Dynamic Positioning Committee

Marine Technology Society

Operations and Procedures

Refining the DP Watch Circle

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Transocean, Inc.

October 17-18, 2006

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Refining the DP Watch Circle

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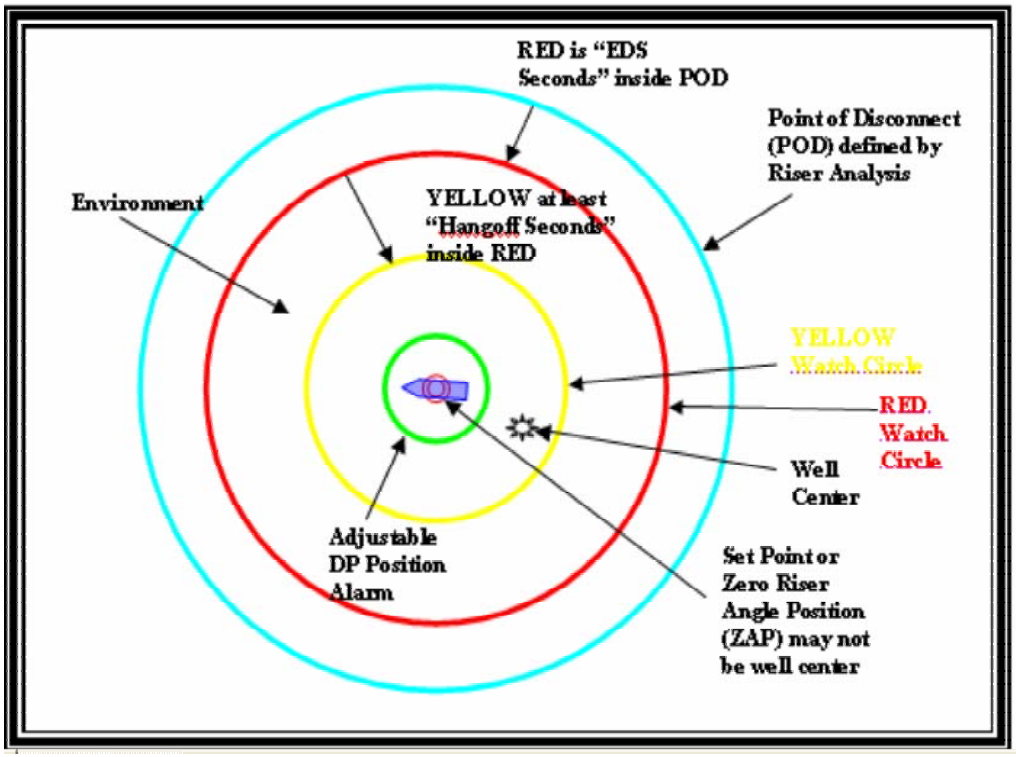
MTS DP Conference Houston
17-18 October 2006

Refining the DP Watch Circle

Watch circles were used on the first DP Oil Drilling Rig, the Sedco 445, in about 1970, to clearly define when to safely disconnect during a loss of location.

- In 1970, riser connectors and EDS timing established watch circles
- DP rigs still use “watch circles”
- As rigs moved into deeper water, more factors had to be considered
- Even deeper water will require even more sophistication.



Refining the DP Watch Circle

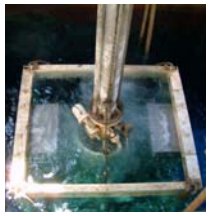
Origin of Watch Circles

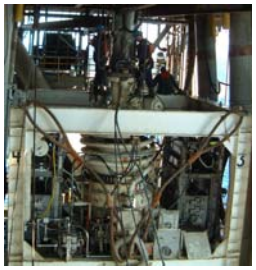
In order to drill offshore the well bore must be extended from the sea floor to the drilling rig. The system used to accomplish this consists of:

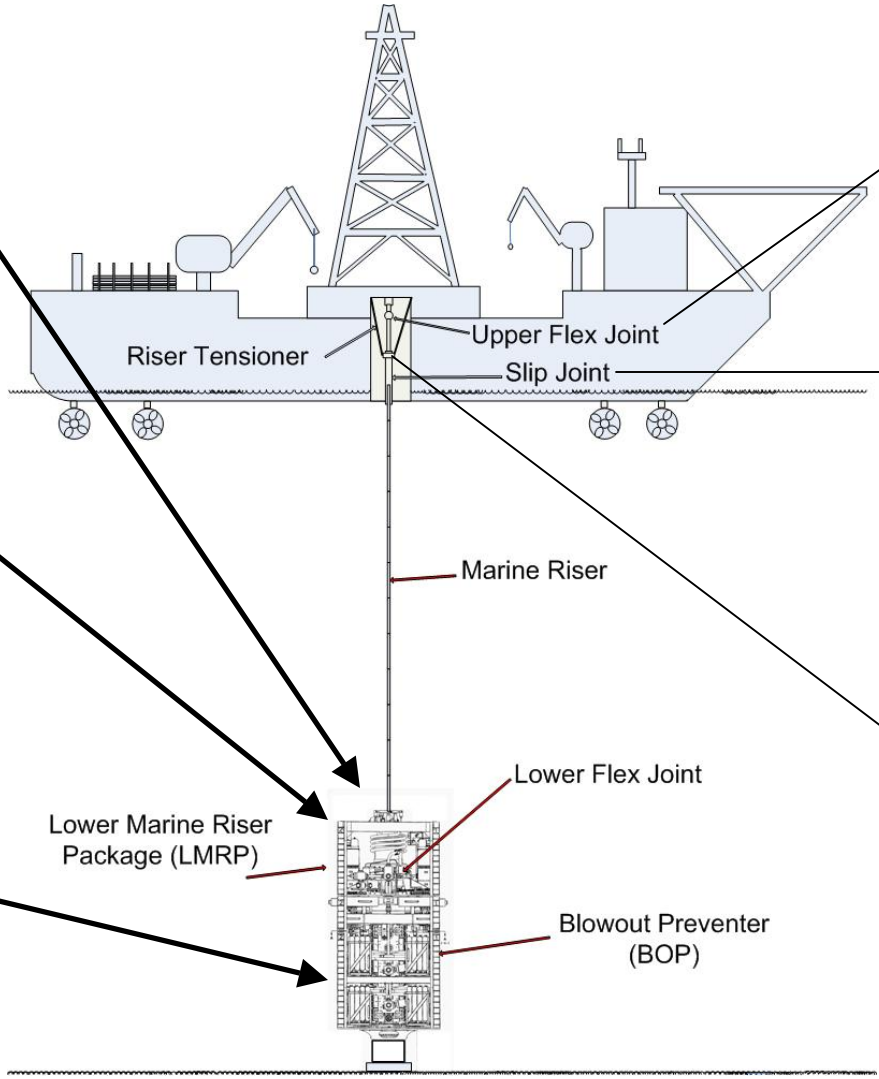
1. Wellhead
2. Blowout Preventer (BOP)
3. Marine Riser
4. Upper and lower flexible joints
5. Telescopic or slip joint
6. Riser tensioners

