Offshore Pipeline Installation

Presented by:

Naveen Ravirala

Author:

Craig Lamison

Pipeline Installation

Definitions

- Primarily covers steel pipe
- 3” nominal diameter and up
- Other alternatives:
  - Flexible pipe
  - Coiled tubing
- Welded connections used for pipelines
- Mechanical connections viewed as:
  - Less reliable
  - More expensive

Definition - Installation

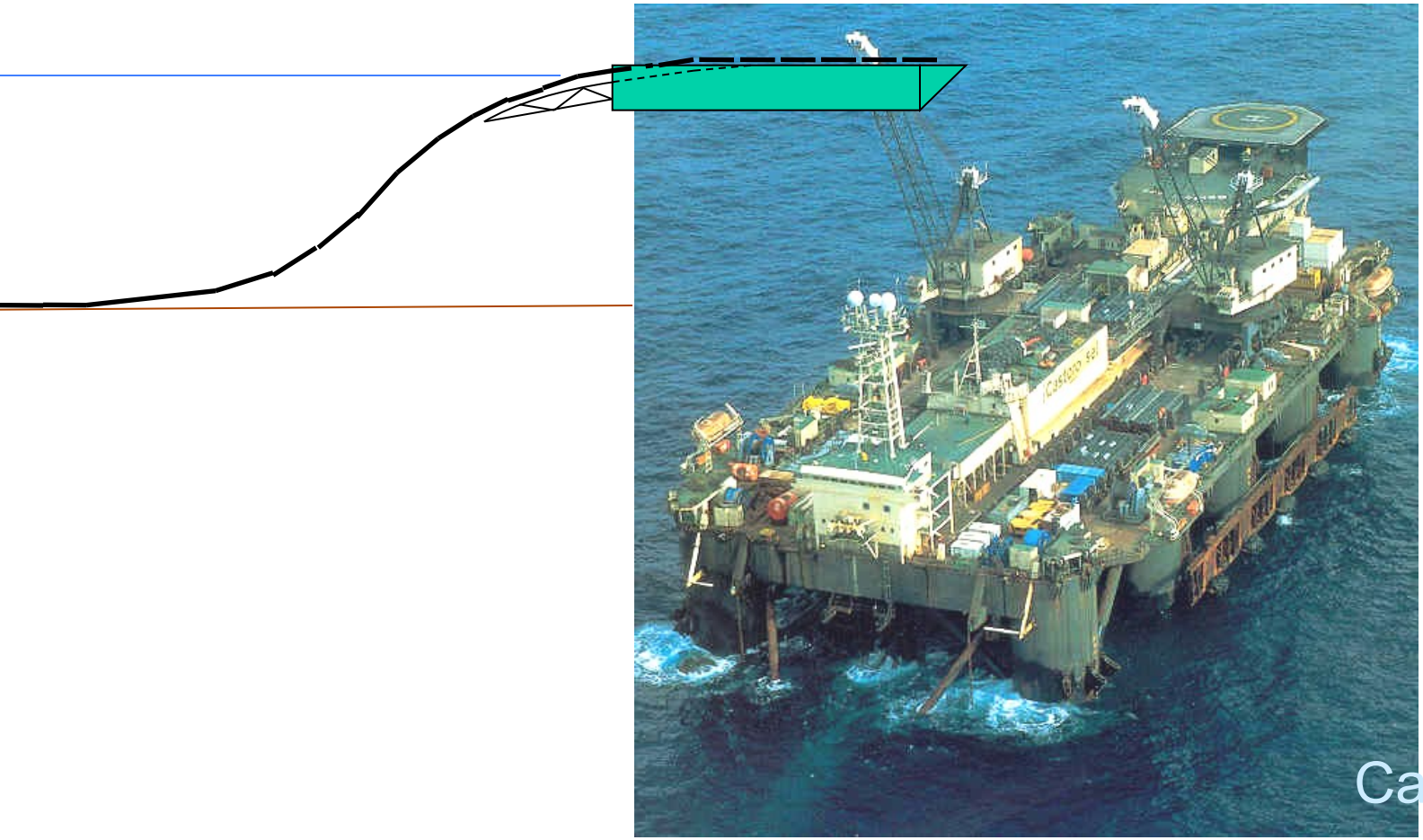
- Fabricating line from joints above water
- Placing line undamaged on the seabed
- Associated activities such as
  - Initiations/Terminations
  - Abandonment/Recovery
  - Tie-ins
  - Risers
  - Burial
  - Shore Approach

What Can Go Wrong – Pipe Buckle

Pipeline/Flowline Installation

- Offshore Fabrication
  - S-Lay (conventional pipelay)
  - J-Lay
- Onshore Fabrication
  - Reel-Lay
  - Tow

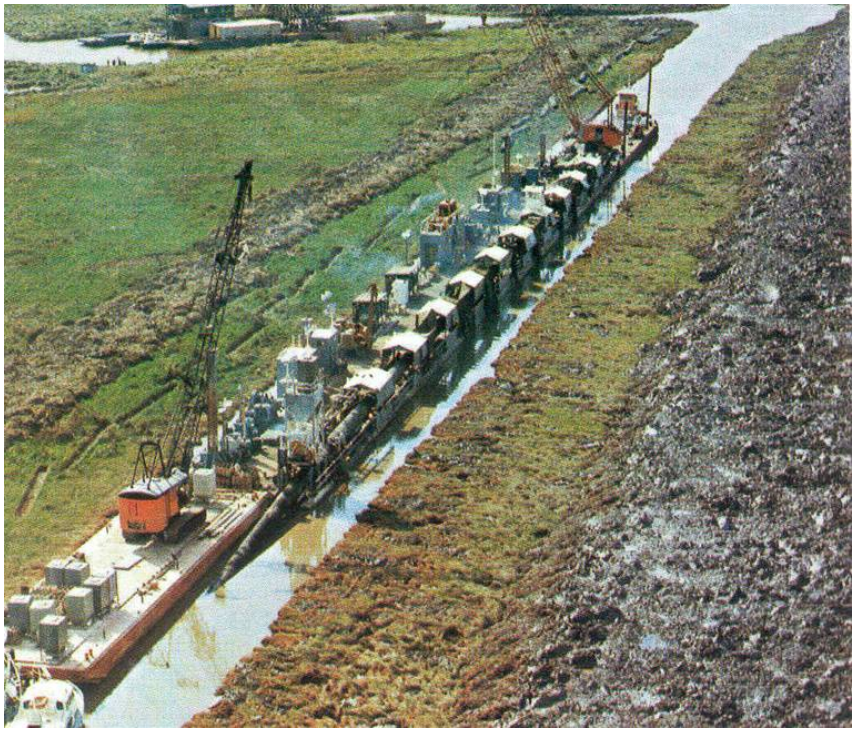
S-Lay (Conventional Pipelay)



Castoro Sei

S-Lay History

- First “offshore” pipeline
- Galveston Bay
- Laid by Brown & Root
- Technology adapted from marsh lay
- Linked “Spud” barges



