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Thesis title:

Drilling Program Elaboration Implemented in Well TOU-15 Gassi Touil Gas-Field

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Gratitude

In the name of Allah the most merciful and the most compassionate

First of all, we thank Allah for giving us the power to finish this work;

After that we would like to express our thankfulness to our parents who deserve the entire honor of our success, and without their support, we would not be here;

We would like to thank our department professors: Dr.BARI Mohamed Abdou and Especially Prof.ABIDI SAAD Aissa who helped us and guided us in the process of making this paper;

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Finally, special thanks for our friends and all those who contributed to finish this paper.

Dedication

At this point in our life We want to share the best moments of it with the human beings we love,

Arrived at the end of our studies, We have the great pleasure to dedicate this modest work:

To our Parents,

To our Sisters and Brothers,

To our Teachers and Professors,

To our Friend and Colleagues,

And To All those we Love and Respect.

BOUREGA Med Salah Edd
GOURARI Mahdi
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Abstract

This thesis explains the drilling program, focusing on the processes and techniques involved in drilling and aims to explain simply what the drilling program is: how it affects the drilling process and to make it more understandable we supported it with the drilling program of the well “TOU-15” in Gassi Touil Gas field, made by Sonatrach’s engineers.

The thesis covered all the angles to make the drilling operation faster and more safe, from the location of the well. The geological data includes the lithological formations. The full detailed casing program. The bit program of every hole. The timeline relating to the time needed to complete every single section hole. The Pre-spud checklist to make the drilling operation safe in all respects (Environment, People, Equipment) and Finally the well control (BOP+Wellhead pressure test) to make sure there is no drilling problem that will face the operation.

ملخص

تشرح هذه المذكرة برنامج الحفر ومنهجية اعداده مع التركيز على العمليات والتقنيات المتضمنة فيه نهدف بهذا العمل الى تسليط الضوء على أهمية برنامج الحفر في عملية الحفر بذاتها وقد دعمنا هته المذكرة ببرنامج حفر البئر ل TOU-15 الواقع بحقل الغاز قاسي الطويل.

غطت المذكرة جميع أجزاء برنامج الحفر من موقع البئر وتشمل البيانات الجيولوجية والتكوينات الصخرية للبئر، برنامج الغلاف بالتفصيل، برنامج رأس الحفر لكل مقطع، الجدول الزمني المتعلق بالوقت اللازم لحفر كل مقطع، قائمة مراجعة ما قبل الحفر المتعلقة بالأمن والسلامة (البيئة ، الأشخاص ، المعدات) وأخيراً التحكم في البئر (اختبار BOP واختبار ضغط فوهة البئر) للتأكد من عدم وجود أي مشاكل حفر.

Résumé

Cette thèse présente la méthodologie de préparation du programme de forage, en mettant l’accent sur les processus et les techniques impliquées. L’objectif de ce travail est de mettre en évidence l’importance du programme de forage dans le processus de forage lui-même. Nous avons illustré cette thèse par le programme de forage du puits "TOU-15" situé dans champ gazier de Gassi Touil.

La thèse a pris en considération tous les aspects du programme de forage, à partir du site du puits ainsi que les données géologiques y compris les formations rocheuses du puits, le programme de tubage détaillé, le programme de forage pour chaque section, l’échéancier concernant le temps requis pour forer chaque section, la liste de contrôle pré-sud liée à la sécurité et à la sûreté (environnement, personnel, équipement), et enfin, le contrôle du puits (test BOP et test de pression en tête de puits) pour s’assurer de l’absence de tout problème de forage.

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List of Symbols

AFE	Authorization for Expenditure
Alarp	As low as reasonably practicable
API	American Petroleum Institute
bbl	barrel
BHA	Bottom Hole Assembley
BHCT	Bottom Hole Circulating Temperature
BOP	Blowout Preventer
BP	Back Pressure
BTC	Buttress Threading
CBL	Cement Bond Log
CCL	Casing Collar Locator
CM	Choke Moudle
DST	Drill-stem Test
ECD	Equivalent Circulation System
EMW	Equivalent Mud Weight
FL	Fluid Level
FV	Float Valve
GR	Gamma-Ray
GTIP	Gassi Touil Inteated Project
HARC	Hazard Analysis and Risk Control
HC	Hydrocarbons
HP	Horse Power
HSE	Health & Safety Executive
HSI	Hydraulic horsepower per square inch
IADC	International Association of Drilling Contractor
L/D	Low Down
LCM	Lost Circulation Material
LGS	Low specific Gravity Solids
lpm	Litre per minute
LTI	Lost Time Incident
MBT	Methylene Blue Test
MDT	Modular Formation Dynamics
MPD	Managed Pressure Drilling
MSDS	Materiel Safety Data Sheet
MSL	Micro Spherical Log
MW	Mud Weight
MWD	Measurement While Drilling
N/D	Nipple Down:To take apart fittings in making a hook up; to assemble a system of pipe, valves, and nipples as in a christmas tree or a blowout preventer.

N/U	Nipple Up:To put together fittings in making a hook up; to assemble a system of pipe, valves, and nipples as in a christmas tree or a blowout preventer .
NPT	Non Productive Time
OBM	Oil Based Mud
PD	Power Drilling
PH	Phasor Log
$POOH$	Pull out of Hole
PPE	Personal Protective Equipment
ppf	Pound per Foot
PV	Plastic Viscosity
$QHSE$	Quality, Health, Safety and Environment
R/D	Rig Down
R/U	Rig Up
RFT	Repeat Formation Tester
RIH	Run In Hole
RKB	Rotary Kelly Bushing
ROP	Rate Of Penetration
RPM	Revolution Per Minute
SCR	Slow Circulation Rate
SG	Special Synthetic Lubricants
sg	Static Gradient
SPM	Strokes Per Minute
$TAGI$	Trias Argilo-Gréseux Inferieur
$TAGS$	Trias Argilo-Gréseux Supérieur
TBA	To Be Announced
TCI	Tungsten Carbide Insert
TFA	Total Flow Area
TOC	Top of Cement
TOL	Top of Liner
TVD	True Vertical Depth
VDL	Variable Density Log
VSP	Vertical Sesmic Profile
WL	Wire-line
WOB	Weight on Bit
WWS	Well Stimulation Service
XO	Cross-over
XPT	Formation Pressure Test Log
YP	Yield Point
P/U	Pick Up

Introduction

Drilling Program Elaboration is the process of developing a detailed plan for a drilling project. This plan should include the following information:

- The goals of the project.
- The target formation or target area.
- The drilling method and equipment to be used.
- The anticipated schedule and budget.
- The potential risks and hazards.
- The contingency plans in case of problems.

The drilling program elaboration should be developed by a team of experts with experience in drilling, geology, and engineering. The team should carefully consider all of the factors involved in the project in order to develop a safe and successful plan.

Once the drilling program elaboration is complete, it should be reviewed and approved by all of the stakeholders involved in the project. This will help to ensure that everyone is on the same page and that the project can be carried out smoothly.

Here are some of the benefits of drilling program elaboration:

- It can help to ensure that the project is completed on time and within budget.
- It can help to identify and mitigate potential risks and hazards.
- It can help to ensure that the project is conducted in a safe and environmentally responsible manner.
- It can help to build consensus among all of the stakeholders involved in the project.

Drilling program elaboration is an important step in the planning of any drilling project. By taking the time to develop a detailed plan, you can help to ensure that your project is a success.

Here are some additional tips for developing a successful drilling program:

- Get input from all of the stakeholders involved in the project.
- Be realistic about the goals and objectives of the project.
- Build in contingency plans for unexpected events.
- Monitor the project closely and make adjustments as needed.

By following these tips, you can help to ensure that your drilling program is a success.

