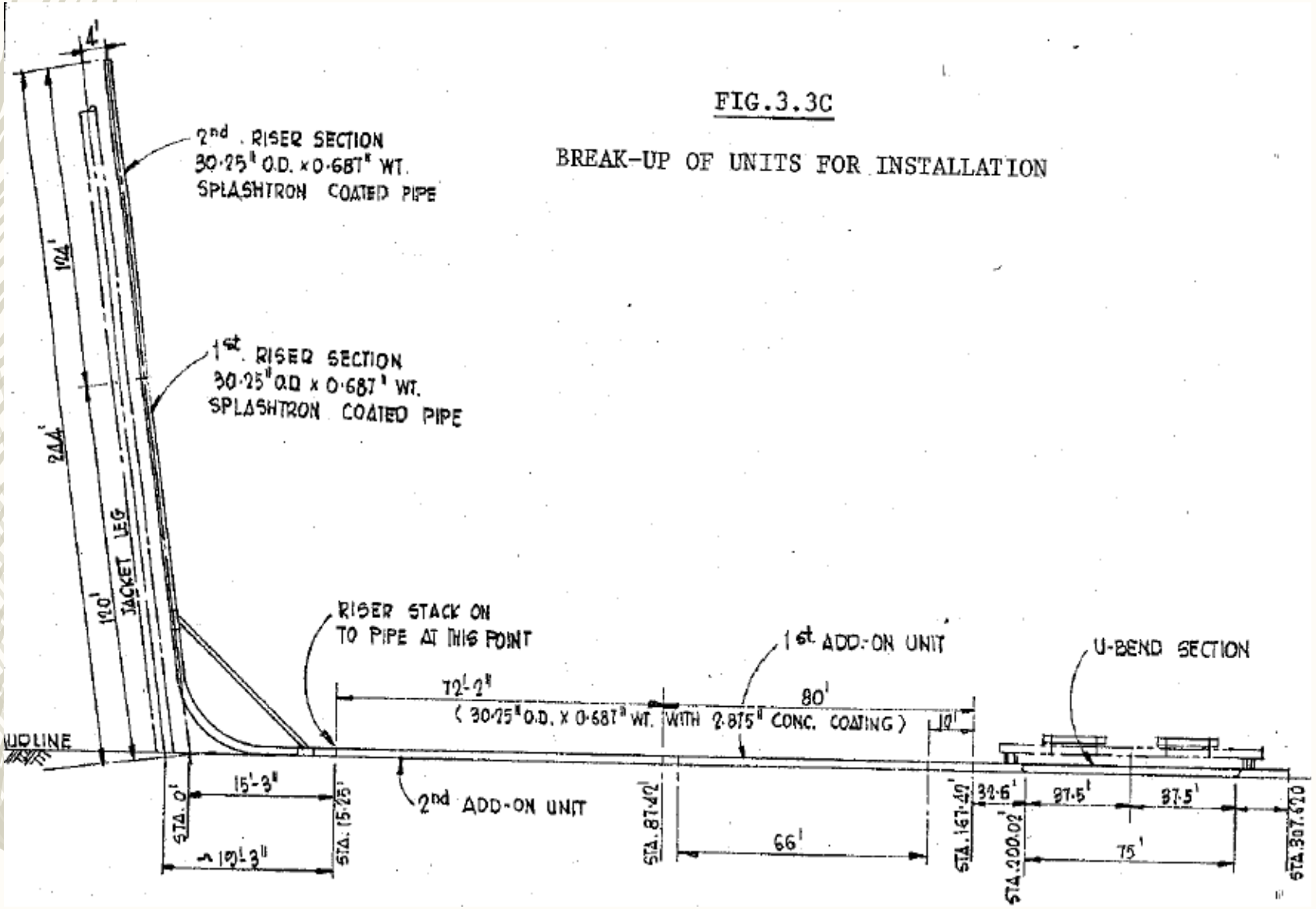


FIG.3.3C

BREAK-UP OF UNITS FOR INSTALLATION



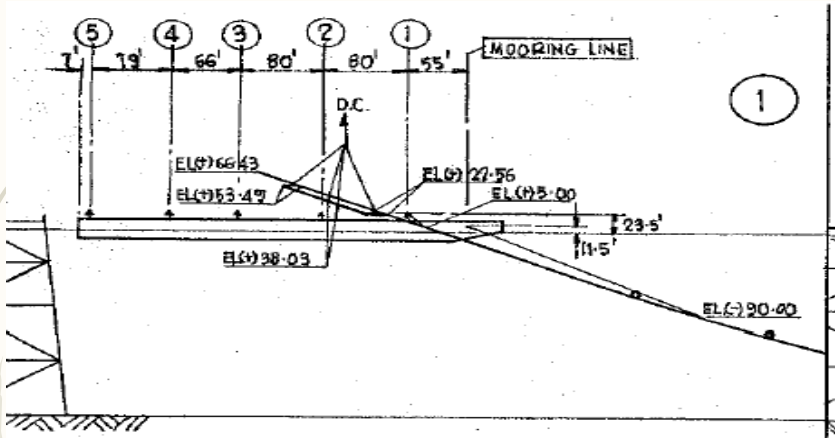


FIG. 3.3D.1 ATTACHMENT OF U-BEND TO PIPE

1. Excess pipe is cut off from cantilever until 10' of cantilever pipe is left.
2. The U-bend is lifted by derrick crane, aligned with pipe and welded on.

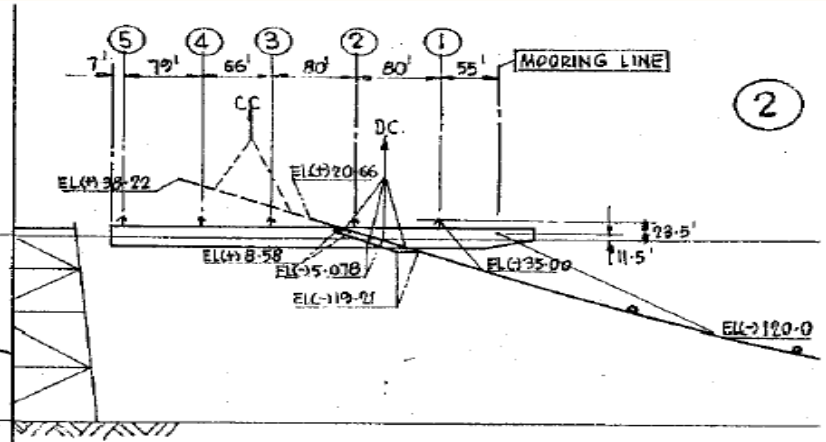


FIG.3.3D.2 STOCK ON OF 1ST ADD-ON UNIT

1. Crawler crane is used for lifting 1st add-on unit.

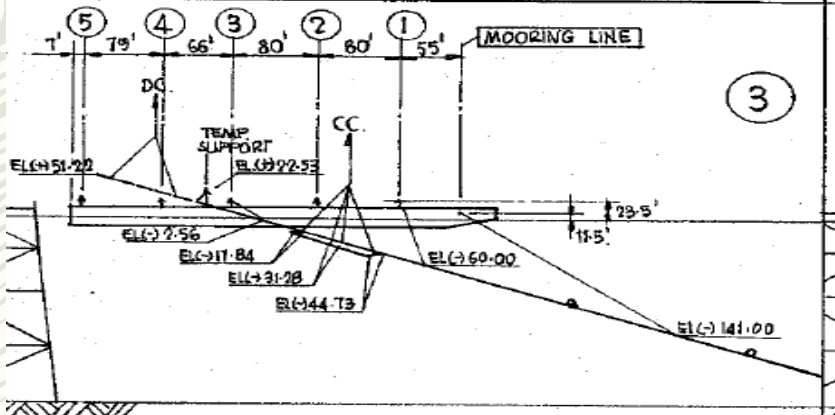


FIG.3.3D.3 STOCK ON OF 2ND ADD-ON UNIT

1. With U-bend supported by derrick crane pipe is lowered until U-bend is submerged.
2. Derrick crane is replaced by crawler crane.
3. Derrick crane lifts up 2nd add-on unit, aligns it and add-on is welded.