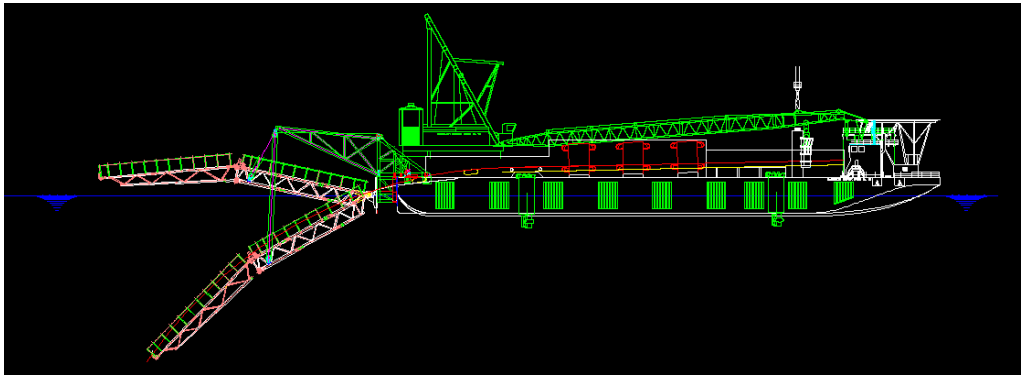
S-Lay (Conventional Pipelay)

S-Lay (Conventional Pipelay)

S-Lay

Monohull (Hercules, DB-16, Solitaire etc.)

- Semi-submersible (Castoro Sei, Semac)
- Lay rates typically on order of 2.0 miles per day
- Commonly used for shallow water
- Some dynamically positioned deepwater vessels
- Good for long distance & large diameter pipelines

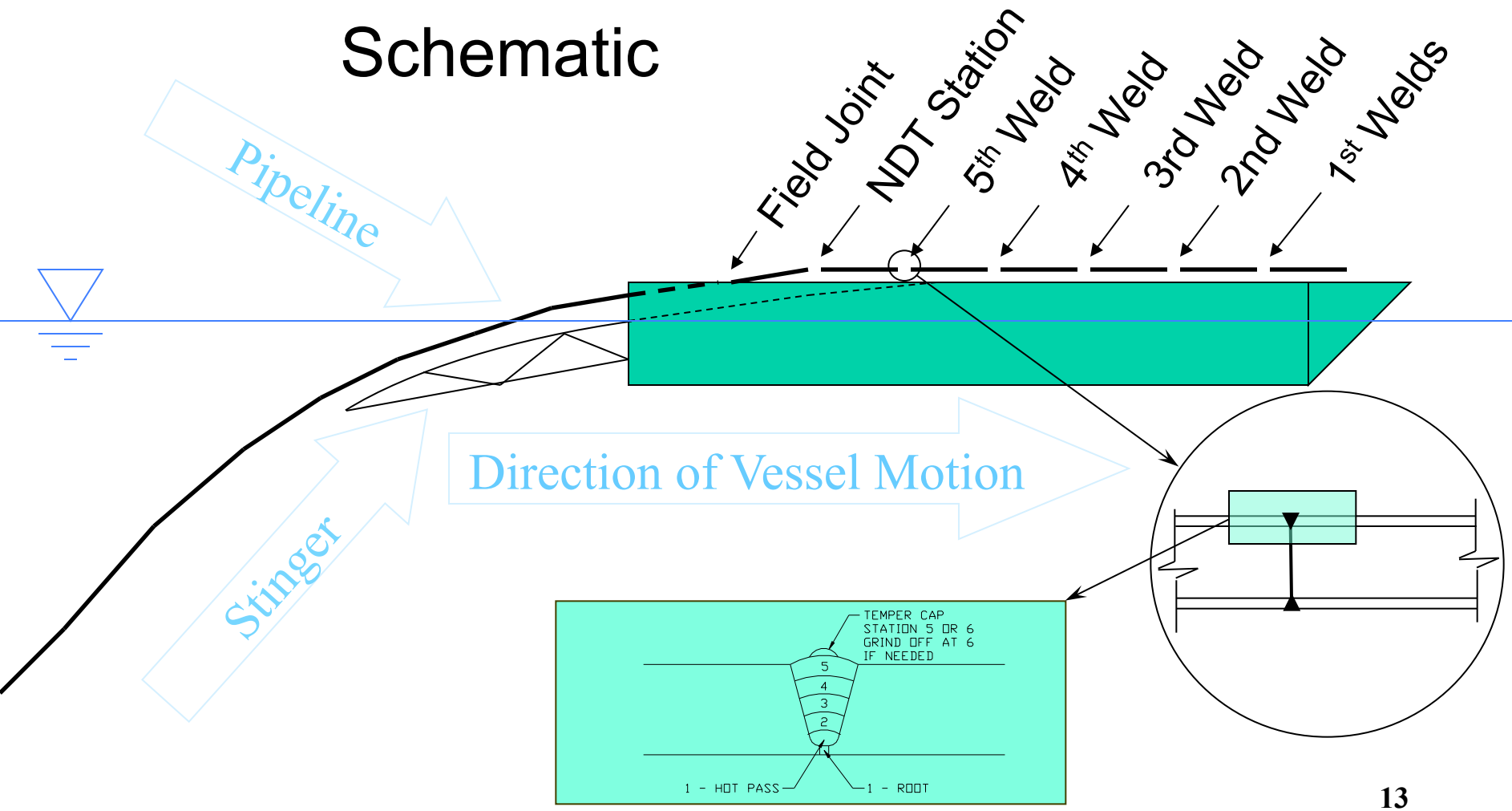


S-Lay

- Pipe brought aboard in 40-80 ft. “joints”
- Joints welded end-to-end on “firing line”
- Firing lines consist of:
  - welding stations (5-7)
  - NDE (Non-Destructive Examination or Testing - NDT) station (1)
  - field joint coating/accessory stations (1-3)

