

Drilling operations need to be carried out in a safe, efficient, and environmental friendly manner for successfully completing the well to meet the desired geological objectives. By following recommended practices, a well can be drilled in shortest possible time and with minimum of complications.

This chapter includes the following topics on drilling operations:

- a) Preparation for spudding the well
- b) Pre-spud meeting/conference
- c) Common drilling practices for all phases
- d) Drilling 26" hole section
- e) Drilling 17 ½" hole section
- f) Drilling 12 ¼"/8 ½"/6" hole sections
- g) Casing integrity test
- h) Shoe integrity test
- i) Leak off test
- j) Extended LOT
- k) Recommended practices for tripping out
- l) Recommended practices for tripping in
- m) Recommended practices for reaming
- n) Recommended practices for back-reaming
- o) Recommended practices for wiper trip in deviated hole
- p) Recommended practices for pack-off
- q) Recommended practices for surface seepages

r) Coring

a) Preparation for spudding the well:

POWER GENERATION & DISTRIBUTION SYSTEM

Check and test all Power Packs.

Check PCR and VFD.

Check all Power Prime Movers to Draw works, Mud pumps, IRD and TDS.

Check all Power Transmission System to Draw works, Mud pumps, IRD and TDS.

HOISTING & TACKLING SYSTEM

Draw works

- Check main brake.
- Check Auxiliary brake.
- Check Emergency Brake.
- Check Parking Brake.
- Set and Check Crown / Floor saving device.
- Check Casing Line.
- Set Tare load and Calibrate block height.
- Carry out Load test and Valve test.

Check Crown block sheaves and lubricating system.

Check Travelling Block sheaves and lubricating system.

Check Oil levels in the Hook and proper function of lock.

Air Winches :

- Check foundation.
- Check air supply
- Check and Test Emergency Air Shut Off valve.
- Inspect wire ropes, check Hoisting End Loop, D-Shackle and Fast end of the wire rope.
- Check and test both Auto and Manual Brakes.
- Ensure Guards are fitted.

Iron Roughneck:

- Check and test hydraulic HPU to rated pressure.
- Check Foundation of Pedestal IR and Rails of Big Foot type IR.

- Check all functions of IR.
- Ensure availability of right sizes of Torque Wrench Jaw with dies.

Check and test Kelly Spinner

Check and Test Pipe spinner with safety rope.

Check all Pipe Handling tools.

Inspect drill string components as necessary and ensure that all of them are NDT tested within the recommended time frame.

Hydraulic Cat Head:

- Check and test hydraulic HPU to rated pressure.
- Check Foundation.
- Check jerk line.
- Test Hydraulic Cat Head.

Vertical Pipe Handler:

- Check and test the system.

Hydraulic Cat Walk:

- Check and test the system.

ROTATING SYSTEM

Rotary Table:

- Check and Test IRD.
- Check and Test Rotary Lock.
- Check and Test pneumatic Brake.

TDS:

- Check VFD is functional.
- Check all electrical functions are complete.
- Check all hydraulic functions.

Swivel:

- Check Swivel and Replace Wash Pipe.
- Test Wash pipe at rated pressure.

CIRCULATING SYSTEM

Mud Pump:

- Check Super Charger pumps.
- Check direct suction lines.
- Check strainers.
- Check Liner sizes.
- Check Pressure Dampener Pre-Charge pressure.

- Check Pressure setting of Safety Valve.
- Ensure anchoring of By-Pass line.
- Ensure anchoring of HP discharge line.
- Pressure test Pump at Liner rating.

H-Manifold:

- Pressure Test H-manifold valves
- Ensure it is properly anchored

Mud Tanks:

- Check all agitators.
- Check all valves and gates.
- Check all water and mud lines.
- Carry out integrity check in water.
- Check Hopper and Shearing system.
- Check Level sensor function.

Solid Control Equipment:

- Check Shale shaker function. Ensure right Screen size.
- Function Check Mud cleaner, De-sander and De-Silter.
- Check De-Gasser.