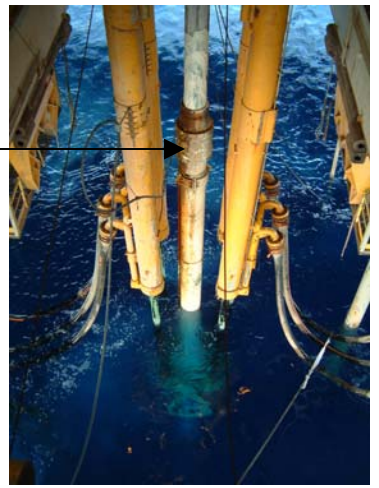
Refining the DP Watch Circle

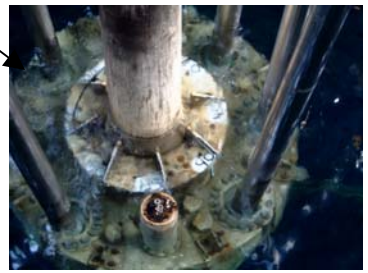
Origin of Watch Circles



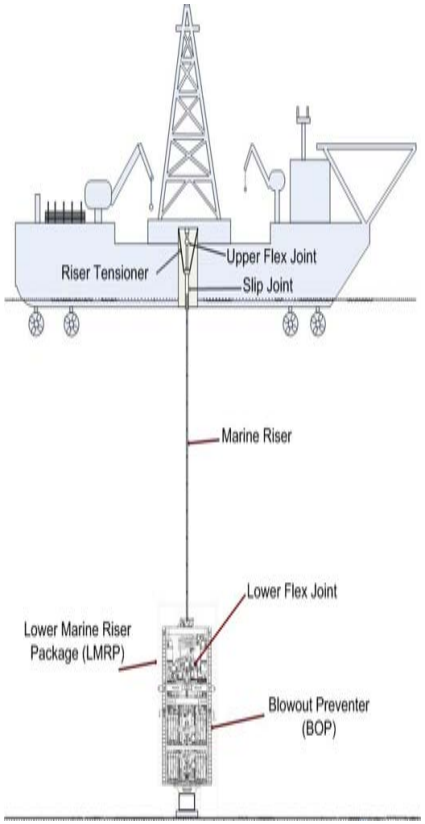




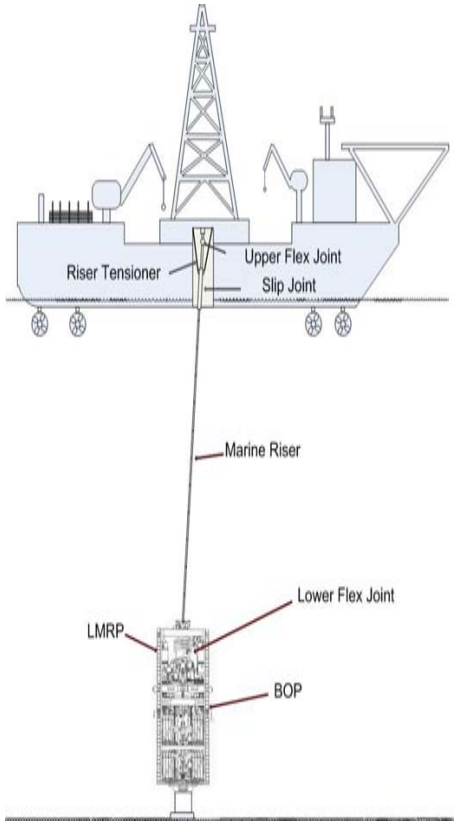




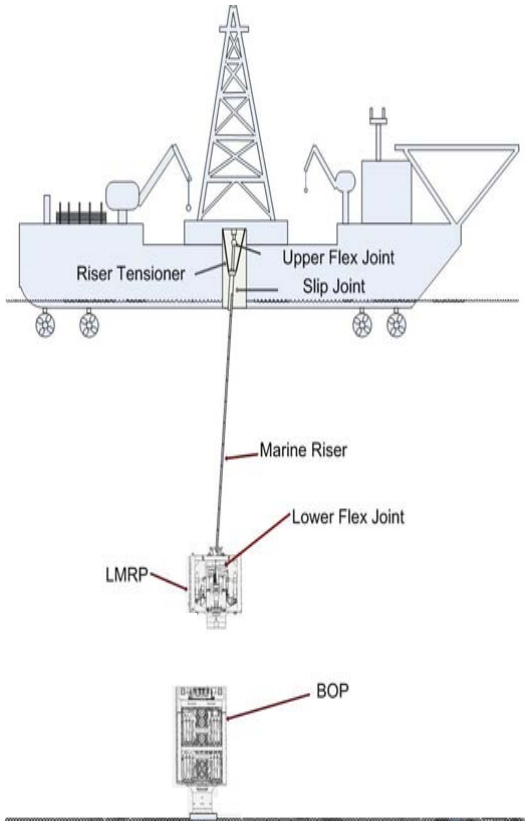
Refining the DP Watch Circle



On Location



5° Riser Angle



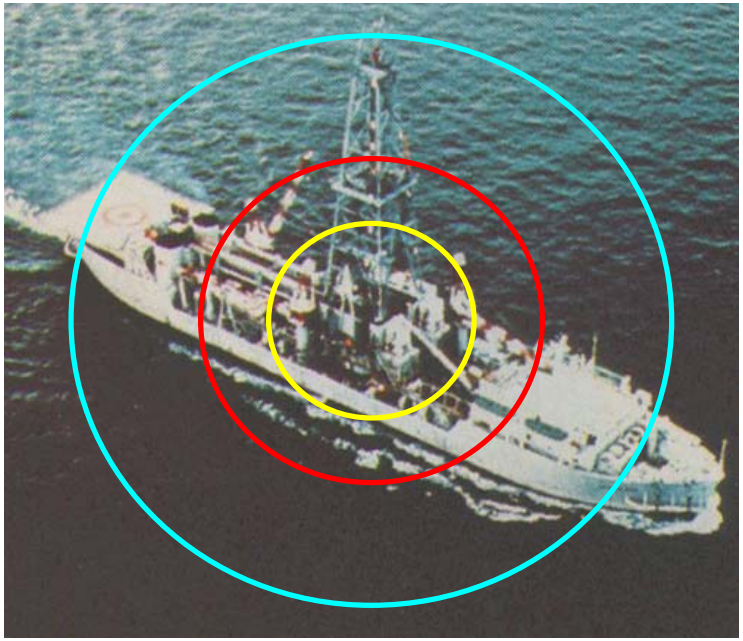
Disconnected

In 1974, the Sedco 445 set a world record for successfully drilling in 600 meters of water.

In 600 meters of water, the limiting factor for rig offset was simple, the maximum angle at which the rig could disconnect from the BOP.

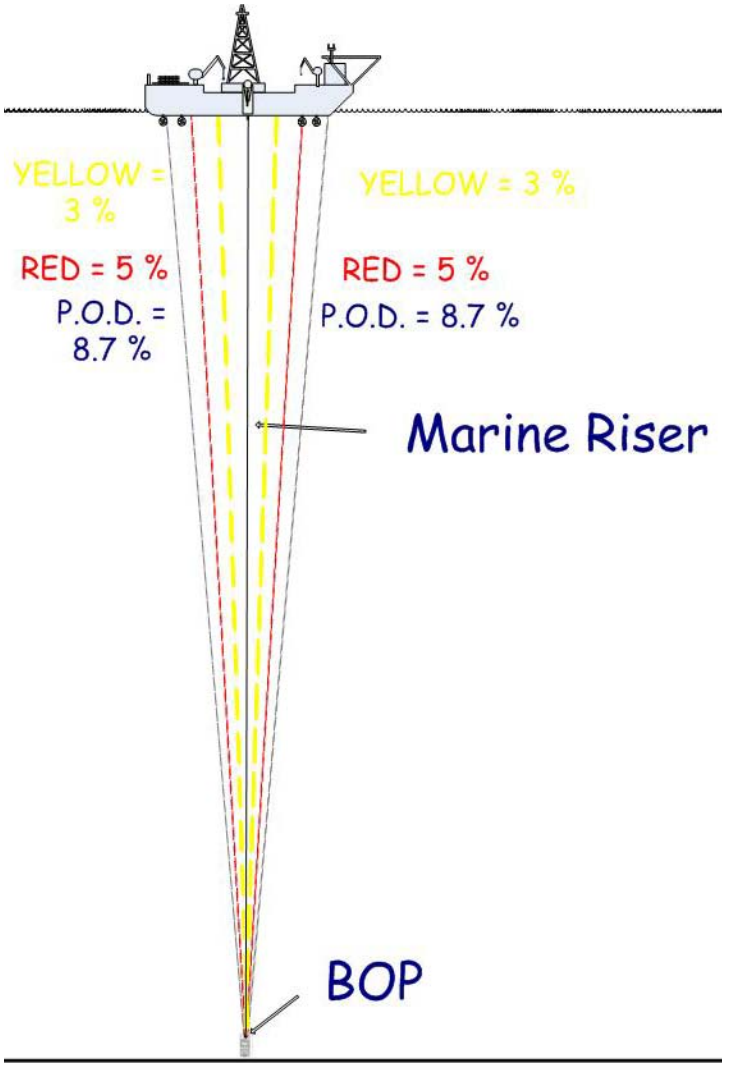
This limit was about 5° (8.7% of water depth) (Scale of ship & BOP adjusted for clarity)

Refining the DP Watch Circle



Watch circles in 1970 allowed a reasonable of rig motion while still keeping risk to a minimum

(Typical of 1970, 600 meters of water – drawn to scale)



Refining the DP Watch Circle

1970 to 1995

- Water depth records increased from 600 meters in 1974 to 2,000 meters by 1983
- YELLOW and RED were larger than the normal operating envelope, yet well inside the POD.
- Simple watch circles provided adequate time to disconnect without unnecessarily restricting drilling operations.
- From 1983 to 1995 the water depth record increased 300 meters
- Watch circles in 1995 similar to 1970.
- Beyond 2,000 meters other limits became important
  - Riser tensioner pulldown
  - slip joint extension
  - Moon pool contact