S-Lay

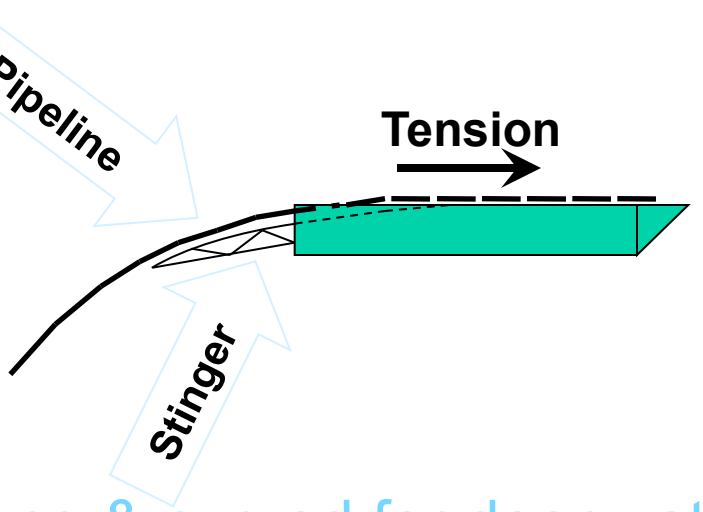
Schematic



S-Lay Welding

S-Lay Limitations

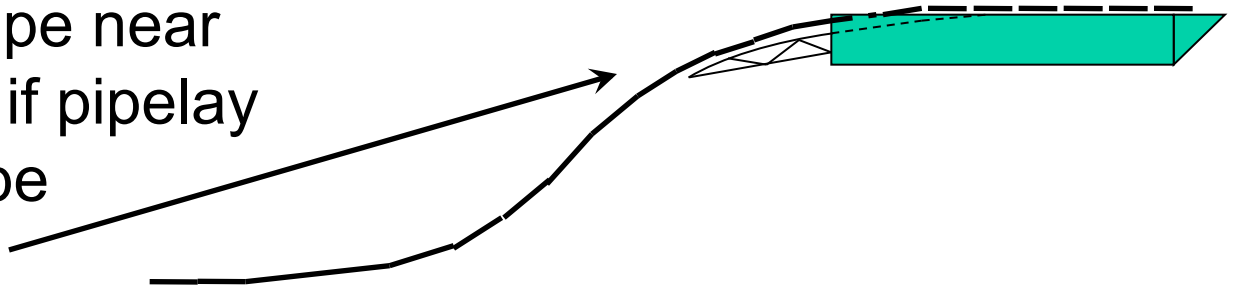
- S-lay uses a “stinger” on the stern of the barge to support the pipe “overbend”.



- Stingers are up to 300 feet long & curved for deepwater
- Radius of curvature selected to avoid pipe overstress
- Sharp radii for small dia. lines, large radii for large lines
- S-Lay generates very high top tensions
- Pipe may undergo plastic strain in the overbend

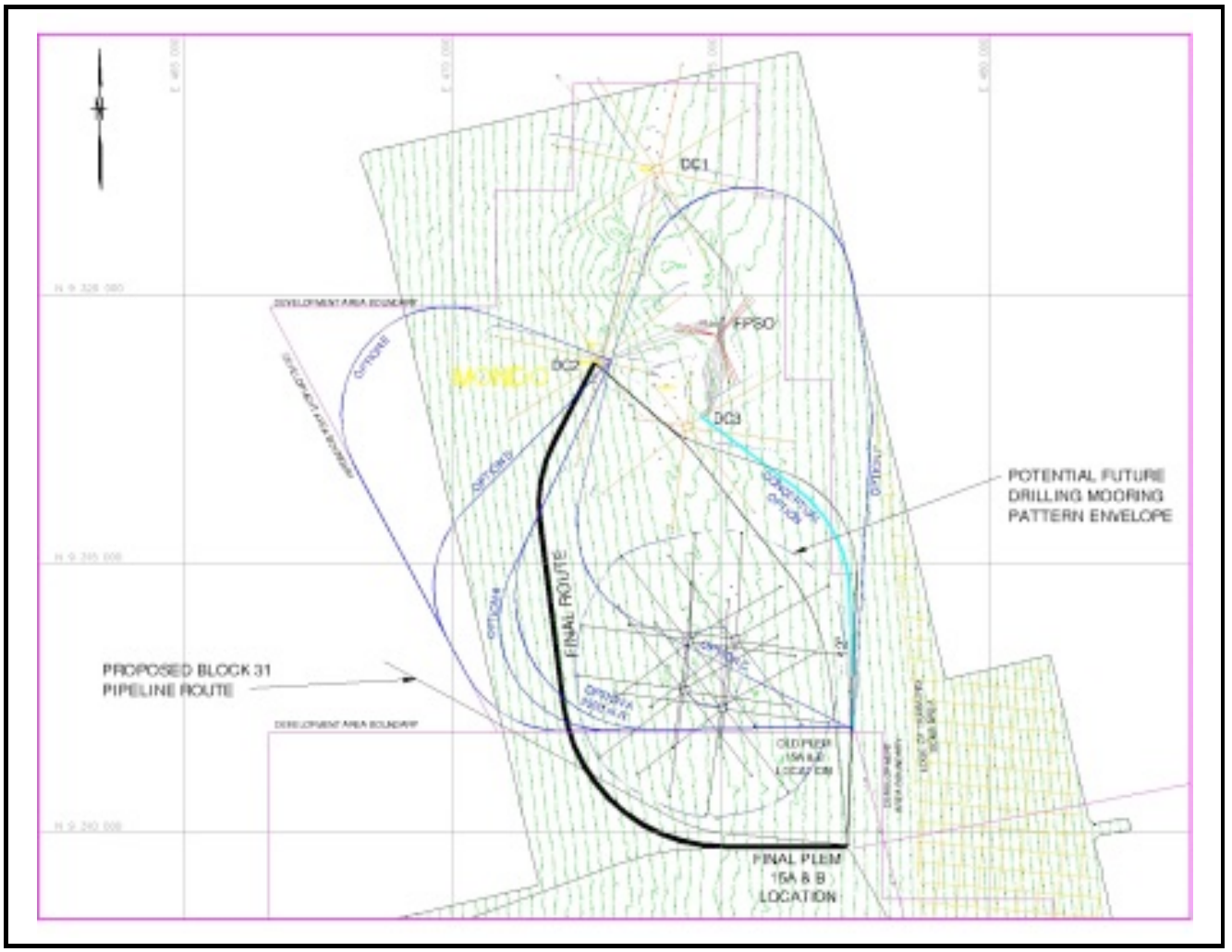
S-Lay Limitations

- Fatigue damage may occur in the pipe near the stinger tip if pipelay halted with pipe suspended.

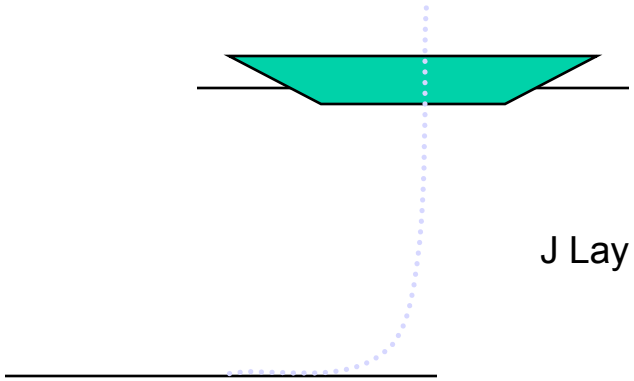


- **Sacrificial anodes collared/tapered to pass over stinger rollers**
- **Special procedures to handle PLEMs and PLETs (Pipeline End Manifolds or Terminations) over stinger**
- **Alternatively attach PLEMs and PLETs by:**
  - **lowering pipe to seabed**
  - **recovering pipeline to side of vessel**
  - **welding on the PLEM/PLET & lowering**