In this thesis we're going to show the methodology of how to prepare a detailed drilling program and it will be supported by a practical example of drilling program of Well "TOU-15" Gassi Touil Gas-Field Reference [7].

Chapter I

Well Data

I.1 Well description and location

This section includes simple info as well coordinates, field/structure, type, well depth, operator and owner Co. data. A typical layout of this is shown below:

- Location.
- Field/ Structure.
- Coordinates of the well.
- Well Name.
- Well Type (Development – Exploratory).
- Water depth (for offshore wells).
- Total Depth.
- Operator oil or gas Company.
- Target Tolerance.
- Rig Name.
- Type of the drilling rig.

Now,Let's provide this with an example using our case study :

Toual Field is located 150km SE of Hassi Messaoud field and 70km N of Rhourde Nouss Central Field in the Gassi Touil block, as part of the Berkine Basin in Algeria. The field is an elongated, NE-SW trending fault bounded anticline located in the southern part of the Gassi Touil project area. The Toual field was discovered in 1963 by the well: TOU -1, which tested gas in the Triassic reservoirs whereas TOU14 drilled to as a vertical well drilled to a total depth of 3,901m TVD (RT), about 40m into **Silurian Argiluex**.

Toual15 is a well dedicated to the development Triassic reservoirs in the region of Gassi Touil, it will be drilled in the structure of Toual it reaches the TAGS, the main objectives TAGI and Silurian sandstone reservoirs F6 and Hamra quartzite, as objectives to be evaluated.

The wells TOU-3, TOU-4, TOU-5, TOU-6, TOU-7, TOU-9, TOU-10 and TOU QZH-1 have all penetrated into both TAGS and TAGI reservoirs. The TOU-8 reached the TAGS only whereas the TOU-2 did not reach the objectives due to technical reasons.

The last two wells TOU-11 & TOU-12 were drilled by ENF-37 & TP-198 respectively within the drilling plan of Gassi Touil Integrated Project (GTIP). Both wells were completed successfully, and this drilling program has benefited from lessons learnt and experienced accumulated during the drilling campaign of TOU-11 & TOU-12 wells.

The TAGS was put on production in 2004, the TAGI in 2000. In 2005 all wells stopped production with the commencement of the current project. Current pressures are calculated as 1.05sg EMW in the TAGS and 0.97sg EMW in the TAGI. The original pressure in the TAGS was 1.12sg EMW and in TAGI was 1.14sg EMW.

In terms of **Silurian targets**, currently no formation pressure available. It has been drilled by 1.45sg mud and no indication of kick. Within Project Integrated Gassi Touil (PIGT) under Repsol Management, two wells have been drilled. TOU QZH-1 was an exploratory well, drilling into the Hamra Quartzite for the first time. The TOU-10 well was planned as a smart completion (i.e., selective TAGS or TAGI production) but due to surface hole instability reasons the well was side tracked and completed conventionally in TAGI in 5 7/8" section. Structural Map of the field is given in Figure I.1.

From Hassi Messaoud to take the national road Amines, a distance of 175km, turn left (east) by following the tarmac road leading to the field Toual, a distance of 24Km. From there take the road to the drilling Toual 4 (heading South / East), a distance of 1.1 km Turn right along the track leading to drilling TOUW1 a distance of 0.7 km Turn left (south) and a distance of 0.7 km is drilling TOU-15.

ENF6 is the selected rig to drill the well; it is a 2000HP DIESEL ELECTRIC – driven with Top Drive (SCR controlled). **The Rotary Table elevation (RT: RKB) is 7.70m from the ground level.**

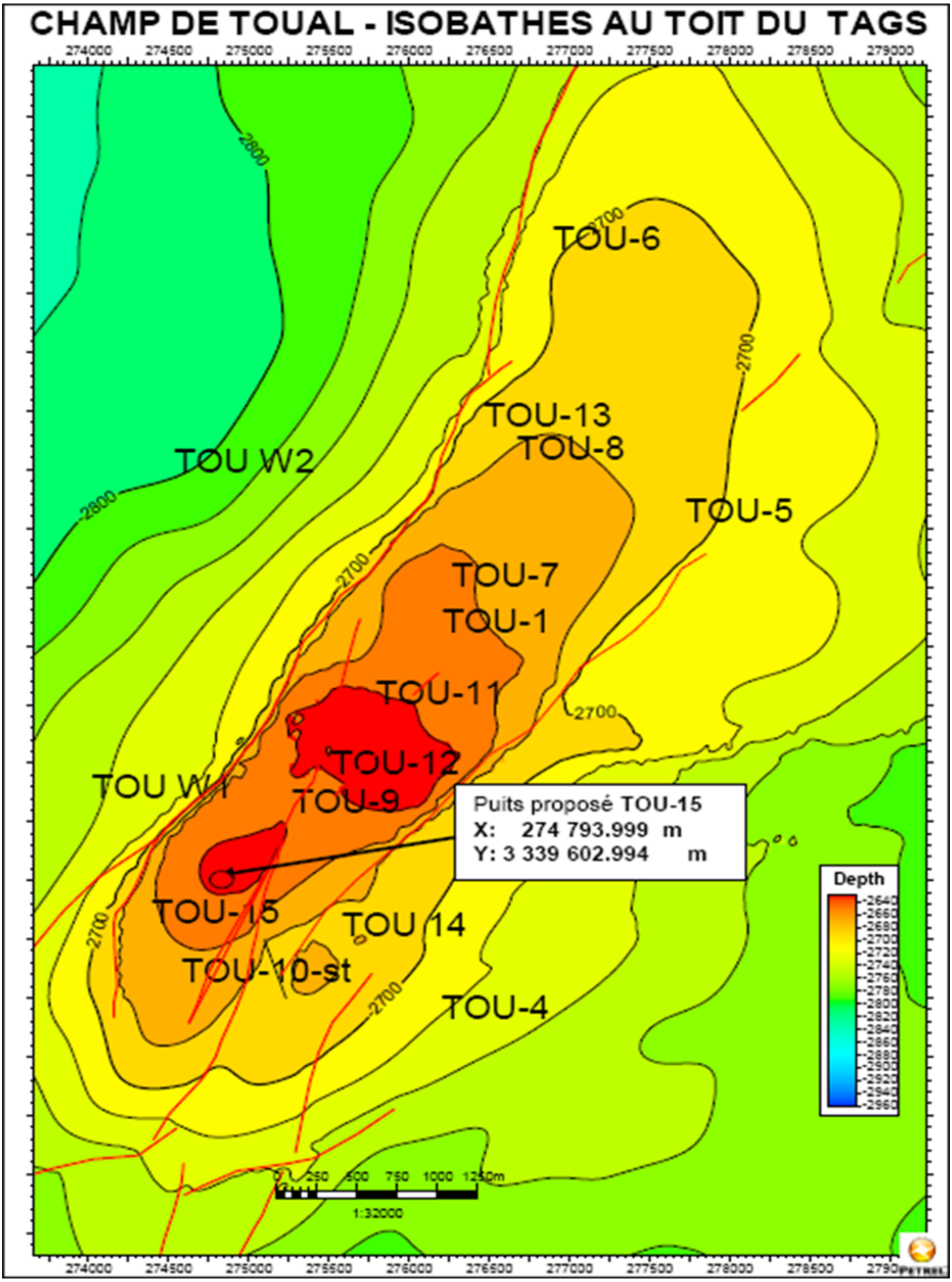


Figure I.1: Structural Map of Toual Field (TAGS)

