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Directional CP Driving to Prevent Well Collision Problem & Improving Drilling Operations Safety & Efficiency by Using 20" Directional Conductor Pipe In PT.Pertamina Hulu Mahakam

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Abstract.
More than one thousand eight hundred wells have been drilled in Mahakam field. With such a "crowded" field, trajectory has become very complex and anti-collision become a regular issue. Therefore, for a well construction operation, a good CP (Conductor Pipe) direction is a paramount factor to avoid several issues such as well collision or the necessary to re-plan the well. Several CP sizes (30", 24" and 20") had been driven in Mahakam Field. 24" CP size have been driven with simple direction control technique in Mahakam Field with satisfying result of maximum ±15^{o} azimuth deviation average. Driving technique, which is continuously employed by the CP driving team. Driven by cost reduction initiatives in 2014, 24" CP was substituted by smaller 20" CP. 24" CP Driving technique was not directly applicable to a smaller CP size. With the same driving technique, the CP direction accuracy dropped into a maximum 48.2 ^{o} azimuth deviation. To answer the challenge and further increase the operational safety, PHM CP Driving Team modified the technique and develop new equipment. Six new improvements which was a combination of new techniques & equipment, successfully restored and even improved the 20" CP direction accuracy. Nowadays, a maximum of 12^{o} azimuth deviation can be achieved by implementing the new procedure. Moreover, the new improvements can also extend the CP's directional capability, as a higher CP inclination (from 5° to 10°) can be realized. This innovation of controlling the direction and inclination of CP greatly reduce the collision risk and reduce significantly the number of production wells that must be closed due to the risk of collision. It improves the drilling operations from the safety aspect, duration and also the expenditure.

Keyword: Technology Improvement, Conductor Pipe, Conductor Pipe Direction Accuracy; Anti Collision; Gyro Survey.

1 Introduction

Since the directional drilling technique used in the oil well drilling, it was known CP always deviates when driven regardless of the CP size (confirmed by GYRO in CP). At the time, CP inclination & direction were not controlled: CP was driven as long as it reached the desired depth. After CP clean out and Gyro run, the well path was nudged to its intended direction Whatever the gyro result on CP (direction & inclination); well path correction with directional drilling work was not risking of colliding the well with well previously drilled. Mean to control 20" CP direction & inclination started to be developed. Directionally controlled 20" CP driving can be done with excellent level of accuracy by applying the improvements. As the result, time and cost for unexpected trajectory correction due to bad CP direction is minimized. Risk of collision is better managed and wells feasibility is greatly enhanced. Answering 20" CP driving challenge and further improving operational safety.

1.1 CP Driving preparation & Operation

- CP String is prepared & delivered to the site with string cumulative length was 126 m
- Shoe joint to be prepared with 6 fins was installed in 1st & 2nd joint, sub-sequence joins are marked on its concave deflection side to be aligned to the mule sharp point and fins scribe line during CP connection.
- Conductor Pipe check :
  (a) Check length for every CP joint and mark with depth marker cumulatively.
  (b) Mule shoe cut-off bevel angle.
  (c) Check CP deflection at scribe line & at 90o clock wise of the scribe line side.
  (d) This Scribe line shall be pointed to well CP plan direction.
  (e) Measure the CP deflection at Scribe line & side deflection.
- Prepared Hydraulic Hammer
- Check Supporting CP Driving tools : Driving Sleeve, Base alignment frame, Fit Up Frame.
- Perform Metal Debris Check
- Run 1st Joint CP, CP shoe joint #1 running is the most important step in the CP driving procedure. The first pipe shall be directed and run perfectly to avoid any bad direction result.
- Continue to pick up joint #2 & aligned to be able welded. Ensure all welding join procedure are fulfilled :
  Hi-lo ovality, seams pipe on stump.
- Pick up and perform Hammering job with hydraulic hammer.
- Final Cut CP and install pin connecter

1. Pre-Make Up

2. CP Measurement

3. Fit up & Welding

4. Pipe Hammering

5. Final Cut

6. CP & Pin Connector

Figure.1 – CP Driving Preparation & Operation

2. Conductor Pipe Driving Requirement & Challenges

2.1 CP Driving Challenges

In the initial TTH fields development where platform was assigned only for one well, the directional work was only attempting of directing well path to hit the well geological targets. Collision issue was not identified apart from well spacing was quite far and location was not crowded with existing wells. At the same time of 20" CP application, following development schemes were also implemented:

- Reduction of infill well grade spacing
- Platform efficiency drilling more wells without building more GTS .

