

# ***DRILLING RISER OPTIMISATION FOR DEEP WATER***

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by

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2H Offshore Engineering Limited**

**Advances in Riser Technologies  
IBC, Airport Skean Dhu Hotel, Aberdeen, June 1997**

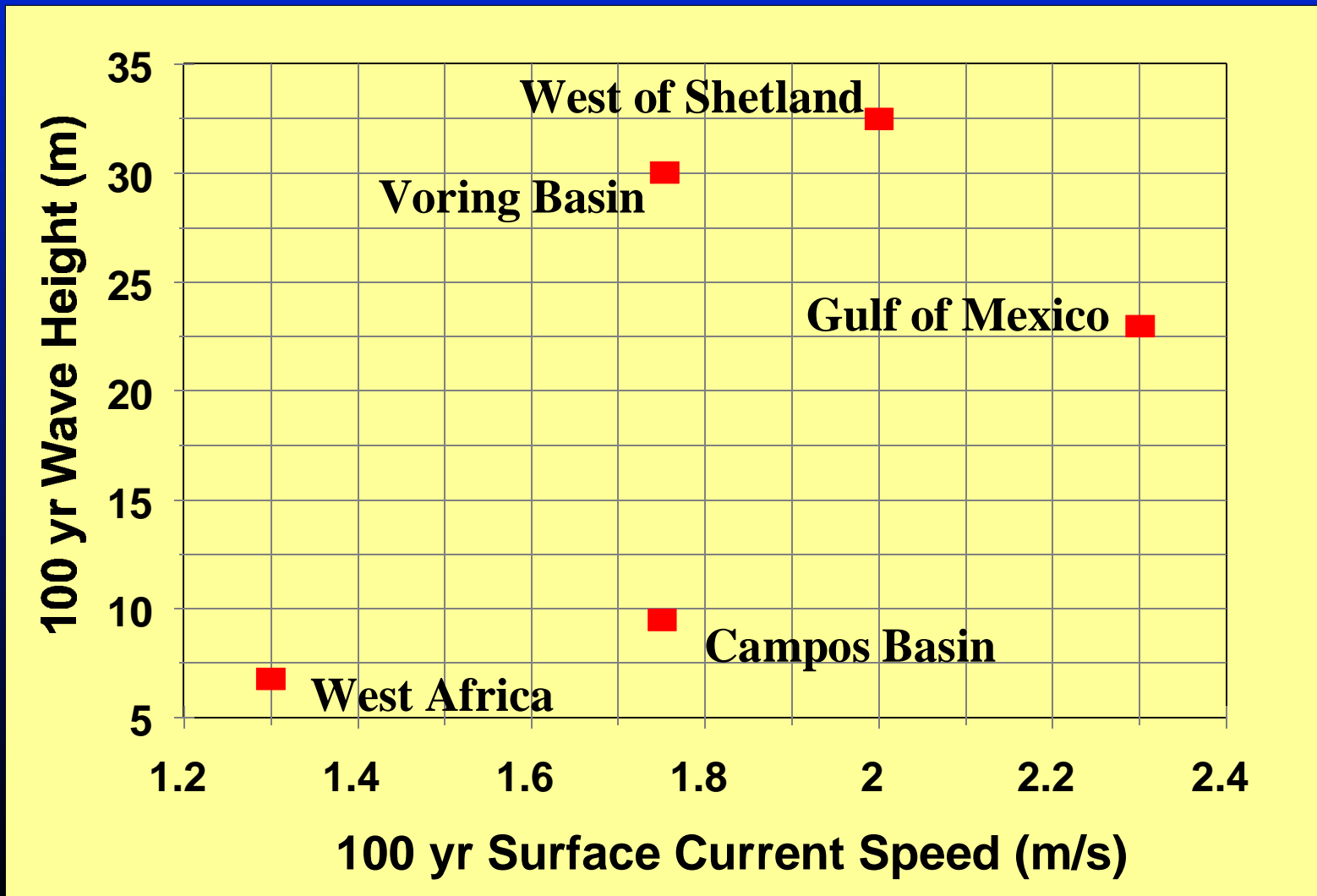
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# *SCOPE OF PRESENTATION*

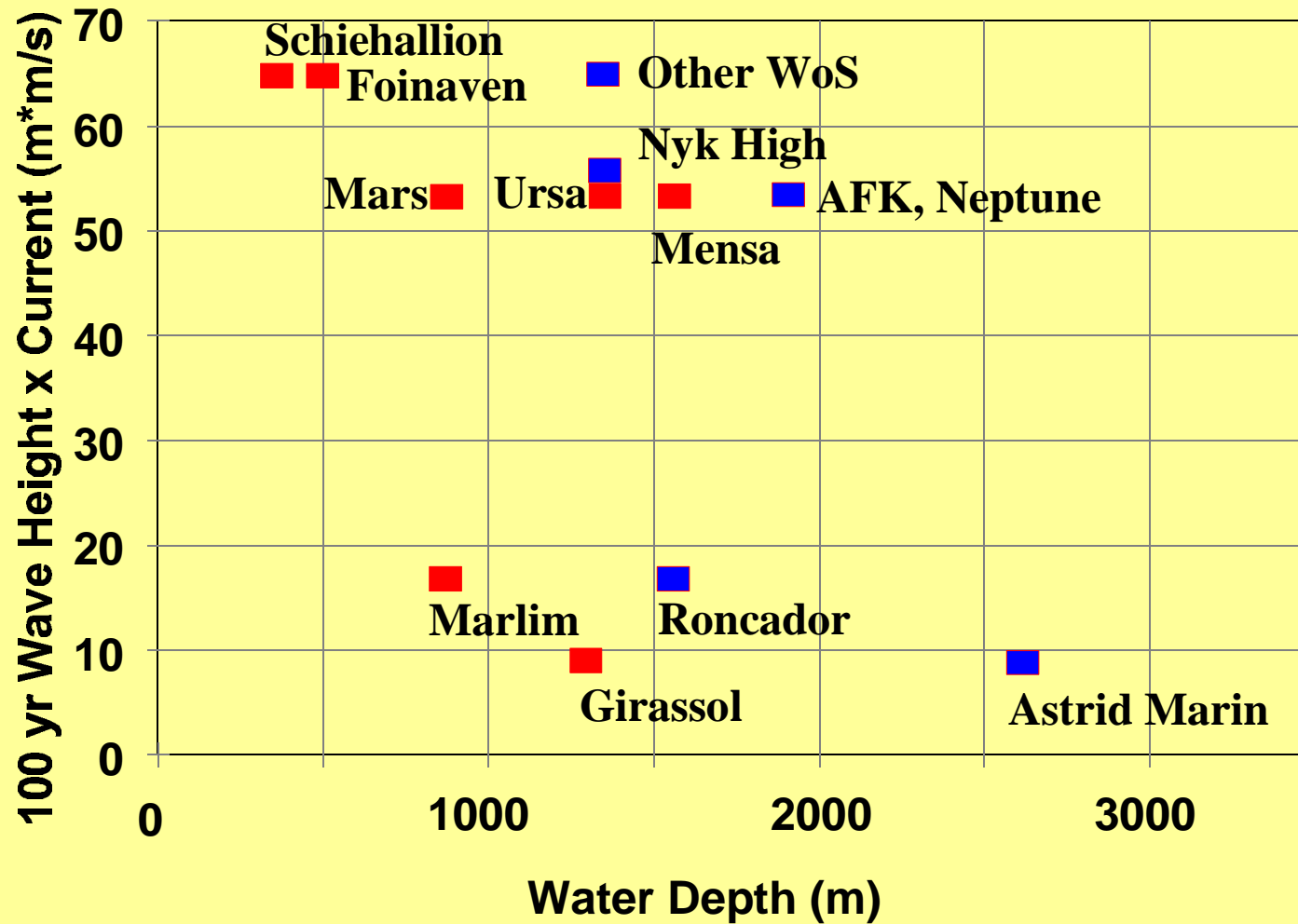
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- **Areas of current and future activity**
- **Effects of deep water**
- **Preliminary configuration and operating limits**
- **VIV's and riser/wellhead interaction**
- **Recoil and hang-off**
- **Forecasting and monitoring**