I.2 Well information

Table I.1: Well TOU-15 information

Well Name	**TOU-15**	
Field	Gassi Touil	
Block	Toual-BLC 237	
Well Classification	Appraisal (TAGS, TAGI, Silurian F6 and Quartzite Hamra-Gas Producer)	
Operator	Gassi Touil Project	
Drilling Contractor	Enafor	
Drilling Rig	ENF-06	
Surface Location	**WGS84**	
	Latitude	30° 10' 09.71327" North
	Longitude	06° 39' 41.07053" East
	UTM – (Zone 32 N – 6°E to 12° E)	
	Easting, X =	274,793.999m
	Northing, Y =	3,339,602.994m
	LSA - (Zone 32 N – 6°E to 12° E)	
Elevations	Ground Level	229.37m above mean sea level (MSL-GL)
	Rotary Table	7.70m above ground level (GL-RT)
	Rotary Table	221.67m above mean sea level (MSL-RT)
Unit System	Depth	m
	Flow rate	lpm
	Density	sg (specific gravity)
	Volume	m^3
	Diameter	in
	Pressure	psi
	Depth Reference	Rotary Table (RT)
Well TD	MD, m	**4,847m (RT)**
	TVD, m	**4,847m (RT)**

I.3 Well objectives

It's specific goals or target of drilling well Priority order of objectives; include well objectives as well as production or exploration. Planned drilling time breakdown (time/depth curve), Estimated cost breakdown (cost/depth curve and costs by category).

- Achieve electric logging acquisition objectives.
- Information and lessons learned gathering for further drilling optimization.
- Accurate and complete data capturing.
- No LTI and light accident during entire well operation.
- No CM service quality incident.
- Operational NPT <10% .Rig NPT < 5%.
- Maintain a vertical hole with a maximum of 3º inclination.
- Drill to 6" TD @ 4,847m (RT) in 85 days.
- Evaluation & Completion 40 days.

• To increase the production of gas condensate in the region of Gassi Touil from Triassic sandstone levels (TAGS & TAGI).

• To assess the potential gas condensate of Triassic carbonate recognized in well TOUW2.

• To assess the potential gas condensate of Silurian F6 recognized in well Toual13 (TOU-13) and Toual14 (TOU-14).

• To assess the potential gas condensate of reservoir Hamra Quartzite (recognized in well TOUP1).

I.4 Geological prognosis

A geological prognosis is the prediction or forecast of the geological conditions that are expected to be encountered during drilling operations. The prognosis is usually based on geological and geophysical data that are collected from the area around the drilling location, as well as from previous drilling operations in the area.

The important points that we need in this any drilling program are:

• Formation samples.
• DST Program.
• Reservoir information.
• Well schematic.

To reflect that in our case study, we summarize it in this way :

I.4.1 Formation samples

• A sample must be repeated every 10 m from the surface Lias Salifere S3.

• From the Lias Argiluex, sampling should be narrow and does everything the 2 to 3m.

• TAGS top of the stop to the coast, it is imperative to conduct a sample with a step of 1 m (if the forward speed permitting).

• A sample will be taken not racked every 10m for analysis pollen.

• A master log will be established on the site until the final rating.

I.4.2 DST Program

In drilling, DST stands for "Drill Stem Test." A DST is a specialized procedure conducted in oil and gas wells to evaluate the productivity and reservoir characteristics of a formation. It is typically performed after the drilling of a well but before the completion and production phases.

During a Drill Stem Test, a temporary testing tool assembly, known as a DST toolstring, is lowered into the wellbore on the end of the drill string (also called the "drill stem"). The DST toolstring consists of various components and instruments designed to measure pressure, fluid flow rates, and other parameters.

The main objectives of a DST program include:

Formation Evaluation: The test helps assess the potential productivity and properties of the reservoir formation, including permeability, fluid content, and pressure gradients.

This information is crucial for reservoir characterization and determining the commercial viability of the well.

Fluid Sampling: The DST allows for the collection of fluid samples from the reservoir. These samples can be analyzed in laboratories to determine the composition, quality, and properties of the reservoir fluids, including oil, gas, and water. This data aids in reservoir modeling and production planning.

Pressure Testing: By manipulating the flow rates and pressures within the wellbore, DSTs can assess the reservoir's pressure response and estimate parameters such as formation pressure, reservoir boundaries, and potential reservoir compartmentalization.

The DST program involves several steps, including:

• Setting the DST toolstring in the wellbore, typically at a specific depth of interest.

• Controlling the flow of fluids by manipulating valves and choke systems in the toolstring.

• Conducting pressure build-up tests, flow tests, and other measurements to gather data on reservoir pressure, flow rates, fluid properties, and other relevant parameters.

• Recording and monitoring the measurements using downhole instruments and surface equipment.

Based on the results obtained during a DST program, decisions can be made regarding the well's future production potential, completion design, stimulation treatments, and overall reservoir management strategies.

It's worth noting that DST programs require specialized equipment and expertise, and they can be expensive and time-consuming. However, the valuable information gained from a well-executed DST can significantly impact reservoir understanding and optimize production strategies.

• Reservoir TAGS: Able to conduct an XPT after crossing in order to determine the communication between the different compartments.
• Reservoir Triassic carbonate: Able to conduct an XPT after crossing.
• Reservoir TAGI: Conduct a measure of XPT training after his crossing.
• Reservoir Silurian: Conduct a measure of XPT training after his crossing.
• Reservoir Hamra Quartzite: Conduct measures MDT Dual Packer after crossing.
• The VSP program is under consideration, if it is chosen, it will be announced later.