  With all the above, wells become more crowded in the same GTS area. Shallow target development with long horizontal displacement, requires kick-off to be performed aggressively at shallower depth. Following illustrations are current situation with well situations in the GTS onTTH field.

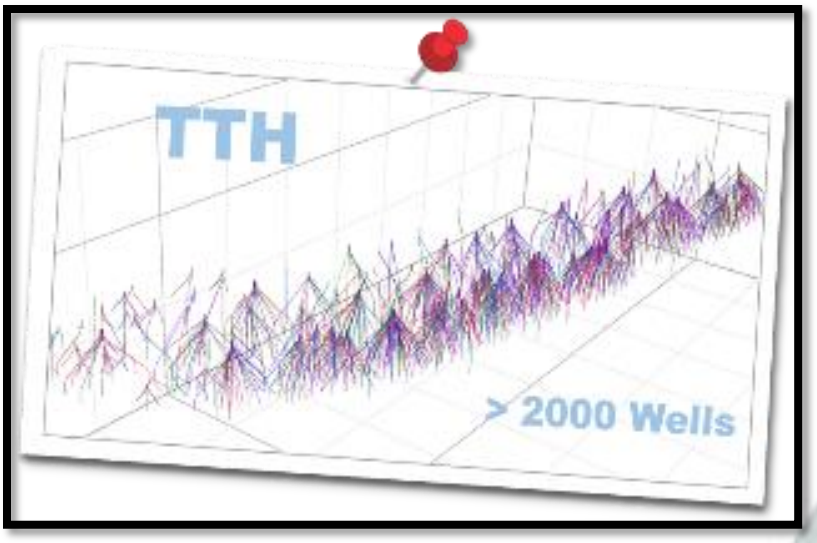


Figure.2 – Well situation in TTH Field

Nowadays, thousand wells have been drilled in Mahakam Swamp area. This condition make trajectory anti collision plan becomes harder challenge. Nowadays, thousand wells have been drilled in Mahakam Swamp area. This condition make trajectory anti collision plan becomes harder challenge. Company Rules with anti collision become more stringent making directional collision issues become more complex. Mitigation is essential to avoid the collision issues. CP is the 1st pipe string in the drilling operation consequently CP direction is affecting the sub- sequence directional drilling operation. With the crowded well trajectory, CP deviation direction tolerant becomes narrower also. In an extreme example the narrowest driven CP driving tolerant was ±2.5^{o} right and left. A close actual CP direction to plan driven CP direction definitely helps securing well from anti- collision issue.

