Guidance for UBO and MPD Techniques for Land Operations

Version 3 – June 2021

Foreword

This document has been created to provide a referenced guidance for MPD operations executed specifically on land locations ensuring it remains aligned to API RP 92M that applies to MPD operations executed on drilling rigs/hoists with surface blowout preventers (BOPs) installed. The document also touches on other techniques UBD, RMD & PMCD

This guidance was initially developed by cataloguing various subsurface conditions (lithology, pressure regimes, fluid types, etc.) and assigning operational risk levels to each condition.

Thereafter the guidance has been written to provide minimum recommendations to operators in respect to the level of equipment required for safe and effective application of MPD technologies on land and to suggest levels of competency of engineers and supervisors to achieve the objectives of delivering safe and effective MPD operations.

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Introduction

The purpose of this document is to give a concise quick reference guidance for MPD land operations. This document is aligned to API RP 92M and aims to give guidance on the recommended level of equipment , planning and competency that is required to mitigate the potential operational risks based on the following: Formation risks, Planning & Execution Competence. The driver / reason for utilizing MPD. Ultimately, the goal is to assist drilling engineers to deliver safe MPD operations.

Definitions

Managed Pressure Drilling (MPD): "MPD is an adaptive drilling process used to precisely control the annular pressure profile throughout the wellbore. The objectives are to ascertain the downhole pressure environment limits and to manage the annular hydraulic pressure profile accordingly. It is the intention of MPD to avoid continuous influx of formation fluids. Any influx incidental to the operation shall be safely contained using an appropriate process.

Underbalanced Drilling (UBD): "A drilling activity employing appropriate equipment and controls where the pressure exerted in the wellbore is intentionally less than the pore pressure in any part of the exposed formations with the intention of bringing formation fluids to the surface".

Pressurized Mud Cap Drilling (PMCD): Drilling with a fixed length annular fluid column, which is maintained above a formation that is taking injected drilling fluid (water)/sweeps and drilled cuttings without returns to surface.

Returns Management Drilling (RMD): Drilling where hydrostatic mud weight could be less than pore pressure of the formation, but the well is not believed to be capable of flow to surface. The intention is to handle/respond to nuisance gas at surface with appropriate equipment. There is no way to manipulate pressure at surface (a non MPD application).

References

API Recommended Practice 92M, 1st Edition, *Recommended Practice for* Managed Pressure Drilling Operations with Surface Back-pressure

API Recommended Practice 92P, 1st Edition, *Recommended Practice for Managed Pressure Drilling Operations — Pressurized Mud Cap Drilling with a Subsea Blowout Preventer*

API Recommended Practice 92U, 1st Edition, *Recommended Practice for Underbalanced Drilling Operations*

Energy Safety Canada – Drilling and Completion Committee Industry Recommended Practice 22, 3rd Edition, *RMD / MPD / UBD Operations*

National Fire Protection Association Standard 68, 2018 Edition, *Standard on Explosion Protection by Deflagration Venting*

How This Guidance Document Works

Users will determine the appropriate selection in tables 1 to 5 as indicated below. Once all sections are completed, Table 6 summarizes these results including the recommended minimum level of planning, the minimum level of field competence and the recommended equipment based on the formation risk mitigation and suitability for the MPD application.

1. Users will identify the drivers for the MPD application on the left column of Table 1, which will indicate what application (s) will help mitigate the project challenges.

2. Table 2 defines the risk level based on the reservoir/formation characteristics listed on the left column.

    - Once the initial risk has been defined based on the main considerations, and if there is one condition among additional considerations that changes the scenario, then the risk level is defined by the X's on the lower section of the table.

    - For example, if a well is classified as Risk Level 2 but it is in proximity to a previously fractured well, then the well needs to be classified as Risk Level 4.

    - Al X's in the additional considerations section are reviewed individually and are not mutually exclusive; the X with the higher risk defines the well risk independently of the original classification by the existing Risk Guidelines document.

3. Once the application type and risk level are selected from Tables 1 and 2, the minimum planning requirements are shown in Table 3.