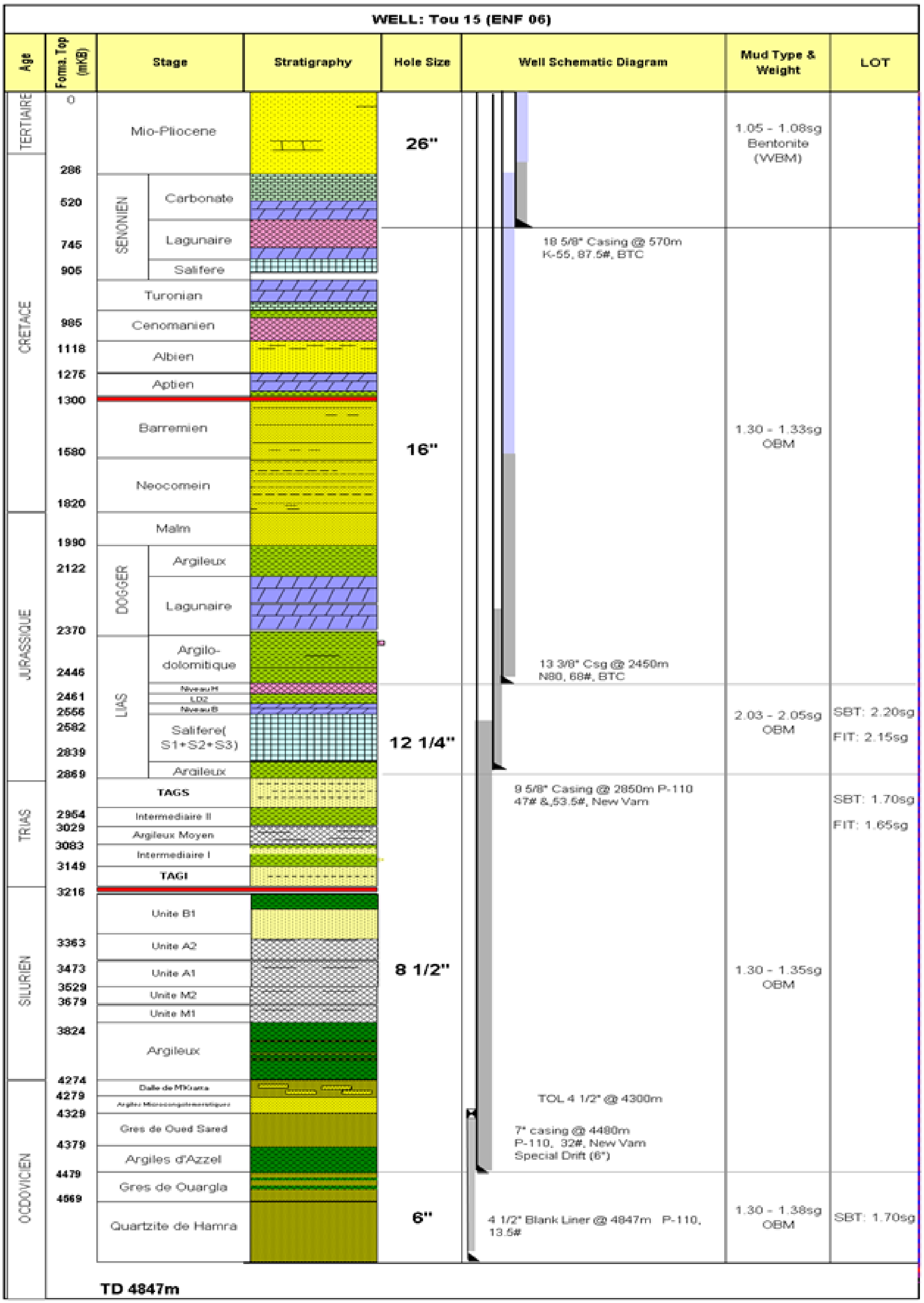


Figure I.2: Expected Lithological Column of TOU15

I.4.3 Reservoir information

The reservoir information shown in the Table I.2.

Table I.2: Reservoir pressures to be revised after Rapport of Implantation!

Formation	**Hydrocarbon Type**	**Expected Pressure**			**Expected Temperature**
		psi	**@ TVDSS m**	**EMW w/ ref to RT, sg**	
TAGS	Gas & Condensate	4,065	-2,762	1.04	≤ 104 ºC
TAGI	Gas	4,246	-2,786	1.07	≤ 114 ºC
Silurian	Gas	5,830	-2,762	1.48	≤ 124 ºC
Quartzite Hamra	Gas	7,987	-4,065	1.38	≤ 124 ºC

Notes:

1. TAGS; the initial pressure recorded is 334.53kg/cm^2 @ -2762m TVDss. The pressure recorded in 2010 on the nearest well TOU-9 is rated at 276.66kg/cm^2 @ -2367m TVDss and 285.82kg/cm^2 @ -2762m TVDss.

2. TAGI; the initial pressure is 376.44kg/cm^2 @ -3089m TVDss. Pressure recorded in 2009 on the nearest well and TOU-10-12 is as 4246psi @ -2786m TVDss.

3. Silurian; the pressure recorded in 2009 when testing of the well TOU-13 is 388.92 kg/cm^2 at -2642.2m TVDss or 409.9kg/cm^2 at –2762m TVDss.

4. Quartzite Hamra; the pressure recorded in 2010 during the DST of the Hamra Quartzite Well TOUP1 is 561.57kg/cm^2 at -4065m TVDss.

5. Gas/Water contact to wells TOU4 TOU5 @ the 2762m TVDss RFT.

I.4.4 Well schematic

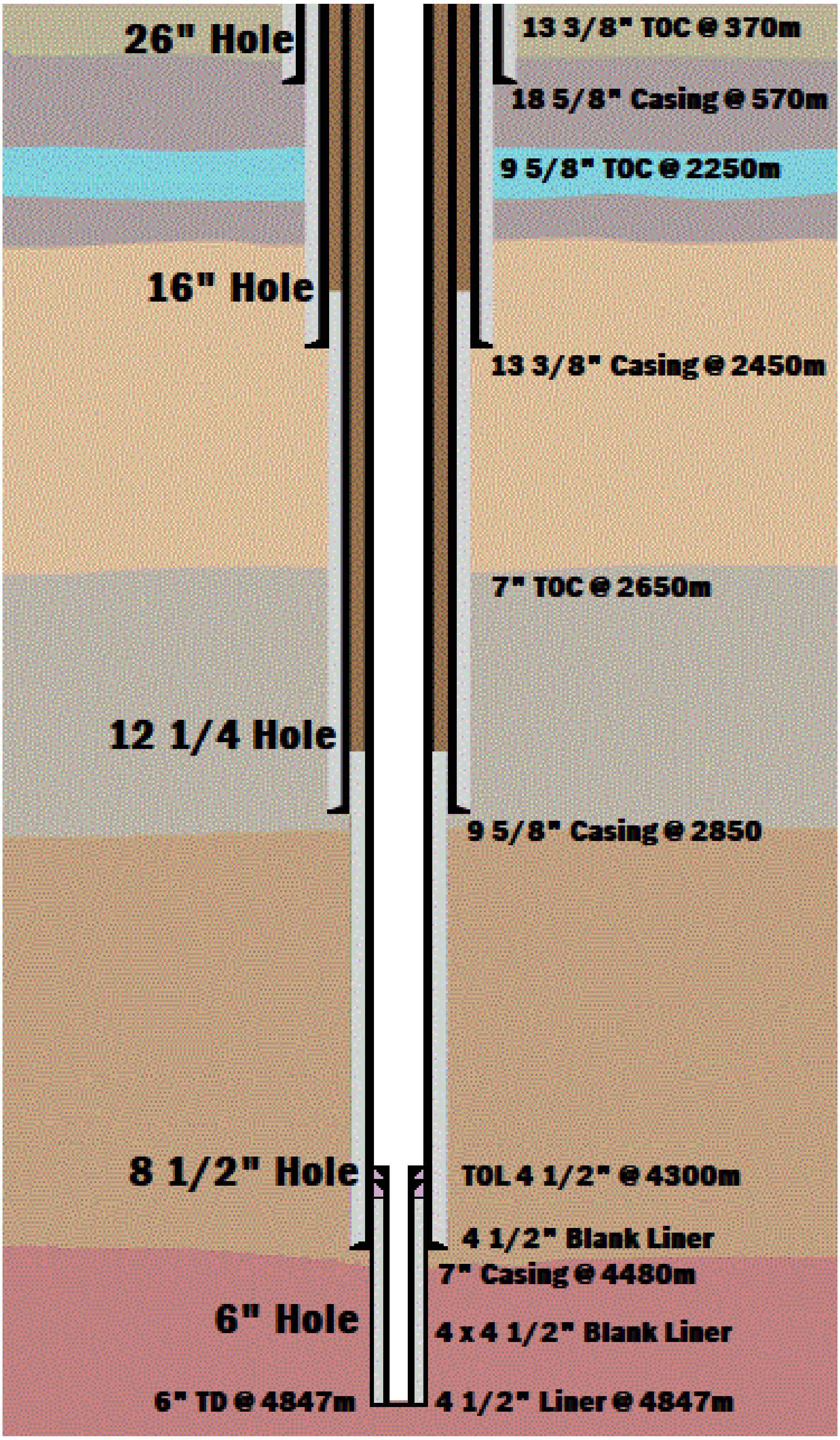


Figure I.3: TOU-15 Well Schematic

Chapter II

Drilling Program & Procedure

II.1 QHSE

Quality, Health, Safety and Environment (QHSE) is the first consideration of any drilling program. Drilling operations are full of risks and hazards. It cannot be performed smoothly without awareness of HSE, The subject program suffices the development of operational safety consciousness in participating audience and make the audience aware of the drill site audits & statutory compliance. [5]

Safety shall be the overriding factor in matters relating to drilling operations especially where onsite decisions are taken on operational activities.

