

What Does 'Prepared for MPD' Mean? a Contractors Perspective

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MPD Prepared; a Contractors Perspective

- Transocean experience
- Previous systems
- MPD System Design Basis
- MPD Equipment Considerations
 - Riser
 - Surface Equipment
 - MPD Degasser
- MPD Operations Management
 - Operations Matrix
 - Hazop
 - Training

Rig Name	Rig Type	Location	Customer	Year	Application	Status
Trident 8	Jack Up	Angola	Cabinda Gulf	2003	PMCD	Completed
Sedco 601	Semi Sub	Indonesia	Santos	2004	PMCD w/ Surface BOP	Completed
Sedco 601	Semi Sub	Indonesia	Santos	2005 - 2006	PMCD w/ Risercap™	Completed
Roger W. Mowell	Jack Up	Malaysia	Talisman	2006 - 2007	CBHP	Completed
Constellation II	Jack Up	Egypt	BP	2007	CBHP, HPHT	Completed
High Island VII	Jack Up	Gabon	Total	2007	CBHP, HPHT	Completed
Deepwater Frontier	DP Drillship	India	Reliance	2007	CBHP, Concentric Riser	Completed
Actinia	Semi Sub	India	Reliance	2008	CBHP, Concentric Riser	Completed
Arctic III	Semi Sub	Libya	ENI	2008 - 2009	ECD, HPHT, Reconfigurable Riser	Completed
Harvey H. Ward	Jack Up	Malaysia	Talisman	2009	CBHP	Completed
Shelf Explorer	Jack Up	Malaysia	Talisman	2009	CBHP	Completed
Trident IX	Jack Up	Indonesia	Pearl	2010	UBD (Low Head Drilling)	Completed
Sedco 601	Semi Sub	Malaysia	Petronas	2010	CBHP	Completed
GSF Explorer	DP Drillship	Indonesia	MSEC	2010 - 2012	CBHP, PMCD, Riser Degassing	Completed
GSF Rig 135	Semi Sub	Nigeria	Addax	2011 - 2012	CBHP, HPHT	Completed
Actinia	Semi Sub	Malaysia	Petronas	2011 - 2012	PMCD w/Risercap™	Completed
Monarch	Jack Up	Denmark	Maersk	2011 - 2012	CBHP	Completed
Marianas	Semi Sub	Ghana	ENI	2012	CBHP, HP; EKD/CC	Completed
HH Ward	Jack Up	Malaysia	Petronas	2012	PMCD	Completed
Compact Driller	Jack Up	Thailand	Chevron	2012	CBHP / Re-entry	Completed
Monarch	Jack Up	Denmark	Maersk	2012 - 2013	CBHP	Completed
Constellation 1	Jack Up	Indonesia	Total	2013 - 2014	PMCD, EKD	Completed
MG Hulme	Semi Sub	Malaysia	Petronas	2015	CBHP, PMCD	Completed
Deepwater Thalassa	DP Drillship	GOM	Shell	2017	CBHP	Ongoing
Deepwater Invictus	DP Drillship	GOM	BHP	2017	CBHP	Ongoing
TBA		Malaysia	Shell	2017	CBHP/PMCD	Tender

MPD Prepared; based on past experience



Concentric riser (DP)
(US patent: 6,273,193)



Integrated RCD (moored)
49 ½ rotary

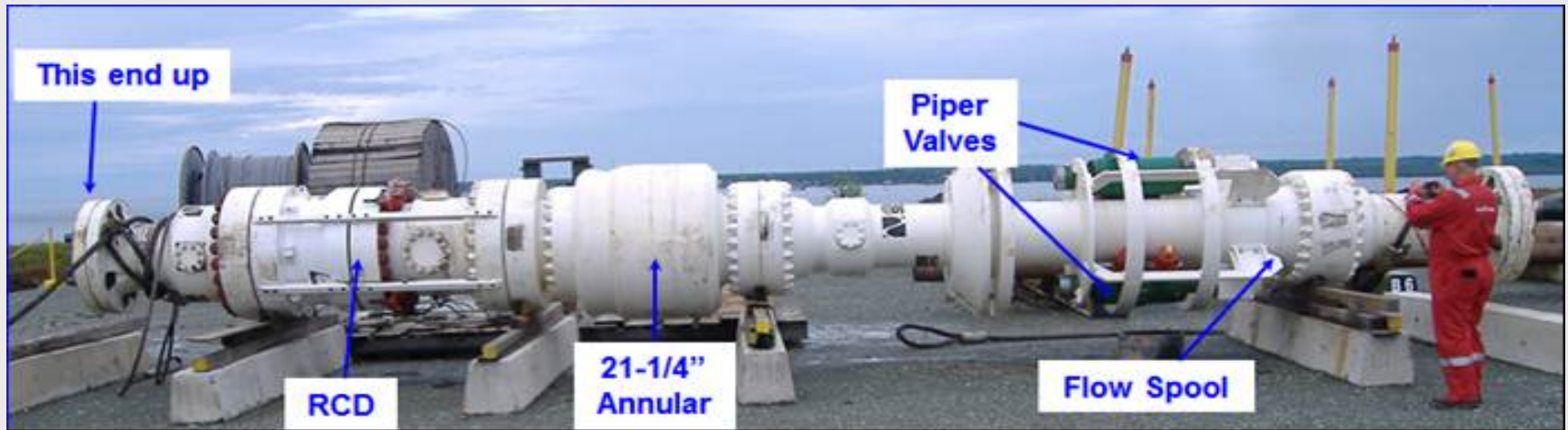


Integrated RCD (DP)
Below Tensioner Ring



Concentric riser (DP)
Above Tensioner Ring
(US Patents 7,866,399
8,631,874)