Vessels don’t turn on a dime



J-Lay



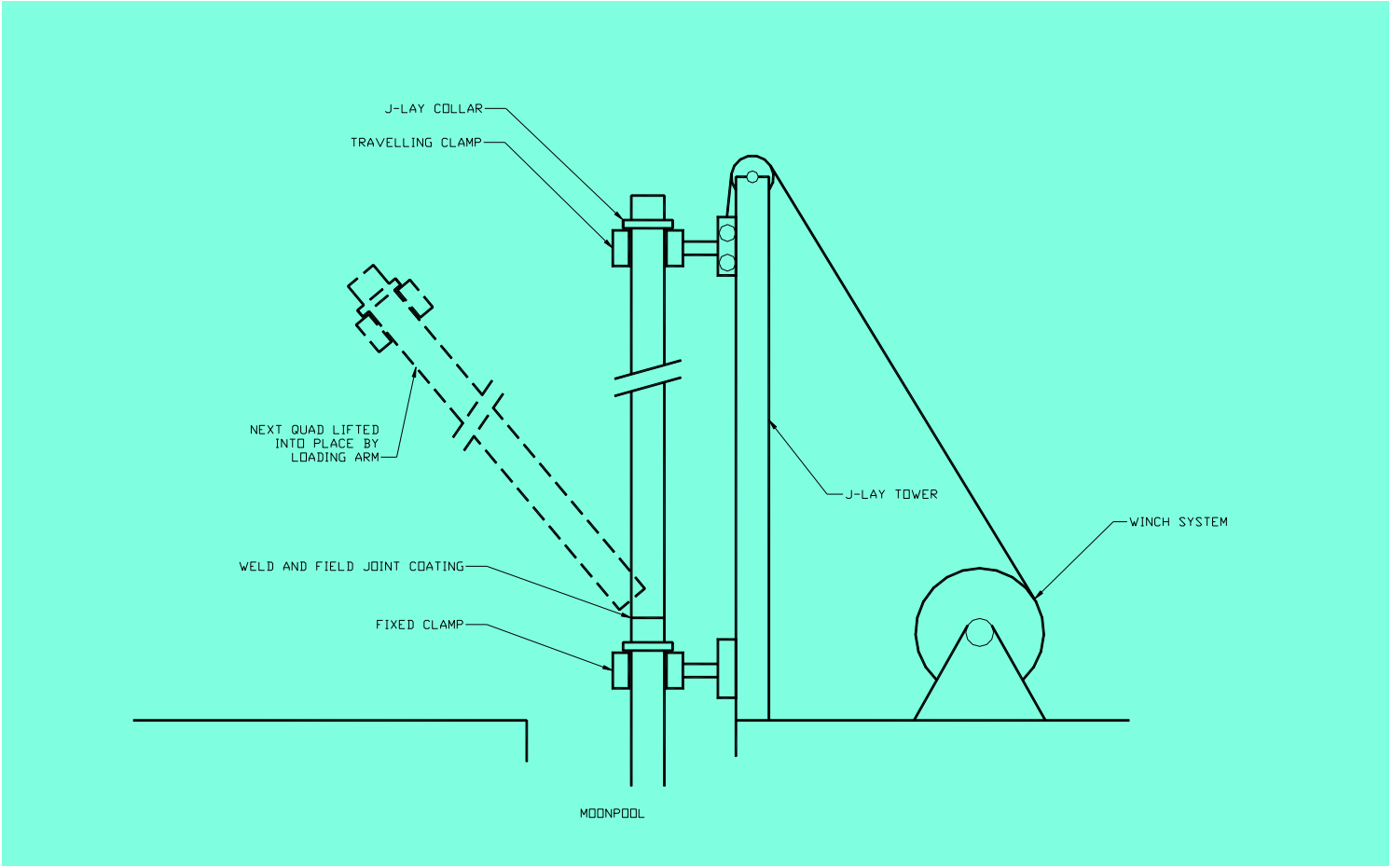
J Lay Method

Modular J-Lay

J-Lay Methodology

- Quad jointing (4) or hex jointing (6)
  - May be done onshore or offshore
- As with S-Lay, remaining welding on vessel
- Multi-joints are upended
- Welding in vertical or near-vertical configuration.
- Pipe may be supported:
  - On forged steel J-lay collars welded to pipe
  - By tensioners

J-Lay Schematic



J-Lay Advantages

- Easy to deploy pipe vertically reducing top tension
- Good for very deep water (6,000 feet plus)
- Configuration good for SCR (Steel Catenary Riser) installation
- Stinger is eliminated.
- No plastic straining of pipe.
- PLEMs and PLETs can be lowered through moonpool (subject to size).

J-Lay Disadvantages


Hang-off table open

- Slowest of all current pipelay methods
  - order of 1 mile per day.
- Still requires some welding offshore.
- Cycle times are long
  - all operations at one work station.
- If need J-lay collar, forgings add to cost
- Limited in shallow water based on diameter