Trip Tank:

- Function Check Pumps.
- Check integrity with water.
- Check level indicator function.

Instrumentation:

- Check Hook Load, Mud pump stroke counter, Stand pipe pressure, Rotary Torque, TDS Torque, Pull Line Torque display.
- Check MVT function and Display.
- Check LEL / H2S sensors and Alarm.
- Check all screens on MSI.
- Check Online Gas detector and Alarm.
- Check Ton-Mile indicator.
- Check Real Time monitoring system.

Safety

- Check Illumination on derrick floor and other areas.
- Ensure all cable trays are properly covered.
- Ensure earthing of all electrical equipment/ mast done with GI strip.

- Ensure double earthing of diesel unloading point done with GI strips.
- Ensure FLP (Flameproof) features of Junction Boxes, lighting and cable connection maintained in hazardous zone.
- Ensure all fuses/relays/circuit breakers installed at their respective place and no system is bypassed.
- Ensure air-conditioning and emergency lightning of PCR room proper.
- Ensure Mat near electrical panel provided.
- Check Condition of electrical connections and cable.
- Ensure aviation light of intermittent type fitted at top of Mast.
- Ensure safety torch available and properly maintained.
- Ensure Air purging system of driller's console is functional.
- Check Emergency shutdown switch.
- Ensure Contingency plan for blowout and fire are updated and displayed in Dog House and Tool Pusher room.
- Ensure Safety & Environmental policy of ONGC are displayed in the Rig.
- Ensure Upper & Lower Kelly Cocks availability.
- Ensure FOSV availability.
- Ensure BOP Accumulator Unit electric and pneumatic system is operational.
- Ensure BOP Remote control panels are available and functional.
- Ensure IBOP is available on Rig Floor.
- Ensure all opening on derrick floor are properly covered.
- Ensure railing with toe board provided to cover derrick floor area.
- Ensure Mud tanks are equipped with railing.
- Ensure good Condition of jerk lines of manual tongs.
- Ensure three clamps are used on jerk lines/guy ropes and cat line as per OMR'2017.
- Ensure Safety belt for top man are available.
- Ensure Portable gas detector is available.
- Ensure First-Aid box is complete in all respect.
- Ensure all safety sign boards available and displayed.
- Ensure Emergency vehicle is in good working condition.
- Ensure TEED is available and checked.
- Ensure intrinsically safe communication system is available.

b) Pre-spud meeting:

Pre-spud meeting/conference should be held before spudding/commencing operation at each drilling location with the participation of all key personnel like Rig In-charge, Mechanical In-charge, Electrical In-charge, Civil engineer, Geology, Drilling fluid services, Logging services, logistics, fire services, Security & HSE officer. Compliance of safety norms as per following pre-spud checklists needs to be confirmed.

Drilling Checklist:

Sl No.	Description	Yes/ OK	No/ Not OK	EDC
1.	Whether Contingency Plan for Fire & Blow out displayed (Regulation 102, OMR 2017)			
2.	Whether Safety & Environment Policy of ONGC displayed			
3.	Whether Layout Plan & Prohibitory Sign Boards displayed (Regulation 128, OMR 2017)			
4.	Whether Members of Rig Crew equipped with PPE (Regulation 121, 122 & 123, OMR 2017)			
5.	Whether Railings around Derrick Floor/ Engine/ Mud Tank Walk Ways provided (Regulation 41, OMR 2017)			
6.	Availability of GTO			
7.	Availability of First Aid Box & Stretcher			