MPD riser joint first deployment from EPL using BTR rcd for MPD



MPD System Design Basis

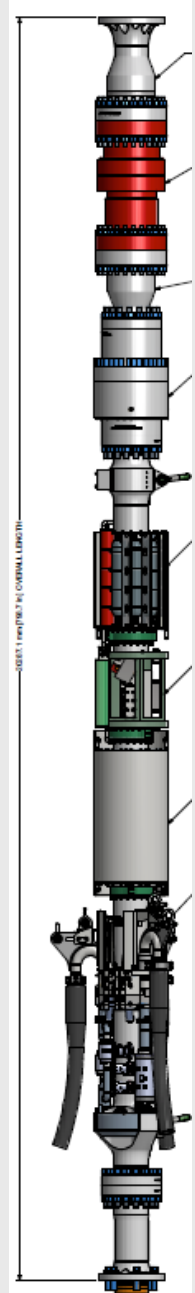
Developing an MPD System Design Basis

What are:

- 1) the maximum anticipated liquid rate
- 2) the maximum resultant gas rate
- 3) the maximum process operating pressures
- 4) the existing equipment capacities and limitations
 - annular/diverter closing speed

What features are desirable

- a) independent safety system
 - SIL level 3 (target)
 - independent relief / discharge lines
- b) independent control system
 - flow out monitoring
 - facility for automated operation
- c) independent flow path
 - independent degasser
 - quick closing annular (complete shut off)
 - optional Rotating Control Device (RCD)
- d) deployable through a 49 1/2" rotary table
 - maximum OD 46 1/2"
- e) modular
 - adaptable rig to rig with minimum modification ie X/O only
 - readily deployable on rigs in service
 - no more challenging than a full DST system install



MPD System Design Basis

Gas Influx volume := 100bbls (above BOP)
 System Back Pressure range := 250psi – 750psi (in RGH mode)

Gas migration velocity := ~ 8,900 ft./hr (~149 ft/min)
 Liquid rate := ~ 2,400 gpm
 Design Safety Factor := 1.25
 Design Liquid rate := ~ 3,000 gpm
 Liquid Density range := 8.56 ppg (SW) – 18 ppg