4. Similarly, Table 4 defines the recommended competence levels based on the application type and risk level selected in tables 1 and 2.

5. Minimum recommended equipment is shown in Table 5 based as well on the application type and risk level selected in tables 1 and 2. Notes for Table 5 must be considered when evaluating an application.

6. Table 6 summarizes the results of tables 1-5 and includes recommended equipment for the specific MPD application.

Table 1 – Application Categories

Application Type	Conventional		(A) MPD Technique			(B) PMCD	(C) UBD
	Overbalanced	RMD Overbalanced	(A1) Hydrostatically Overbalanced	(A2) Hydrostatically Underbalanced	(A3) Multiphase (Service Gas Injection)	Drilling with total losses	Drilling with formation production
RCD only (diverter)	**Yes**	N/A	N/A	N/A	N/A	N/A	N/A
Drilled Nuisance Gas / Excessive gas at shakers	N/A	**Yes**	**Yes**	**Yes**	N/A	N/A	N/A
Shallow Water Flows	N/A	N/A	**Yes**	**Yes**	N/A	N/A	N/A
Wellbore Ballooning	N/A	N/A	**Yes**	**Yes**	N/A	N/A	N/A
Narrow Window Pore Pressure / Fracture Gradient	N/A	N/A	**Optional***	**Yes**	N/A	N/A	N/A
Sub-normal pressure reservoirs that would lose circulation with conventional drilling fluid densities	N/A	N/A	N/A	N/A	**Yes**	N/A	**Optional**
Enhanced drilling safety: • Kick detection • Mitigate Swab / Surge	N/A	N/A	**Yes**	**Yes**	N/A	N/A	N/A
Wellbore Stability: • Reduces cyclic pressure transitions between pumps on/ pumps off • Sloughing shales	N/A	N/A	**Yes**	**Yes**	N/A	N/A	N/A
Reduce Overbalance to formation: • Higher ROP • Reduced Formation Damage	N/A	N/A	**Optional***	**Yes**	N/A	N/A	**Optional**
Non-existent drilling window or severe production impairment from reservoir damage	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**
MPC (Managed Pressure Cementing): • Compensate for increased hydrostatic when performing MPD cementing operations	N/A	N/A	**Optional***	**Yes**	N/A	N/A	N/A
Total Losses	N/A	N/A	N/A	N/A	N/A	**Yes**	N/A
Comments	Not MPD	Not MPD. For more details ref. IRP 22	MPD. For more details ref. API RP 92M	MPD. For more details ref. API RP 92M	MPD. For more details ref. API RP 92U	Not MPD. For more details ref. API RP 92P	Not MPD. For more details ref. API RP 92U

* These types of applications typically require Hydrostatically Underbalanced mud weights. It could also be possible to employ Hydrostatically Overbalanced mud weights if conditions allow.

Table 2 – Risk Levels

Variables	Risk Level					
	0	1	2	3	4	5
	No expectation for encountering Hydrocarbon producing Zones (performance enhancement only)	Well incapable of natural flow of hydrocarbons, with possibility of water influxes	Well capable of natural hydrocarbon flow to surface but enabling conventional well kill methods resulting in Limited Consequences	Non-hydrocarbon production. Maximum shut-in pressure is less than the MPD maximum equipment operating pressure rating.	Well is capable of natural hydrocarbon flow to surface but maximum shut-in pressure is less than MPD equipment operating pressure rating	Well has potential for hydrocarbon production Maximum projected surface pressures are expected to exceed MPD equipment operating pressure rating
Main Considerations						
Presence of Hydrocarbons	No	Yes	Yes	No	Yes	Yes
Well capable of flowing naturally		No	Yes	Yes	Yes	Yes
Max MASP > MPD Equipment Pressure Rating			No	No	No	Yes
Additional Considerations						
Narrow Mud Weight (PP-FG or Hole Stability-FG) Window					X	
Mud weight window in the reservoir changed as a result of hydrocarbon production or water injection (e.g., infill well)					X	
Potential for cross flow between formations					X	
Well bottom hole trajectory in proximity to a previously fractured or stimulated producing well					X	
Potential for uncontrolled or total losses while drilling the reservoir			X			
Unstable wellbore (active shales, salt, coal, etc.)			X			
High pore pressure with low permeability formations.			X			
Geothermal application				X		
Presence of sour gas expected						X
Presence of Aromatics Risk of exposure at shakers						X