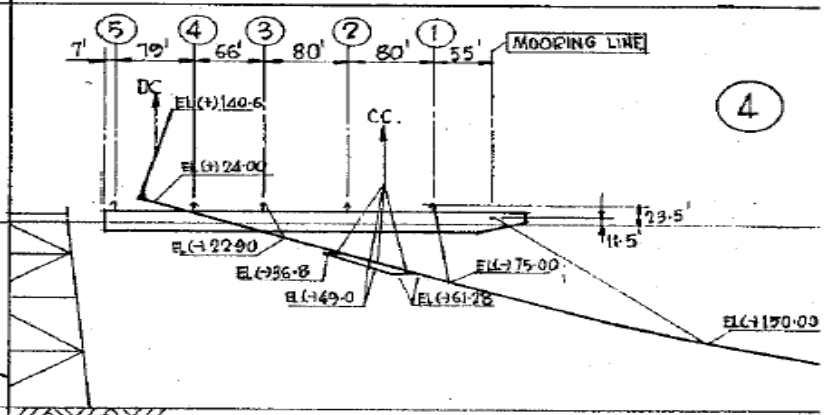


FIG.3.3D.4 INSTALLATION OF 1ST RISER SECTION

1. 1st riser section is lifted by derrick crane , aligned with pipe and welded on.

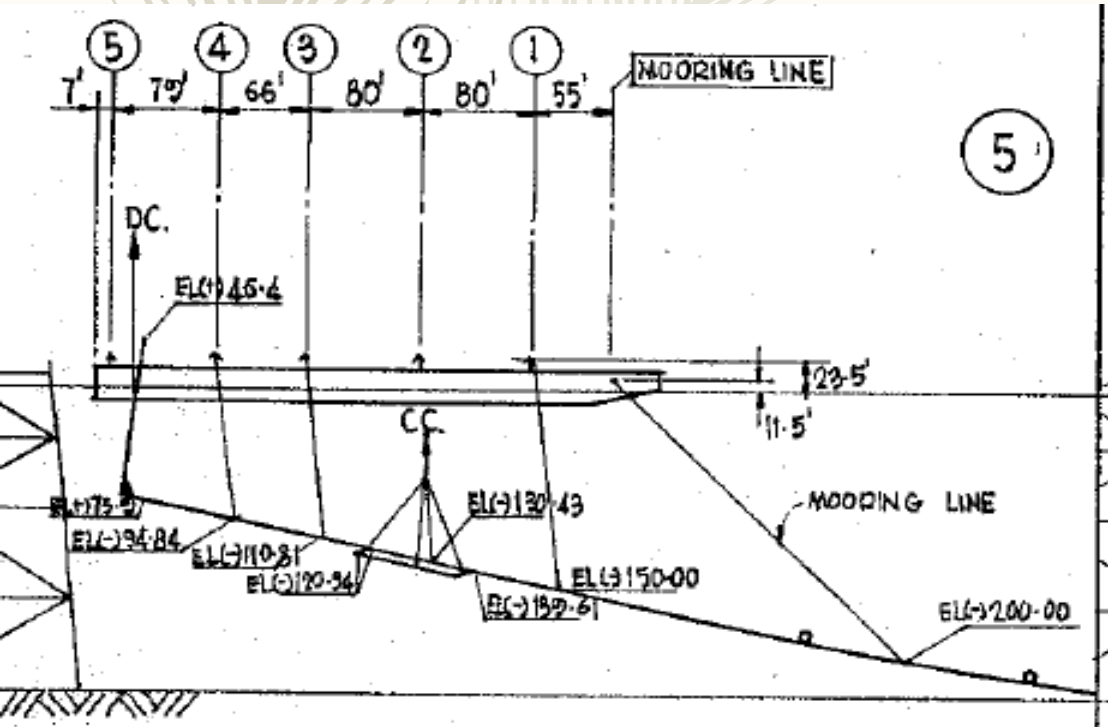


FIG.3.3D.5 LOWERING OF RISER TO SEABED

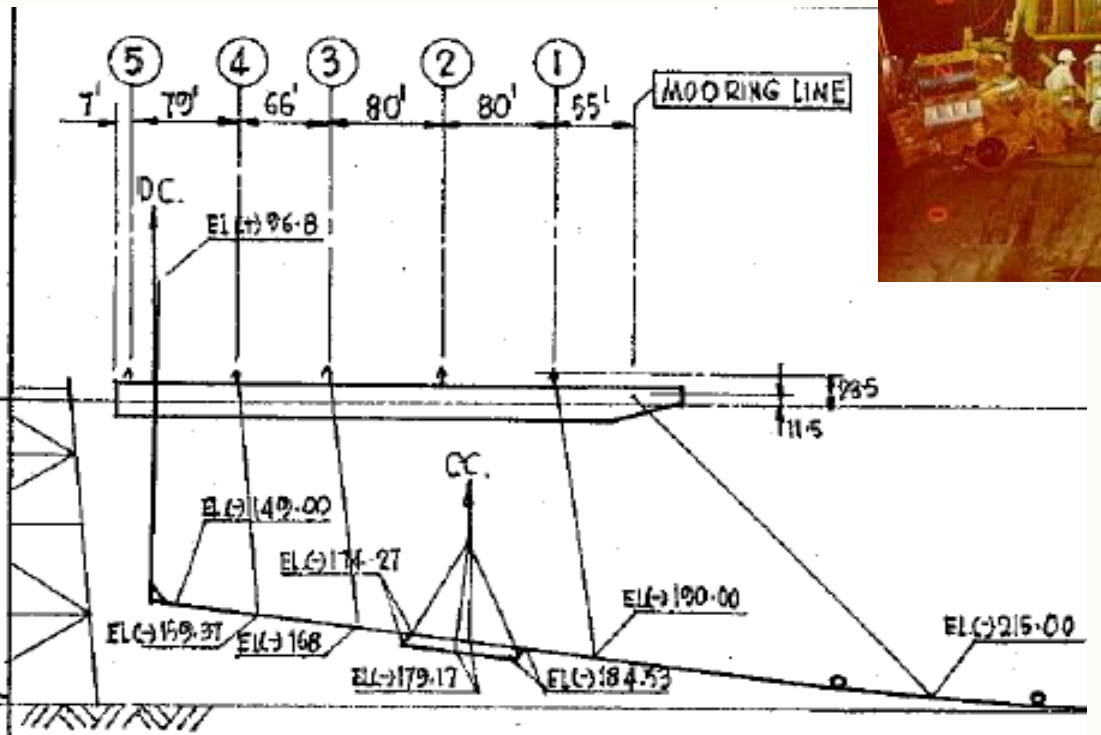
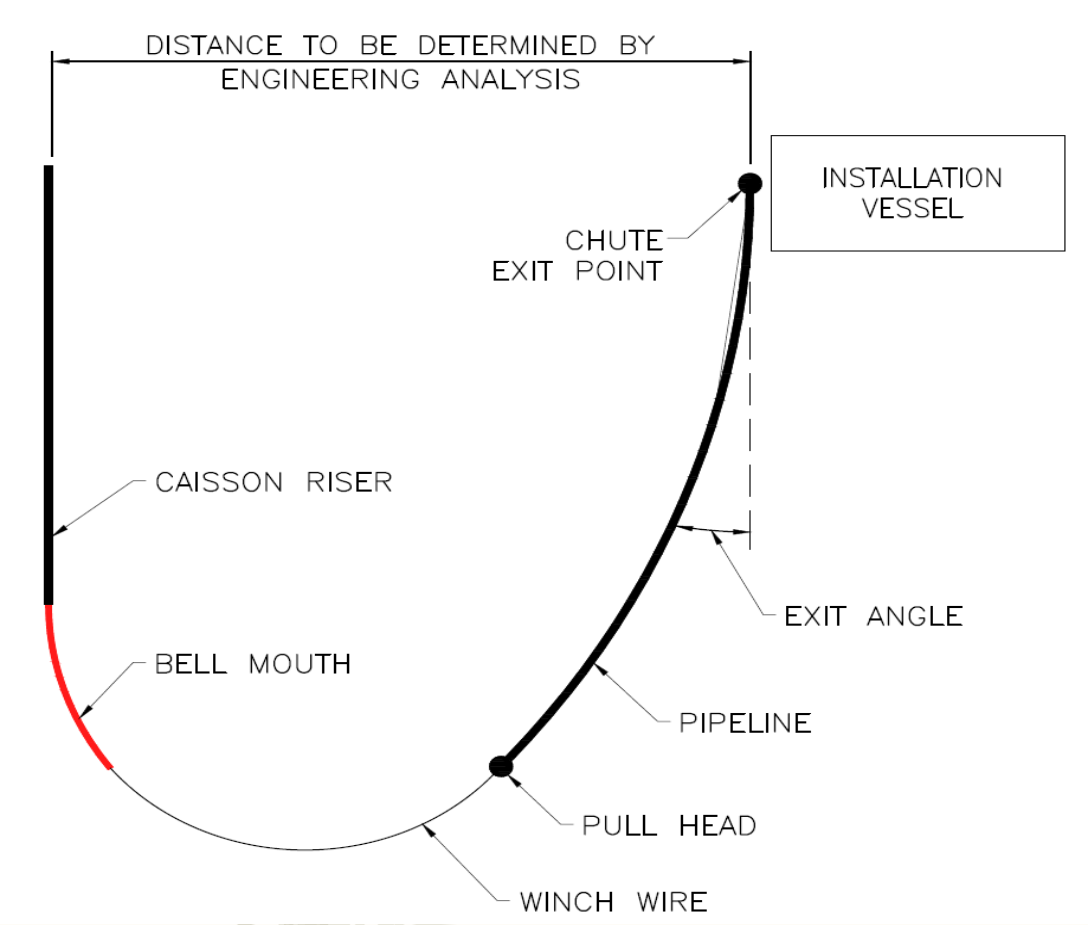


