SUBSEA PIPELINES DESIGN CHALLENGES

PRESENTATION TO IPLOCA BOARD MEMBERS (21st APRIL, 2015)

Presenters: Mr. Gbenga Suleiman (Lead Pipeline Engineer)
Mr. A. K. Sangal (Pipeline Engineering Manager)
Mr. Oussama Takieddine (Vice President Engineering)
NPCC ENGINEERING CAPABILITIES
ONE STOP SHOP

- Conceptual Engineering
- FEED and Basic Engineering
- Detailed Engineering
- Constructability Engineering Review
- Construction Engineering
- Installation Engineering
- Naval Engineering
NPCC ENGINEERING CAPABILITIES

NPCC ENGINEERING EXPERIENCE

- Offshore / Onshore upstream facilities
  - Well Fluid Gathering
  - Separation System
  - Gas Compression
  - Gas Dehydration
  - Fuel Gas Treatment
  - Produced Water Treatment and Disposal
  - Sand Treatment / Separation
  - Water and Gas Injection Facilities
  - Crude / Products Storage

- Flare, Vent and Drain Systems
- Utilities (Inst. Air / Cooling Water / Hot Water etc.)
- Power System
- Telecom
- Control Systems
- Buildings: Accommodation and Technical Building
NPCC ENGINEERING CAPABILITIES

NPCC ENGINEERING EXPERIENCE

Our offshore capabilities includes subsea pipelines, cables and flexible engineering design, as well as onshore pipeline design capability.

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NPCC ENGINEERING CAPABILITIES

We also have about 275 staff in other engineering support center – India
ENGINEERING MANPOWER HISTOGRAM

Over 95% of our workforce are permanent staff
CONTENTS

1. PIPELINES/CABLES ROUTE SELECTION
   - General Route Selection Criteria
   - Route Selection Challenges
   - New Approach to Route Selection

2. PIPELINES/CABLES STABILITY ON SEABED
   - Concept of Stability Design
   - Conventional Approach to Stability Design & Mitigation Method
   - New Approach to Stability Design & Mitigation Method

3. SOME EMERGING TECHNOLOGIES IN SUBSEA PIPELINES
   - Materials selection
   - Design / Analysis
   - Pipeline Integrity

Beyond the Possible

Wednesday, May 06, 2015 9
1. PIPELINES/CABLES ROUTE SELECTION
PIPELINES/CABLES ROUTE SELECTION

GENERAL ROUTE SELECTION CRITERIA

- Minimize route length as much as possible.
- Minimize health and safety risk and ensure marine life sustainability.
- Consider environmental and regulatory factors.
- Optimise flow assurance (minimize pressure losses).
- Minimize pipeline free spans and amount of intervention work.
- Consider the piggability philosophy of the pipeline.
- Avoid Flare Heat Affected Zone (HAZ), dropped object areas, etc.
Avoid boulders, pockmarks, submarine exercise area, dredging, wrecks, fishing areas, etc.

Avoid Sabkha areas (Onshore)

Avoid pre-defined areas due to existing infrastructure and geo-technically unstable areas

Minimize local slide risk (avoiding the steepest slopes)

Minimize and/or avoid crossings on curves and within proximity of existing crossings, wherever possible.

Ensure crossing angle, if required, is not less than 30°
ROUTE SELECTION CHALLENGES

- Seabed features e.g. Boulders, Rocks, Rough bottom, and Steep slope which are susceptible to landslide.

- Seabed obstructions from existing structures e.g. wrecks, PLEM, PLET, e.t.c.

- Construction limitations e.g. shore/platform approaches, bend radius, laybarge draft, etc.

- Other seabed, users, e.g. shipping lanes, fishing, dredging, exclusion zones, etc.
NEW APPROACH TO ROUTE SELECTION - Geographical Information System (GIS)

Application used is called ArcGIS

- It is a real-time method of pipeline and cable route selection.
- It integrates data from different sources into a centralized database used for modeling and analysis based on spatial component.
- It has better precision capability in optimizing route.
- It saves time and cost as compared to the conventional system of route selection.

- Good Geophysical / Geotechnical knowledge however, is required.
2. PIPELINES/CABLES STABILITY ON SEABED
Installed subsea pipelines/cables are likely to become unstable under the influence of hydrodynamic forces and buoyancy effects.

Stability of such pipelines/cables are checked by analysis at the onset of the project design.