Table 3 – Minimum Planning

Application	MPD / UBD / PMCD Specific Program incl. Operations Matrix[1]	HAZOP [4] Recommended	MPD Training Familiarization[2]	Running Completions & Managed Pressure Cementing
Conventional & RMD	N/A	N/A	N/A	N/A
MPD – Hydrostatically overbalanced (A1)	**Yes**	**Yes**	**Yes**	Optional
MPD – Hydrostatically underbalanced (A2)	**Yes**	**Yes**	**Yes**	**Yes**
MPD - Multiphase MPD (A3)	**Yes**	**Yes**	**Yes**	**Yes**
PMCD (B)	**Yes**	**Yes**	**Yes**	**Yes**
UBD (C)	**Yes**	**Yes**	**Yes** [3]	**Yes** [3]

[1] The program should include the following elements: 1) MPD Hydraulics plan to stay in drilling window, 2) MPD Pump Rate vs. SBP Ramp Profile, 3) Tripping Plan (Swab and Surge Analysis) and 4) Roll Over Schedule for pill spotting to balance the well and stay within wellbore pressure boundaries (if applicable).

[2] Includes training on: Connections, Influx response, Start Up and Shutdowns.

[3] Not MPD, please refer to 92U.

[4] It is recommended to HAZOP / risk assess the Process Instrumentation Diagram in regards to how the MPD system is installed.

Table 4 – Recommended Competence Level

Application	Field Supervisors and/or MPD Engineer: IADC Surface/BOP Stack for Supervisor Level or equivalent	MPD Crew: Basic Knowledge of relevant Operational Matrix / Knowledge of Relevant systems (UBD/MPD/PMCD)	MPD Crew: Onsite personnel competence requirements
Conventional	Yes		
RMD	Yes		
MPD – Hydrostatically overbalanced (A1)	Yes	Yes	▪ Competent personnel with at least 2 years of Experience in MPD [1] [2] [3]
MPD – Hydrostatically underbalanced (A2)	Yes	Yes	▪ Competent personnel with at least 2 years of Experience in MPD[1][3]
MPD - Multiphase MPD (A3)	Yes	Yes	▪ Competent personnel with at least 2 years of Experience in MPD [3] ▪ Service gas Injection and 3-4-phase separation experience required
PMCD (B)	Yes	Yes	▪ Competent personnel with at least 2 years of Experience in PMCD
UBD (C)	Yes	Yes	▪ Competent personnel with at least 2 years of Experience in UBD ▪ Multi-Skilled team ▪ On site Competent UBD Supervision

[1] Two or more years of MPD experience. Ability to follow detailed MPD operations plans for spotting pills, kick detection & response, etc.

[2] For A1 applications (MPD - hydrostatically overbalanced), if it is a simple low-risk operation like for example MPD shut in on water flows for connections, then the competence of the operator needs to be appropriate to mitigate issues such as pumping against a closed choke, for example.

[3] IADC MPD training when released will be recommended.

Table 5 – Minimum Recommended Equipment

Application Type	Risk Level	Minimum Recommended Equipment										
		BHA Float Valves [1]	Drill String Float Valves [2]	RCD	Overpressure Protection System [3]	Primary Flow Line & Isolation Valve [4]	Secondary Flow Line [5]	Equalization Line [6]	Choke Manifold [6,7]	Suitable Flow Measurement [8]	Atmospheric MGS & Flare [9,10]	Pressurized Vessel & Flare [9,10]
Conventional	**0 – 5**											
Conventional (RMD)	**0 – 1**	X		X		X					X	
MPD (A1)	**0 – 3**	X		X	X	X		X	X			
MPD (A1)	**4**	X		X	X	X		X	X	X		
MPD (A1)	**5**	X		X	X	X	X	X	X	X	X	
MPD (A2)	**0 – 3**	X		X	X	X		X	X			
MPD (A2)	**4 – 5**	X		X	X	X	X	X	X	X	X	
MPD (A3)	**0 – 3**	X	X	X	X	X		X	X		X	
MPD (A3)	**4 – 5**	X	X	X	X	X	X	X	X	X		X
PMCD (B) [11]	**0 – 4**	X		X	X	X		X				
PMCD (B) [11]	**5**	X		X	X	X	X	X				
UBD (C)	**0 – 2**	X	X	X	X	X		X	X	X		X
UBD (C)	**3 – 5**	X	X	X	X	X	X	X	X	X		X