# *DEEP WATER ENVIRONMENTS*



# CURRENT & FUTURE ACTIVITY

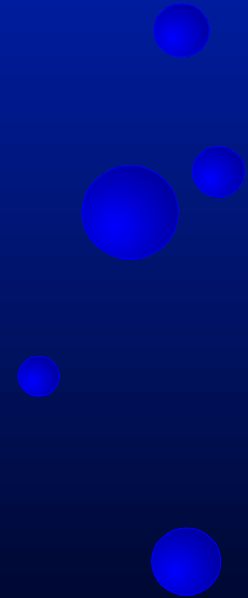


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# ***DEEP WATER EFFECTS***

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- **Riser curvature and wear increased**
- **Buoyancy effectiveness reduced**
- **Collapse pressures increased**
- **Disconnect overpulls larger**
- **Hang-off deflections increased**
- **Running and retrieval takes longer**



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# CHALLENGES

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- **Drilling**  
*Small flex-joint angles to maximise productive operations and resist/limit fatigue damage from vortex induced vibrations*
- **Completion, Coiled Tubing and Well Test Ops**  
*Need small flex joint angles for running and retrieval and satisfactory windows for well test*
- **Wellhead and Conductor System**  
*Large base tensions, increased static and dynamic loading from drilling riser*

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# ***KEY REQUIREMENTS***

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- **Maintain small flex-joint angles**
  - **Resist/limit fatigue loading from VIV's**
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# *PRELIMINARY CONFIGURATION*

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- Check collapse resistance
- Select buoyancy arrangement
- Assess tension and mooring system requirements:  
*conduct static analysis*  
*vary top tension, current profile and offset*  
*monitor flex- joint angles*

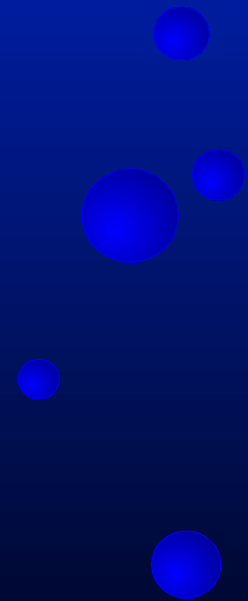
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# ***COLLAPSE RESISTANCE***

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- **20.5in x 5/8in, X52 riser good to 1500m (5000ft)**
- **Below 1500m, need:**

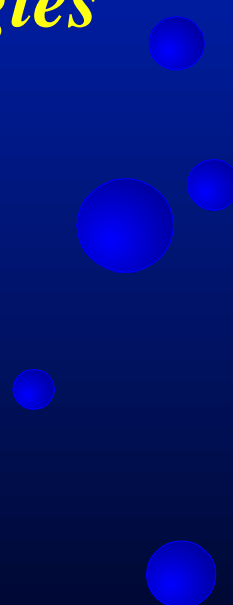
***Higher grade material  
Thicker wall  
Fill-up valve***



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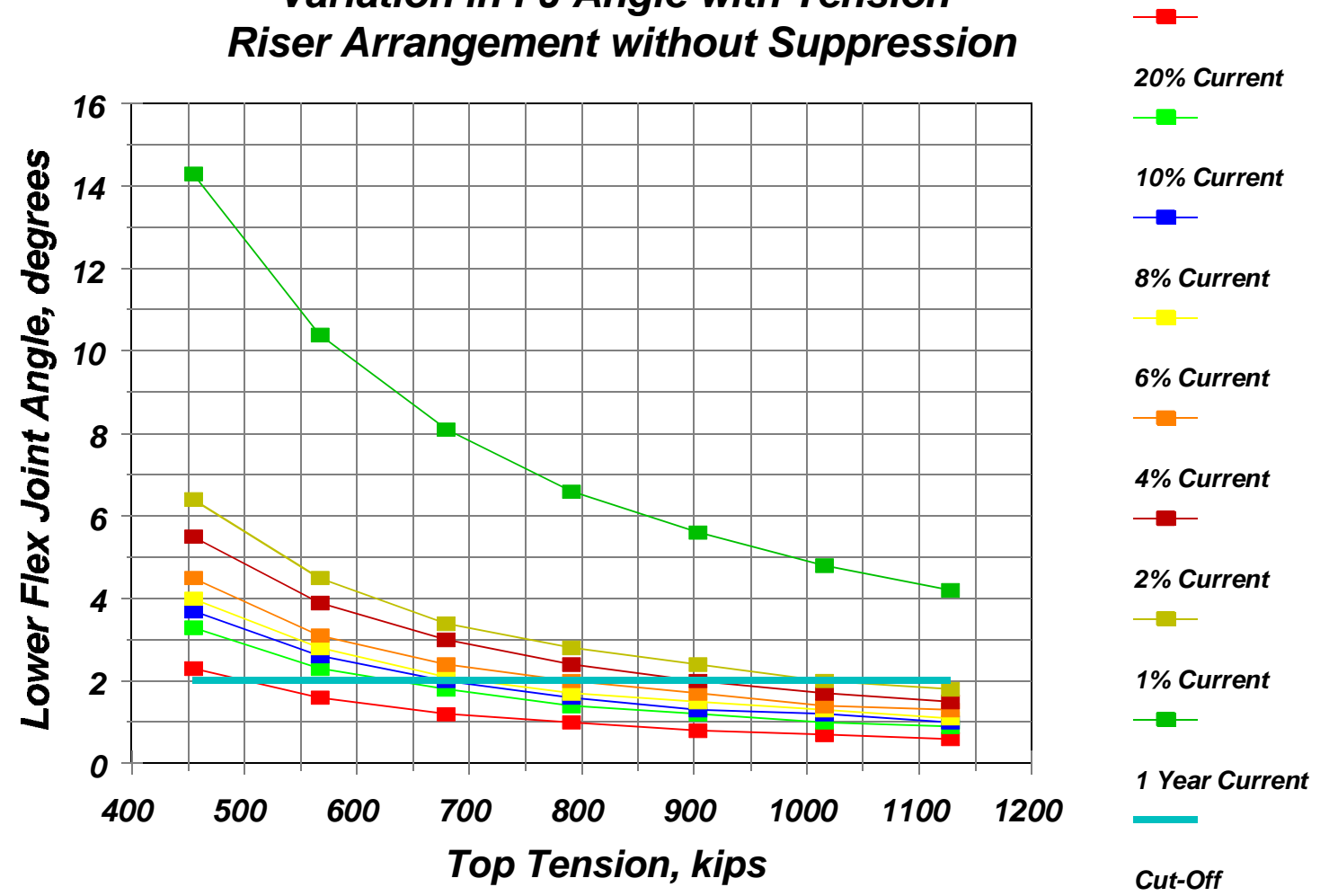
# ***BUOYANCY ARRANGEMENT***