Refining the DP Watch Circle

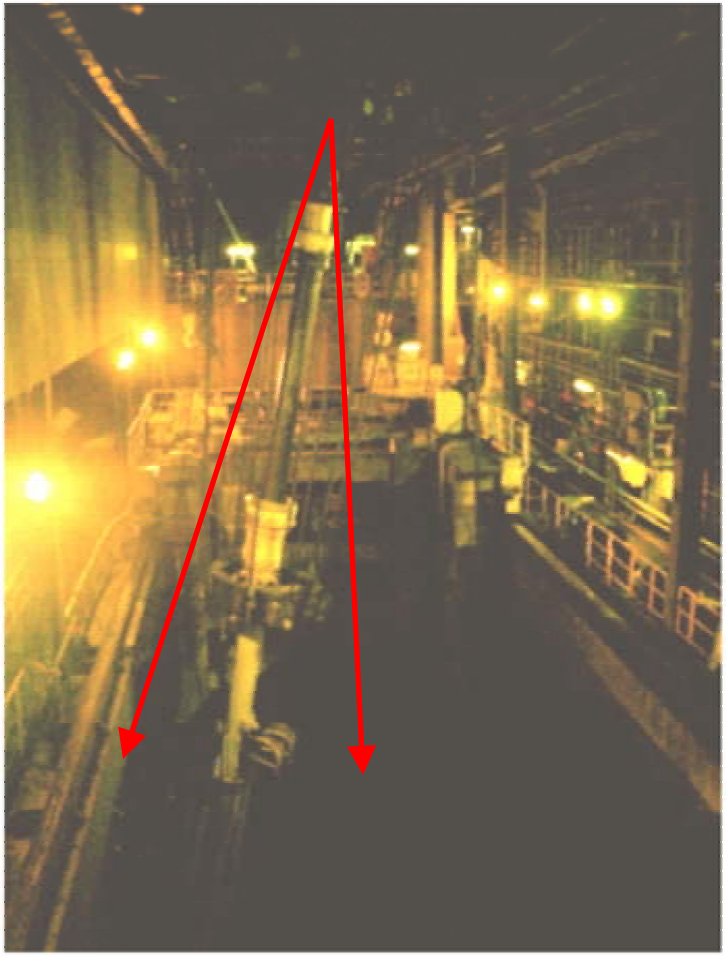


Figure 3 - Wide Moonpool Allows Large Upper Angle

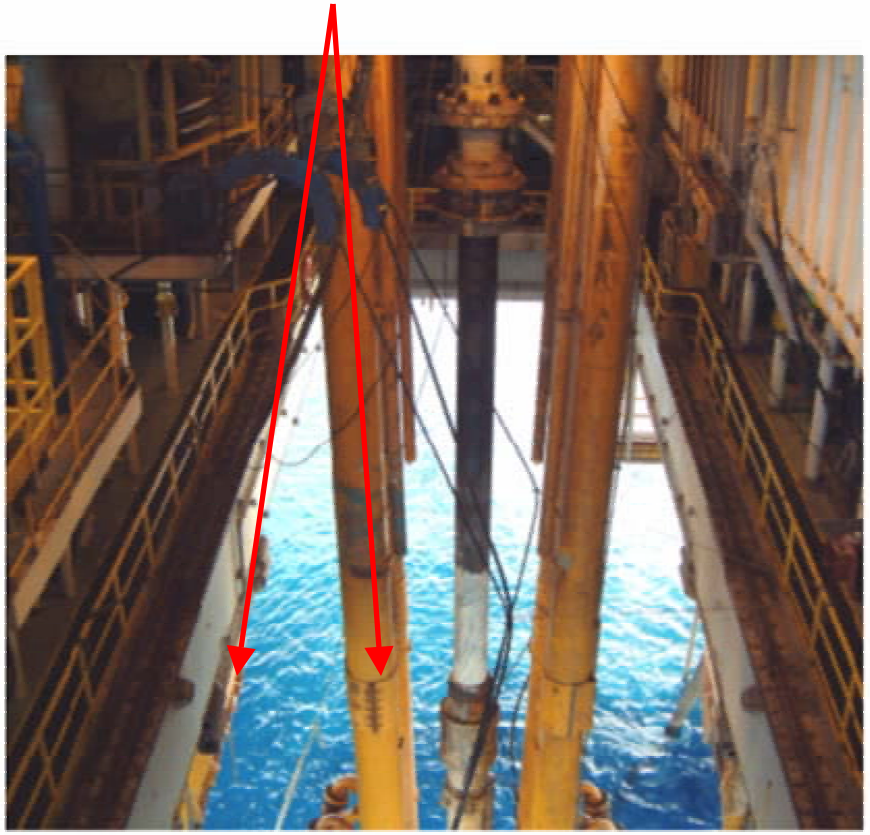


Figure 4 –Narrow Moonpool Limits Upper Angle

Refining the DP Watch Circle

1995 to 2006

- By 1995 the offshore drilling industry was recovering
  - Seismic technology greatly increased find ratio in deep water
  - World economic recovery
  - Tax Incentives to drill offshore
- Many attractive targets beyond 2,300 meters required
  - Longer, stronger, heavier riser
  - Taller and heavier BOPs, more functions, slower EDS
  - Taller drill floors
  - New drilling technologies
  - More crew and specialists
- Drilling in deeper water required larger rigs

Refining the DP Watch Circle

1995 to 2006

- Larger rigs changed the risk formula.
- Watch circles of 1970 were inadequate.
- Factors to be considered included:
  - Riser connector
  - Riser tensioner / slip joint stroke range
  - Multiple EDS sequences
  - Flex Joint stiffness
  - Upper flex joint angle
  - Well head / casing / soil strength
  - Rig velocity
  - Drift off analysis
  - Special operations or equipment
- Sophisticated tools required for complex analysis

Refining the DP Watch Circle

Transocean

DP Vessel Drift-off and Watch Circle Program
Discoverer Spirit (3825)
Revision 2
04-May 2004
(This program is **only** to be used for specified vessel above)

Site Information (Items in **BLUE** need to be updated for each new well)

Region of Operation:	GOMEX	(GOMEX, Brazil, West Africa, North Sea, etc.)	