II.1.1 QHSE Objective

The objective is to comply with the safety and environmental standards of Sonatrach and to achieve the following objectives:

- Safety is always the #1 objective for all rig-site operational activities.
- No LTI's.
- Complete all operations in accordance to Sonatrach standard HSE guidelines so as to have no accidents and no adverse environmental impact.
- No serious, major or catastrophic service quality incidents.
- Daily QHSE events reporting.
- Project QHSE forward plan to cover all the QHSE issues and Remedial Work Plan (RWP) to improve the QHSE level.
- PTW, Permit to Work System for non routine activities.
- Ensure Job Safety Analysis (JSA) or pre job safety operational meetings will be held with all personnel involved in the next operation in order to clearly identify safety risks and precautions.
- Clearly address the importance of stepping, handling and lifting.
- Perform and record a weekly STOP tour with all leaders of the companies on locations.
- The STOP cards will be used as the risk reporting tool.
- HARC (Hazard Analysis and Risk Control) for any operation on the rig site where it is not clear how the risk will be mitigated.

• Muster areas should be clearly identified in the location and communicated to all personnel.

• Before leaving the location, install an identification sign on the wellhead and to the location entrance. Make sure the location is properly cleaned as per Sonatrach procedure.

Drills should be made as per the following recommendations (operations permitting):

• Kick drill – weekly, or more frequent as decided by WSS. The kick will be recorded on daily operation report.

• Pit drill – weekly, or more frequent as decided by WSS.

• Trip drills – on trips, or more frequent as decided by WSS.

• BOP test – Will be performed as per Sonatrach BOP Testing Standard Procedures. Must be reported along with the duration in the daily drilling report.

• Fire Drill – monthly.

II.1.2 Environmental

• Daily cleaning of location and living camp.

• Proper disposal of any waste.

• Segregation of the waste (Plastic, Metallic...).

• At the end of the wells, the disposal areas have to be properly closed.

• Ensure human waste pits are built as per standards and cleaned/closed after completion of the well.

• Do not put wastes in the cellar.

• No environmental spills and minimum environmental impact.

II.1.3 People and Material

• Any safety area has to be properly signed and indicated.

• Clean the drill floor as many times as required.

• All personnel entering the location must have all required PPE.

• Hold daily safety and tool box meetings prior to special operations.

• Verify personnel certifications and perform periodic inspections of equipment and products.

• Rig induction has to be done for all new arrival and rig visitors.

II.1.4 Communication

• Daily Operational Meetings must be carried out with all companies involved.

• Pre-job safety meetings including highlighting all involved risks and Prevention/ mitigation measures are mandatory.

• WSS is responsible to deliver driller instructions, review the same with Drilling superintend and it has to be communicated to all involved parties. The responsible parties have to be clearly highlighted.

• Constant communication between Office and Rig site must be maintained.

• All the daily reports must be sent to the office on time: Daily drilling, QHSE, Mud and all operation reports @ 06:30 and the Situation Report @ 14:00. DIMS report has to be correctly.

II.1.5 Service Companies

In the Table II.1 below we see all of the service companies operating in the Well TOU-15.

Table II.1: Service Companies

Service	**Service Providers**
Drilling Contractor	Enafor
Drilling Fluid Serive	MI
Mud Logging	CRD
Solid Control	MI
Coring	TBA
Logging	TBA
Casing / Tubing Running	Weatherford
Liner Equipment	BOT 4 1/2" Liner
Liner Equipment	TBA
Cementing service	BJ
Motor	n/a
MWD & GR	n/a
Turbine	TBA
Fishing Services	Weatherford
Waste Management	Sea Harvest

II.2 Basis Of Design

A Basis of Design document for the drilling site in one referable statement describes the objective, principles, philosophies, risks, permitting and HSE plans for the construction and operation of the drilling site before, during and after the drilling operation has taken place [8], it contains :

- The drilled depth of every section.
- Cemented length of every section.
- The formation data of every section.
- Rop.

These instruction made the operation easier and faster, and to make it more understandable let's apply it on our case study :

• To avoid Wellbore Stability problems in the top hole, a 42" Construction Pipe will be set prior to rig move at ± 8 m. Drilling will be started with 26" section and drilled to 570m, 50m into the Senonien Lagunaire (Anhydrite at 520m). Mud weight must be closely watched and kept below 1.08sg. Drilling parameters must be controlled to make sure that the annulus is not overloaded (ROP: 10 to 12 m/hr). 18 5/8" casings will be cemented to surface.

• A 16" section will be drilled ± 4m inside the Lias Niveux H formation, section TD 2,450m. 1.3sg is required to drill the Albian to prevent possible fresh water influx & mechanically sustain wellbore from encroaching & tightening (salt zones). ECD should be kept below 1.32sg in order to avoid losses in the weak zone below the Albian. 13 3/8" casings will be cemented 200m into the 18 5/8" casing.

• A 12 1/4" section will be ended inside the Lias Argiluex by ±11m, section TD 2,850m. Casing setting depth is essential. Triassic formation must not be penetrated in this section. In such a case, severe losses might occur due to high mud weight and this may result in a kick. Maximum 20m will be drilled from top of Lias Argiluex. 9 5/8" casing will cover the entire Lias section and will be cemented to 200m inside the 13 3/8" casing.

• Primary targets (TAGI/TAGS/Silurian) of the well will be drilled in 8 1/2" section and cased off with 7" casing to surface. The 8 1/2" phase will be ended ± 1m inside Gres De Ouargla. The 7" casing will be set at ±4,480m.

• Secondary target of the well is Quartzite Hamra potentially over pressurized sandstone bearing layer. This section will be around 278m below 7" shoe. This 6" section will be covered with 4 1/2" liner depending on feasibility of reserves in Quartzite Hamra. 4 1/2" will be cemented to TOL at 4,300m, 180m overlap.

II.3 Casing Objective

Giving the goal of every casing section , the objectives are usually came in the drilling program to make the whole process clear See Table II.2, the important informations are :

- The section.
- outside diameter (OD).
- Specs.

- The objectives.
- The section depth.

Table II.2: Casing objective

Hole Size in	Casing	OD in	Specs	Objective	MD m
26"	Surface	18 5/8	K-55 87.5#, BTC	50m below the top of the Senonian Lagunaire to cover upper formations	570m
16"	Intermediate	13 3/8		4m below the top of the Lias-Niveux H formation (Before entering the salt formation)	2,450m
12 1/4"	Intermediate	9 5/8	P-110, 47# N. Vam 0-+-1500m	Set 11m inside the Lias Argiluex	2,850m
			P-110, 53.5# N. Vam 1500m-TD		
8 1/2"	Casing	7	P-110, 32# N. Vam	Cover the Triassic & TAGS /TAGI and Silurian reservoirs	4,480m
6"	Production Liner	4 1/2 Blank	P-110, 13.5# N. Vam	180m overlap inside 7" liner @ 4,300m	4,847m
		4 1/2 Perforat	TBA		

II.4 Cement Tops

As a general rule surface casings are cemented to surface (or seabed in an offshore operation), intermediate and production casings to 200 m inside the previous string, and liners up to the hanger. For long casing strings, this criteria would lead to excessive cement usage and hydrostatic pressures exceeding formation strength. In these cases, a compromise has to be found, often in the form of placing the cement top 200 m above the highest fluid or gas-bearing interval.[2].

The cement place usually written in a section in the program named top of cement (toc), with the type of the proprieties of cement (type + density) and the section, and the length of the cement, and the depth that should be cement.