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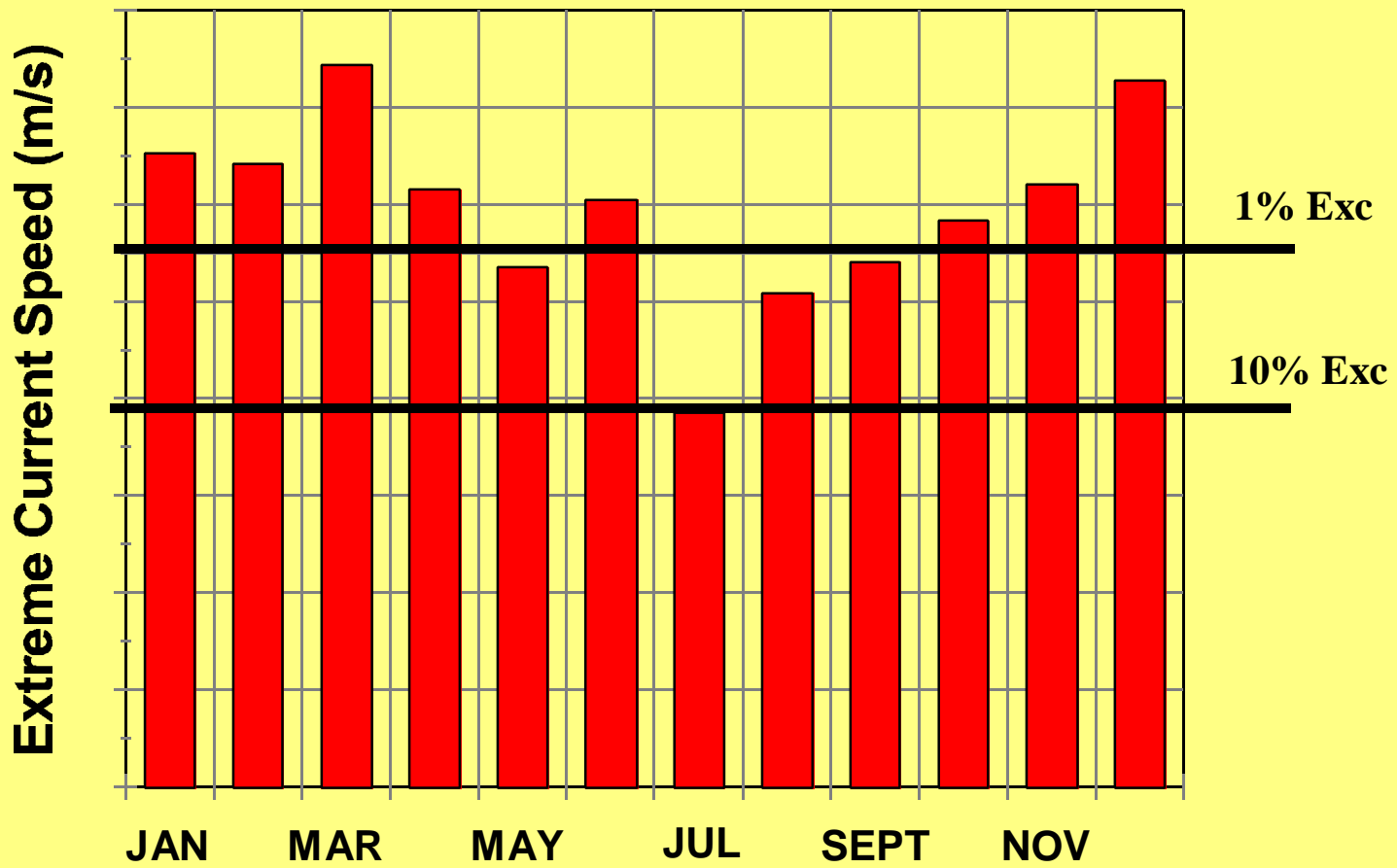
- **Use in regions of lower current speed**  
*reduce riser curvature and flex-joint angles*
  - **Use lower density, smaller diameter**  
*reduced drag and flex joint angles*
  - **Staggered**  
*assist VIV suppression*
  - **Profiled surface**  
*assist in VIV suppression?*
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# FLEX-JT ANGLE v TENSION

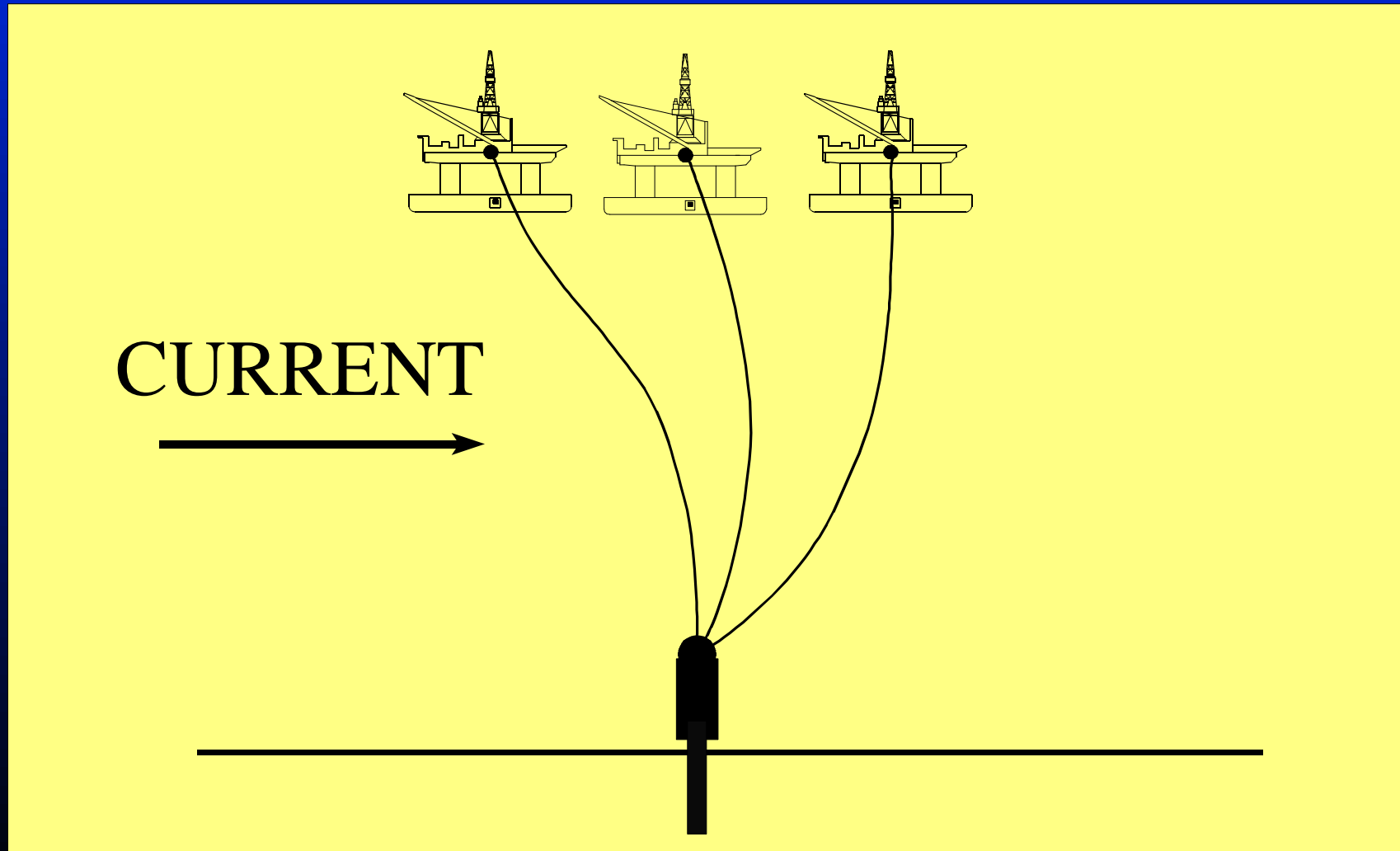
Variation in FJ Angle with Tension  
Riser Arrangement without Suppression