FIG.3.3D.6 LOWERING OF RISER TO SEABED

Riser Installation by Pull-in Method for small rigid or flexible riser

Schematic showing the pull-in of small diameter rigid or flexible pipeline



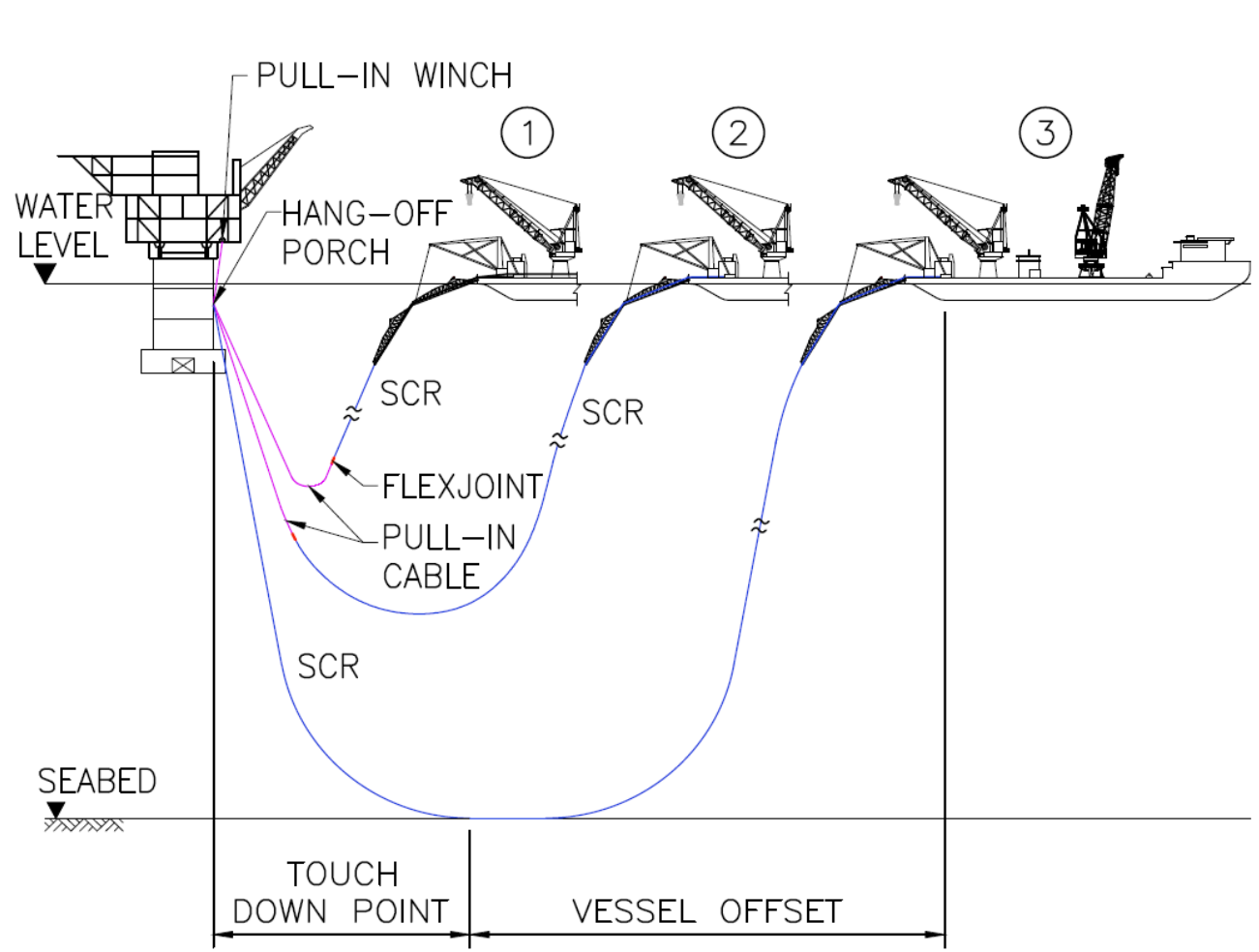
For small diameter pipelines, installation of the riser can be carried out by a pulling-in process. This applies to both fixed platforms in shallow water as well as a floating platform in deeper water. For such an operation, a J-tube or I-tube should be pre-installed on the platform.

- The lay vessel is positioned a pre-determined distance from the J/I-tube (pre-determined by lay analysis);
- A pull wire is retrieved from the J/I-tube and handed over to the lay vessel where it is attached to the pulling head;
- The pull wire at the platform end is connected to a pulling winch.
- As the pipeline is being laid, the pull wire is pulled in by the pulling winch. By doing so, the pipeline is being pulled towards the J/I tube at the platform.
- ROV and/or divers monitor the profile of the pipeline as it is being pulled.
- Once the pull head is safely pulled to the platform, the pull head is secured and normal pipelay operation commences as the vessel lays away the pipeline with normal lay conditions.

Typical example of small diameter pipeline being installed through a J/I tube and subsequently secured at the top of the tube – pictures taken on flexible pipeline but same principle applies for rigid pipeline

Installation of Steel Catenary Risers

Installation of Steel Catenary Risers (Deep Waters)