Notes:

[1] BHA float valves are considered primary well barrier elements.

[2] Drill string float valves are used for optimizing connection process and times.

[3] A suitable method should be in place to guard against inadvertent overpressure of formation or equipment without fully venting wellbore pressure (Ref. 5.1.4 in API RP 92M).

[4] Isolation valves are not intended for choking fluid flow for pressure / flow regulation. Admin Control / Engineering controls are recommended to mitigate overpressure risk.

[5] It is recommended that this loop remains independent from the rig well control equipment. An Equalization Line refers to a means to equalize pressure below and above the annular BOP. Typically, the secondary flow line is connected below the annular BOP and it can serve the purpose of an equalization line in MPD operations.

[6] MPD control system capabilities will depend on application type and objectives of MPD on the drilling operation.

[7] For applications where a precise control of SBP is required (e.g., narrow mud weight windows: the difference between ESD and ECD in a conventional scenario is greater than the drilling window), or in applications in which losing one choke valve will have detrimental consequences to operational safety and/or efficiency, it is recommended to have choke redundancy (dual choke manifold).

[8] In addition to having a suitable flow measuring devices aligned with the objectives of MPD on the drilling operation, on risk categories 4 and 5 of an A2 application type Early Kick Detention is recommended.

[9] Any atmospheric MGS planned to be used should be suitably sized for operation and monitored to prevent gas blow-by on the mud seal (liquid leg). For applications where fluid erosional velocities in the MPD system are low, an atmospheric vessel could be used instead of a pressurized one if a proper risk analysis is conducted.

[10] Flare system shall have flame detonation protection in line that complies with NFPA 68. Flashback protected flare system not required with a pressure vessel.

[11] If PMCD is planned in conjunction with MPD, each application must be evaluated separately.

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Table 6 – Summary of Results

Application Type	Risk Level	Min Planning	Competence	Equipment Set-Up
Conventional	0 - 5	▪ Drilling Program (Conventional)	▪ Well Control Certificate (Supervisor Level)	▪ No MPD equipment necessary
Conventional (RMD)	0 - 1	▪ Drilling Program (Conventional)	▪ Well Control Certificate (Supervisor Level)	▪ BHA Float Valves ▪ RCD ▪ Primary Flow Line & Isolation Valve ▪ Atmospheric MGS & Flare
MPD (A1)	0 - 3	▪ MPD Specific Program ▪ MPD Operations Matrix ▪ HAZOP ▪ MPD Training Plan	▪ Well Control Certificate (Supervisor Level) ▪ Basic MPD Operational Matrix Knowledge ▪ Basic Knowledge of MPD System ▪ Competent personnel with at least 2 years of Experience in MPD	▪ BHA Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Equalization Line ▪ Choke Manifold
MPD (A1)	4	▪ MPD Specific Program ▪ MPD Operations Matrix ▪ HAZOP ▪ MPD Training Plan	▪ Well Control Certificate (Supervisor Level) ▪ Basic MPD Operational Matrix Knowledge ▪ Basic Knowledge of MPD System ▪ Competent personnel with at least 2 years of Experience in MPD	▪ BHA Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Equalization Line ▪ Choke Manifold ▪ Suitable Flow Measurement
MPD (A1)	5	▪ MPD Specific Program ▪ MPD Operations Matrix ▪ HAZOP ▪ MPD Training Plan	▪ Well Control Certificate (Supervisor Level) ▪ Basic MPD Operational Matrix Knowledge ▪ Basic Knowledge of MPD System ▪ Competent personnel with at least 2 years of Experience in MPD	▪ BHA Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Secondary Flow Line ▪ Equalization Line ▪ Choke Manifold ▪ Suitable Flow Measurement ▪ Atmospheric MGS & Flare
MPD (A2)	0 - 3	▪ MPD Specific Program ▪ MPD Operations Matrix ▪ HAZOP ▪ MPD Training Plan ▪ Running Completions ▪ Managed Pressure Cementing	▪ Well Control Certificate (Supervisor Level) ▪ Basic MPD Operational Matrix Knowledge ▪ Basic Knowledge of MPD System ▪ Competent personnel with at least 2 years of Experience in MPD	▪ BHA Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Equalization Line ▪ Choke Manifold