# *MONTHLY CURRENTS*

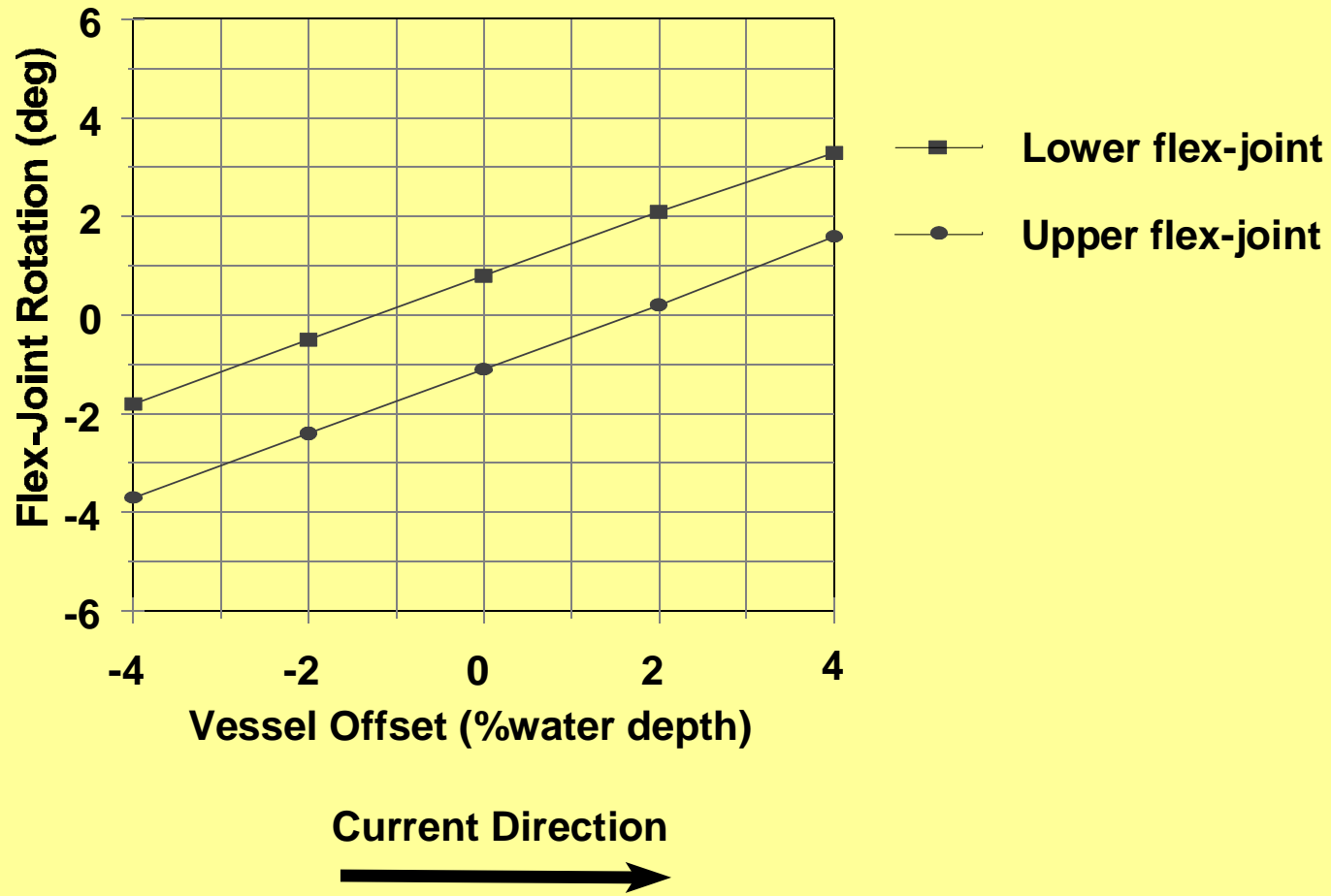


# *EFFECT OF VESSEL OFFSET*

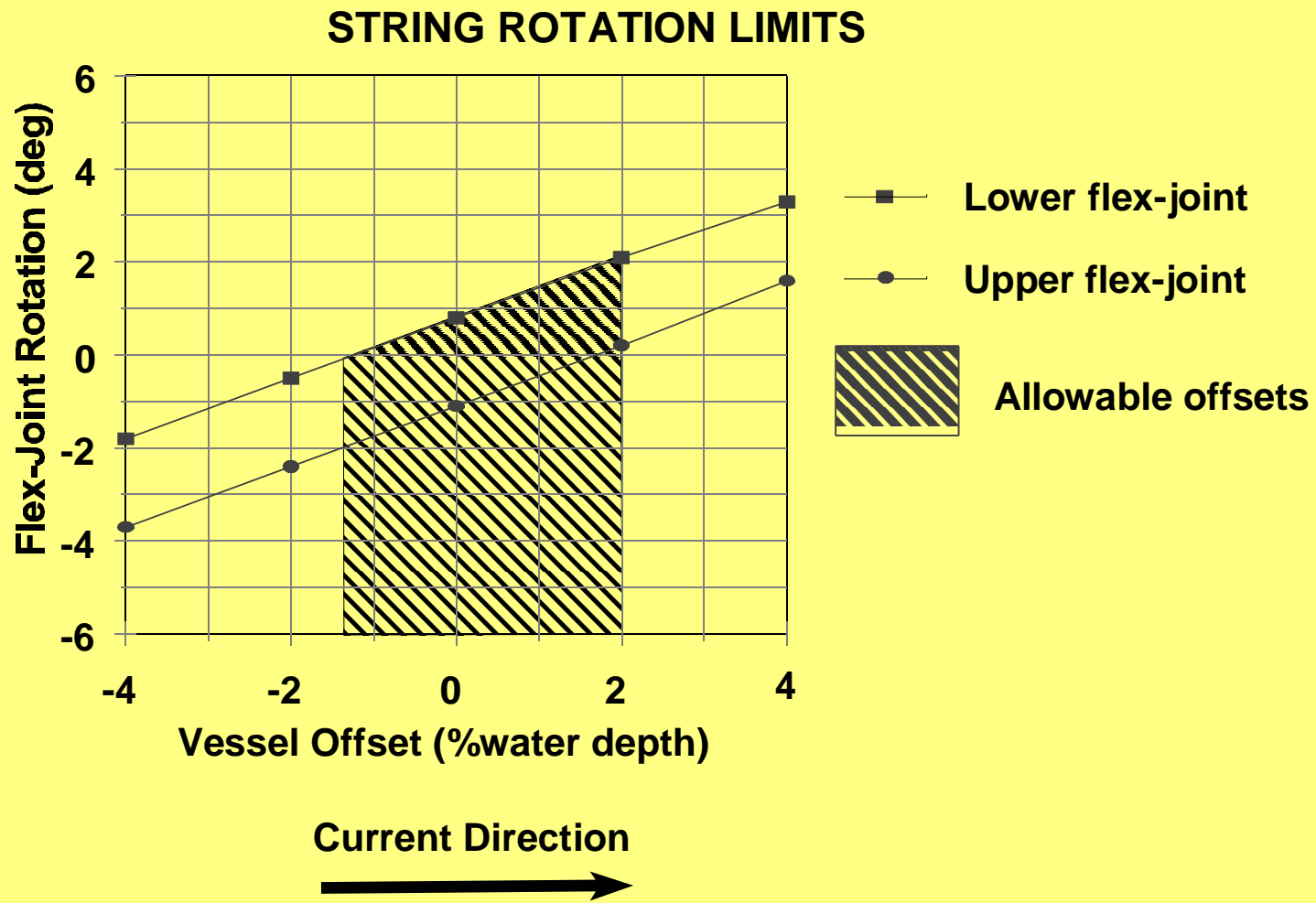


# ***FLEX-JT ANGLES v OFFSET***

**FLEX-JOINT ANGLES IN 10% EXCEEDENCE CURRENT**



# DRILLING WINDOW



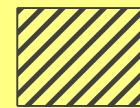
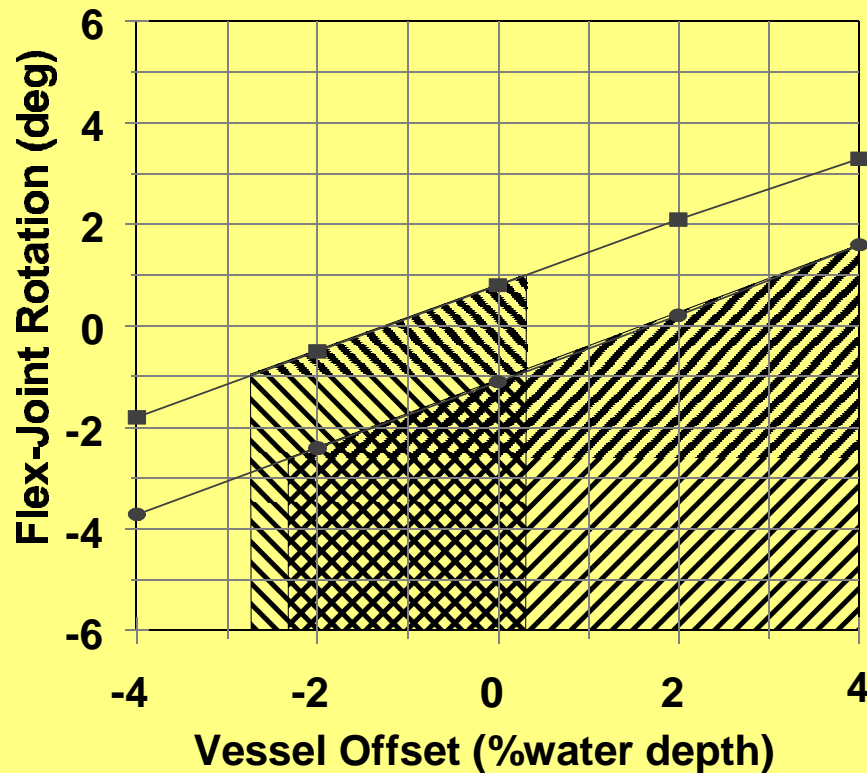
# ***COMPLETION RUNNING AND RETRIEVAL***

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- **Running and Retrieval**  