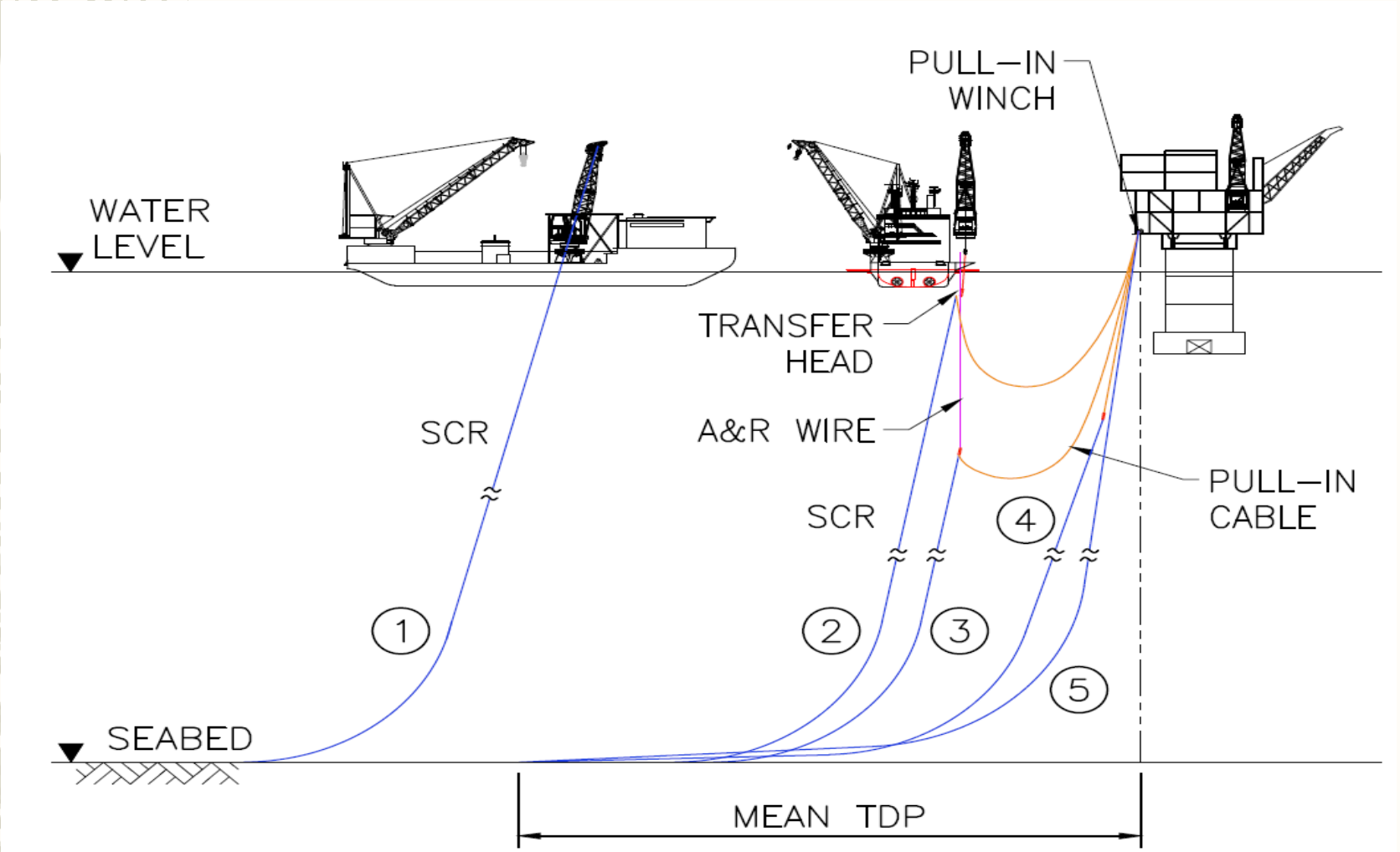


Applies to:

- ✓ *S-lay*
- ✓ *J-lay*
- ✓ *Reel-lay*

Schematic Showing SCR Installation during Pipelay Initiation (a.k.a. First End Sequence)

Installation of Steel Catenary Risers (Deep Waters) – Cont'd

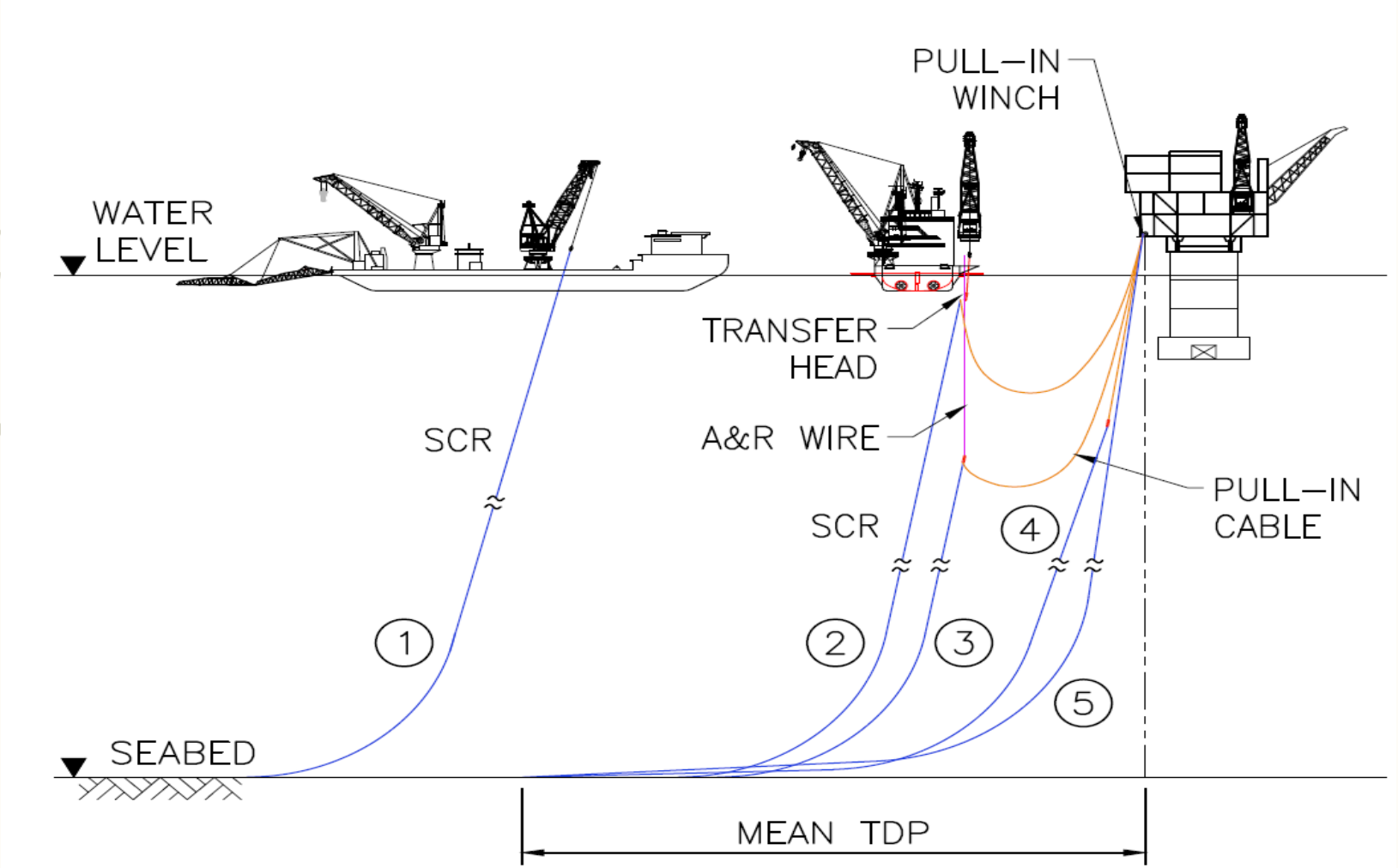


Typically used for:

- ✓ *J-lay*
- ✓ *Reel-lay*

Schematic Showing Abandonment Method of SCR Installation (a.k.a. Second End Sequence or Handover Method)

Installation of Steel Catenary Risers (Deep Waters) – Cont'd



SCR is laid & abandoned on seabed; Subsequently, recovered from wet-parking and Iinstalled on the Platform

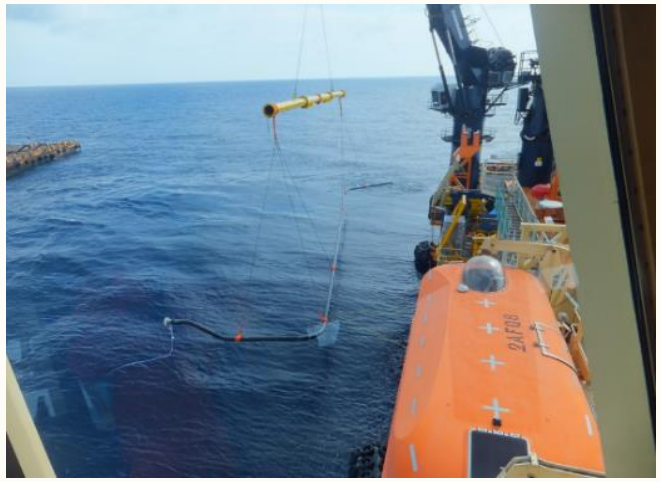
Typically used for:

- ✓ *S-lay*
- ✓ *Reel-lay (if platform not yet installed)*
- ✓ *J-lay (if platform not yet installed)*

Schematic Showing Abandonment Method of SCM Installation (a.k.a. 2nd End Sequence)

Installation of Risers and Spools by Subsea Tie-in

Examples of spools with flanges at the ends being deployed for subsea connection

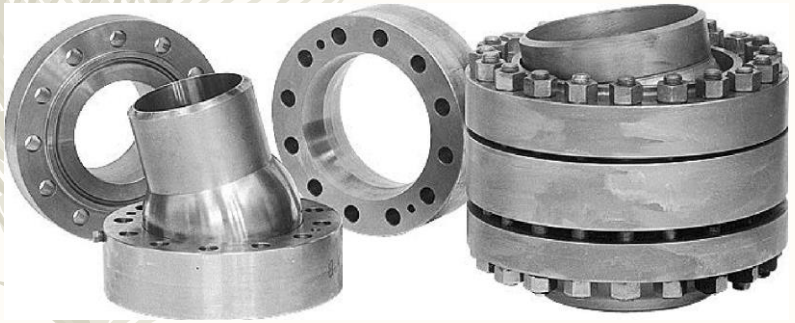


Underwater bolt tightening using Hydratight bolt tensioning equipment.