8.	Availability of Fire Fighting Equipment (Regulation 100, 101, OMR 2017)			
9.	Availability of Safety Belt with Life Line (Regulation 37, OMR 2017)			
10.	Availability & Condition of Emergency Vehicle			
11.	Availability of Portable Gas Detector and Functional Status			
12.	Condition of Ladders (Regulation 46, OMR 2017)			
13.	Condition of Casing Line (Regulation 36, OMR 2017)			
14.	Condition of Safety Lines for Tongs & Status of Fastening Clamps (Regulation 44 & 45, OMR 2017)			
15.	Condition of Handling Tools, viz. Elevators, Slips, Power Tongs etc.			
16.	Status of Control Instruments			
17.	Functional Status of Floor - o-matic & Crown – o - matic Devices			
18.	Functional Status of Top man Emergency Escape Device (Regulation 38, OMR 2017)			
19.	Functional Status of Fall Prevention Device			

20.	Availability of Trip Tank & its Functional Status			
21.	Status of BOP Control system including Remote Control system (Regulation 55, OMR 2017)			
22.	Status of Rig Building			
23.	Any Other Point, If any			

Mechanical & Electrical Checklist:

Sl No	Description	Yes/ OK	No/ Not OK	EDC
1.	Condition of Power Pack Engines			
2.	Condition of Mud Pumps (Regulation 51, OMR 2017)			
3.	Condition of Compressors			
4.	Condition of Generators			
5.	Condition of Mechanical/ Pneumatic/ Hydro-matic Brake			
6.	Condition of Solid Control Equipment			
7.	Whether Pressure Relief Line(s) for Mud Pumps Fitted & Secured (Regulation 51, OMR 2017)			
8.	Status of Guards on Moving parts Regulation 112, OMR 2017)			

9.	Status of Auto Shut off system			
10.	Status of Pressure Vessels with Testing Records			
11.	Availability of Spark Arresters at Exhaust Manifold of Engine(s) (Regulation 50, OMR 2017)			
12.	Status of Communication system (Regulation 125, OMR 2017)			
13.	Status of Earthing system			
14.	Whether Sufficient Illumination provided at Rig (Regulation 117, OMR 2017)			
15.	Whether Light point provided at Toilet			
16.	Availability of Emergency Light (Regulation 120, OMR 2017)			
17.	Availability of Aviation Light at Gin pole			
18.	Any Other Point(s)			

Civil Checklist:

Sl No	Description	Yes/ OK	No/ Not OK	EDC
1.	Status of Hardening & Rolling of Drill Site Area			
2.	Condition of Approach Road			

3.	Parking Area for Logging unit, Cementing unit & Bunkers			
4.	Capacity of Waste Pit			
5.	Capacity of Fire Water Tank			
6.	Number of Rooms made for storing Chemicals			
7.	Whether Drinking Water Tank covered			
8.	Whether Toilet provided with Water Connections			
9.	Whether Septic Tanks provided			
10.	Whether Proper Drainage system with Brick work provided			
11.	Whether Fencing around Drill site provided (Regulation 130, OMR 2017)			
12.	Whether Fencing around Fire pit provided (Regulation 130, OMR 2017)			
13.	Whether Locking system of Chemical Store Room provided			
14.	Whether Sand Cushion provided at the Landing points of Top man Emergency Escape Device			
15.	Any Other Point(s)			

Note: The above checklist is made comprehensively and is indicative only. Any additions required may be suitably incorporated.

Before spudding the well, it should be ensured that all the observations/recommendations of pre-spud meeting/conference have been implemented. Minutes of pre-spud meeting should be signed by all the participants. It should be ensured that EDC (Expected Date of Completion) of pending observations/recommendations are indicated in the minutes & compliance be monitored.

c) Common drilling practices for all phases:

1. Hold tool box meeting. JSA (Job Safety Analysis) should be part of TBT (Tool Box Talks).
2. Record bit details: Make, type, serial number, IADC Code and length.
3. Check and record bit nozzle size before lowering the bit. Check TFA for confirmation against plan.
4. Check the planned BHA and ensure availability and usability of proper size of slips for all components of the string. Ensure Safety Clamps are available for use at appropriate points.
5. Ensure lifting Subs are available wherever required, especially with Vendor supplied string components. Tighten the lifting subs properly to avoid accidental opening during string M/Up.
6. Record OD, ID and Fish neck diameter of all components of the string. Care should be taken when lowering bottle neck cross overs.
7. Ensure the ID of all string components above the MWD tool should be at least minimum required for tool retrieval in case of String Stuck situation.
8. Capacities & displacement of all the string components should be recorded along with other parameters like length, Tool Joint connection, OD/ID, Serial Number if applicable, MOP etc in the pipe tally.
9. **Drilling Jar:** When a Drilling Jar is used in the string the following are to be noted during surface handling:
 - Never rack back the jar without a Safety Clamp properly installed on the mandrel.
 - Do not remove the Safety Clamp until the jar is safely in tension.
 - The Safety Clamp of Drilling Jar must remain installed until the tool is ready to be run into the hole.

- Keep the jar in tension at all times. If the jar is accidentally closed during surface handling, it must be extended to the fully opened position before running into the hole. Support the weight below the jar in the slips and pick up 5 to 10Kps with the elevators. Continue to apply this force until the jar is fully extended.
10. Handling of SDMM & RSS may be carried out as per instructions of the concerned service provider and for additional information on the same, ***Chapter: 9 on Directional Drilling*** may be referred.
 11. Ensure make-up torque for all size of drill pipe, drill collars, casing and tubing are displayed in dog-house. For vendor supplied drill string components, obtain the Torque Charts from the vendor. Ensure proper torquing of all joints.
 12. During RIH, monitor mud returns through trip tank. Analyze and take corrective action in case of abnormalities. Maintain trip sheet throughout the trip.
 13. Record BHA weight in mud from weight indicator.
 14. String fill up at regular intervals has to be ensured, if float is added in the string.
 15. Record up Weight, Down Weight, Static weight, rotating torque & weight and pressure profile at the casing shoe. Fingerprinting exercises are to be conducted in cased hole before drilling out the shoe to identify only benign effects of flow and temperature not influenced by the open hole. In addition, when changing of the mud weight or when a new BHA configuration is run, some exercises may be repeated in open hole such as extended flow checks, to identify a new benchmark for benign wellbore behaviour.
 16. Circulate at regular intervals for Gel break depending on time of last circulation and type of drilling fluid. Gel break at shoe should be ensured in all cases except during RIH in emergency.
 - 17. Circulations/any tests at casing shoe are to be carried out at least 50 to 100m above casing shoe and not exactly at casing shoe depths.**
 18. Trip at controlled speed to avoid surging & swabbing.
 19. DO not push through tight spots. Wash Down / Ream depending on the situation.
 20. Keep the drill string free 3-4m on either side of tool joint before setting slips. Monitor closely for off the slip extra pull. If noticed, this can be a sign of differential sticking. In such cases string idle time has to be

- reduced to minimum possible. And always set the slips while string is moving down.
21. During circulation in open hole, the string **should not be kept** on rotation at one place. Move the string up/down continuously with rotation. Rotation helps in effective hole clean up, especially in deviated holes.
 22. Wash down at least 2 to 3 singles to bottom even if the hole is free.
 23. Start the circulation at slow rates and bring the Mud Pump to the required SPM gradually.
 24. KRP to be recorded as detailed in the chapter for Well Control.
 25. Bit breaking in to be done when using a new bit.
 26. Monitor the drilling parameters closely. All deviations have to be noted and the trend graphs to be analyzed in case of abnormalities.
 27. Monitor MVT and analyze in case of abnormalities.
 28. Monitor cutting generation at Shale shaker and analyze in case of abnormalities.
 29. Use APWD tool, if available in the string, for ECD monitoring. Analyze and take corrective action in case of abnormalities.
 30. Stick slip has to be closely monitored for information on string torsional vibration. Analyze and take corrective action in case of abnormalities.
 31. Optimize drilling parameters. Keep a check on ECD values (if APWD tool is available) to avoid annulus loading.
 32. Frequent reaming has to be done when drilling through transition zones and interbedded formations to avoid formation of ledges. Follow the procedures in Directional Drilling chapter for reaming practices in deviated holes.
 33. Use Key Seat wiper when
 - a. low ROP is expected,
 - b. drilling soft clay at low ROP,
 - c. drilling long open hole sections,
 - d. KOP is at soft formation/ KOP is much below the Casing Shoe.
 34. Keep constant watch on SPP trend graph. Minor drop in pressure coupled with low ROP and increasing bottom hole torque can be sign of string mud cut at deeper part of the string. Analyze and take corrective action.
 35. Analyze and take corrective action in case of all SPP Changes / fluctuations, Torque fluctuations, Changes in Up/Down/Rotating string weight , ROP variations, ECD variations, Mud Volume changes, Drilled / Back ground / Trip gas percentage changes etc.
 36. Carry out Wiper trips as per plan depending on hole profile, formation, Type of mud, Lessons learnt from offset wells, consequent operations