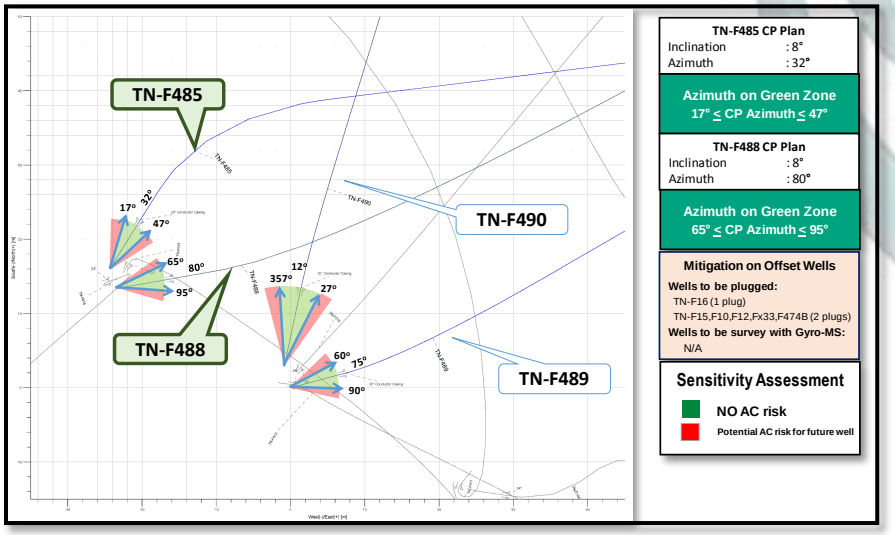


Figure.3 – Narrow CP driving Tolerance

2.2 High Flexibility of CP to rotate

The high flexibility of 20" CP can be seen on CP Gyro run result after clean out. 20"CP is observed turning/spiraling from surface to the CP shoe. As the CP size & thickness reduced, the 20" CP sting is more flexible to be flexed when driven. To prevent 20" CP spiraling when driven, it is desired to make the 20" CP string more rigid and prevent to turn when driven. By adding fins it is expected able to suite the desire to make 20" CP string more rigid. Six fins are installed at same high side/scribe line concave deflection side of the CP join. Number of the fins are 6 each with 6 m distance among the fins. Fins numbers 1st to 3rd are designed with two taper shapes at the front and rear of fins. This fins double tapered shape help fins pass through the driving sleeve rail when 20" CP is reciprocated. The CP usually is reciprocated to ease off formation turning effect when CP string still in the self penetration stage. Once CP string in the hard formation and penetration is done with hammer weight (and blow), the formation turning effect is prevented by the fins.

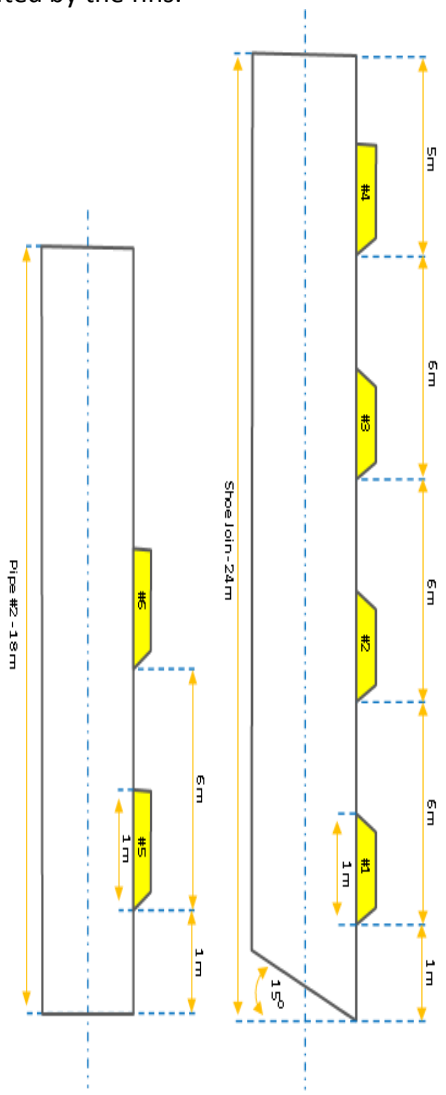
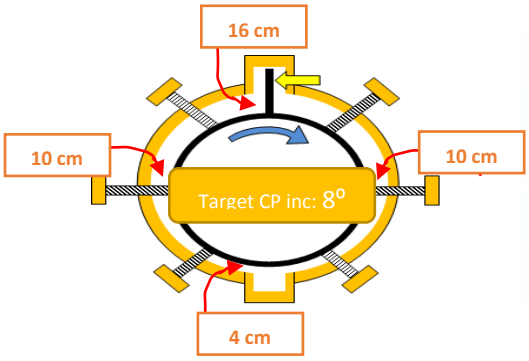


Figure.4 – CP Fins Configuration

Number of the fins are 6 each with 6 m distance among the fins. Fins numbers 1st to 3rd are designed with two taper shapes at the front and rear of fins. This fins double tapered shape help fins pass through the driving sleeve rail when 20" CP is reciprocated. The CP usually is reciprocated to ease off formation turning effect when CP string still in the self penetration stage. Once CP string in the hard formation and penetration is done with hammer weight (and blow), the formation turning effect is prevented by the fins.

