Deepwater Riser Technology, VIV and Fatigue Management

F. Lim

Slender Well Workshop, Aberdeen
Mar. 1999
DEEP WATER RISER TECHNOLOGY, VIV & FATIGUE MANAGEMENT

by Dr Frank Lim
2H Offshore Engineering Limited

Slender Well Workshop
Aberdeen, March 1999

SCOPE OF PRESENTATION
- Deep Water Riser Design Issues
- AMJIG Guidelines
- Guideline Applications and Findings
- Analysis Limitations
- VIV Prediction and Effects
- Fatigue Management and Riser Monitoring

DEEP WATER ENVIRONMENTS

1 YEAR CURRENTS

DEEP WATER CHALLENGES
- Riser curvature and wear increased
- Buoyancy effectiveness reduced
- Mud pressures increased
- Collapse pressures increased
- Base/disconnect tension at BOP increased
- Hang-off deflections increased
- Running and retrieval takes longer
- Fatigue damage increased

AMJIG - Deep Water Drilling Riser Integrity Management Guidelines
- Extension NOT replacement for existing guidance
- Emphasis on system approach:
  - All components - riser, wellhead, conductor
  - All operations - riser installation, operations, monitoring, inspection

Learn more at www.2hoffshore.com
AMJIG RISER GUIDELINE DEVELOPMENT
- Directed by BP, Shell and Elf
- Reviewed by operators, drilling contractors and analysis consultants
- Guidelines in 3 Parts:
  - Analysis
  - Operations
  - Inspection

PART I - RISER ANALYSIS
- Riser configuration
- Drilling and survival limits
- Completion and well test operations
- Riser VIV
- Riser-wellhead-conductor interaction
- Recoil and hang-off
- Riser, casing and conductor installation

PART II - RISER OPERATIONS
- Tension and tension variation
- Installation and retrieval envelopes
- Drilling and survival envelopes
- Monitoring operating conditions
- Recording riser operations
- Recording riser usage

PART III - INSPECTION
- Inspection Assessment
  - Service category
  - Usage history
  - Inspection types and frequency
  - Acceptance criteria
  - Provision for inspection
- Components to be Inspected
- Inspection Procedures by OCTG

GUIDE APPLICATIONS
- Assess fitness-for-purpose
- Optimise riser configuration
- Predict downtime
- Provide input to operating procedures
- Predict inspection requirements

DEEP WATER RISER FINDINGS
- Need thicker walls for internal and external pressures and tension
- Hang-off requires bare lower riser
- Soft soils improve LFJ and WH response
- Retainer valves needed for disconnect
- High VIV fatigue damage = increased inspection and/or suppression

Learn more at www.2hoffshore.com
ANALYSIS LIMITATIONS
- Only as good as input assumptions:
  - Currents
  - Drag coefficients
  - Uncertainty in effects of drill string tension
  - Requires margin of conservatism
  - Can be costly - VIV

VORTEX INDUCED VIBRATIONS
- Still subject to research
- Analysis methods relatively new
- Do VIV’s really happen?
- What are the effects?
- How good/bad are our predictions?
- How are VIV’s best managed?

VIV ANALYSIS METHODS
- DnV Rules
  - Uniform risers in uniform, planar current
- SHEAR7
  - Uniform top tensioned risers
  - Sheared, planar, monotonic current profile
- VIVA
  - Variable riser properties along the length

VIV ANALYSIS APPROACH
- Analyses conducted with several current profiles
- Current profiles of varying severity, typically based on exceedence level
- Fatigue damage factored according to duration of profile
- More refined selection of profiles at more severe currents

VIV FATIGUE

VIV DRAG AMPLIFICATION
VIV UNCERTAINTIES
- Current profile and direction
- Slick and buoyant joints
- Choke and kill lines
- Drill string tension
- Damping of multi-string system
- Conductor interaction

VIV - ACTUAL v PREDICTED

DRILL STRING TENSION
- No drill string tension
- 100% drill string tension

MODELLING UNCERTAINTIES

IMPLICATIONS OF VIV FATIGUE
- Resistance:
  - Change tension/buoyancy
  - Higher quality fatigue details in riser and wellhead/conductor
  - More frequent inspection
- Suppression:
  - Fairings - expensive but reduce drag
  - Strakes - cheaper but increase drag

VIV FATIGUE MANAGEMENT
- Objectives
  - Minimise conservatism
  - Account for actual environment
  - Reduce modelling uncertainties
- Options
  - Entirely predictive
  - Analysis predictions used in conjunction with measured environment
  - Monitored environment and response

Learn more at www.2hoffshore.com
ENTIRELY PREDICTIVE

PARTLY PREDICTIVE

MOSTLY MONITORED

- Stress or displacement amplitudes and frequencies
- Used with predictions to give fatigue damage distribution over riser length
- Used with current measurements to calibrate predictions
- Removes environmental and modelling uncertainties

RESPONSE MONITORING APPROACHES

- On-Line System
  - Hardwired
    - Increased installation time, cable damage
  - Signal transmitted by telemetry
    - Large batteries, expensive
- Passive System
  - Run with riser, or ROV installed
  - Data processed after unit retrieval
  - Low cost

PASSIVE MONITORING EXAMPLES

- BP Schiehallion Drilling Riser
  - 360m water depth, 3 monitoring locations
  - VIV up to mode 4 observed
  - Response being evaluated
- NDP
  - 500-1400m, 5 monitoring locations
  - 3 Fields, Nyk High, Vema and Helland Hansen
  - Small responses

CONCLUSIONS

- Deep water presents many challenges
- AMJIG Guidelines needed to supplement existing codes
- VIV fatigue significant
  - Analysis may overestimate damage
  - Inspection requirements based on analysis may be overly conservative and costly
  - Monitoring provides more rational approach to fatigue management

Learn more at www.2hoffshore.com