Well Name/Number:	xxx		
Operator:	xxx		
Spud Date:	xxx		
Water Depth:	1400 m	4593 ft	

Note: Per MMS Policy, maximum RED watch circle for this water depth is 175-ft. This limit can be restricted further based on environment conditions

Riser System & EDS Parameters

Riser Point of Disconnect Offset Limits

Parameter	Allowed Value	Offset from Well Center at Which Limit Occurs		
Lower Flex Joint	6 deg	6.7% WD	93.8 m	308 ft
Upper Flex Joint	7 deg	8.0% WD	112.0 m	367 ft
Stroke-out (mean)	18.5 ft	8.0% WD	112.0 m	367 ft
Well Head Bending Moment	5100 kip-ft	4.4% WD	61.6 m	202 ft
Structural Casing Bending Moment	5969 kip-ft	7.4% WD	103.6 m	340 ft

Values should be obtained from Level 2 riser analysis conducted by Engineering

Active Emergency Disconnect Sequence

Sequence	Description	Duration	Active Sequence
1	Disconnect	59 sec	x
2	open	0 sec	
3	open	0 sec	
4	open	0 sec	
5	open	0 sec	

EDS times MUST be confirmed and approved by OIM

Rig Heading & Environmental Conditions

Rig Heading Set Point Towards: 0 deg TN
Rig Position Set Point Relative to Well: 0.0 m N (enter neg value for S) 0.0 m E (enter neg value for W)

Environmental Conditio Date of Last Update: 28-Sep-06 Time of Last Update: 1000

Wind (10m, 1-min mean)	17.0 m/s	33 kts	from	15 deg TN
Current	1.03 m/s	2.00 kts	from	345 deg TN
Seas Sig. Wave Height (H	0.0 m	0.0 ft	from	0 deg TN
Tp, seas	3.0 sec			
Wave Spectrum: JONSWAP	Gamma:	2.0		
Swell Sig. Wave Height (I	0.0 m	0.0 ft	from	0 deg TN
Tp, swell	3.0 sec			
Wave Spectrum: JONSWAP	Gamma:	7.0		