Table 6 – Summary of Results (cont.)

Application Type	Risk Level	Min Planning	Competence	Equipment Set-Up
MPD (A2)	4 – 5	▪ MPD Specific Program ▪ MPD Operations Matrix ▪ HAZOP ▪ MPD Training Plan ▪ Running Completions ▪ Managed Pressure Cementing	▪ Well Control Certificate (Supervisor Level) ▪ Basic MPD Operational Matrix Knowledge ▪ Basic Knowledge of MPD System ▪ Competent personnel with at least 2 years of Experience in MPD	▪ BHA Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Secondary Flow Line ▪ Equalization Line ▪ Choke Manifold ▪ Suitable Flow Measurement ▪ Atmospheric MGS & Flare
MPD (A3)	0 – 3	▪ MPD Specific Program ▪ MPD Operations Matrix ▪ HAZOP ▪ MPD Training Plan ▪ Running Completions ▪ Managed Pressure Cementing	▪ Well Control Certificate (Supervisor Level) ▪ Basic MPD Operational Matrix Knowledge ▪ Basic Knowledge of MPD System ▪ Competent personnel with at least 2 years of Experience in MPD ▪ Service gas Injection and 3-4-phase separation experience required	▪ BHA Float Valves ▪ Drill String Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Equalization Line ▪ Choke Manifold ▪ Atmospheric MGS & Flare
MPD (A3)	4 – 5	▪ MPD Specific Program ▪ MPD Operations Matrix ▪ HAZOP ▪ MPD Training Plan ▪ Running Completions ▪ Managed Pressure Cementing	▪ Well Control Certificate (Supervisor Level) ▪ Basic MPD Operational Matrix Knowledge ▪ Basic Knowledge of MPD System ▪ Competent personnel with at least 2 years of Experience in MPD ▪ Service gas Injection and 3-4-phase separation experience required	▪ BHA Float Valves ▪ Drill String Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Secondary Flow Line ▪ Equalization Line ▪ Choke Manifold ▪ Suitable Flow Measurement ▪ Pressurized Vessel & Flare
MPD (A3)	0 - 4	▪ PMCD / MPD Specific Program ▪ PMCD / MPD Operations Matrix ▪ HAZOP ▪ PMCD / MPD Training Plan ▪ Running Completions	▪ Well Control Certificate (Supervisor Level) ▪ Basic PMCD / MPD Operational Matrix Knowledge ▪ Basic Knowledge of PMCD / MPD System ▪ Competent personnel with at least 2 years of Experience in PMCD	▪ BHA Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Equalization Line

Table 6 – Summary of Results (cont.)