RGH reaction time := <5s <=15s

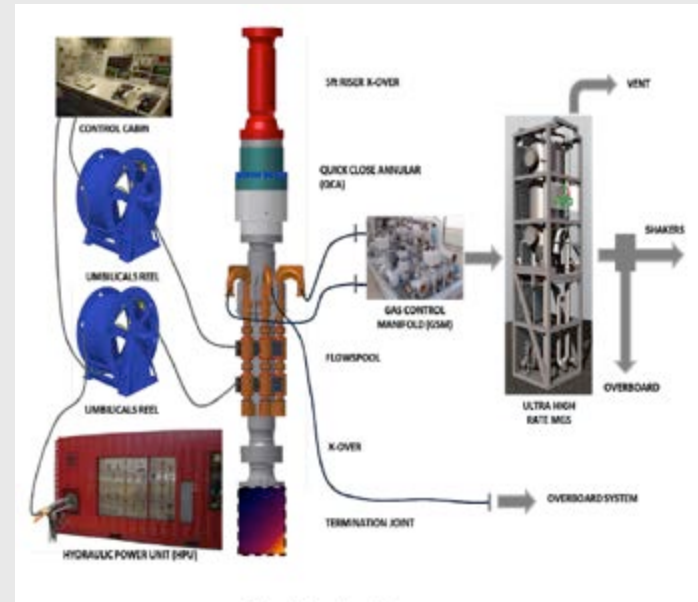
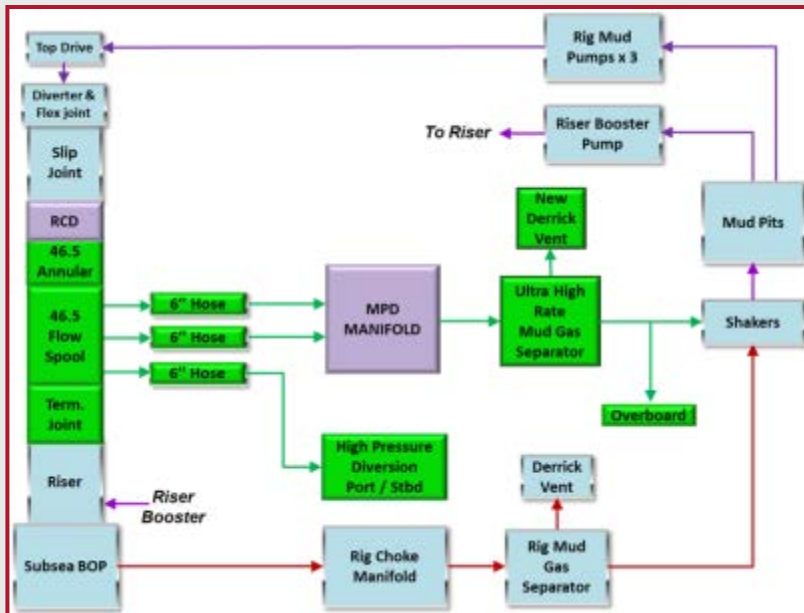
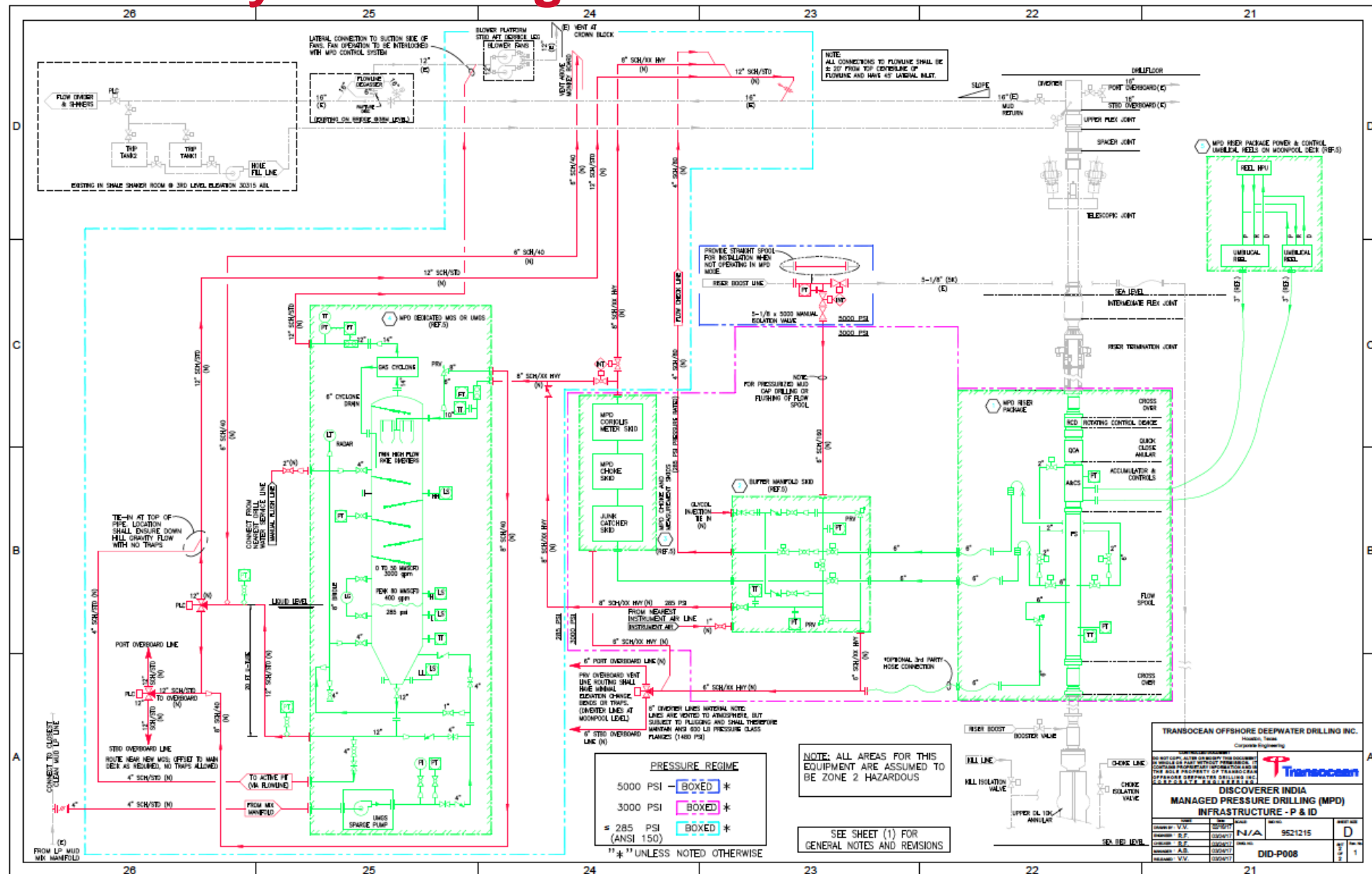


Figure 2: Overview of main components

MPD System Design Basis



MPD Equipment Considerations

MPD Drilling Matrix	Surface Pressure Indicator			
	At Planned Drilling Back Pressure (100psi)	At Planned Connection Back Pressure (100psi + ECD but <500psi)	> Planned Back Pressure & < Back Pressure Limit (>100psi + ECD & <1,000psi)	≥ Back pressure Limit (1,000psi)
No Influx	Continue Drilling	Continue Drilling	Increase pump rate, mud weight, or both AND reduce surface pressure to planned or contingency levels	Pick up, shut in SS BOP, evaluate next action
Operating Limit (5bbbls)	Increase back pressure, pump rate, mud weight, or a combination of all	Increase back pressure, pump rate, mud weight, or a combination of all	Increase pump rate, mud weight, or both AND reduce surface pressure to planned or contingency levels	Pick up, shut in SS BOP, evaluate next action
< Planned Limit (10bbbls)	Cease Operations. Increase back pressure, pump rate, mud weight or a combination of all, circulate out any influx prior to resuming operations	Cease Operations. Increase back pressure, pump rate, mud weight or a combination of all, circulate out any influx prior to resuming operations	Pick up, shut in SS BOP, evaluate next action	Pick up, shut in SS BOP, evaluate next action
≥ Planned Limit (>10bbbls)	Investigate problem, Pick up, shut in SS BOP, evaluate next action	Investigate problem, Pick up, shut in SS BOP, evaluate next action	Pick up, shut in SS BOP, evaluate next action	Pick up, shut in SS BOP, evaluate next action

Primarily related to **barriers** and **riser**;