being planned or as the hole demands. ***Preferably wiper trips are to be done after every 300m of drilling or 36 Hours from the last trip whichever is earlier. However, depending upon the well's behavior, trips can be carried out earlier than the recommended values.***

Frequency of wiper trips should be increased in wells with high chances of Key Seat formation. Short trips should be done only for specific cases.

37. Tandem / Hi-Vis pills are to be used to ensure proper hole flushing. The frequency should be increased in case of lower volumes of cuttings are observed at the shale shaker compared to the volume drilled, Increase in ECD, increase in bottom hole torque, lower than expected values of ROP or as the hole demands.
38. POOH in case of pressure drop and string mud cut is expected. Pull out without slugging the string and without rotation. The rate and range of pressure drop will vary on the depth of mud cut in the string among other factors. Analyze and take corrective actions immediately in case of abnormalities in this case to avoid string failure.
39. Record SPP at intermittent depths within casing shoe while R/I and maintain a pressure tally. This information might come in handy for cross-checking of SPPs in case of any discrepancies.
40. Changes in Up/Down drags of drill string will depend on many factors like hole profile, type of drilling fluid, cutting accumulation, depth and speed of string movement. Improving drilling fluid lubricity will help in reducing the up and down drags.
41. Circulate and condition the mud at least for one cycle prior to any planned pull out. Tandem / Hi-Vis pills are to be used to ensure proper hole flushing prior to pull out. It is recommended to place lubricating pill in the open hole while pulling out for Pipe conveyed logs or Casing lowering if the hole condition allows and when using WBM as drilling fluid.
42. Flow check the well before commencing Pull Out.
43. Swabbing can cause well bore failure or activity. If swabbing is noted RIH to bottom and circulate. Monitor the mud returns for change in parameters indicative of well activity. In case swabbing is expected against any formation, pump out the drill string in the section.
44. Do not pull through tight spots. Pump out / Back ream to clear the spot as per recommended practices mentioned later on in this chapter. Pump out should be done at minimum Annular Velocity required for clearing the tight spot.

45. Begin trip normally after proper hole cleaning. Do not force the drill string out of tight spots with excessive over pull. Attempt pump out as described above. If not successful, back reaming will have to be done
46. Circulate for bottoms up during string Pull Out at the following locations:
 - Casing Shoe (50-100m above) in case of pump out / Back reaming / deviated holes.
 - At hanger top in all situations.
47. Check Gauges of Stabilizers and Bit after P/O. Connections of all BHA components have to be checked. Any abnormality to be noted and analyzed. Dull bit grading to be done immediately after P/O and recorded in DPR.
48. Keep a Full Open Safety Valve (FOSV) always on the rig floor in open position with required x-overs during all drilling operations.
49. After every phase of drilling, a schematic of BOP stack indicating distance from rotary should be displayed in dog house to ensure distance of all rams and annular BOP from rig floor is known to the driller.
50. Ensure schematic diagram of choke, kill manifold and MGS in rig floor.
51. Ensure schematic diagram of flow path hard/ soft shut in procedure and positions (Open/ Close) of choke and manual valves in up and down stream in rig floor.(Refer to Well Control Chapter 11)
52. Ensure Mud Logging Unit if available, is installed and calibrated.
53. Ensure RTDMM system is connected and enabled.
54. Equivalent thread connections:
 4-1/2" IF=NC 50; 4" IF=NC 46; 3-1/2" IF=NC 38; 2-7/8" IF=NC31;
 2-3/8" IF=NC 26