*limit upper flex-joint angle for tubing hanger entry and exit*
- **Landing**  
*limit lower flex-joint angle for TH and upper flex-joint angle for cased wear joint*
- **Emergency Disconnect**  
*control offset for release of tools from BOP*

# COMPLETION RUNNING LIMITS 1

## INSTALLATION - Landing Tubing Hanger



CWJ entry to diverter



Tubing Hanger entry to BOP

Allowable offset given by overlap

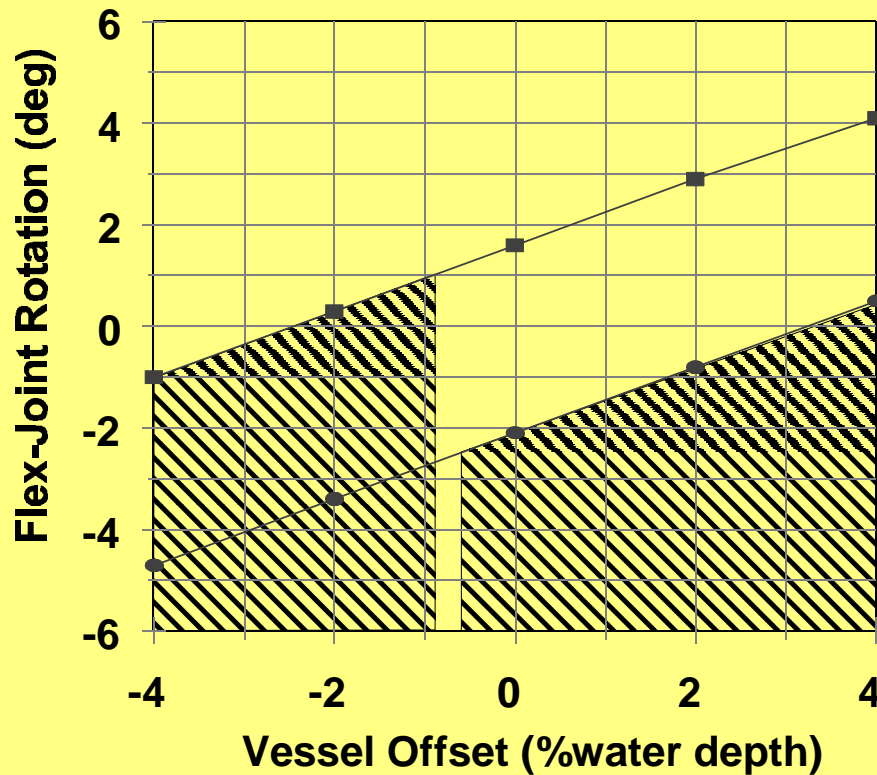
**NO OVERLAP -  
OPERATION NOT ALLOWED**