Barrier management procedures

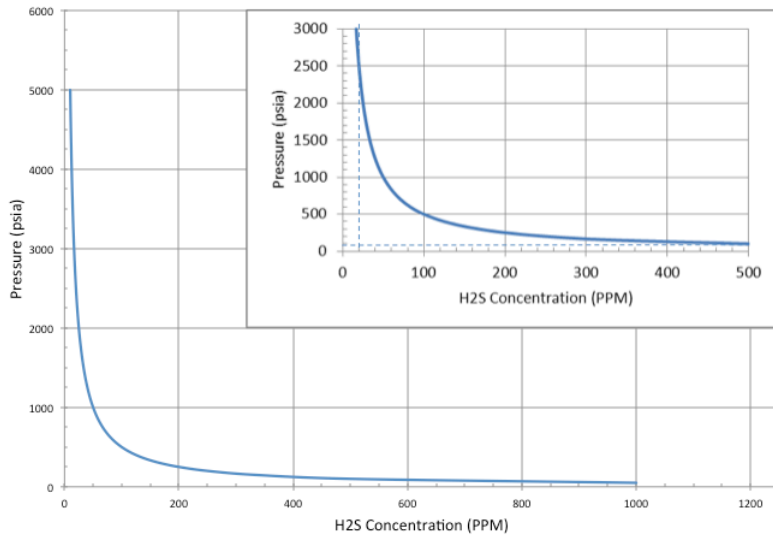
Riser maximum **combined loading** capacity?

What's in the well bore environment ie H2S, CO2?

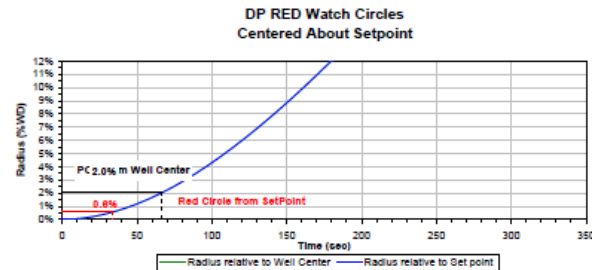
External delta P acting on the riser, BOP or wellhead?

Additional station keeping or EDS considerations?

H2S Partial Pressure = 0.05 psia

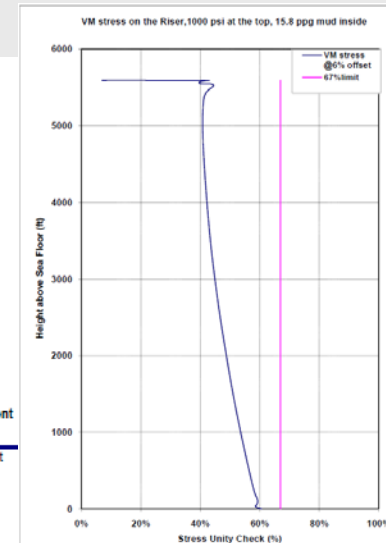


c) operability-10year



Sequence	EDS Time	POD	Red Circle Radius	Reaction Time [sec]	Comment	
	[sec]	(%WD)	(feet)			
Blind Shear	32	6.5%	4.6%	333.0	152	Drilling Environment
Blind Shear	32	2.3%	0.9%	61.6	47	1-year Storm
Blind Shear	32	2.0%	0.6%	41.3	34	10-year Storm

Collinear Environments assumed at 15-deg off rig heading for assessment.



MPD: Surface Equipment Considerations

Mud Properties:

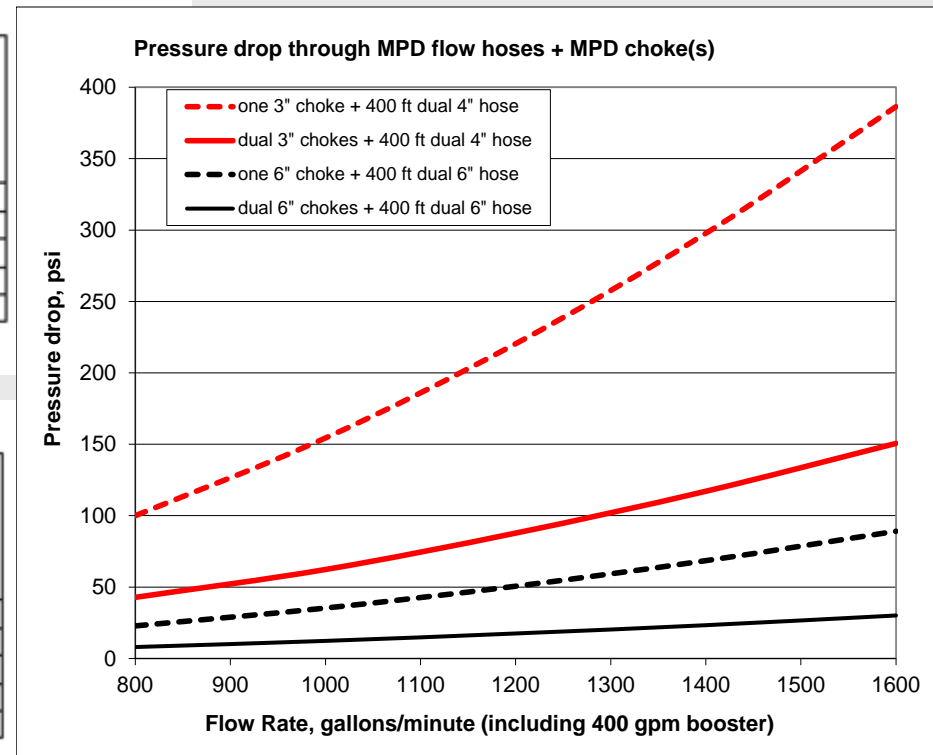
MW	12 ppg
PV	25 cP
YP	30 lb/100sqft

Pressure Drop Through 3" Choke and 4" Hose System:

Flow Rate GPM	Pressure Drop (psi)			Total Pressure Drop thru one choke system	Total Pressure Drop thru dual choke system
	through one 3" choke	through 2 x 3" chokes	400 ft hose 2 x 4"		
800	78.6	21.4	21.4	100	42.8
1000	122.8	30.7	31.6	154.4	62.3
1200	176.8	44.2	43.6	220.4	87.8
1400	240.7	60.1	57	297.7	117.1
1600	314.3	78.5	72.1	386.4	150.6

Pressure Drop Through 6" Choke and 6" Hose System:

Flow Rate GPM	Pressure Drop (psi)			Total Pressure Drop thru one choke system	Total Pressure Drop thru dual choke system
	through one 6" choke	through 2 x 6" chokes	400 ft hose 2 x 6"		
800	19.7	4.9	3.1	22.8	8
1000	30.7	7.7	4.6	35.3	12.3
1200	44.2	11.1	6.4	50.6	17.5
1400	60.2	15	8.3	68.5	23.3
1600	78.6	19.6	10.5	89.1	30.1



MPD Prepared: Surface Equipment Layout

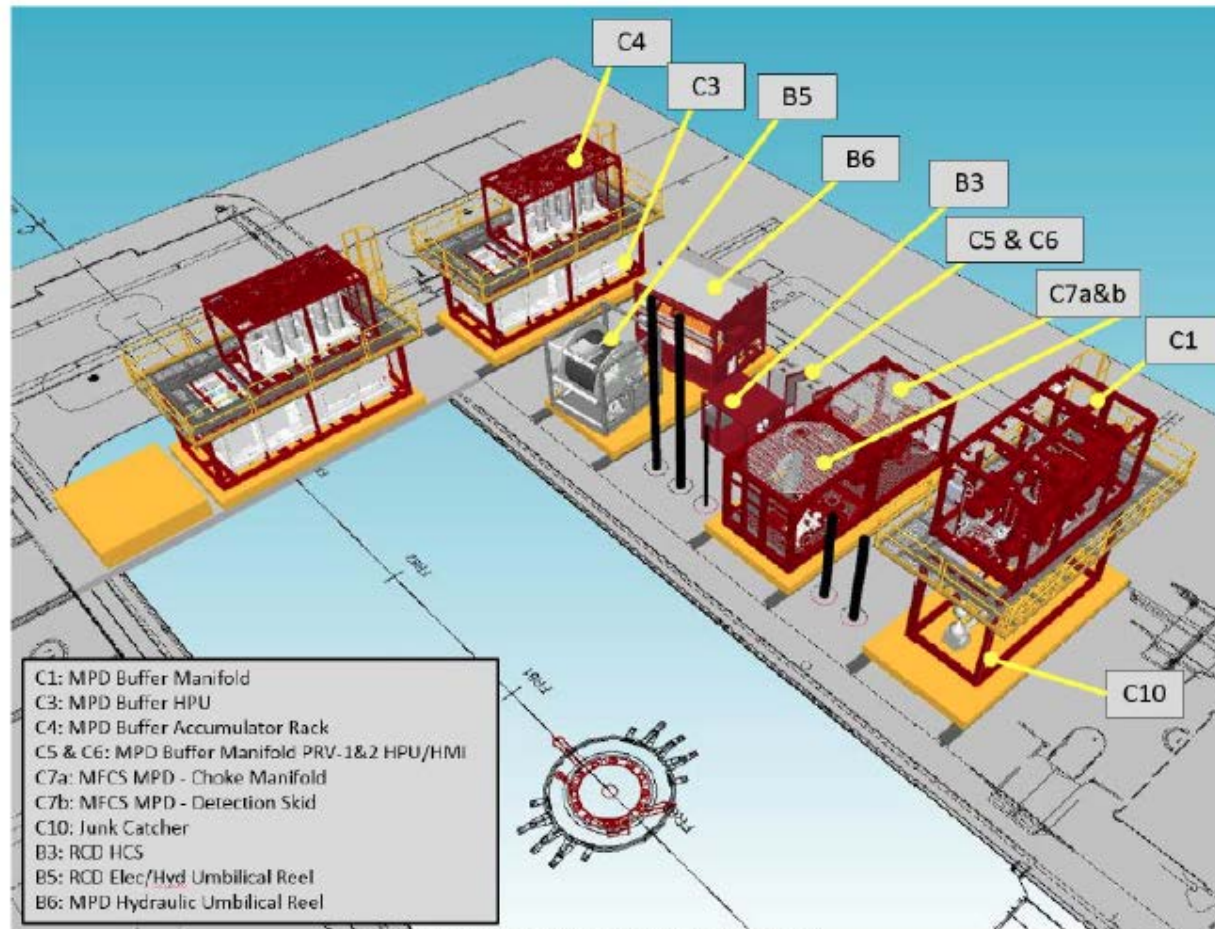
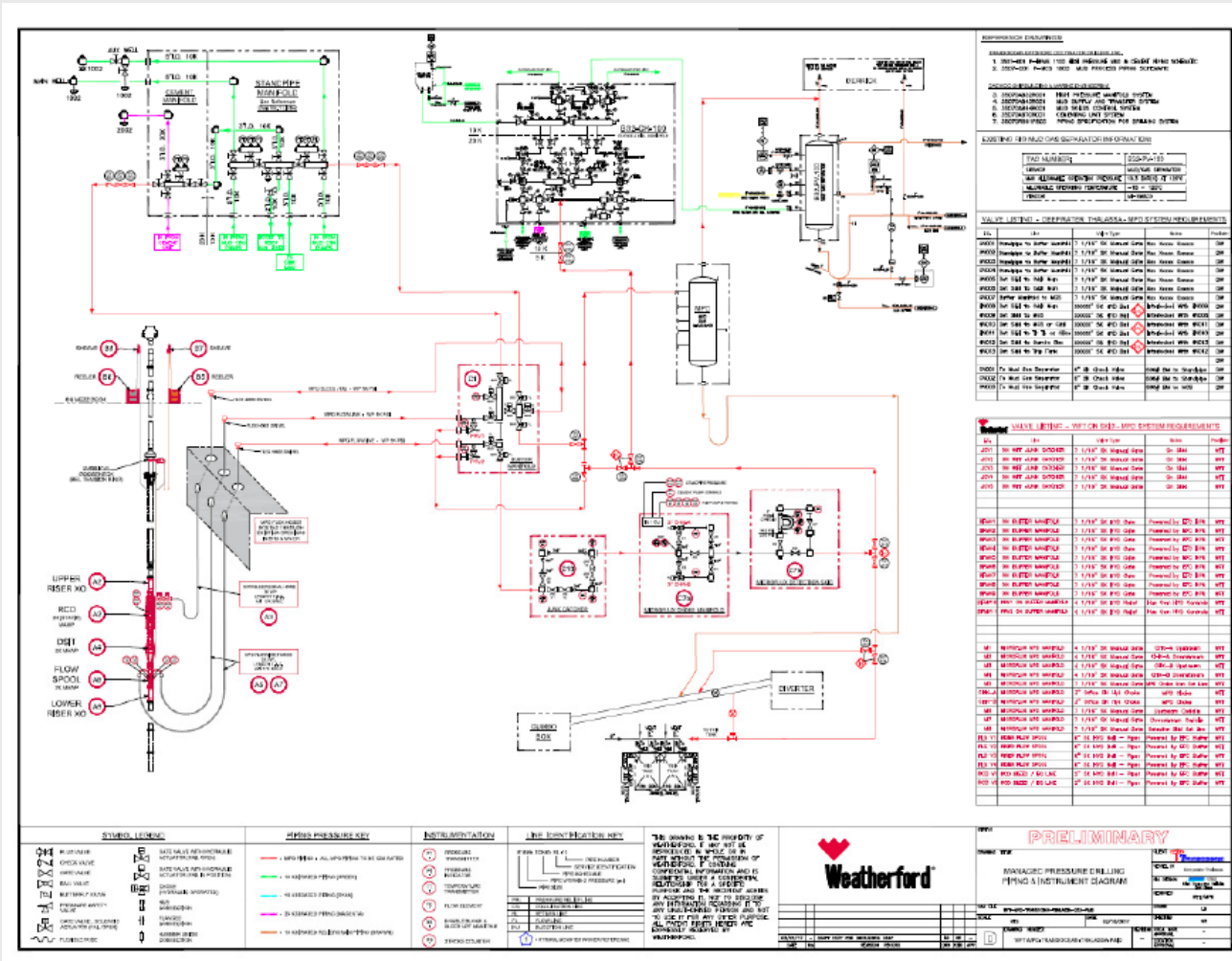