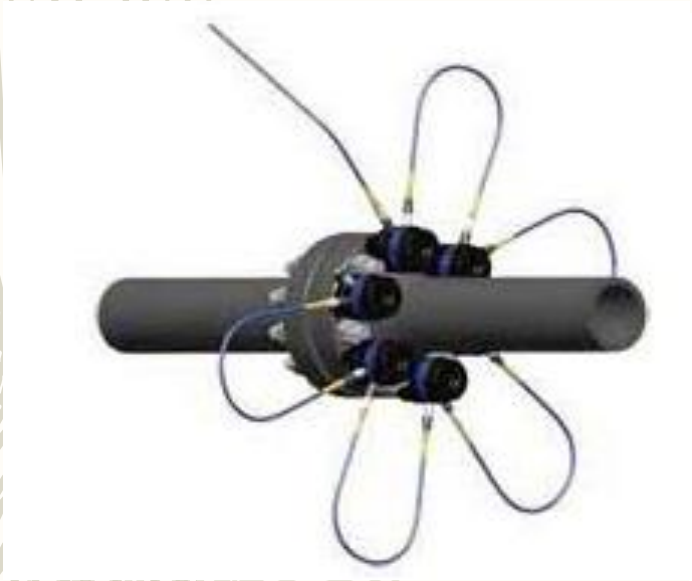
Types of flanges typically used for subsea application