Current Direction



# COMPLETION RUNNING LIMITS 2

## INSTALLATION - Landing Tubing Hanger



CWJ entry to diverter



Tubing Hanger entry to BOP

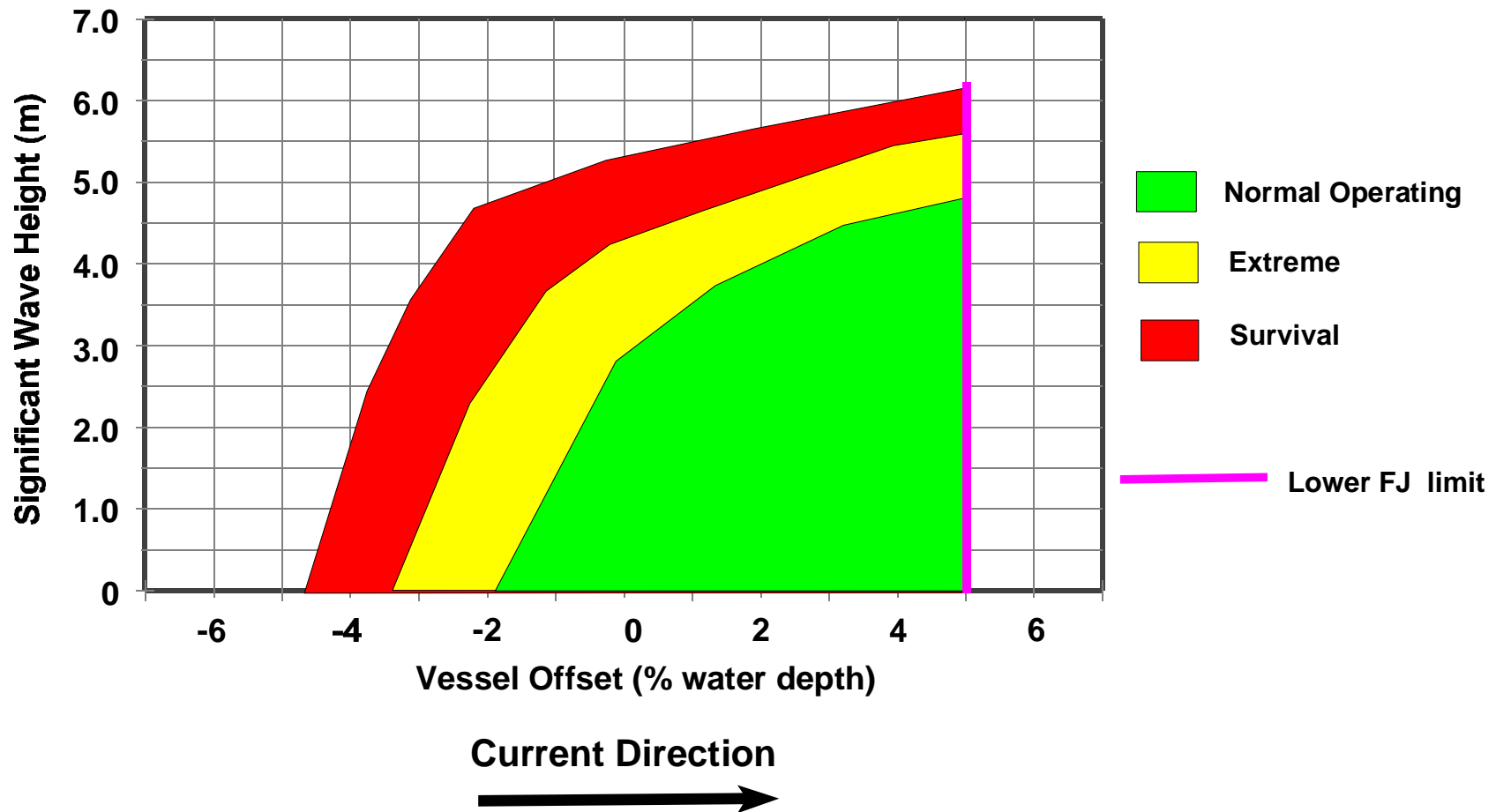
Allowable offset given by overlap

**NO OVERLAP -  
OPERATION NOT ALLOWED**

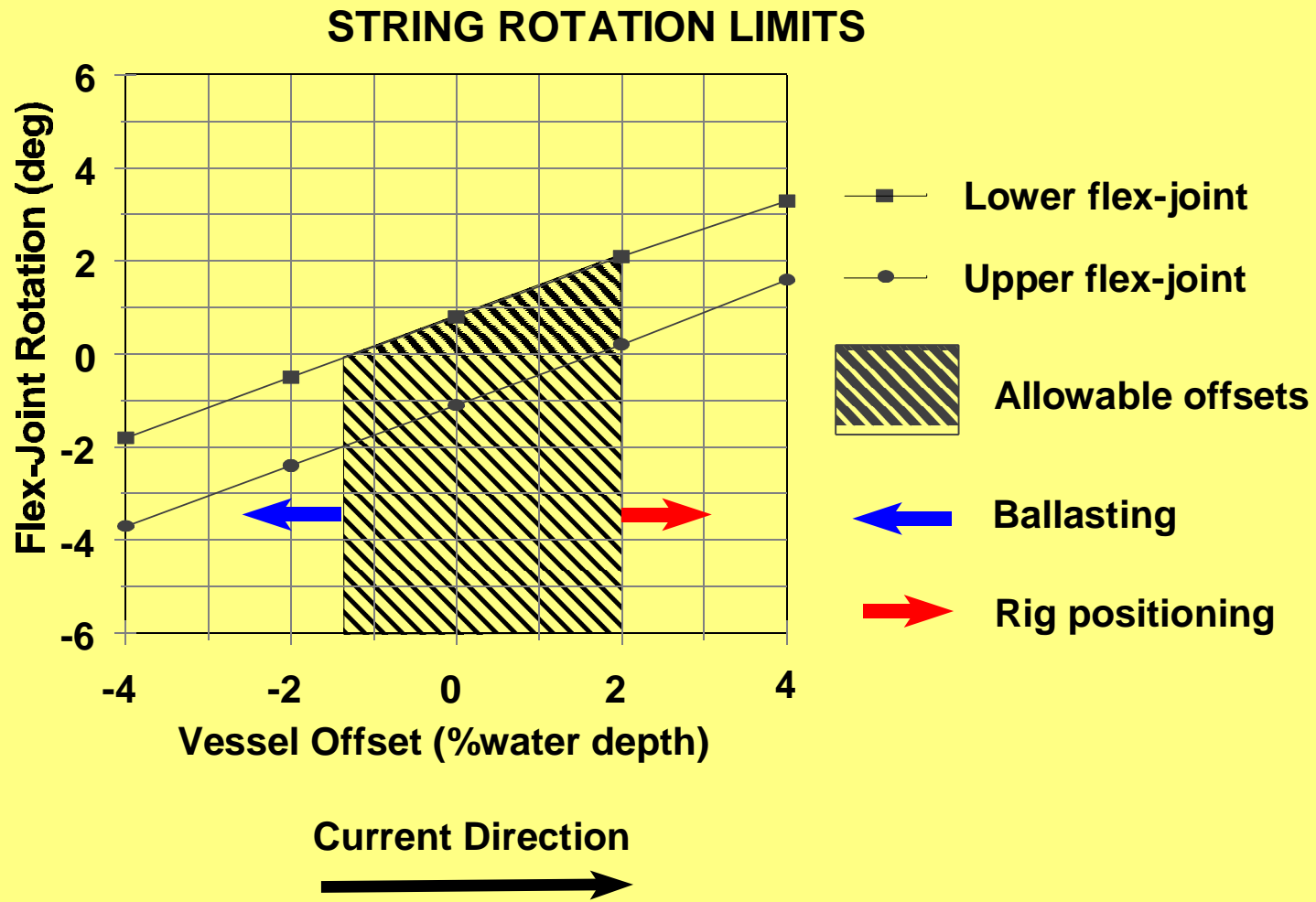
Current Direction



# COILED TUBING AND WELL TEST LIMITS




# FLEX-JOINT ANGLE REDUCTION



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# *CONFIGURATION STATUS*

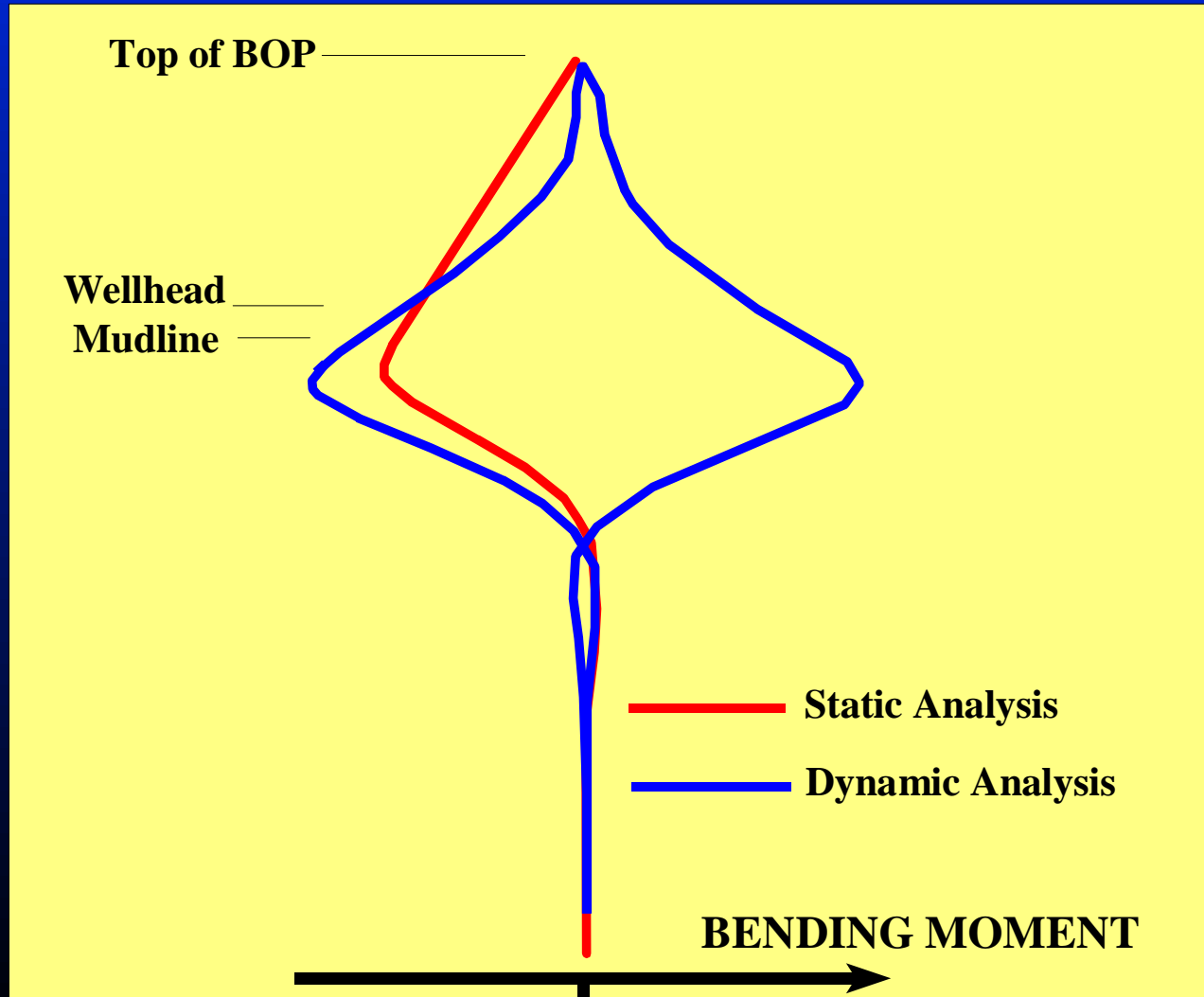
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- **Got an idea of:**
    - required tension/buoyancy*
    - potential downtime v season*
    - mooring requirements*
    - potential difficulty of completion operations*