Table II.3: Cement tops

Casing in	Top of Tail m	Top of Lead m		Slurry Type	TOC
18 5/8	470	Surface	Lead	Bentonite 1.58sg	If no cement comes to surface Top Job is required.
			Tail	Class G - 1.90sg	100m above the 18 5/8" casing shoe
13 3/8	1,480	370	Lead	LiteCRETE1.34sg	200m inside the 18 5/8" casing
			Tail	Class G – 1.90sg	100m above the top of Neocomian
9 5/8	2,850		Single	Class G – 2.10sg	Single slurry Top of cement 200m above previous 13 3/8" Casing String
7	2,650		Single	ISOBLOK Slurry Silica w/Gas BLOK - 1.90sg	Top @ 2,650m, Single Slurry 200m above 9 5/8" shoe
4 1/2	4,847		Single	GASBLOK Slurry Silica GasBLOK 1.90sg	Single Slurry Top is 50m above 4 1/2" TOL at 4,300m

II.5 Planned Time Versus Depth Curve

Estimate times and costs to prepare an authorization for expenditure (AFE) and time/depth curve. (Note: a more accurate estimate can be made after finishing the drilling program but timescales usually dictate that an AFE is done sooner. [11]

It is an essential component of a drilling program and provides a roadmap for the drilling team to follow during the drilling operation.

In the Figure II.1 below we can see the Curve time vs depth plan of the well TOU-15. additionally, The table II.4 Well TOU-15 Planned Days.

Figure II.1: TOU-15 Time vs Depth Plan

Table II.4: Well planned days

Well Planned Days			
Phases	Days	Cum. Days	Depth
Move	15.00	0	0
Drill 26"	5.50	5.50	570
Interphase	3.50	9.00	570
Drill 16"	6.75	15.75	2450
Interphase	6.50	22.25	2450
Drill 12 1/4" Vertical	2.50	24.75	2850
Interphase	5.25	30.00	2850
Drill/CORE 8 1/2"	31.00	61.00	4480
Interphase	8.00	69.00	4480
Drill/CORE 6"	16.00	85.00	4847
Completion	40.00	125.00	4847
Total Without Moving	125.00		
Total With Moving	140.00		

II.6 Survey Requirements, Drilling Target

In a drilling program, survey requirements refer to the information needed about the wellbore position and direction, including inclination, azimuth, and depth, at various points during the drilling process. This information is crucial for ensuring that the wellbore is drilled accurately and reaches the desired target zone.

Drilling target, on the other hand, refers to the specific location in the subsurface where the wellbore is intended to reach.In this case the the survey and the drilling target came up like this :

Directional Objective: TOU-15 is vertical development well.

The Target Tolerance at the top of the reservoir "Quartzite Hamra" is 100m radius circle with the well surface coordinates being at the center.

No Totco is required if MWD is in the BHA.

If there are deviation problems in 8 1/2" and above sections, a pendulum BHA may be run to drop the inclination. But in 8 1/2" and 6" sections a pendulum BHA is not effective to drop the inclination as the pendulum force is very small. Since there is a known deviation problem in TOUAL field in general.

Deviation Discussion:

There is no tendency for deviation in TOUAL field in general.

In the offset wells, deviation tendency is not appear; however when drilling in TAGI and below in Silurian the deviation tendency is checked on most of the wells with the rotary BHA.

II.7 Pre-spud Operational Checklist

Is a list of tasks and checks that need to be done before starting a drilling operation. It covers various aspects of the rig, such as diesel, water, drill floor, derrick, mud tanks, mud pumps, [3] etc. It is used to ensure safety and efficiency of the drilling process.

1. Check rig water supply; a rate of $24m^3/hr$ is sufficient providing that the rig has a provision of minimum $140m^3$ of water. In case this is not achievable, plan for water trucks (recommended minimum 5 trucks of 10 m^3) in a continuous supply or additional water tanks. Check salinities of water samples from water well & trucks.

Well will not spud unless enough water is available.

2. Service holes (mouse hole) should be drilled with Bentonitic mud to minimize the risk of washing out the surface sand.
3. Prepare a minimum of $350m^3$ (preferably $450m^3$) Bentonitic spud mud as described in drilling fluids section.
4. N/U 42" riser, bell nipple and flow lines. Secure 42" conductor by tying it to the structure with wire rope.
5. Install drain plug(s) at the base of 42" conductor. The plug will also be used to flash the conductor after the cement job with stinger.
6. Check that the required materials for drilling fluids (including LCM material) and cement for surface section are complete.
7. Ensure that 18 5/8" stab-in shoe is available and inspected. It is going to be made up at the rig-site.
8. Confirm the alignment of the derrick, rotary table over the conductor.
9. Measure wellhead, cellar and RT heights to GL. Record this on the IADC and Daily Drilling Report.
10. Confirm that the flow line is properly spaced out.
11. Install and test cellar pumps and lines leading to cutting pit.
12. Install 6 1/2" liners in mud pumps. Check if mud pumps safety relief valves have been tested and set to proper pressure.
13. Perform mud pump efficiency tests and record in the Daily Drilling Report.
14. Make sure that the proper sizing shale shakers screens are installed and there is sufficient stock at rig site.
15. Make sure that the drill string components have been inspected, cleaned and calibrated as per Sonatrach policies.
16. Inspect Stabilizers. Preferred stabilizers are spiral integral blade with 3 or 4 blades. maximum wear for stabilizers should be limited to 1/16".
17. Make sure the stinger is on site, "O" rings are in good condition, and spare parts are available on site.
18. Cementing unit to be on location in case of potential losses in the surface hole. Lab test results should be available.
19. Neither the Kelly nor the Kelly Rat Hole will be installed. Entire Kelly system will remain well protected, in the ground on location, in case it is required as an emergency.
20. P/U 5 stands of 5" HWDP and maximum number of 5" DP stands ($\pm$100 stands) and setback on the derrick prior to Spud in (note: to have room in derrick in case of run 30" conductor).
21. Review 26" hole section well program before the spud.

Hole Sections

II.8 Harmonization

The goal of harmonization is to select the drilling diameters and casing string sizes to be lowered into the well.