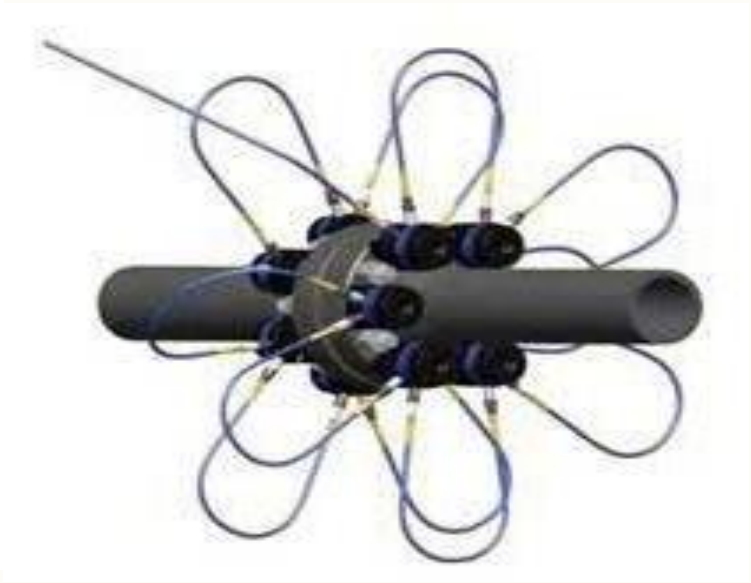
Typical weld-neck flanges

Typical swivel ring flanges



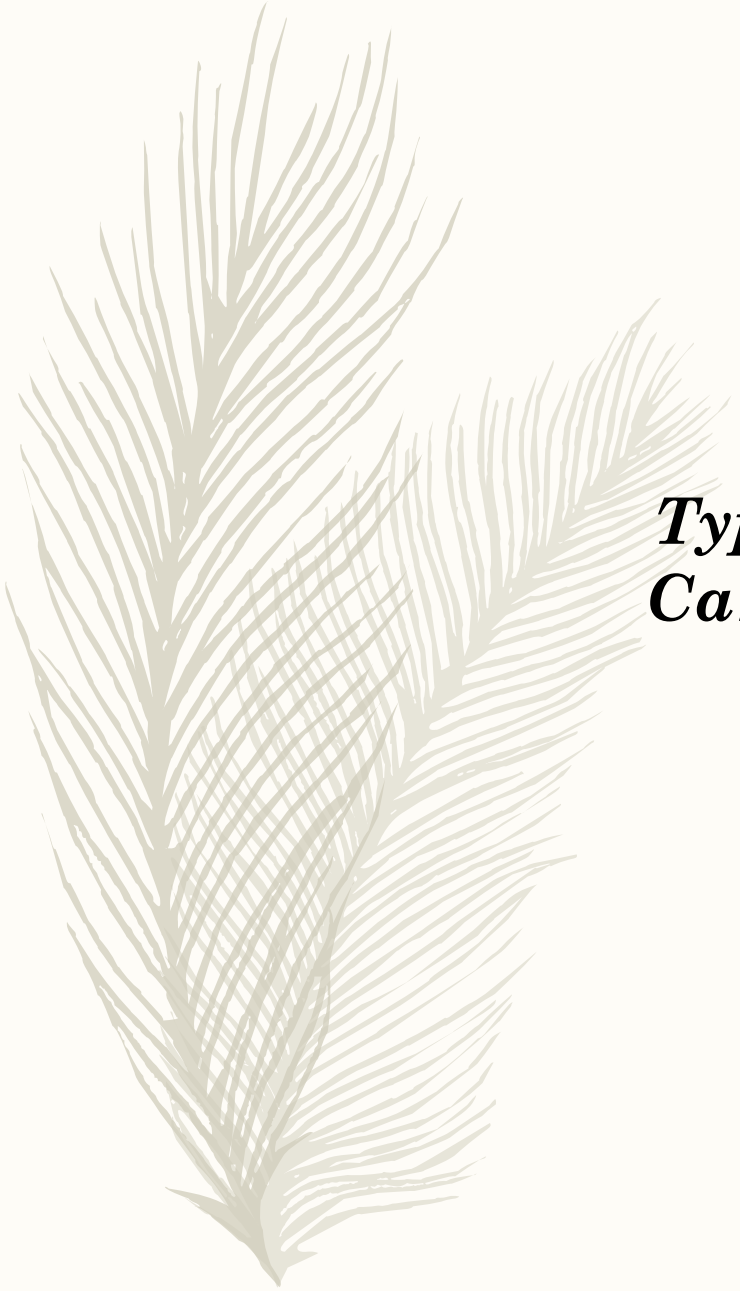
Typical misalignment flanges





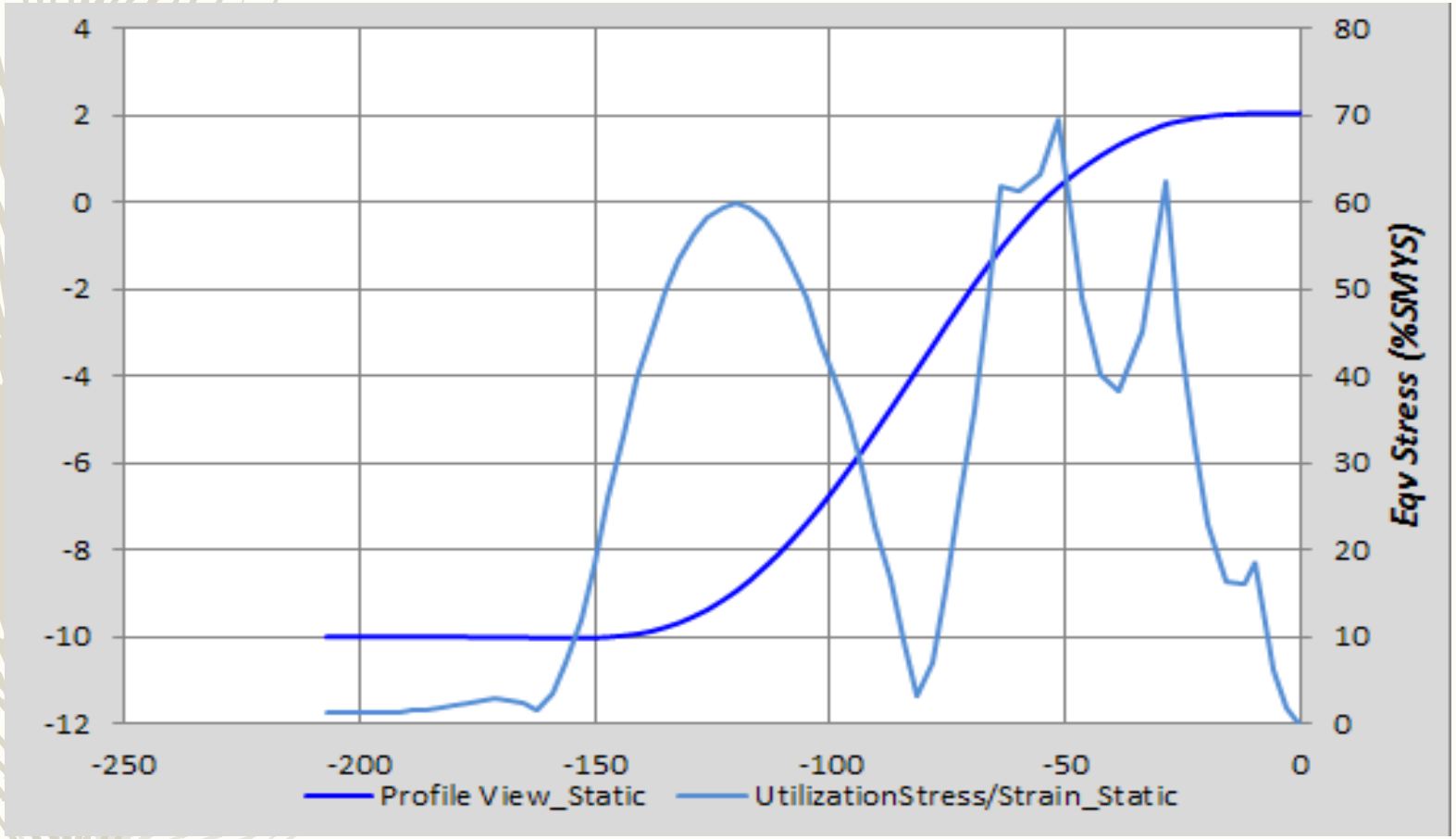
The general procedure for bolt tensioning is as follows (for each tool connected to one stud):

- Bolt tensioner is fitted over the stud
- Hydraulic pressure is applied to the tensioner (which then stretches the stud)
- Stud's nut is wound down against the joint face
- Pressure is released and the tool is removed



Typical Installation Engineering Carried out for Riser Installation

Typical analysis carried out for davit lifting of pipeline

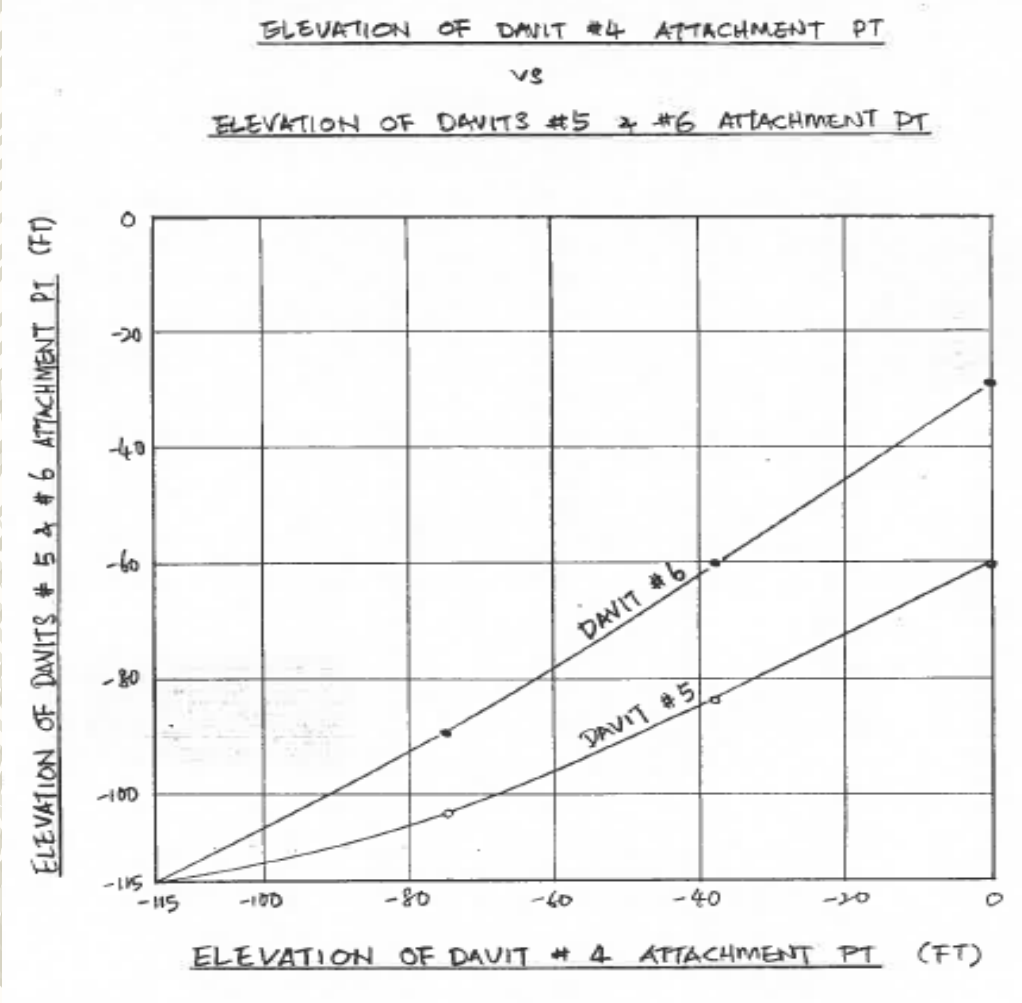


Typical output from installation analysis for davit lift showing pipeline profile and corresponding stresses along the pipeline during final stage of lift

Common software (finite element or finite difference)

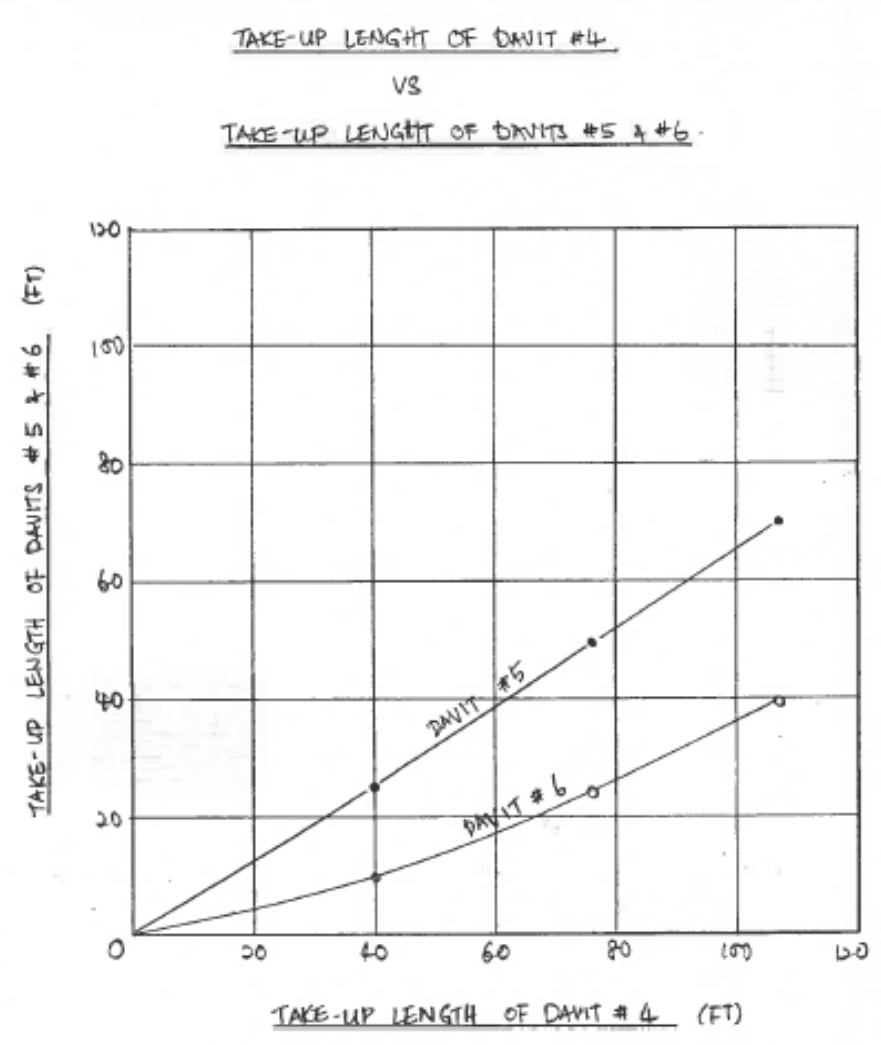
- *OFFPIPE*
- *ORCAFLEX*
- *PIPELAY*

Typical guidelines for field application using relative elevation of davit attachment points