  - **Now need to address:**
    - dynamic limits (same as shallow water)*
    - VIV response*
    - riser-wellhead-conductor interaction*
    - recoil and hang-off*
- 

# *VIV RESPONSE*

- **Analysis using combination of SHEAR7 and FLEXCOM**
- **Can be improved by**
  - Increased tension*
  - Addition of buoyancy*
  - Use of suppression devices*
- **Benefits to riser can be detrimental to wellhead and conductor**

# ***RISER LOADING ON WH SYSTEM***



# *CONFIGURATION CONFLICTS*

- **Apply more tension to control curvature and reduce riser VIV fatigue damage**

*increase fatigue damage in wellhead and conductor, riser may dictate conductor size*

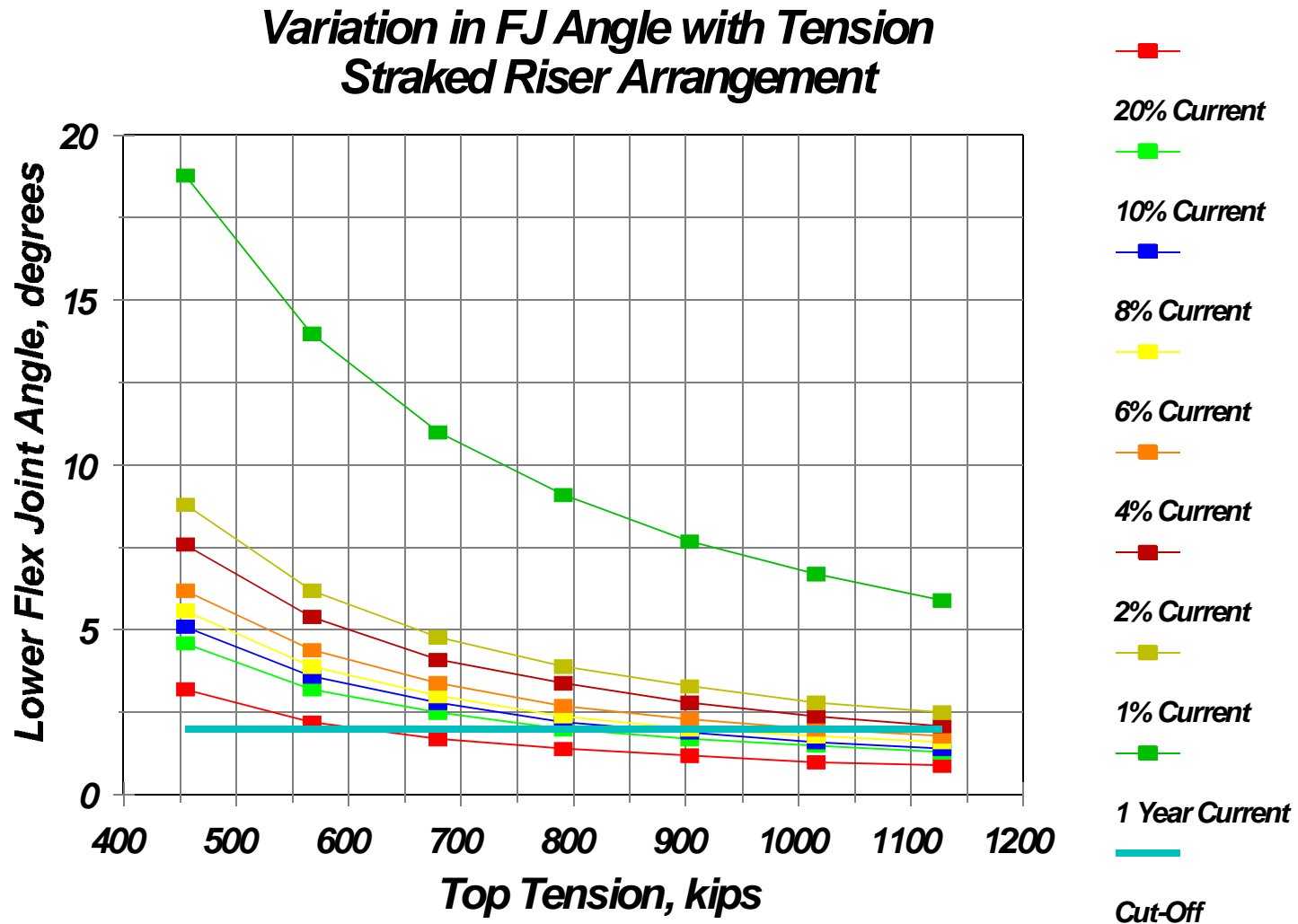
- **Use buoyancy to reduce tension needed from rig**