2.3 CP tends to turn in soft formation

Sometimes CP tends to turn when it is self penetrating the formation due to formation effect the solution was created *Driving Slee*ve Tools. The Driving Sleeve tools was. 30" diameter by 6 m long steel cylinder with rails for fins to pass through which prevent CP to turn when 20" CP is running and penetrating soft formation. Six alignment bolts on top of driving sleeve adjusted to assist keeping the CP vertical. The fins rail side of driving sleeve is directed to the well plan direction. The fins rail keep the 20" CP scribe line of concave deflection and mule shoe sharp end at plan well direction when 20" CP is run through. The distant among the 20" CP fins is 6 m. With this combination mechanism the 20" CP scribe line is kept at the well plan direction. When one fin is passing bottom of driving sleeve; the next fin enters the fin rail.



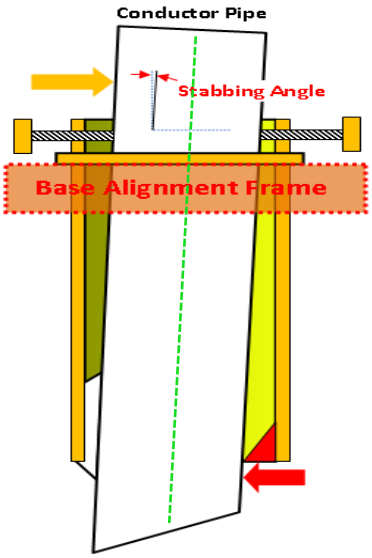


Figure.5 – Driving Sleeve

2.3 Precision Surface Direction

Eliminating this ambiguity, WAD-GPS (Wide Area Differential GPS) was utilized for direction confirmation. WAD-GPS is a very accurate GPS with 5 cm accuracy. For direction correction check, two WAD-GPS antennas were installed at BAF as in picture below. The position of two antennas is representing the CP direction. By knowing the location coordinate of the two antennas, direction can be defined and confirmed.

Figure.6 – Azimuth Confirmation

2.4 CP Joint Side Deflection Control

Bottom Driving Sleeve is controlled; CP is deflected using alignment bolts. When CP is checked using spirit level, the CP still leaning to perpendicular of plan direction sides. Further checked on CP shoe join), it is observed apart deflecting on scribe line, join also deflecting on perpendicular of plan direction sides. On gyro results, side deflection is affecting:

- Direction at 40 m ~ stabbing depth
- Direction & inclination at CP shoe.

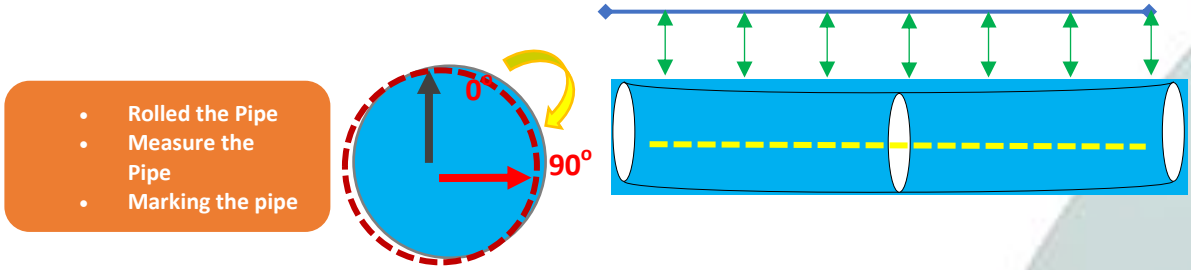


Figure.7 – Side And Main Deflection Measurement

Based on actual data result, CP direction deviation will be minimum; if:

$$\frac{\textbf{Deviation at 90° Off Scribe Line}}{\textbf{Deviation Scribe Line}} < 0.5$$

