OFFSHORE PLATFORM TOPSIDES RAISING USING SYNCHRONIZED JACKING

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Air Gap is Important!
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Why Could the Air Gap be too Small

• Original platform design was completed to old codes
• Seabed subsidence has occurred (reservoir consolidation)
• Platform consequence of failure has increased
• Design waves have got bigger (Gulf of Mexico post 2004 & 2005 hurricanes)
Options for Remediation

• Wave load reduction (remove unused conductors, remove marine growth)
• Local member strengthening (grouting, clamps, additional members)
• Foundation reinforcement (retrofit skirt piles)
• Elevate the topsides
Facility Damage without Platform Failure (partial success)
Deck Raising by Jacking

Ekofisk 1987 (6 platforms, 4 simultaneously raised by 6m)
Deck Raising by Jacking

• Ekofisk
  – No additional lateral support
  – Handling and installation of leg spools
  – Bolted/flanged connections
• USD 600 Million (1987)
• 15,000 people involved at the peak
Gulf of Mexico 2006

Two drilling/production platforms raised by 4.5m
Gulf of Mexico 2006

- Two drilling and production platforms had reduced air gap due to seabed subsidence
- Operator planned on field life extension
- Required topsides to be raised by 15 feet (4.5m)
Top of Jacket Walkway
Options Considered

• Remove deck, add leg extensions, re-install deck
• Fabricate new replacement deck with longer leg sections
• Raise deck in-situ by jacking (precedence established by Conoco in the North Sea at the Ekofisk field)
Selected Solution (Proprietary)

- Raising performed by hydraulic jacking
- Synchronized control using PLC (+/- 0.5 inch)
- Introduction of split leg sleeves (NEW)
  - Legs fully encapsulated during raising
  - Excellent lateral stability
  - Redundant jacking solution
  - Immediate storm safe pin-off condition
  - Sleeves form the permanent leg extensions
Split Sleeve Configuration

Solution covered by US Patents 7,780,375/8,002,500/8,353,643 and all associated international patents received, applied for and pending
Bushing and Leg Cut Detail

(View Before Extension Sleeve Installation)

First Cuts
Scale: 3/8" = 1'-0"

(View After Extension Sleeve Installation)

Remaining Cuts
Scale: 3/8" = 1'-0"
Typical Sleeves
Bushing Installation
Sleeve Installed Offshore
Leg Pre-cut
Well Bay Solution (leave in place)
Leg Cut Sequence

• Legs are pre-cut 60% of circumference prior to installing sleeves (meets L-2 case)
• Cutting by regular torch
• Final leg cut is made after sleeves have been installed and jacks have been pre-loaded.
• Final leg cuts made through windows in the sleeve
• Continuous lateral leg containment
Raising Control System

- Extension of each leg measured by 2 string potentiometers
- PLC control system measures all leg motions continuously and varies hydraulic flow to rams each leg as required (0 to 100% control)
- Orange alarm at +/- 0.5-inch out of synch.
- Red alarm at +/- 1-inch out of synch.
- Deck strength checked for +/- 2-inch out of synch
Design Basis

• Each leg cluster of 4 jacks designed as follows:
  – Operation continues with loss of one jack
  – Operation CAN continue with loss of two jacks
  – Jacks are load balanced (common lines)
  – Each jack fitted with an onboard counter balance valve (hard piped)
  – Ram end support conditions true pins – reduce side load to near zero
  – Provide a high capacity pin connection for temporary connection after leg is 100% cut (before and after jacking)
  – Lock off leg in final elevation prior to full weld out
Sleeve Design

Time: 5 s
Time Step: 5 of 5

Maximum Value: 50206.3 lbf/(in²)
Minimum Value: 33.225 lbf/(in²)
SIT under Full Working Load
SIT Under Full Working Load
Platform Raised in 90 minutes
Typical Schedule

• Rig-up deck – 30 days
  – Cut risers
  – Cut well bay framing
  – Retrofit all jacking steel

• Rig-up 32 rams and controls – 7 days

• Make final cut and jack +14 feet – 4 hours

• Weld out (L-1 condition) – 2 days
Indonesia 2013

Three platforms & three bridge structures simultaneously raised by 4.0m
Indonesia

• Complete field undergone subsidence
  – Quarters platform
  – Production Platform
  – Compression platform
  – Bridge linked
  – Two Flare bridge supports
  – Bridge support on the wellhead platform

• To be raised by 4 m to extend life by 12+ years
Typical Configuration

Very low starting “hook height”
Design Basis

• All legs full contained within sleeves at all times
• Operation can be performed with the loss of any one ram at each leg
• Fully reversible
• Storm safe pin-off detail
• PLC control of all rams
  – +/- 0.5 inches between legs per platform
  – +/- 1.0 inches between platforms
Versabar Equipment supply

- 6 no. HPU’s, 2 engines each
- 108 Stage 1 and Stage 2 RAMS 250Te capacity
- Control System and self contained Control Room
- Complement of spares and tools
- Designed and Manufactured by Versabar USA
- Design, Manufacturing x works 1 year
Bridge Support Structure Raising
Power Unit Positions
SIT Under Full Working Load
Stage 1 Storm Safe Pin-off
Stage 2 Raising SIT
Offshore Raising Works
All decks raised by 4m
Typical Deck
Typical Leg RAMS
Flare Bridge Frames
Leg Cutting and Pin Assemblies
Stage 2 Lift Complete
Offshore Schedule

• Stage 1 rig-up in parallel to other installation works – 3 months, 300 man accommodation work barge
• Stage 1 raise (2 hours), RAM removal (2 days) & weld out (3 days) – Total 5 days
• Stage 2 rig-up – 1 week
• Stage 2 raise (4 hours) & Ram removal and weld out (5 days)
• Recommission platforms – (15 days)
Closure

• Multiple solutions exist for deck raising by hydraulic jacking (single platform, entire complexes)
• Proven by multiple field applications on a worldwide basis
• Proven to be economic when compared against the alternatives
Closure

• Scalable solution – 20,000+ tons topside
• High lateral stability
• Redundant configuration
• Reversible operation
• Weather insensitive (compared to other options)
• Fast (leg sleeves become leg extensions)
• Pin-off details provide storm safe condition