Reel Lay

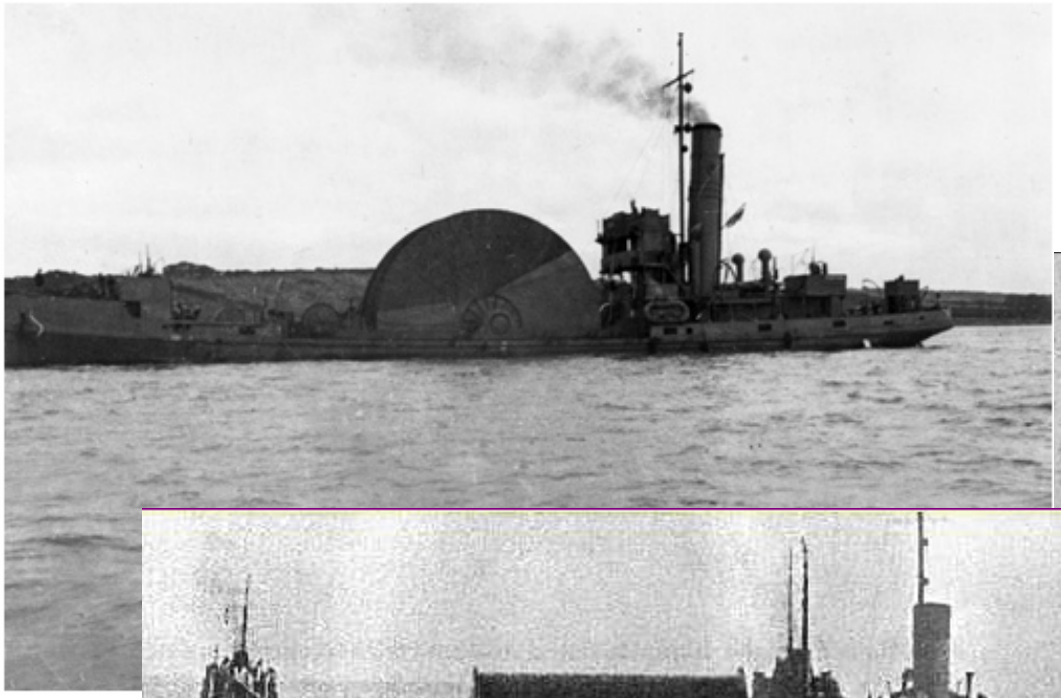
Technip Deep Blue

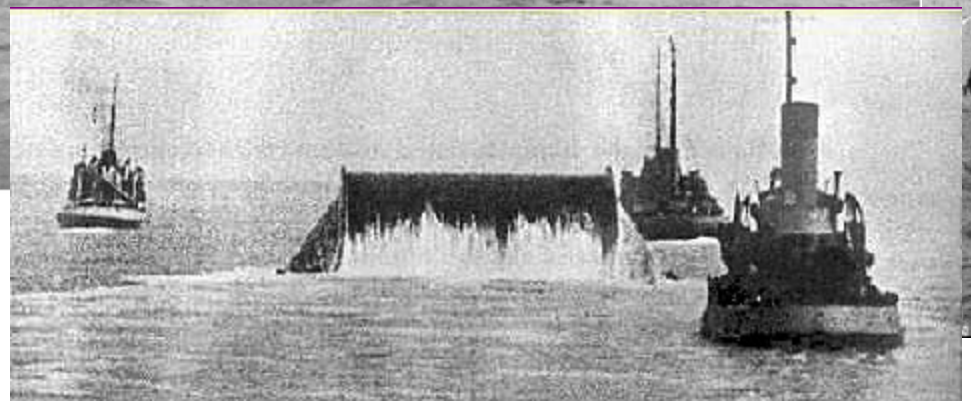
Cal Dive Kestrel

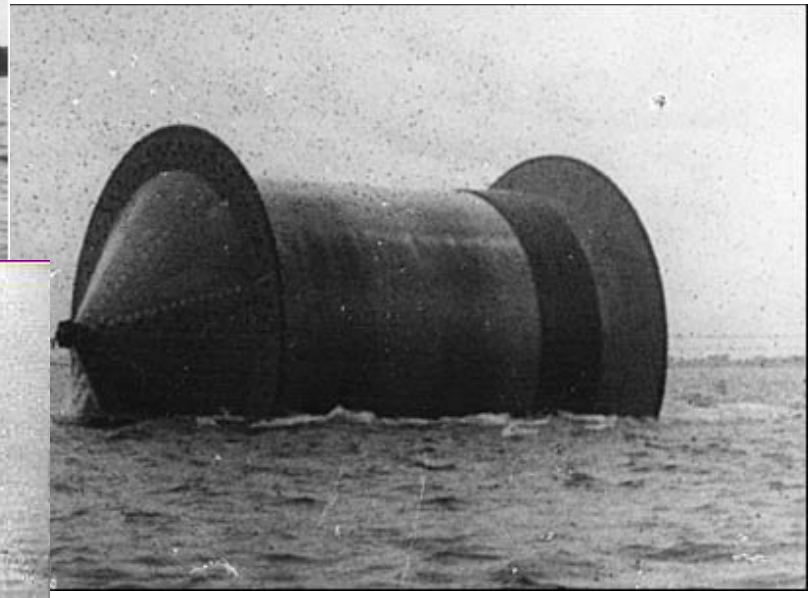
Global Chickasaw

Subsea 7 Scandi Navica

Reel-Lay History - Operation PLUTO







Pipelines under the ocean

- D-Day June 1944
  - 4-inch pipelines laid from England to France
  - Fuel for Allied invasion forces.
  - Lead pipe, wrapped in steel reinforcing cables
  - Coating -- coal tar enamel
  - Wound onto large floating reels or “conundrums”
  - Reel towed across Channel laying pipe
- 1945
  - Hopper dredge HMS Persephone converted to vertical reel
  - Laid rigid steel pipe as first reel ship.

Horizontal Reel Barges

Santa Fe Reel Barge

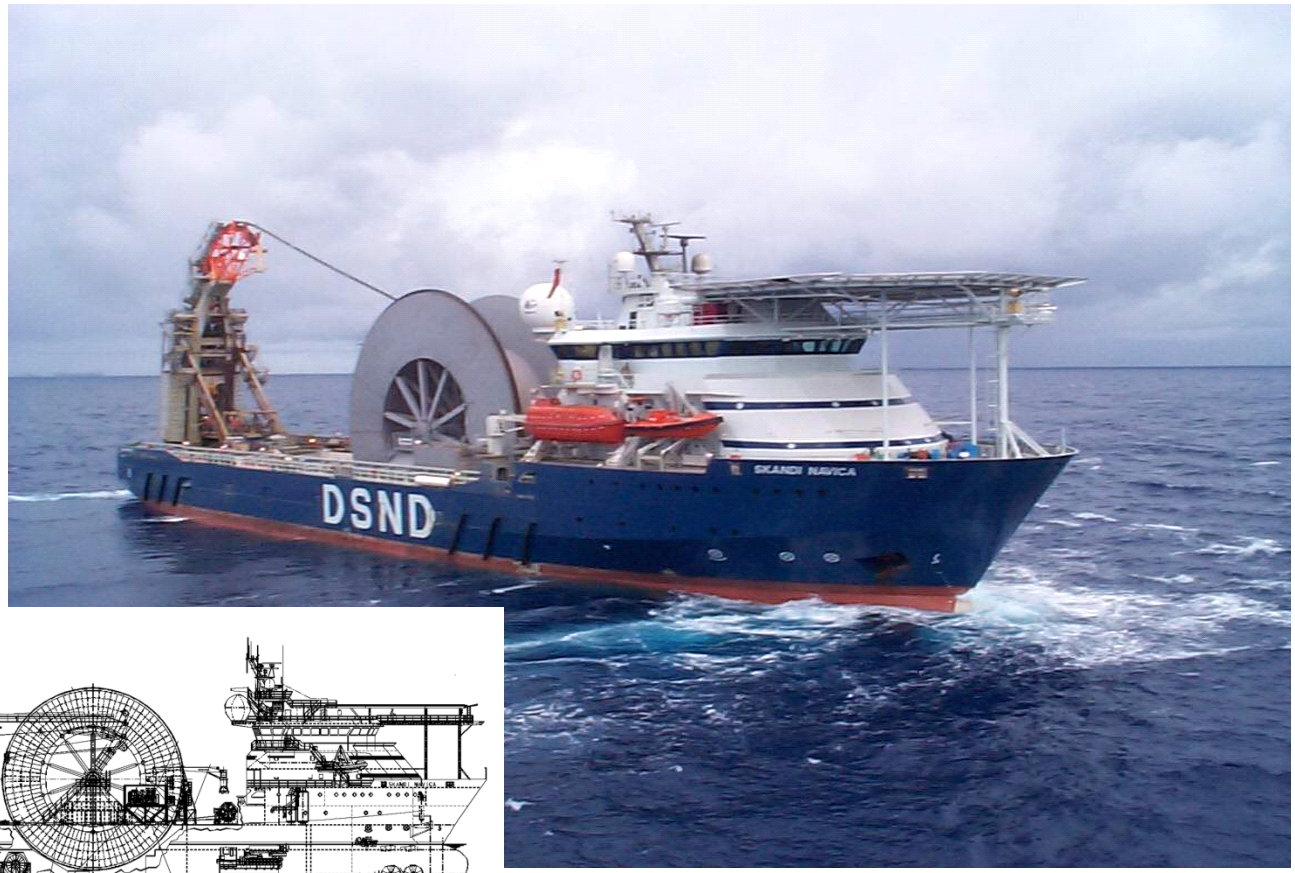
- RB-2 “Chickasaw”, 1970
  - Purpose-built barge
  - In service with Global Industries
  - Upgraded w/dynamic positioning