To minimize CP direction deviation it is required to full- fill the above condition by choosing CP shoe join with minimum ratio of deflection at 90° scribe line side over deviation at scribe- line. If the ratio is not acceptable, CP shoe join to be rejected & repaired at welding shop. API 5L is allowing maximum deflection 0.2% of the pipe length. Since the purchase of OCTG mainly referring to API Specs, then all the CP material always has
deflection.

Table.1 Measurement result of Side deflection

Conductor Pipe Measurement									
Condition	Location	Max (mm)	1 (mm)	2 (mm)	3 (mm)	4 (mm)	5 (mm)	6 (mm)	7 (mm)
Initial	0 Deg	20	5	10	16	20	15	9	4
	90 Deg	4	1	2	2	4	1	1	1
Welding	0 Deg	30	7	12	18	30	16	10	6
	90 Deg	4	0	0	2	4	3	2	2

High side deflection may affect the CP will be turn the CP direction azimuth while penetrate the formation, because our field have anti collision issues with a thousands of well have been Drilled, we need a specific requirement due to avoid any collision issue in the further. The specific Requirement shall be followed with good result. Please see the table below :

Table.2 Specific Requirement for CP in Mahakam Field

Item	Requirement	Concern
1	OD, Out of roundness Ovality Flatness or Peaks	Fit up difficulty prior welding, welding quality, clearance with Drillings BHA, Pin Connector/WH installation and seal integrity (tested to 1000psi)
2	Pipe Straightness Or Deflection	Control on CP direction during hammering operation (azimuth and inclination)
3	Residual Stress	Control on CP direction, Pipe movement during hammering.

3. Conclusion

Based on CP Driving result from 2019 The CP Driving shown good result with hundreds of wells was driven and Clean out after gyro show the azimuth of the CP direction should be in line with the trajectory.

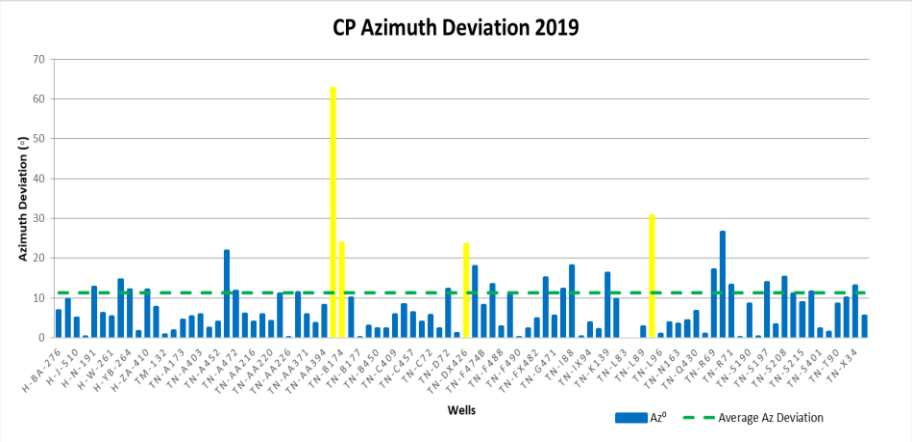


Figure.7 – CP Driving Result 2019

As Shown in the following chart CP improvement and the use of all the initiatives increase CP driving accuracy from 20° azimuth to 12° azimuth. From hundreds of well has been Drive. 97 wells are which in good direction. This chart shown the proven technique of CP driving. Continuous improvement on procedure and equipment has achieved excellent CP directional control. Consequently, time and cost for unexpected trajectory correction due to bad CP direction is minimized. Collision risk is reduced and wells feasibility is greatly enhanced. Furthermore, with the new technique and equipment, CP driving operation is much better controlled and allowing better wells perspective.

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