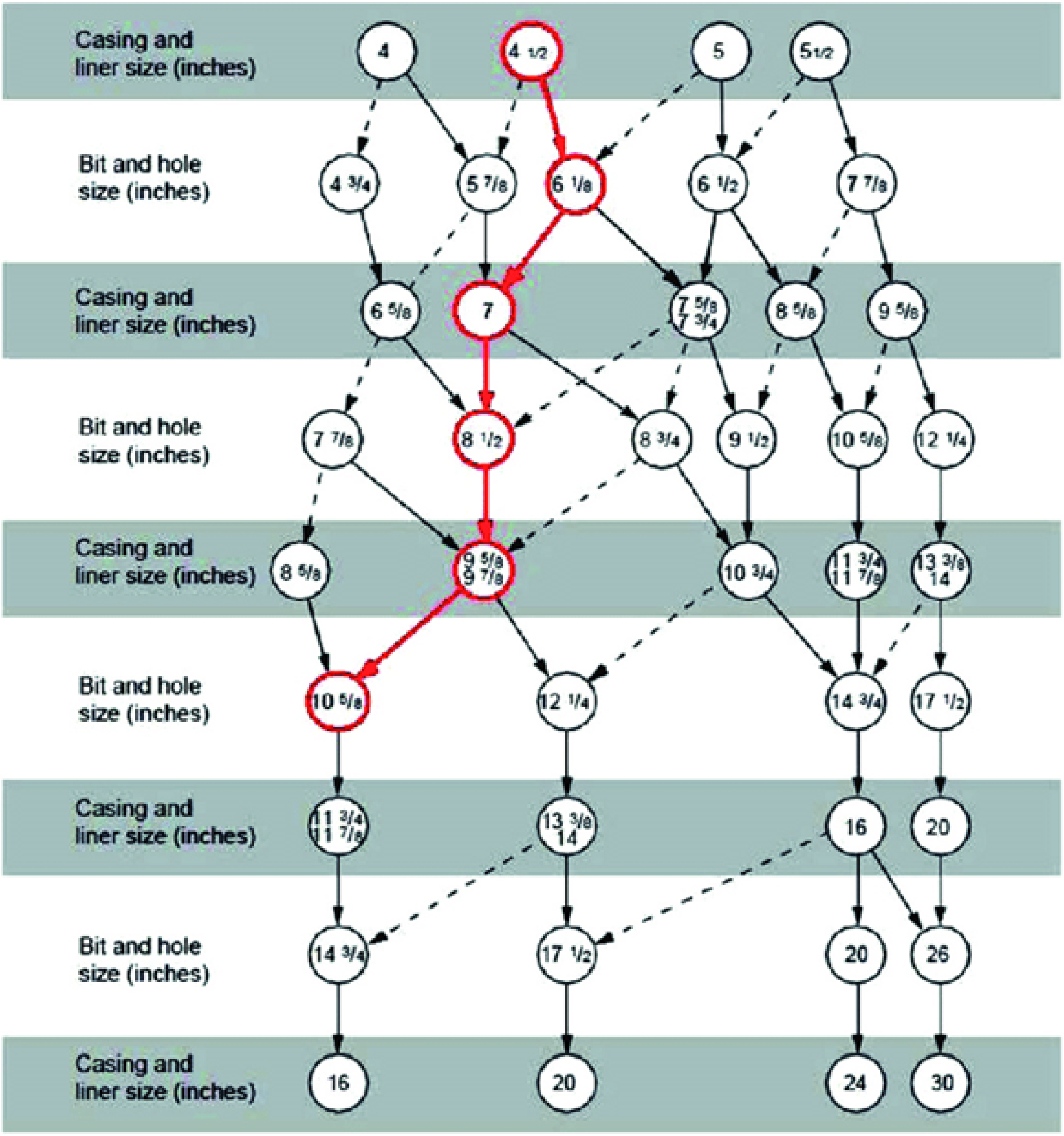


Figure II.2: Usual dimensions of bits by considering the casings to be lowered

The diameters of the bit and casing for the various phases are determined by the diameter of the last column to be lowered (production tubing); then we decide the diameter of the hole to drill for each phase in such a way that the casing falls freely while sticking to API requirements.

II.8.1 The harmonization program

Effects by:
A- Last phase :
Calculate the bit diameter (Do) that will drill this phase:
Do= Dm+2
Do : bit diameter
Dm : the casing sleeve diameter
B- Previous Phase :
Calculate the inside diameter of the column (Dint):
Dint= Do+2

II.9 Casing Setting Depth

The selection of casing string and setting depth is based on formation pore pressure and fracture gradient of the well.

For the casing setting depth determination, pore pressure and fracture gradient are normally described in PPG.

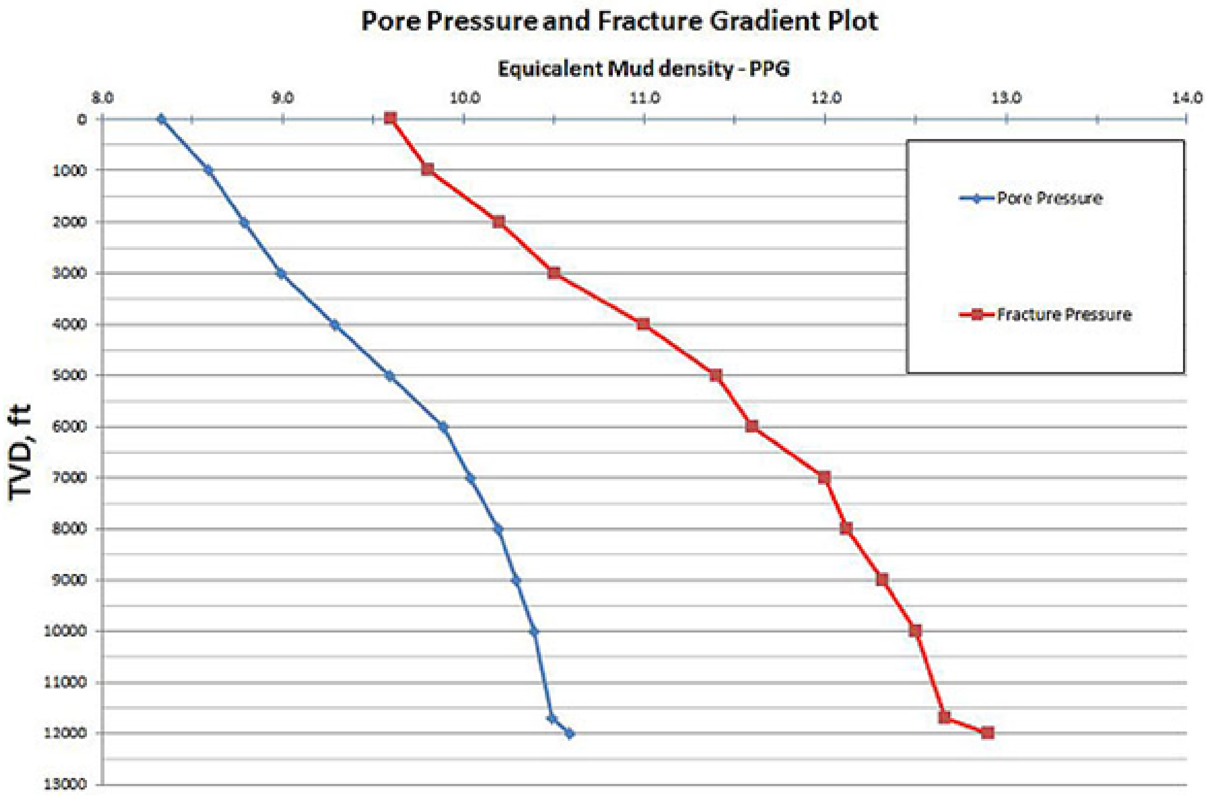


Figure II.3: Pore Pressure and Fracture Gradient PLOT

The solid lines in the chart are not accounted for safety factor; therefore, for the first step of casing seat design, safety margin must be applied,ou need to add the safety factor into formation pressure and subtract it from the fracture gradient. What's more, the safety factor value may depends on where you work and how much confident in your data.