Graph provides co-relationship between elevations of the respective davit attachment points on the pipeline.
Following this co-relationship during the lift will result in the pipeline being lifted up very smoothly and in a very controlled manner, with stresses within the design allowable

Typical guidelines for field application using relative take-up length of davit lines



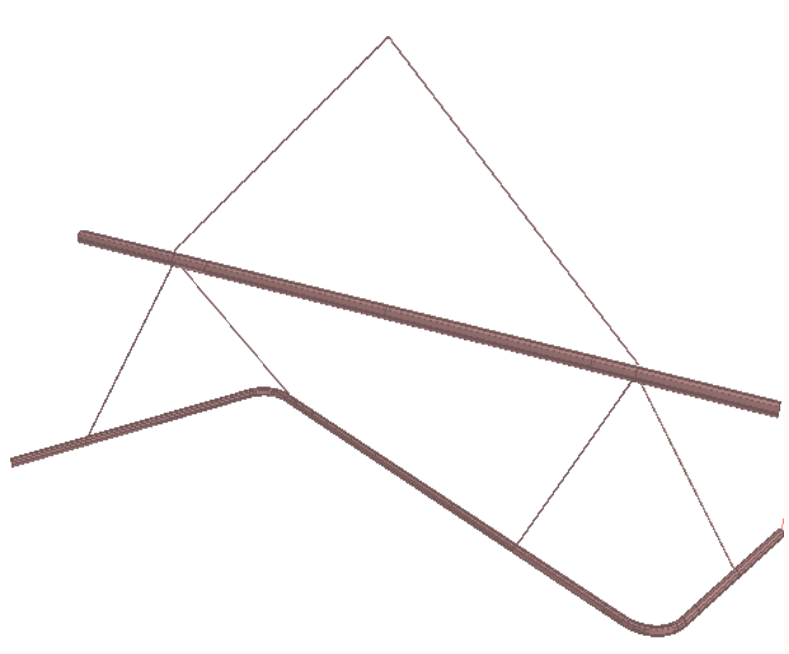
This graph provides the relationship between the take-up-lengths of the respective davit attachment points on the pipeline.

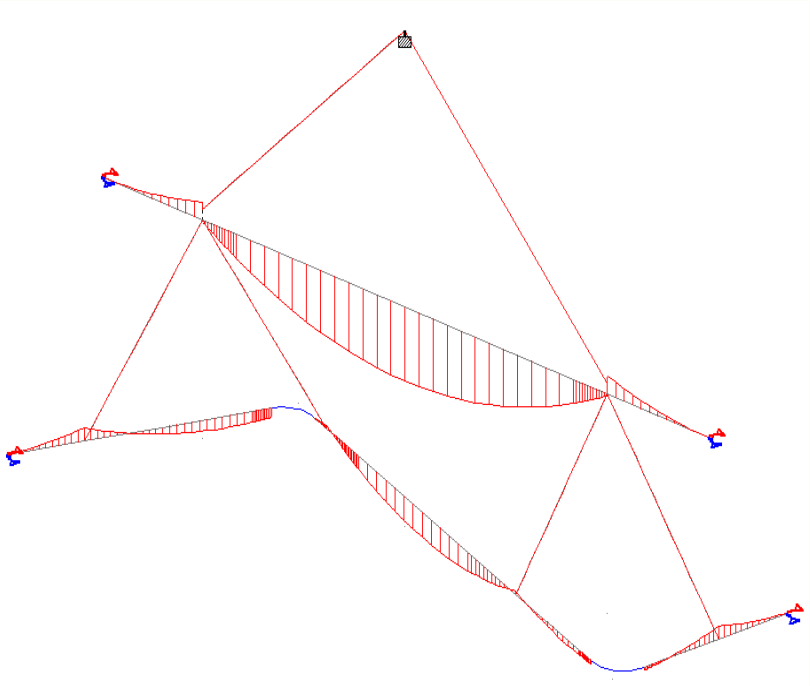
Take-up length refers the amount of davit line being ‘taken-up’ or wind-in.

Following this co-relationship during the lift will result in the pipeline being lifted up very smoothly and in a very controlled manner, with stresses within the design allowable.

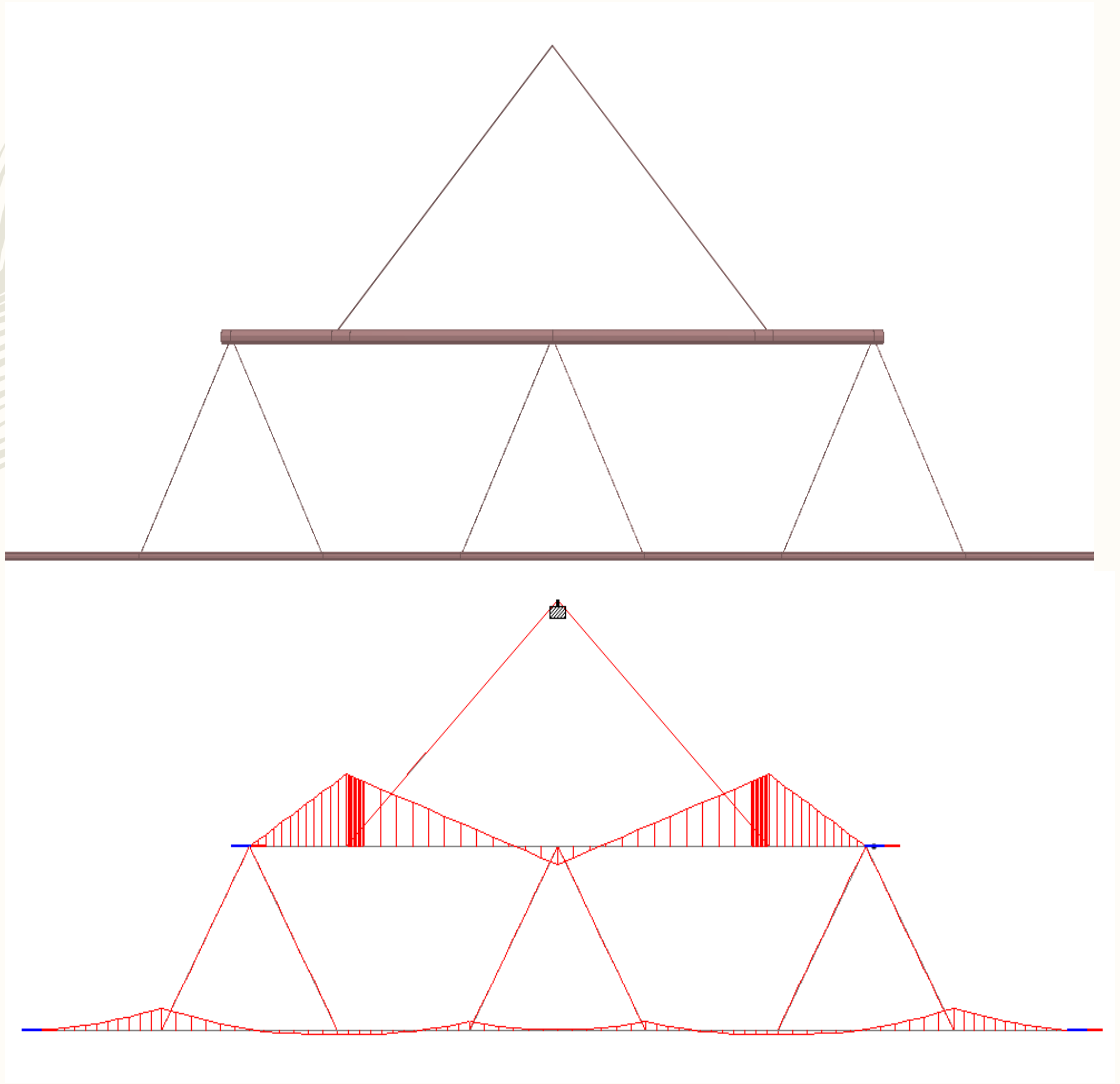
In theory, the use of either preceding or present guidelines will have the same outcome