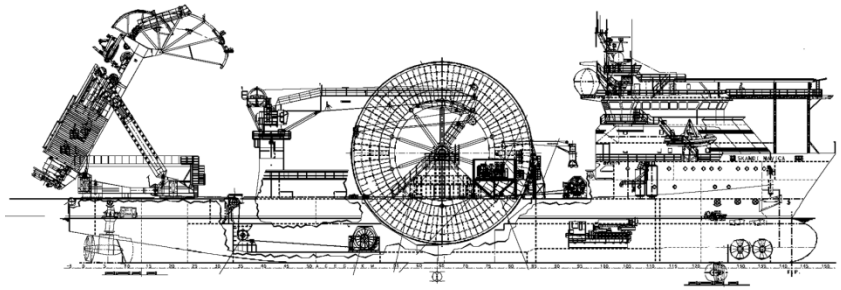
Technip Deep Blue

Technip Deep Blue

- Dual reels hold 5600 metric tons
  - 4-inch to 18-inch diameter pipe.
- Additional 5600 tonnes of storage
  - on deck for J-lay pipe
  - under-deck baskets/on-deck carousels for umbilicals
- Reel-lay up to 550 tonnes top tension
- J-lay up to 770 tonnes top tension.

Subsea 7 Seven Scandi Navica





Subsea 7 Seven Navica

- 2500 ton reel capacity
- 2” – 16” Pipe
- Single load approximately:
  - 43 miles of 6”
  - or 7.5 miles of 16”
- 250 Short ton tensioning capacity

Spoolbase Fabrication

Mobile Spoolbase, Alabama

Pipe Spooling at Mobile

Reeling 18-Inch Pipe

Advantages of Reeled Pipe

- Fabrication is performed onshore
- Controlled environment, off the critical path
- Weld repairs are performed on onshore
- Lay rates of up to 10 miles per day
- No stinger w/ J-Lay configuration for vertical reel
- Stinger required for horizontal reel

Disadvantages of Reeled Pipe

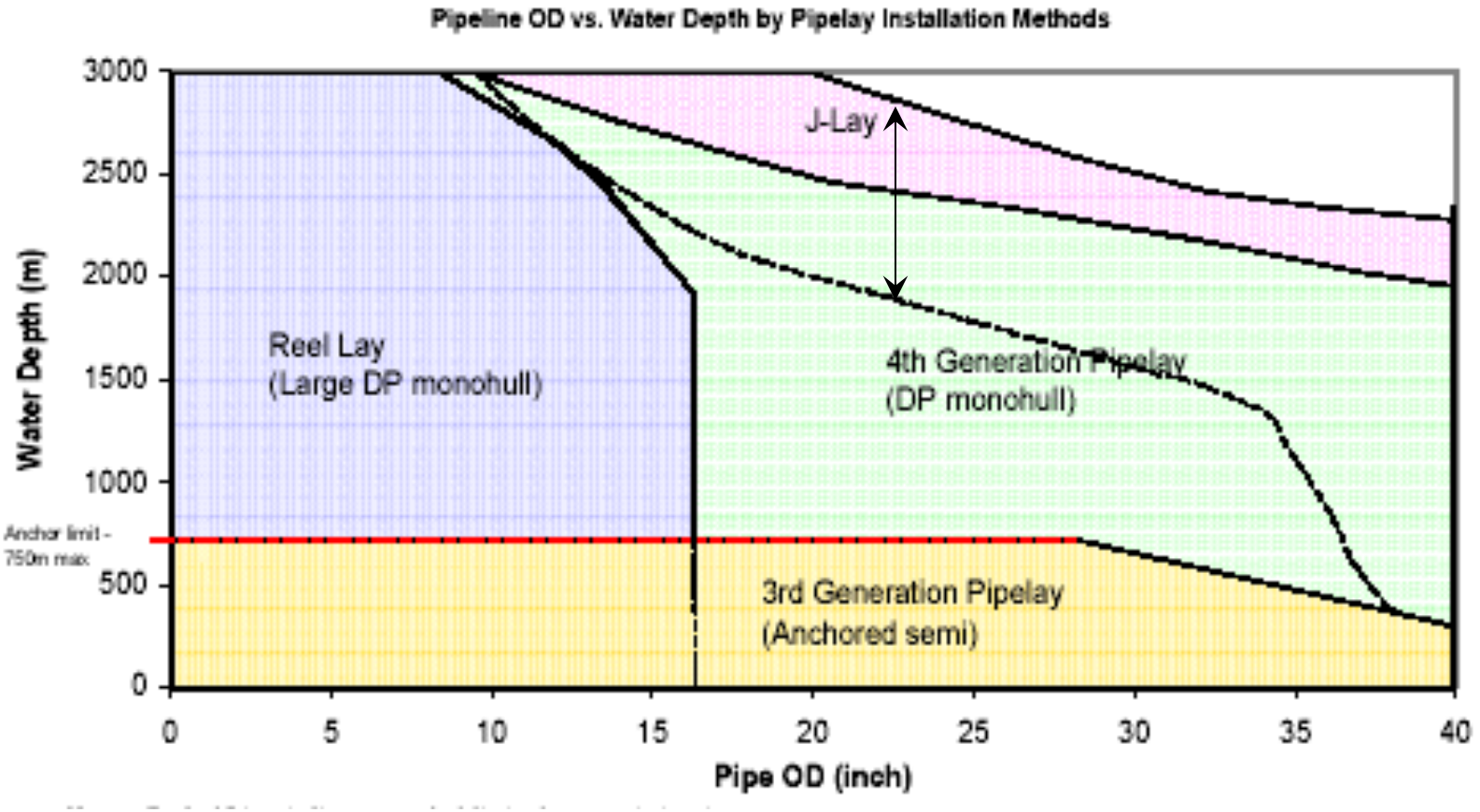
- Requires stringent pipe quality control
  - Match dimensional & mechanical properties.
- Requires testing of coatings and field joints
  - Bending strains of up to 2% on reel
  - High crushing loads on reel.
- Pipe undergoes plastic straining
  - Marginally affects fatigue performance.
- Rule of thumb, requires D/t ratio < 20
  - Results in thicker pipe in shallow waters
- Concrete weight coatings not feasible
- Integral buckle arrestors cannot be used.