Application Type	Risk Level	Min Planning	Competence	Equipment Set-Up
PMCD (B)	5	▪ PMCD / MPD Specific Program ▪ PMCD / MPD Operations Matrix ▪ HAZOP ▪ PMCD / MPD Training Plan ▪ Running Completions	▪ Well Control Certificate (Supervisor Level) ▪ Basic PMCD / MPD Operational Matrix Knowledge ▪ Basic Knowledge of PMCD / MPD System ▪ Competent personnel with at least 2 years of Experience in PMCD	▪ BHA Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Secondary Flow Line ▪ Equalization Line
UBD (C)	0 – 2	▪ UBD Specific Program ▪ UBD Operations Matrix ▪ HAZOP ▪ UBD Training Plan ▪ Running Completions ▪ UBD Refer to API RP 92U ▪ Extensive planning Required	▪ Well Control Certificate (Supervisor Level) ▪ Basic UBD Operational Matrix Knowledge ▪ Basic Knowledge of UBD System ▪ Competent personnel with at least 2 years of Experience in UBD ▪ Multi-Skilled team ▪ On site Competent UBD Supervision	▪ BHA Float Valves ▪ Drill String Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Equalization Line ▪ Choke Manifold ▪ Suitable Flow Measurement ▪ Pressurized Vessel & Flare ▪ Service Gas system
UBD (C)	3 – 5	▪ UBD Specific Program ▪ UBD Operations Matrix ▪ HAZOP ▪ UBD Training Plan ▪ Running Completions ▪ UBD Refer to API RP 92U ▪ Extensive planning Required	▪ Well Control Certificate (Supervisor Level) ▪ Basic UBD Operational Matrix Knowledge ▪ Basic Knowledge of UBD System ▪ Competent personnel with at least 2 years of Experience in UBD ▪ Multi-Skilled team ▪ On site Competent UBD Supervision	▪ BHA Float Valves ▪ Drill String Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Secondary Flow Line ▪ Equalization Line ▪ Choke Manifold ▪ Suitable Flow Measurement ▪ Pressurized Vessel & Flare ▪ Service gas system

General Notes:

* The use of the rig well control equipment (rig chokes) is not recommended for MPD operations nor intended for pressure/flow regulation while drilling/connections. Non-common Secondary well barrier elements shall be activated only when the integrity of the primary well barrier has been compromised beyond the ability of reinstate it.

** Please refer to tables 3,4 & 5 notes.

*** API RP 92P covers PMCD with a subsea BOP stack, but PMCD fundamentals and most surface equipment requirements are common to land operations.

Examples

Example #1

High-Pressure Gas Well: The drivers for wanting MPD are as follows: (1) Increasing ROP by managing the Dynamic and Static Surface Backpressures (SBPs) while drilling the horizontal production hole by staying above 17.0 ppge pressure limit and below ≈ 18.0 ppge FIT/Upper Pressure Boundary, (2) Minimizing/reducing Ballooning, (3) Avoiding Losses and Gains, (3) Minimizing the Mud Weight changes and keeping the costs down.

- From table 1 the best fit for these drivers would clearly be **(A2)** Hydrostatically Underbalanced MPD as this solution will minimize ECD overpressure to formation, giving potential for ROP increase. This solution also allows for pressures to be controlled to allow drilling in a narrow window between upper and lower pressure boundaries and allows for ability to manipulate pressures to minimize ballooning, react to losses / gains and reduce overall mud costs and time conditioning mud.
- From Table #2 this well would have a risk rating of **(5)** the well is high-pressure gas well where an influx could exceed MPD surface equipment rating.
- From Table #3 this well requires the following planning: MPD/ Specific Program incl. Operations Matrix, a HAZOP is recommended, Training Familiarization is required and impact on casing, and completions running need to be studied.
- From Table #4 the following competency levels are recommended; the person in charge of the MPD operations needs to have a Well Control Certificate (Supervisory Level). The MPD crew needs to have basic Knowledge of MPD Matrix Limits / Knowledge of MPD systems and at least 2 years of experience in MPD.
- From Table #5 MPD(A2), Risk Level 5 has the following Minimum Recommended equipment (BHA float valves, RCD, Overpressure protection System, Primary flow line isolation valve, secondary flow line, equalization line, choke manifold, Suitable flow measurement equipment, Atmospheric MGS and Flare stack equipped with flashback protection). [7] For applications where a precise control of SBP is required (e.g., narrow mud weight windows: the difference between ESD and ECD in a conventional scenario is greater than the drilling window), or in applications in which losing one choke valve will have detrimental consequences to operational safety and/or efficiency, it is recommended to have choke redundancy (dual choke manifold).