Example of spool lifting with spreader bar and resultant stresses on bar and spool

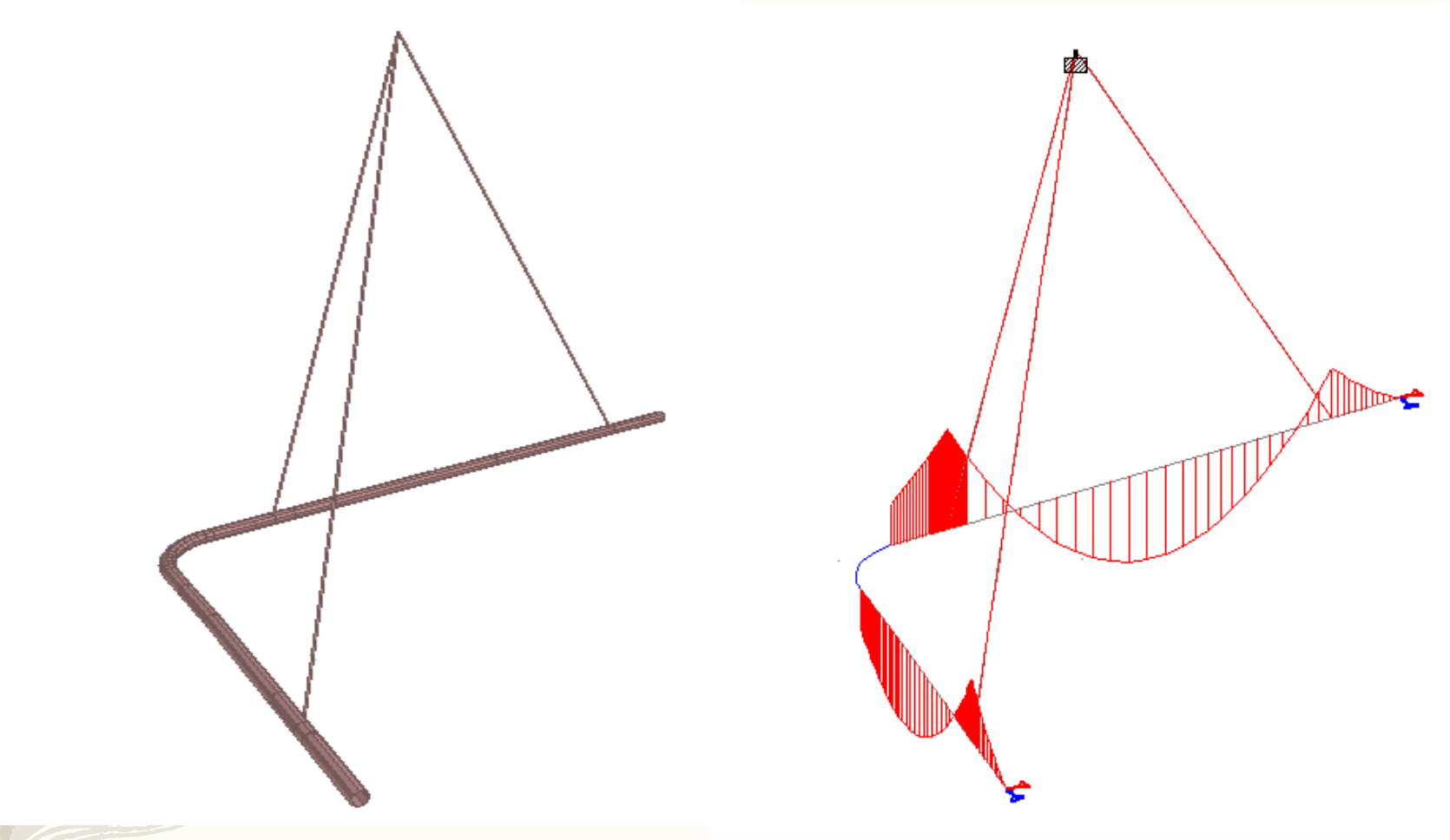




Example of lifting of ultra-long spool with spreader bar and resultant stresses on bar and spool

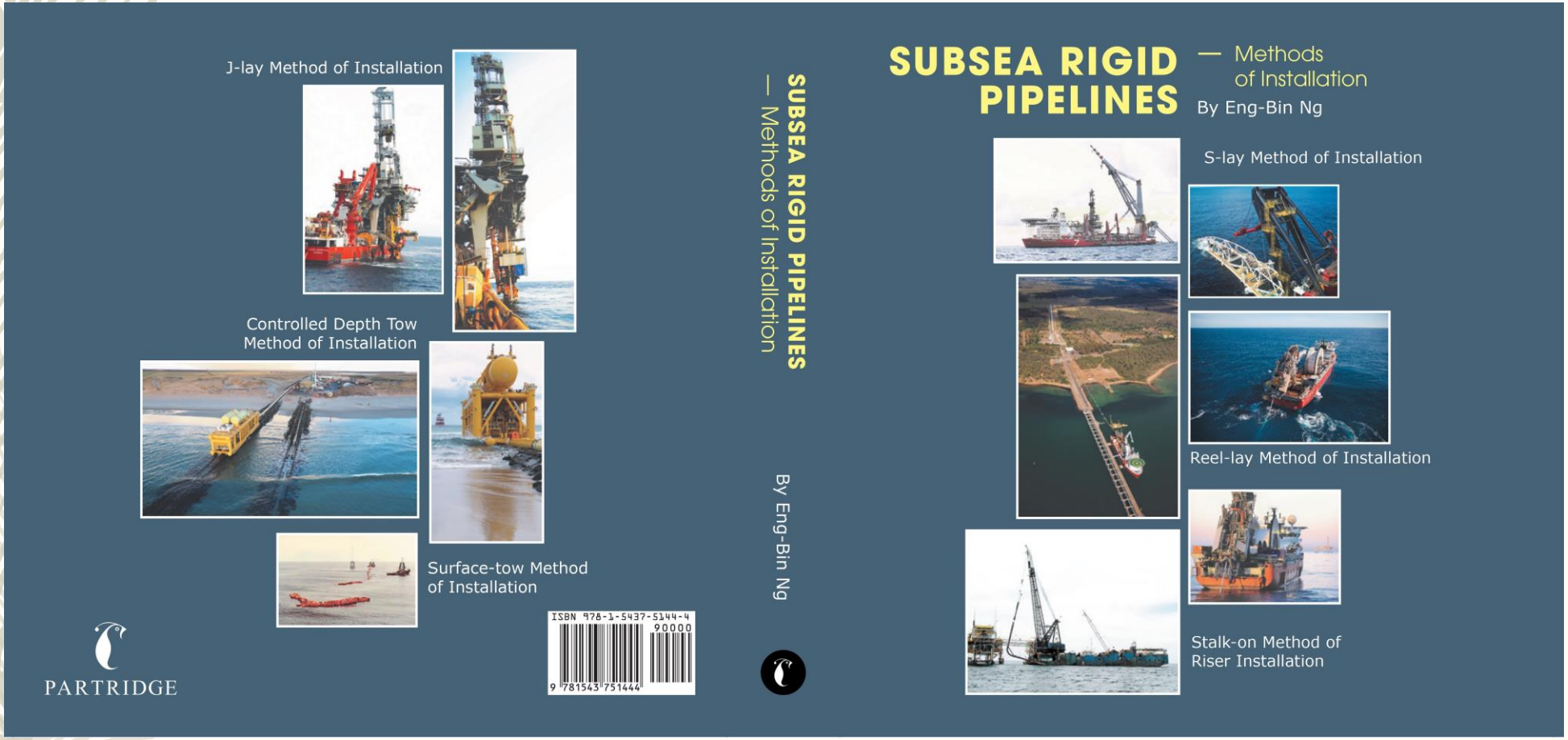


Example of lifting of 'elbow type' spool on single point and resultant stresses on bar and spool



For more details on riser installation, refer to my new book:

“Subsea Rigid Pipelines – Methods of Installation”



QUESTIONS ????