List of Handling Tools:

SN	Items	No required
1	Bits (TCR & PDC)	As planned
2	Bit Breakers & bit Gauges	01
3	Float valve for bit sub	01
4	Baffle Plate	01
5	Circlip nose plier	01

6	Nozzle gauge	01
7	Drill Pipe Elevator(5 ½/5/3 ½")	02 each
8	Drill Collar Elevator(6 ½ /8/9 ½") (150 t)	02 each
9	Drill Pipe Slip(5 ½/5/3 ½")	02 each
10	Drill Collar Slip (6 ½ /8/9 ½")	02 each
11	Bit subs as required	02 each
12	X-overs as required	02 each
13	Kelly saver sub (4½"IF _{Box} X IF _{Pin})	02
14	Drill pipe/ Drill collar dope	02 Buckets
15	Stabilizers of each size	03 (1 NBS +2 SS)
16	Drill pipe wiper	02
17	Steel Measuring tape	02
18	Core bit	01
19	Core barrel with handling tools	01
20	Safety clamp	01
21	Test Plug as required (21 ¼"/13 5/8"/11"/7 1/16")	01 each
22	Safety Clamps (all sizes)	01

d) Drilling 26" hole section:

Preparation:

1. Record clear distance from Rotary Table to bottom of Cellar Pit.
2. Confirm 20" Casing and casing handling equipment are on location.
3. Ensure proper diameter of return flow line from conductor to shale shaker is installed.
4. Ensure drain plug is installed in false conductor casing nearer to the grouting and arrangements made for releasing the same after surface casing cementation.

Sequence of Operations:

1. Make up 26" bit and BHA for spudding. After drilling two singles make up string stabilizer at 18m (60 ft.).
2. Install float valve with baffle plate.
3. RIH with the 26" BHA inside the 30" Conductor.
4. Use a lower flow rate when drilling around 30" shoe to avoid wash out of the shoe. In case of severe seepage, discharge is recommended to maintain at lowest.
5. While drilling first 50 m below false conductor, conduct controlled drilling with only one pump or at 50 - 60% of recommended flow rate.
6. In the next 30m, flow rate should be increased to recommended flow rate to drill (800-1250 GPM).
7. Drill ahead to phase target depth with controlled drilling to avoid annulus loading.
8. Viscous sweeps of sufficient volume should be frequently used for drilling this section and monitor the volume of cuttings coming out to confirm proper hole cleaning.
9. In case 17 ½" pilot hole is drilled first, the hole should be enlarged with 26" hole opener in second run.
10. After reaching phase TD, sweep hole with 10 m³ Hi-Vis pill of 150 sec viscosity and circulate to clean the hole.
11. Perform wiper trip. POOH
12. Make a round trip with 2 string stabilizers at 9m (30ft) and 18 m (60 ft.) then make a round trip with 3 stabilizers preferably – NBS at 0 m, SS at 9 m (30ft) & 18 m (60 ft.) respectively.
13. Ream if necessary. Check for fill and circulate for hole clean.
14. Wash down last single to avoid plugging of nozzle.
15. Sweep hole with 10m³ Hi-Vis pill of 150 sec and circulate clean with recommended flow rate.
16. Circulate and condition mud. As a general practice place fresh mud of 0.02 SG higher density in well before pulling out for casing.
17. POOH to run 20" casing.

e) **Drilling 17 ½” hole section:**

Preparation:

Ensure all required tools and material are available on the rig.