Watch Circle and Reaction Time

Sophisticated Analysis

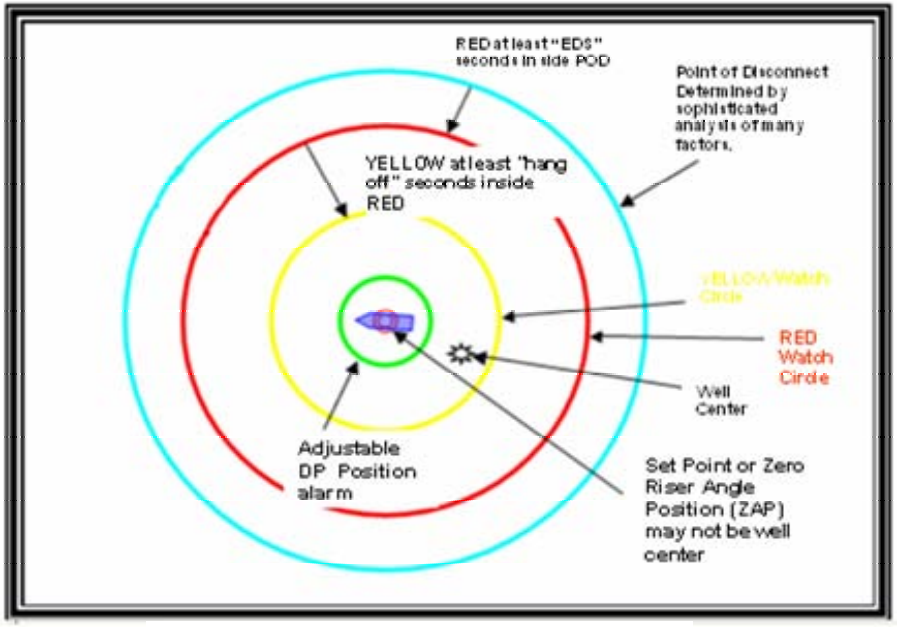
Watch Circle and Reaction Time

Press Here to Update Drift-off Calculation

Distance from Well Center to Disconnect	4.4% WD	62 m				
Distance from DP Set Point to Disconnec	4.4% WD	61 m		Drift Time	143 sec	(2.4 min)
EDS Sequence Duration					59 sec	(1.0 min)
Reaction Time					**Reaction Time**	
Red Watch Circle Radius (centered on set po	1.6% WD	22 m	73 ft		83 sec	(1.4 min)
Yellow Watch Circle Radius (0.6 x distance to	0.9% WD	13 m	43 ft		64 sec	(1.1 min)

Note: Watch Circle restricted further than normal limits for environmental condition