Application Type	Risk Level	Min Planning	Competence	Equipment Set-Up
MPD (A2)	4 – 5	▪ MPD Specific Program ▪ MPD Operations Matrix ▪ HAZOP ▪ MPD Training Plan ▪ Running Completions ▪ Managed Pressure Cementing	▪ Well Control Certificate (Supervisor Level) ▪ Basic MPD Operational Matrix Knowledge ▪ Basic Knowledge of MPD System ▪ Competent personnel with at least 2 years of Experience in MPD	▪ BHA Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Secondary Flow Line ▪ Equalization Line ▪ Choke Manifold ▪ Suitable Flow Measurement ▪ Atmospheric MGS & Flare

Example #2

Tight rock/impermeable shale gas wells on heavily developed areas: The drivers for the application the MPD technique are as follows: (1) Increasing ROP by exerting the lower possible ECD/EMW by utilizing a combination of Hydrostatically OB or UB drilling mud and SBP, (2) Ability to increase ECD/EMW to manage water influxes from nearby injection wells, (3) Assist during tripping operations while minimizing mud weight changes.

- From table 1 the best fit for these drivers could be **(A1)** Hydrostatically Overbalanced MPD or **(A2)** Hydrostatically Underbalanced MPD, most likely to be **(A2)** Hydrostatically Underbalanced MPD; this solution will minimize ECD/EMW resulting in higher ROPs. It would also allow managing the annular pressure profile during drilling and connections to avoid hole stability issues, while managing kick indicators, by increasing/decreasing the surface back pressure by means of an MPD choke.
- From Table #2 this well would have a risk rating of **(1)** since that even though hydrocarbon bearing formation are being drilled the well is not capable of producing hydrocarbons due to its tight/impermeable nature, however, water influxes could still take place and such occurrence, though it could generate NPT, it would have limited consequences.
- From Table #3 this well requires the following planning: MPD/ UBD/ PMCD Specific Program incl. Operations Matrix, a HAZOP is recommended, Training Familiarization is required and impact on casing, and completions running need to be studied.
- From Table #4 the following competency levels are recommended; the person in charge of the MPD operations needs to have a IADC Surface/BOP Stack for Supervisor Level or equivalent well control certification. The MPD crew needs to have basic Knowledge of MPD Matrix Limits / Knowledge of MPD systems and at least 2 years of experience in MPD.
- From Table #5 the minimum recommended equipment for the binomial MPD-A2/0-3 (Application/Risk Level) would be: BHA Float valves, RCD, Overpressure Protection System, Primary Flow Line c/w Isolation Valve, Equalization Line, and MPD Choke Manifold.
- Finally, Table #6 delivers wrap-up of minimum recommended Planning, MPD Technician Competency, and Equipment, as summarized below:

Application Type	Risk Level	Min Planning	Competence	Equipment Set-Up
MPD (A2)	0 - 3	▪ MPD Specific Program ▪ MPD Operations Matrix ▪ HAZOP ▪ MPD Training Plan ▪ Running Completions ▪ Managed Pressure Cementing	▪ Well Control Certificate (Supervisor Level) ▪ Basic MPD Operational Matrix Knowledge ▪ Basic Knowledge of MPD System ▪ Competent personnel with at least 2 years of Experience in MPD	▪ BHA Float Valves ▪ RCD ▪ Overpressure Protection System ▪ Primary Flow Line & Isolation Valve ▪ Equalization Line ▪ Choke Manifold

List of Acronyms

API	American Petroleum Institute
BHA	Bottom Hole Assembly
BOP	Blow Out Preventor
ECD	Equivalent Circulating Density
ESD	Equivalent Static Density
FG	Fracture Gradient
FIT	Formation Integrity Test
HAZOP	Hazard and Operability Analysis
IADC	International Association of Drilling Contractors
MASP	Maximum Allowable Surface Pressure
MGS	Mud Gas Separator
MPD	Managed Pressure Drilling
NFPA	National Fire Protection Association
PMCD	Pressurized Mud Cap Drilling
PP	Pore Pressure
ppge	Pounds Per Gallon Equivalent