Sequence of Drilling Operations:

1. Install well head, BOP, C&K manifolds and test as per guidelines in chapter on Wellhead Installation and Well Control.
2. Make up 17 ½”BHA as per well program (keep baffle plate in place).
3. RIH with 17 ½”bit and tag cement top, circulate & condition mud.
4. Test casing to 500 psi or as per specific requirement of well maximum of 80% of burst rating of casing / well head rating/MASP (Maximum Anticipated Surface Pressure) whichever is lowest.
5. Drill through cement and shoe with 2-3 T WOB and 50 to 60 RPM
6. Perform Shoe Integrity Test.
7. Wash down to bottom of 26” hole and drill ahead 3 m fresh hole.
8. Circulate hole clean till mud is conditioned.
9. Pull string inside 20” casing shoe.
10. Carry out LOT/ PIT and record max allowable Mud Weight. (**Preferably:** LOT in exploratory well and PIT in development well)
11. Change BHA as per requirement. For vertical well, use 18 m (60ft) pendulum assembly.
12. Resume drilling.
13. Perform drill off tests to optimize RPM/WOB combination.
14. Optimum Flow rate as per land mark software calculation to keep the hole clean depending on well profile i.e. Depth/ Inclination, and rheology of mud. (**For generalized flow rate refer to hydraulics chapter**)
15. Drill ahead to 17 ½” phase target depth.
16. Monitor shakers for signs in change and volume of cuttings.
17. Monitor pit levels for mud loss/gain.
18. Make wiper trips preferably after 36 hours/ 300 m of drilling or as the well demands. Record tight spots. Do not pull into the tight spot.
19. Drill to Phase Target Depth and drop TOTCO tool, if required.

20. On reaching Phase Target Depth /Target Depth, circulate bottoms up with full discharge until the shakers are clean. (However exact discharge may be calculated as per landmark software).
21. Make wiper trip to the 20" shoe. POOH
22. Run back to bottom and ream down last 03 singles. Check for fill.
23. Circulate until hole is clean and mud is conditioned
24. POOH for logging/ casing if planned.
25. During logging, monitor the well through **trip tank**.
26. Once logging is over, probe the well with two or three stabilizers as per well's requirement if the well is vertical. In case of deviated well/high angle, follow BHA as received from Directional Driller
27. Wash down last 03 singles. Check for fill and clear the same
28. Circulate and condition mud for casing lowering.
29. On the trip out once bit is inside 20" casing, mud pumps should be checked to ensure their reliability during the cement displacement.
30. Change pipe ram size to casing size.
31. Rig up casing handling tools for lowering 13 3/8" casing.

f) Drilling 12 1/4"/8 1/2"/6" hole section:

Preparation:

1. Keep compatible Well head test plug ready. Check test plug seals.
2. Keep drilling jar ready if planned.
3. Ensure coring equipment is available at the drill site, if planned.
4. Change liners of mud pump as per section hydraulics.
5. Keep FOSV and IBOP with required X/O ready in open position on rig floor.
6. Ensure information about PIT, LOT, MAASP, casing burst pressures etc. are available and displayed properly.
7. Ensure distance of all rams and annular BOP from rotary is displayed in doghouse.
8. Schematic diagram of choke and kill manifold, MGS and positions of choke and manual valves should be displayed.
9. Ensure Rig Instrumentation Sensors are installed and calibrated

10. Ensure well shut-in procedures are displayed in the dog house/Driller's Cabin (refer Chapter on Well Control).
11. Ensure activation balls/darts (e.g. for PBL circulating subs, core barrel etc.) are of correct size and will pass through BHA components and kept in locker in the dog house.