Figure 4: Concept GA Layout (not the final GA Layout)

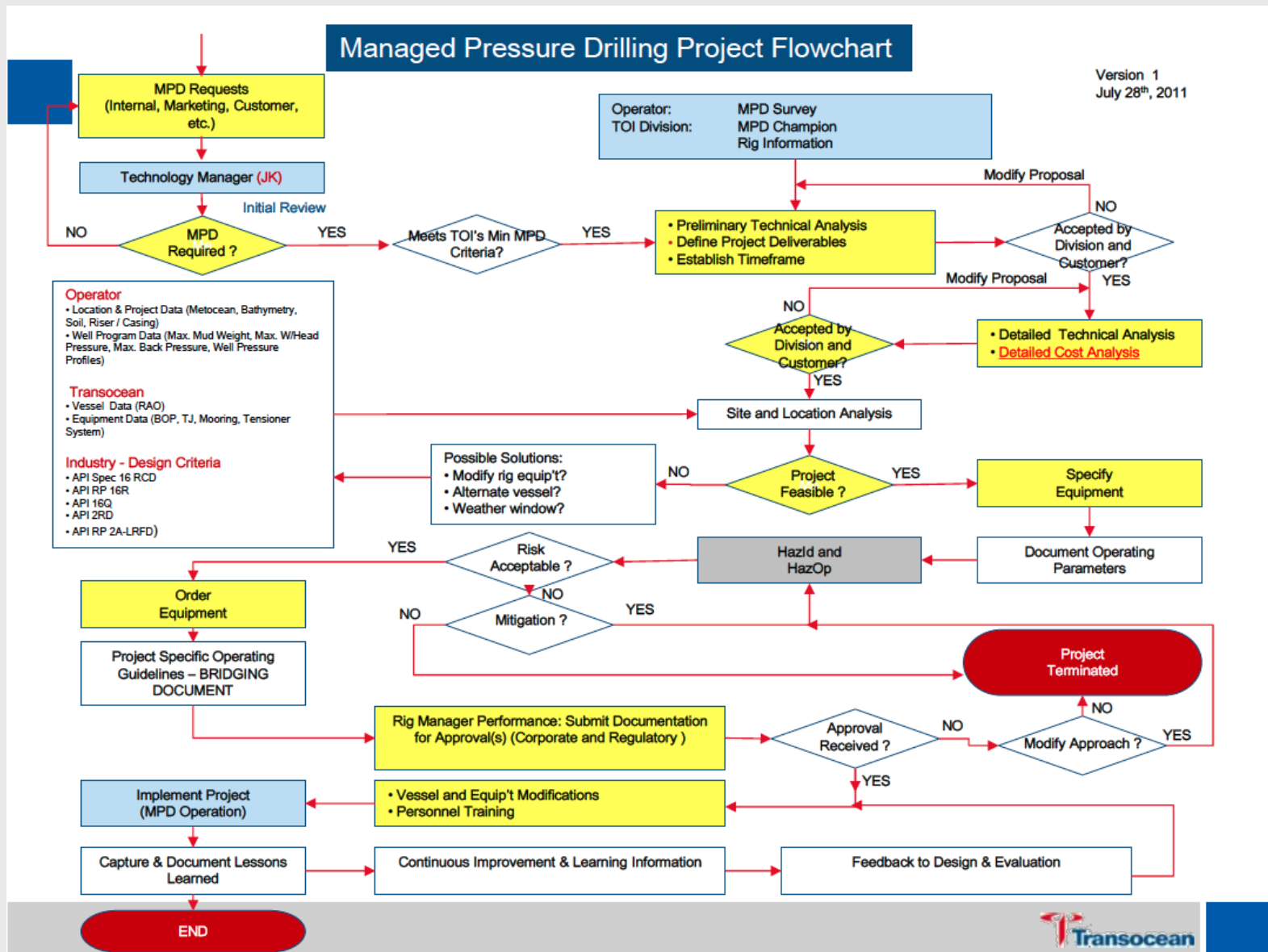
MPD Prepared: Surface Equipment Interfaces