Adequate solutions are then considered to prevent the undesired condition.
PIPCONVENTIONAL APPROACH TO STABILITY DESIGN

☐ Analysis is usually carried out to determine pipelines/cables stability requirement using software applications such as:
  - AGA software, DNV Stablelines, Plus-one software, etc..

CONVENTIONAL MITIGATION METHOD

☐ Typical mitigation usually recommended for subsea pipelines/cables stability correction are:
  - Increase system weight by adding concrete weight coating
  - Addition of concrete mattresses
  - Use on Anchor blocks / Screw Anchors
CONVENTIONAL MITIGATION METHOD (CONT’D.)

- other mitigation methods are:
  - Rock-dumping on the installed pipeline
  - Grout bag installation
NEW APPROACH TO STABILITY DESIGN

- ORCAFLEX - developed for dynamic simulation of subsea cables stability.
- ABAQUS - a finite element based software used for optimal pipeline/cables stability analysis.

MITIGATION METHOD

Use of leaded Uraduct and ballasting module for subsea cable stability.

- It has been used by NPCC in previous projects
- Currently in use by NPCC in ongoing project
- Installation is done on the barge,
- Divers assistance is not required
- No degradation of rope like in concrete mattress
- Accurate and efficient

Use of Artificial seaweed mattresses

- Reduce the effect of seawater current on the installed pipelines/cables.
- Restores disturbed marine habitat.
- Not commonly used in this region due to smooth seabed and relatively low current speed
3. EMERGING TECHNOLOGIES IN OFFSHORE/SUBSEA PIPELINES
DEVELOPMENT OF CORROSION RESISTANT ALLOYS (CRA) CLADDING IN STEEL PIPES

ADVANTAGES
- Elimination of Corrosion Allowance (CA)
- It allows pipe wall thickness optimization
- Prevents pipeline internal corrosion

LIMITATIONS
- Not cost effective
- Diameter limitation due to cladding
- Selection is based on highly corrosive content only e.g. wet sour gas service
- Cost is only justified in highly corrosive service
3LPE / 3LPP (FBE + ADHESIVE + PE/PP) COATING

- It has replaced banned Coal Tar Enamel coating due to its environmentally friendly property.
- Better resistance to high temperature system
- Better bonding properties and
- Ease of Cathodic Protection system installation
Advent of Finite Element Method approach has:

- Introduced the system of discretization of pipeline system for effective and efficient design
  (Discretization: breaking down into distinct elements)
- It enhances the non-linear finite simulation of global behavior of pipeline system such as Lateral Buckling and Walking
ENGINEERING CRITICAL ANALYSIS (ECA)

- Based on Fracture Mechanics
  (Fracture Mechanics – study of crack propagation in materials)
- Introduces the development of Weld Imperfection Acceptance Criteria
- Preferred method for field girth weld inspection and quality control for long pipeline projects.
- Used in Crack Tip Open Displacement (CTOD) test in Line pipe
- It has been extensively applied by NPCC in previous projects
SOIL LIQUEFACTION AND SEABED SCOURING

- Soil liquefaction causes seabed subsidence along the pipeline route.
- Scouring induces unwanted span along the pipeline route.
- These phenomena has necessitated the need for further seabed study at the onset of pipeline design.
- It's becoming a concern at crossing locations / touch-down points.

Advantages includes:

- Reduces risk of pipeline failure.
- Reduces intervention / maintenance cost.
EMERGING TECHNOLOGIES - PIPELINE INTEGRITY MANAGEMENT

PIM APPROACH AT DESIGN STAGE
- Pipeline cathodic protection system
- Pipeline external corrosion coating
- Pipeline internal corrosion lining
- Design of anti-corrosive injection system, e.t.c.

PIM APPROACH AT OPERATION STAGE
- Pipeline In-Line Inspection by introduction of intelligent Pigging
- Routine Ultrasonic Thickness Measurement (UTM)
- Introduction of Corrosion Coupon monitoring system
- Injection of anti-corrosive compound e.g. Biocides for internal corrosion prevention, e.t.c.
The global recognition of Integrity Management has created ample brown field project opportunities,

As the IOCs and NOCs focuses more on Integrity Management for sustainability, PIM opportunity is bound to grow.

**WAY FORWARD**

- Invest in R & D to provide pipeline design Lifetime Extension (LTE) solution to our client/operators.
- Improve on existing pipeline design/integrity technologies currently available.
- Embark on drastic, but sustainable cost cutting measures to remain competitive
THANK YOU

Questions please