Muddy Waters – Combination Vessels

- Acergy Falcon

  - S-lay firing line
  - reel lay vertical stinger & straightener

Installation Methods vs. OD & WD Traditional Limitations



Pipe fabrication limitations can also govern

Installation State of the Art is Advancing

- Largest diameter pipelines -- 56” (Shallow)
- Large deepwater pipelines
  - Blue Stream Pipeline (J-Lay Saipem 7000) 24”, 6900’ WD
  - BP/Shell Okeanos Gas, NaKika, 24”, 7,300’ WD
  - BP Proteus Oil to Thunder Horse 28”, 5,350’ WD
  - Vessels for BP jobs
    - Heerema’s J-lay Balder >3,700’
    - Allseas’ S-Lay Solitaire < 3,700’
  - Independence Hub, 24” PL, 20” SCR Solitaire ~8000’ WD
    - SCR Hang-off by Balder

Installation State of the Art -- Continued

- Large deepwater pipelines (Cont'd)
  - Independence Hub, 24" PL, 20" SCR
  - Solitaire ~8000' WD
  - SCR Hang-off by Balder
  - Perdido
  - 18" PL & SCR
  - Solitaire 8,250' WD

Universal Installation Activities

- Pipe Haul
- Sorting
- Welding
- Inspection
- Field Joint Coating

Pipe Haul


SAFETY
BEWARE
COFLEXIP STENA OFFSHORE
EVANTON SPOOLBASE
C.S.O. PROJECT NO
TEXACO CAPTAIN EXP M1418
15

Ready Racks - Pipe Sorting

Pre-Heat

Internal Line-Up Clamp

Root and Hot Pass

Fill and Cap

Radiographic Examination

- Automatic Ultrasonic Testing (AUT) Also Used

Radiographic Interpretation

Field Joint Blasting

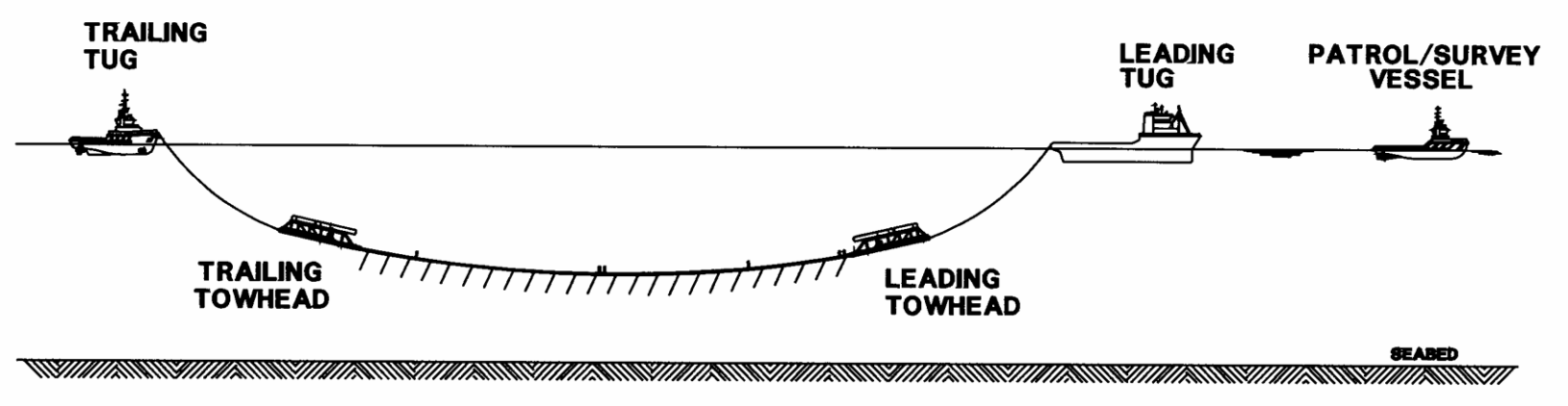
Field Joint Coating Application

Towed Pipeline Installation

- Two common methods
  - Controlled Depth Tow Method (CDTM)
  - Bottom Tow
- CDTM, North Sea & Australia
- Bottom Tow, Gulf of Mexico

CDTM Fabrication Site

CDTM Technique



CDTM Launch

Bottom Tow Launch

- Enserch GB 387 Tie-Back
- 28” Casing
- Six 3” Flowlines & Umbilical

Bottom Tow Fabrication Site

Tow Advantages

- Onshore fabrication & quality control
- Installs multiple bundled lines at once
- Can be readily insulated
- Rapid offshore installation
- Inexpensive offshore spread
- Low stress even in deepwater

Tow Disadvantages

- Limited by length of fabrication site
  - CDTM ~7 km
  - Bottom tow ~ 7 miles
- Longer lines require offshore connection
- Bottom tow requires extensive survey
- Few fabrication sites
- Requires delicate weight balance

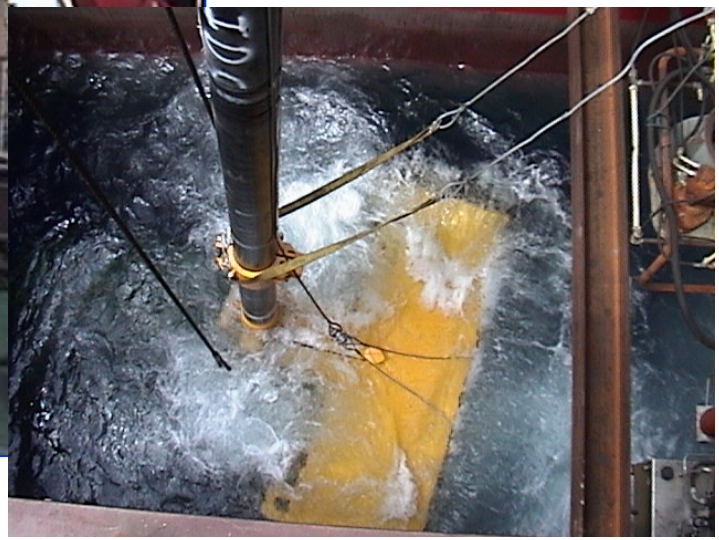
Associated Activities

- Pipeline Burial
- Pipeline Terminations
  - PLETs, FLETs, & PLEMs
  - Jumpers
  - SCRs
  - Shore Approaches