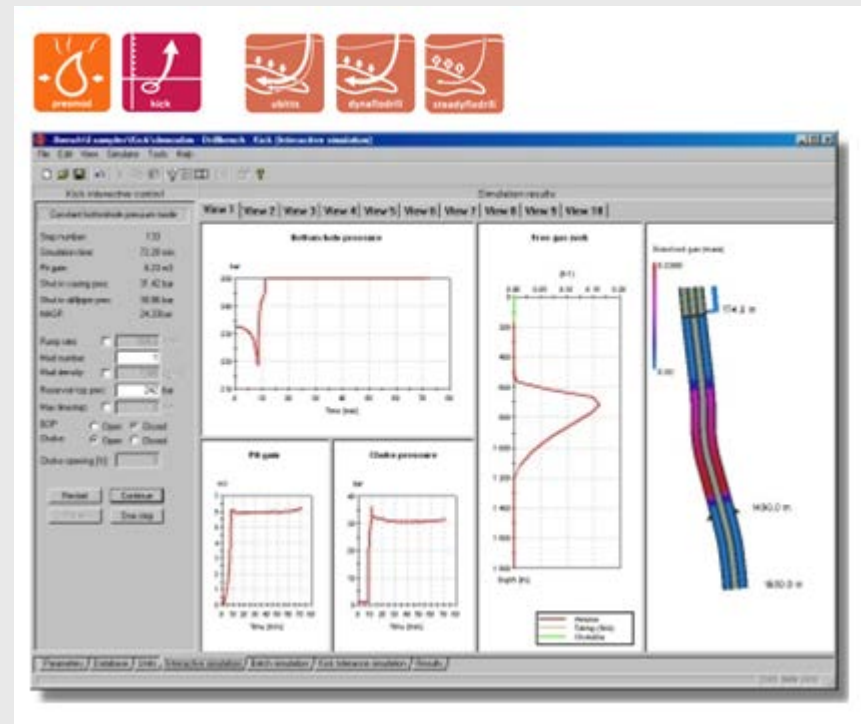
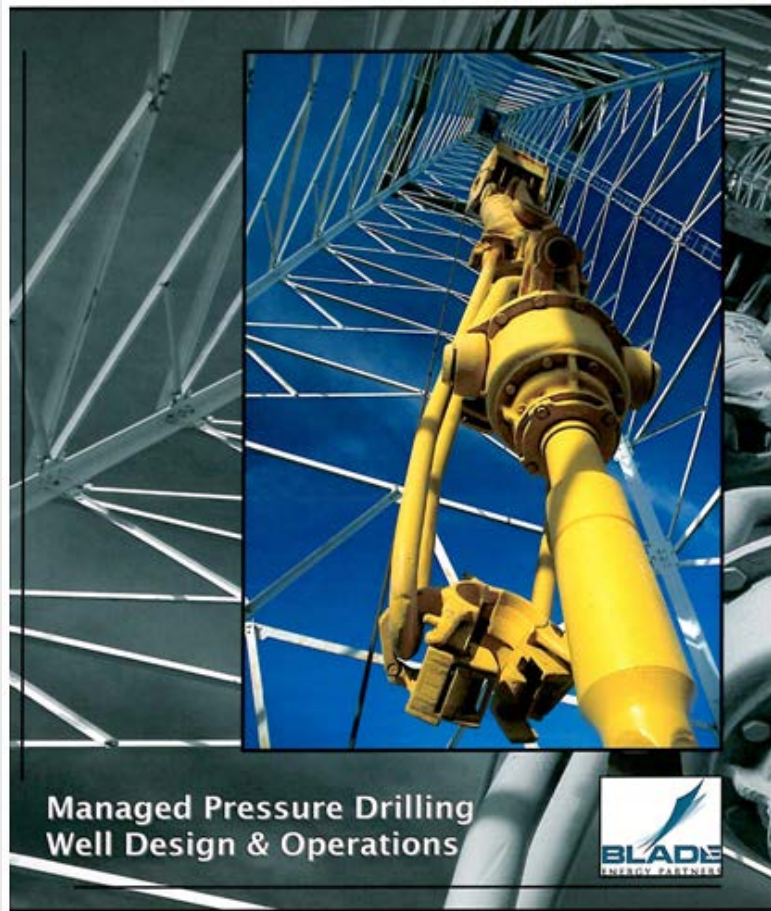
MPD Operations Management