Sequence of Drilling Operations:

1. Function and pressure test of all rams of BOP stake, all valves of choke and kill manifold, IBOP, FOSV and surface equipment as per standard lay down procedure. (Refer to Well Control Chapter)
2. RIH with bit with TOTCO ring (baffle plate) / BHA as per program. If the section is vertical, make up string stabilizer at 18m (60ft) in BHA. For drilling harder formations, an additional 9m (30ft) stabilizer along with 60 ft stabilizer may also be lowered.
3. Tag float collar and test casing to 80% of burst rating/well head rating whichever is less.
4. Drill Float Collar and up to top of the Shoe. Conduct CIT. Drill shoe + 0.5m and conduct SIT (as detailed in section h. Shoe Integrity Test).
5. Wash down to bottom and drill 3-5m fresh hole.
6. Circulate and condition mud.
7. Pull out string inside shoe and conduct LOT. (LOT in exploratory well and PIT in development well)
8. Drill further down 20-30 m.
9. Perform drill off tests to optimize RPM and WOB
10. Maintain annular velocity and flow rate as per software simulation. (For generalized flow rate refer to hydraulics chapter).
11. Drill ahead to phase TD.
 - a) Check drag with pump off & on every connection to analyze any down-hole problem.
 - b) Record all drilling parameters periodically
 - c) Kelly/string should be lifted after every definite interval of drilling to flush the hole. Sweep with high viscous pills after every 3 singles/as per hole situation, to clean hole and avoid hole pack off.

- d) Monitor shakers for change in size and volume of cuttings and pit levels for mud loss/gain.
 - e) Flow check all drilling breaks and report same in DPR.
 - f) Monitor connection gas and trip gas and report in DPR.
 - g) Prior to a connection, circulate & ream drilled portion.
 - h) Record on bottom and off bottom string weights.
 - i) If losses occur, refer to ***Chapter on Drilling Fluid Management*** for Loss Control formulations.
12. Make wiper trips (with pumps on for slim holes) preferably after 36 Hours/ 300 m of or as the well demands. ***However, depending upon the well's behavior, trips can be carried out earlier than the recommended values.*** Record tight spots. Do not pull into the tight spot.
 13. Circulate and condition mud once on bottom.
 14. While drilling lift Kelly/string after every ½ hr. or 2m (whichever is earlier) wherever sticking tendencies are observed.
 15. Before pulling out for logging ensure mud is properly conditioned.
 16. POOH (with pumps on for slim holes) for logging.
 17. During logging, monitor well on trip tank. After 24 hrs. of TLC, preferably circulate the well through circulation port if available.
 18. Once logging is over, probe the well with two stabilizers (30' & 60') if the well is vertical. In case of deviated well/high angle, follow BHA of directional drilling.
 19. Wash /ream down last 03 singles/ 01 STD.
 20. Circulate and condition mud.
 21. Make wiper trip (with pumps on for slim holes). Wash down last 3 singles.
 22. Circulate and condition mud for casing lowering.
 23. Place Lube pill in open hole prior to casing lowering
 24. POOH (with pumps on for slim holes) to run casing.
 25. While POOH and once inside casing shoe, mud pumps should be checked to ensure reliability during cement displacement.
 26. Change pipe ram to casing ram.
 27. Rig up handling tools for lowering casing.

g) Casing Integrity Test (CIT):

After casing cementation, casing is pressure tested prior to further drilling.

Casing test before drilling float collar:

The sequence of operations to test casing are as follows:

- RIH and tag cement top
- Establish circulation
- Clear cement up to float collar
- Circulate and condition mud
- Test casing to 80% of the burst rating of the casing or well head or BOP test pressure whichever is minimum.
- In case of combination casing string, the lowest burst rating of casing pipe should be considered.

$$\text{MASP} = \frac{\text{BHP/e}}{0.0001138 \times \text{SG of gas} \times \text{TVD of next shoe (meter)}} \text{ in KSC (SG of Gas is 0.65)}$$

(Maximum anticipated surface pressure)

- While pressurizing casing, ensure to keep the outer annulus (annulus of the casing being pressurized) open to inspect for any leak.
- Test duration is 5 minutes.
- Test is considered OK/satisfactory if the pressure holds or a pressure loss of equal to or less than 5% of the initial test pressure is encountered.
- Pressure gauges to be used to monitor the test pressure must have a scale such that the test pressure is 40%-60% of full scale. The gauge shall