Pipeline Burial

12-Inch PLET Over Moonpool

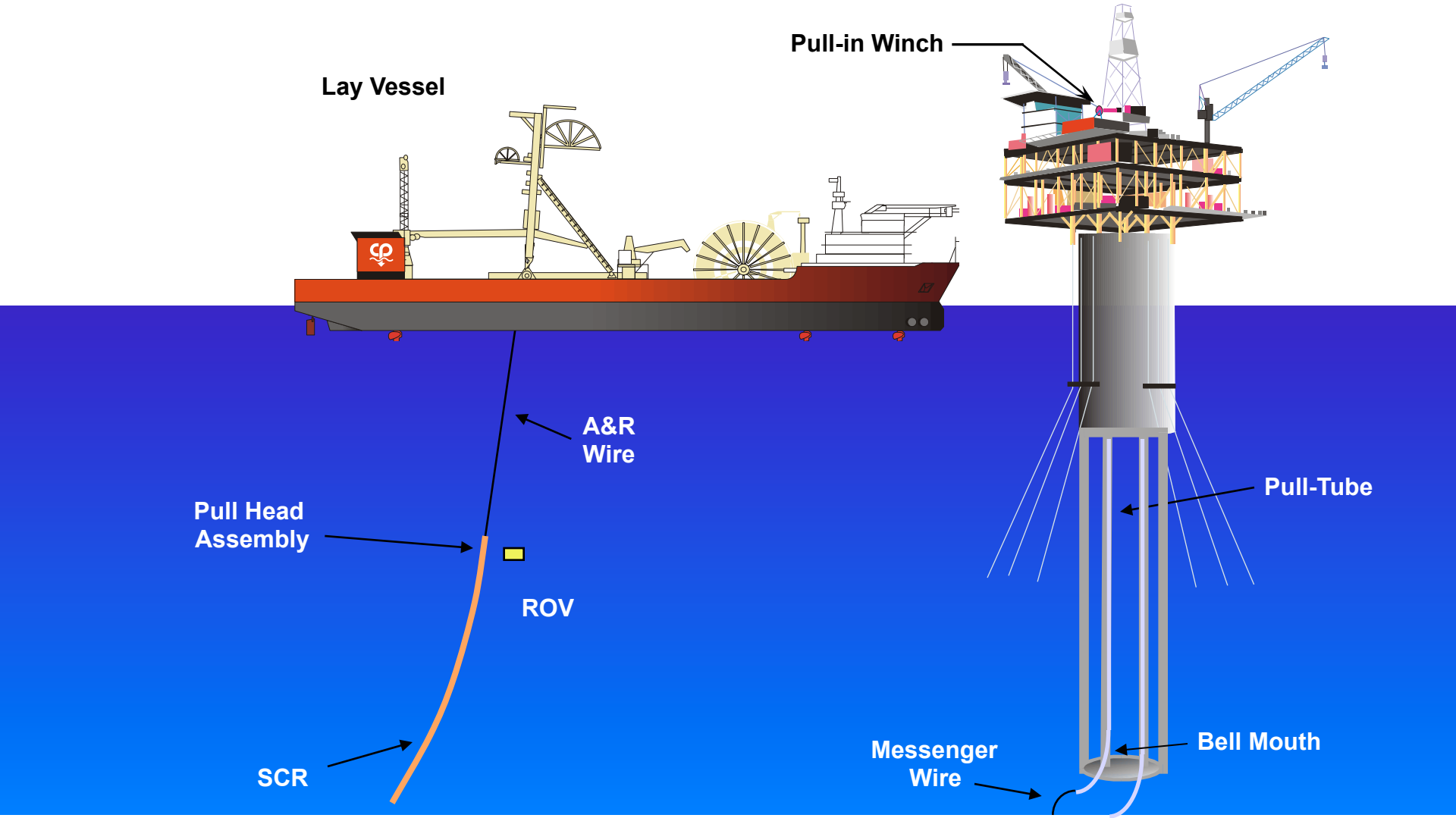
PLEM Ready for Load-Out



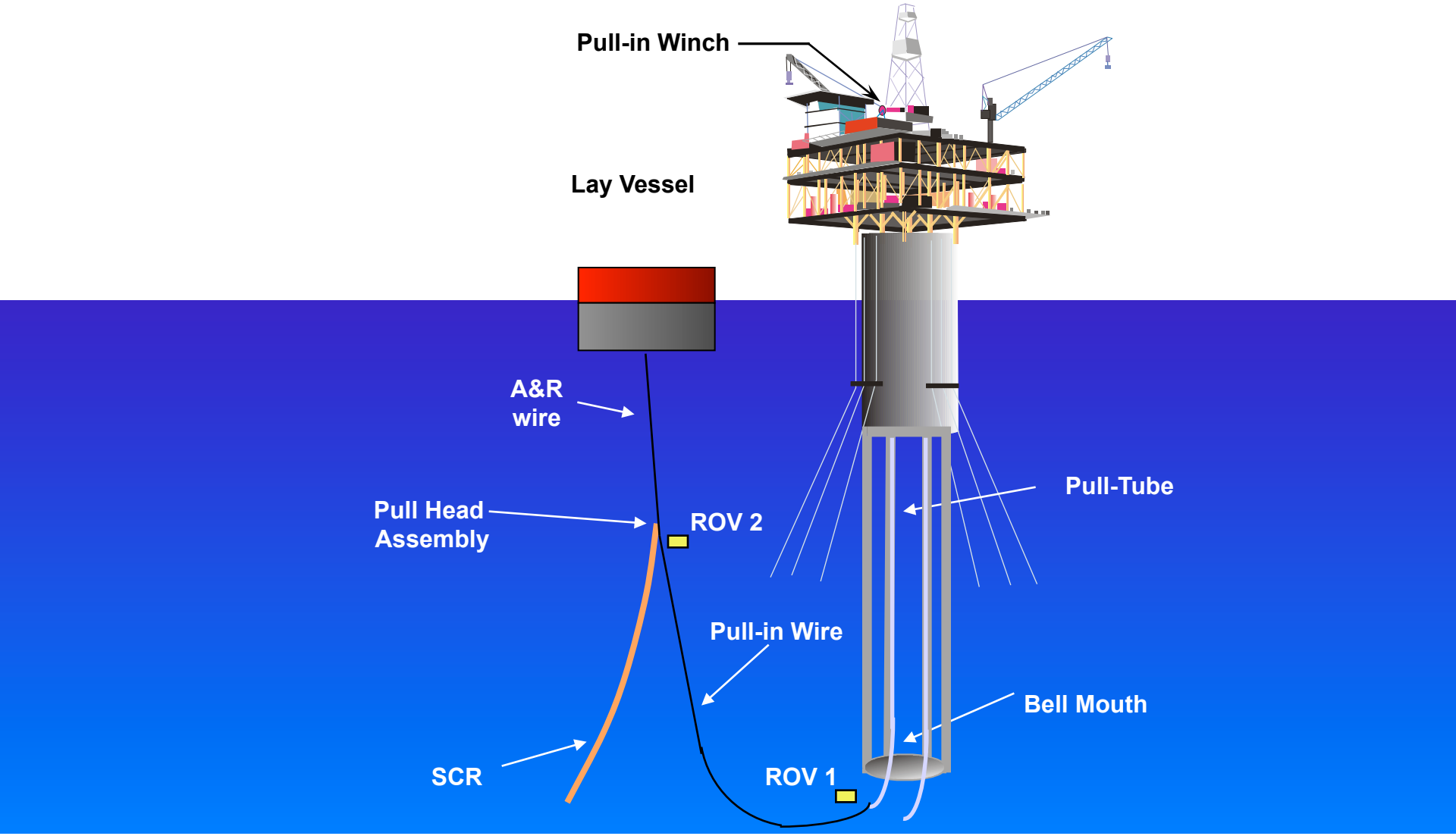
Pipeline Jumper Installation

Steel Catenary Riser (SCR) Installation

J-Lay or Reel SCR Installation Method



J-Lay or Reel SCR Installation Method



Shore Approach

- Petronas Carigali, Malaysia
- Three 30” Pipelines

Questions?