- MPD Operations approved on a case by case basis
 - Conducted in accordance with Transocean policies and procedures
 - Conducted in accordance with local regulatory requirements
- How?
 - Design Review, HAZID, Barrier Philosophy, Procedures list
 - HAZOP, Procedures Review
 - Training, Well Planning Review
- Operational Oversight
 - Transocean local Operations Management
 - Transocean HQS Performance and Operations Group
 - Non-Standard Operations and Technology Support Group (Planning and Execution involvement)

MPD Operations Management



MPD Training and Well Planning Review



- **Extended SPT's Drillbench**
 - MPD/DG Drilling analysis
 - DG Well Control analysis

- Transocean / Blade MPD Course
 - Focus on offshore MPD operations

MPD Planning Guidelines (IADC)

UB & MPD Operations – HSE Planning Guidelines

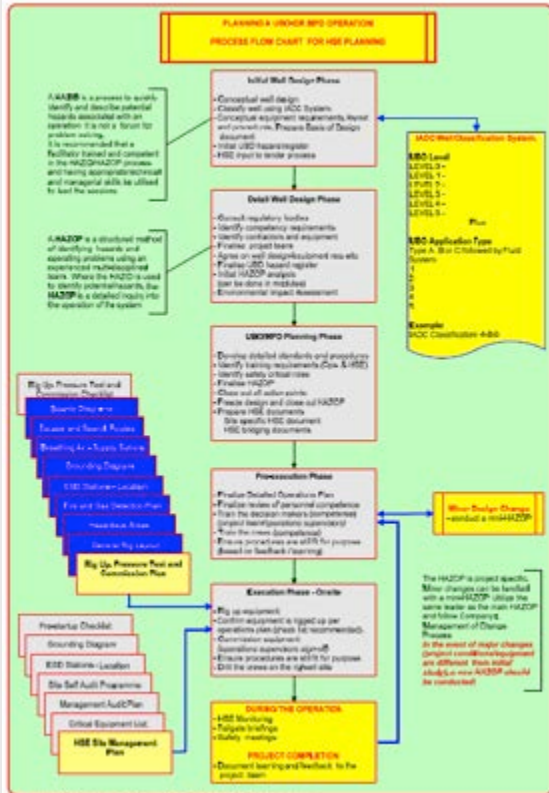


Figure 4 - Process Flow Chart for HSE planning

UB & MPD Operations – HSE Planning Guidelines

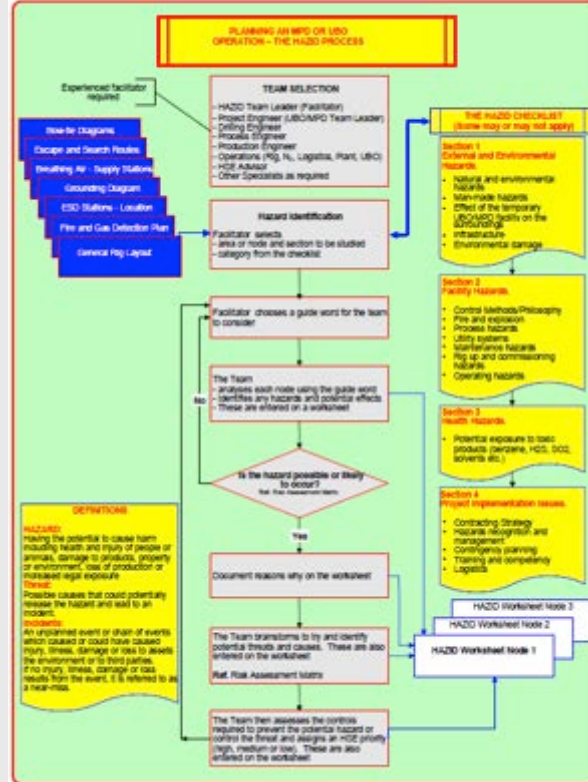


Figure 5 - HAZID Process

UB & MPD Operations – HSE Planning Guidelines

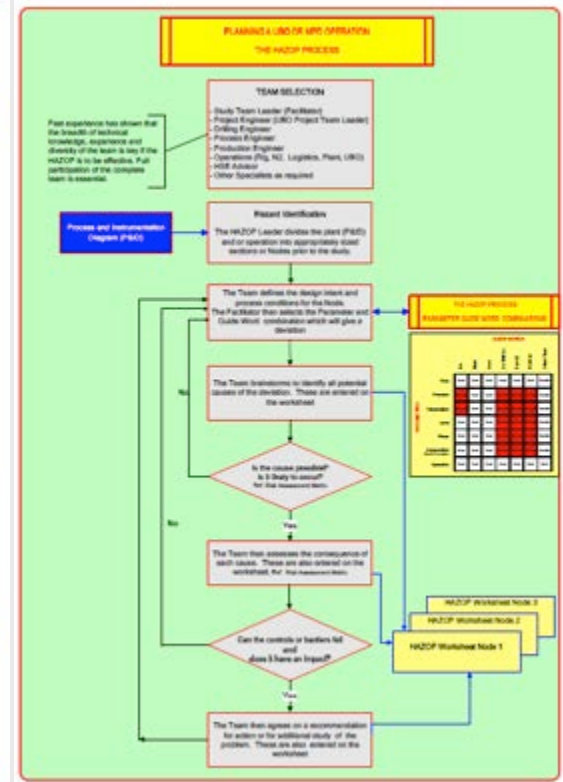


Figure 6 - HAZOP Process