Outputs simple watch circles



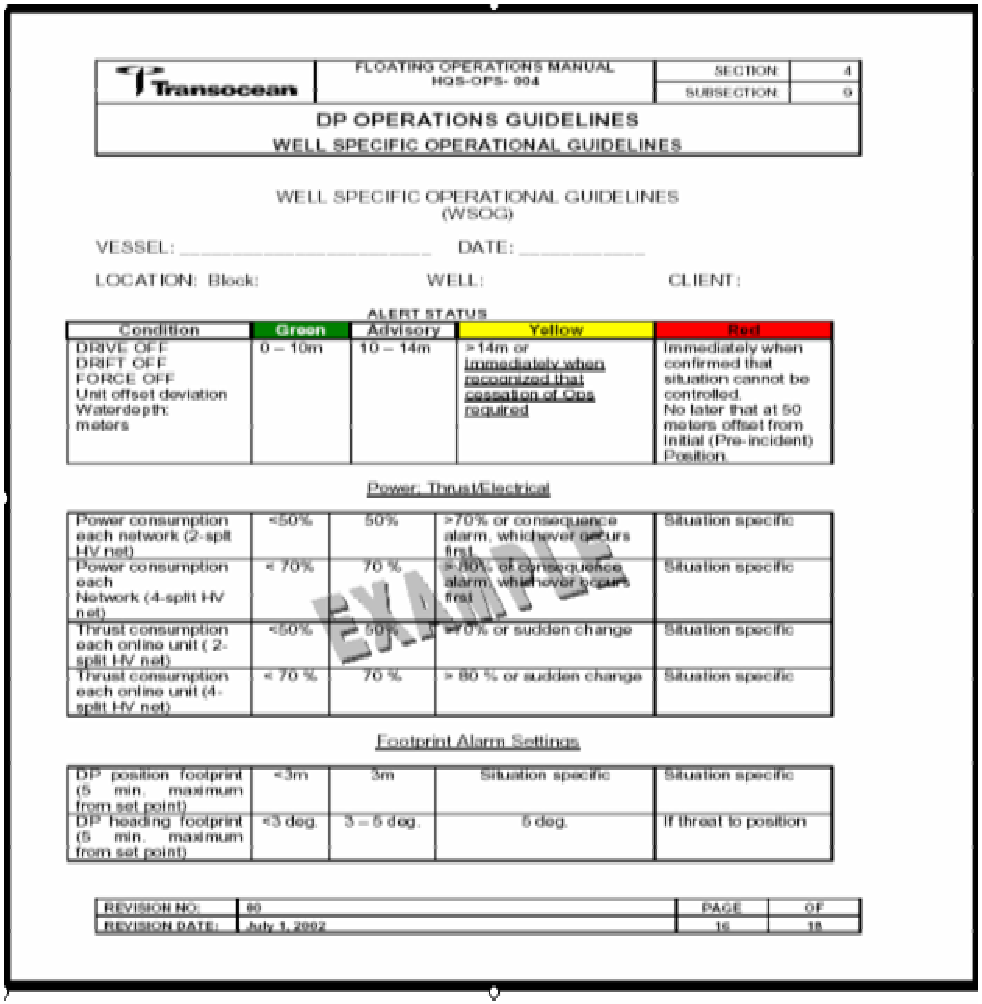
Similar to 1970

Refining the DP Watch Circle

Well Specific Operating Guidelines

Define the response for any situation.

- Critical equipment faults or failures
- Operating near capability
- Special operations
- Normal operations infrequently performed
- Vessel motion
- Sea floor obstructions
- Hurricanes
- Loop current
- SIMOPS
- CLOSEOPS



Transocean | FLOATING OPERATIONS MANUAL HQS-OPS- 004 | SECTION: 4 | SUBSECTION: G

DP OPERATIONS GUIDELINES
WELL SPECIFIC OPERATIONAL GUIDELINES

WELL SPECIFIC OPERATIONAL GUIDELINES
(WSOG)

VESSEL: _____ DATE: _____

LOCATION: Block: WELL: CLIENT:

ALERT STATUS

Condition	Green	Advisory	Yellow	Red
DRIVE OFF DRIFT OFF FORCE OFF Unit offset deviation Waterdepth: meters	0 – 10m	10 – 14m	>14m or Immediately when recognized that cessation of Ops required	Immediately when confirmed that situation cannot be controlled. No later that at 50 meters offset from Initial (Pre-incident) Position.

Power, Thrust/Electrical

Power consumption each network (2-split HV net)	<50%	50%	>70% or consequence alarm, whichever occurs first	Situation specific
Power consumption each Network (4-split HV net)	< 70%	70 %	> 80% of consequence alarm, whichever occurs first	Situation specific
Thrust consumption each online unit (2-split HV net)	<50%	= 50%	>70% or sudden change	Situation specific
Thrust consumption each online unit (4-split HV net)	< 70 %	70 %	> 80 % or sudden change	Situation specific

EXAMPLE

Footprint Alarm Settings

DP position footprint (5 min. maximum from set point)	<3m	3m	Situation specific	Situation specific
DP heading footprint (5 min. maximum from set point)	<3 deg.	3 – 5 deg.	5 deg.	If threat to position

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REVISION DATE: July 1, 2002

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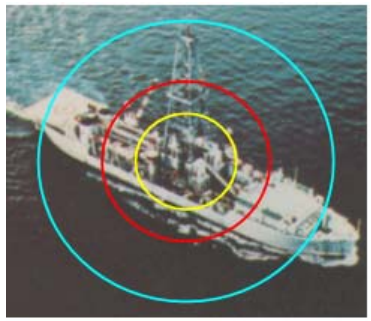

Sedco 445 in 600 meters of water

Deepwater rig in 600 meters of water

Deepwater rig in 1,400 meters of water

Deepwater rig in 3,000 meters of water

Refining the DP Watch Circle

The Future

- New rigs will likely be more complex and larger
- SIMOPS will become more common
- CLOSEOPS will become more common
- Drilling innovations will require that we move closer to the operating envelope
- The challenge for the DP industry is to make sure we can support the advance of drilling technology while maintaining acceptable watch circles.
- Following are some ideas how we may progress

Refining the DP Watch Circle

The Future

- Faster emergency disconnect
- BOP stack angle
- Riser tension management
- Riser angle management
- Velocity measurement
- Velocity management
- Dynamic watch circle
- Whatever we do, keep it simple

Refining the DP Watch Circle

Conclusion

The watch circle is a powerful, yet simple tool to manage risk.

Over the past 3+ decades, we have been able to retain this tool, though the analysis to derive the watch circles has changed significantly.

It seems likely that we can continue to define our limits as watch circles as we move into deeper water in our search for more oil.

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Thank you

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