*increased diameter and curvature, need weight for satisfactory hang-off response*

# *VIV FATIGUE REDUCTION*

- **Use higher quality welding and inspection on wellhead/conductor**
- **Tension balanced to suit both riser and wellhead/conductor system**
- **Use of suppression devices**  
*Fairings - expensive but reduce drag*  
*Strakes - cheaper but increase drag*

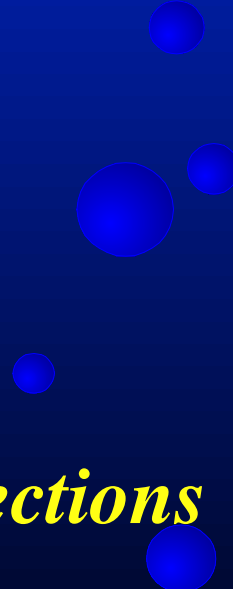
# LOWER FJ, WITH STRAKES



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# *RECOIL AND HANG-OFF*

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- **Why a concern?**
  - **Recoil**  
*higher tension drop to accommodate  
potentially large vertical accelerations*
  - **Hang-off**  
*larger diameter, less weight, higher deflections  
possibility of overstressing near vessel  
limiting conditions may drive disconnect*
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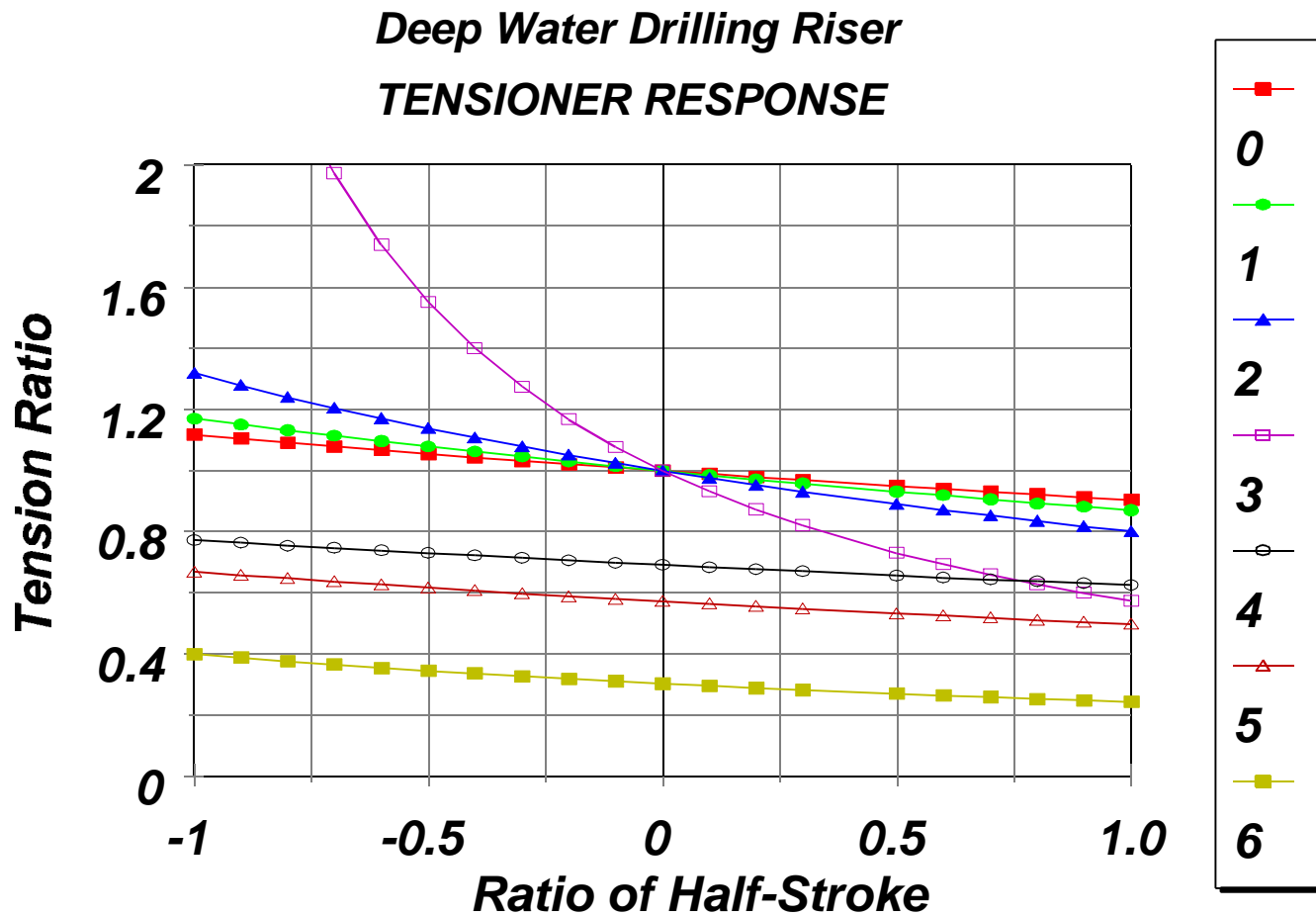
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# *HANG-OFF OPTIMISATION*

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- **Configure tensioners and recoil system**
  - **Move buoyancy from wave zone**
  - **Add weight to LMRP**
  - **Use retainer valve**
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# TENSIONER OPTIONS



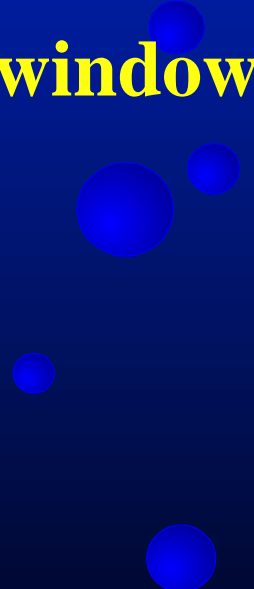
# ***FORECASTING AND MONITORING***

- **Role of forecasting**  
*running and retrieval takes longer*  
*need forecasting to avoid abortive operations*  
*reduces possibility of equipment damage*
- **Role of monitoring**  
*provide reliable feedback on behaviour*  
*maximise operating windows*  
*reduce wear*  
*reduce possibility of damage*  
*provide riser useage history*

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# ***MONITORING***

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- **Riser tension - more important**
  - **Flex-joint angles - maximise operating windows, minimise wear**
  - **Current profile measurements**
  - **Riser response**
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# ***CONCLUSIONS***

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- **Must adopt a system approach - all components & operations**
  - **Optimisation more complex**
  - **Forecasting and improved monitoring can maximise productive ops and reduce mishaps**
  - **Record keeping needed and rationalisation of inspection**
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