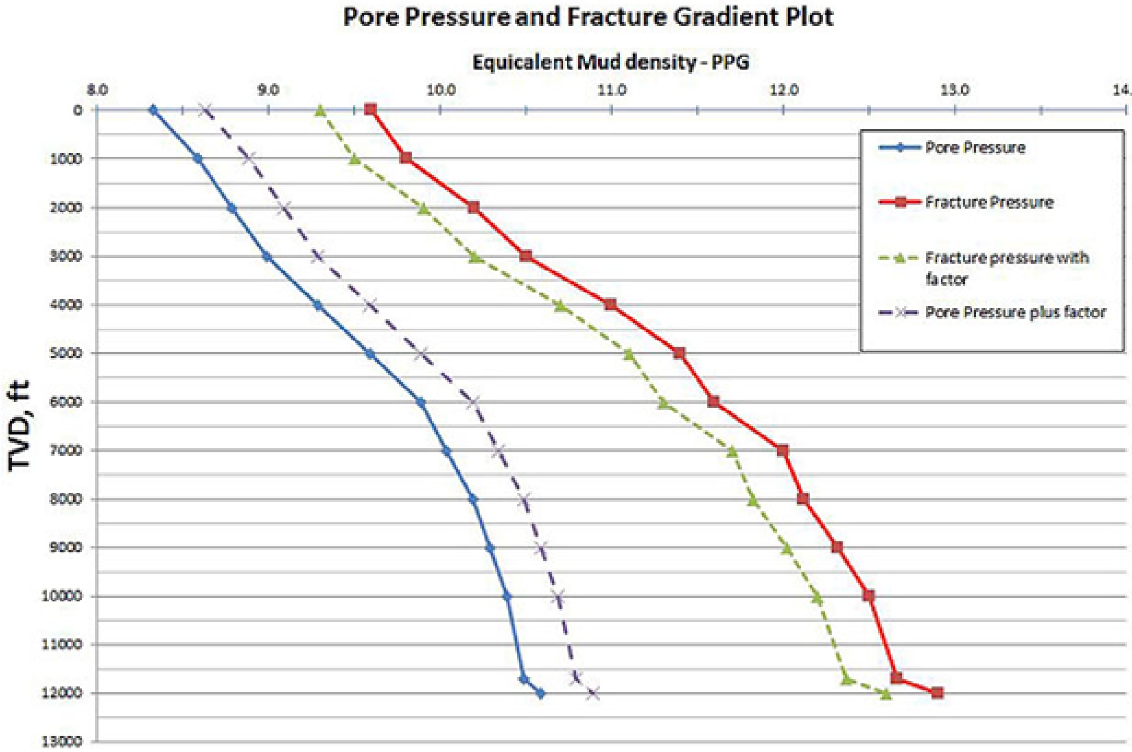


Figure II.4: Pore Pressure and Fracture Gradient PLOT with safety factor

determine casing setting depths using bottom-up method.

This design will start from the bottom of the well up to the surface and the setting depths are designed within the safety factor limits (dotted lines).

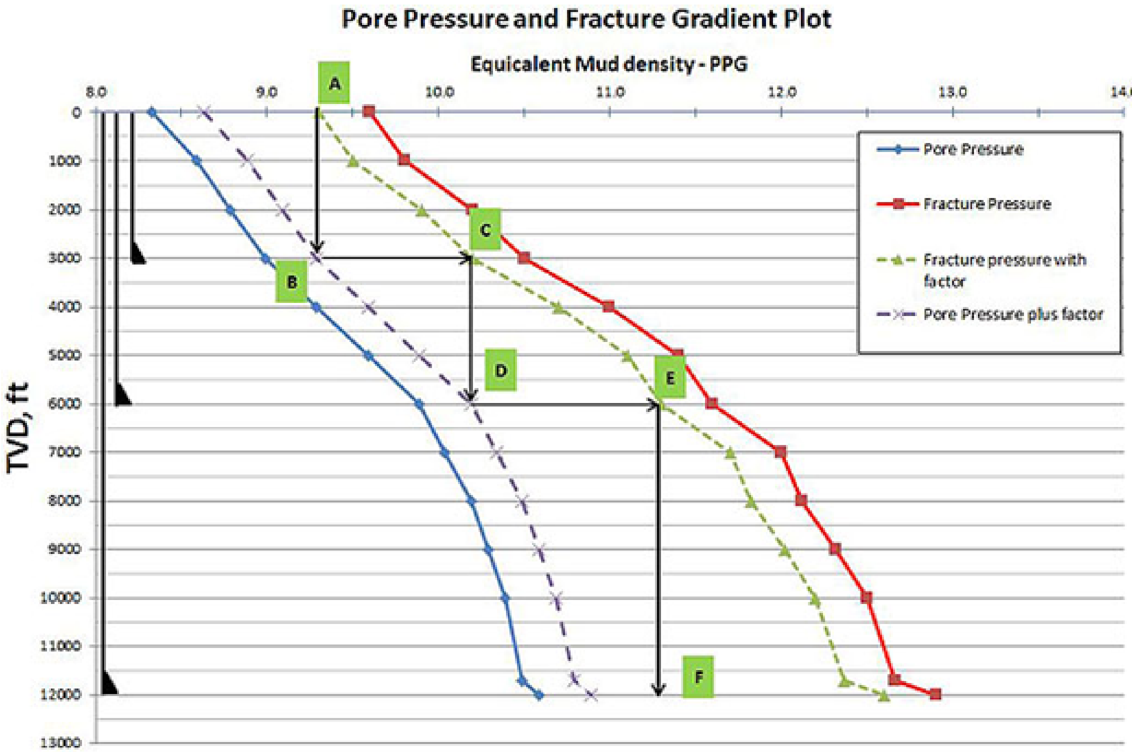


Figure II.5: Pore Pressure and Fracture Gradient PLOT Setting Depth

II.10 26" Hole Section

The hole section contains basic information about the depth from which we start drilling to the depth at which we stop drilling, the specified duration of the operation, and what formation the section contains.

To understand more, See the Table II.5 of the 26" hole section's information.

Table II.5: 26" Hole Information

From	Surface
To	570m
Time Planned	9.00 days
Formation	Mio-Pliocène, Sénonien Carbonate, 50m of Sénonien Lagunaire

II.10.1 26" Section Objectives and Hazards

Objectives:

- Drill the section to $\pm 570m$ (50m into Anhydrite Senonien formation) and set 18 5/8" casing in a competent formation. The section will be drilled in a single bit run TCI.
- Achieve cement returns to surface for a proper mechanical integrity.
- Case off any unconsolidated formation or thief zones.
- Sufficient casing integrity to install the BOP.
- Obtain good cement bond to surface behind 18 5/8" casing.
- Avoid contamination of the surface waters.

Hazards:

The hazards are potential risks that need to be identified and addressed to ensure the safety of personnel and equipment. Like Well control issues and blowouts.. Etc.

See Table II.6 for the 26" hole section's hazards.

Table II.6: Hazards

Problem Experienced Expected	Proposed Solution
Partial or total losses in Mio-Pliocene and the Senonien carbonate	-Control mud parameters to ensure that the annulus is not overloaded by continuously dumping of old mud and addition of new (@ 1m3 to 2m3 per every meter drilled) -If mud preparation or dilution is an issue, then control ROP to avoid overloading the annulus.(ROP $<$ 12m/hr). -Ensure good hole cleaning, pump hi-vis-pills, extend circulation times at connection (10 min) when the ROP is high (10 – 15m/hr). -Always keep MW out below 1.08 SG.
Water supply not sufficient.	-Make sure the water supply is sufficient.
In TOU-10ST, 524m away, after having total loss in 26" section, the hole collapsed and string got stuck, resulting in a sidetrack.	-To avoid this problem, unconsolidated sands at the surface will be cased off with 30" conductor. -Ensure good hole cleaning, pump hi-vis pills. -Always keep MW out below 1.08 SG. -Treat with LCM if losses initiated.
Hole washouts.	-Avoid high flow rate. -Keep mud rheology high to ensure good hole cleaning. -Pump HV LCM pills Note: Use recommended parameters as given in the program.
Fill on bottom prior to running casing	-Spot hi-vis pill on bottom prior to POOH.
Severe bit bouncing, especially in Mio-Pliocene and low ROP	-Shock sub is added to BHA, more WOB and optimum RPM.
Hole packing off while drilling across loose Miocene Pliocene surface sands	-While drilling check if sand settling down on hole bottom prior to pipe connection. P/U slowly one joint. Run to bottom & check for hole fill.Fill on bottom is first indication of surface sands becoming unstable. -If it is not possible to control stability of loose surface sands, stop drilling,POOH, and consult office to run 30” conductor pipe. -Fill up well backside in case observing losses. Hole may pack of if there is no mud to support loose surface sands. Stop drilling, POOH, and consult office to run 30” conductor pipe.
Tight spots while POOH at Senonien Lagunaire, Senonien Carbonate, Eocene formations	-If there is any overpull observed at connections, make sure the interval is worked out before making connection. Free without pumping out, max 5T overpull.
Bit Balling	-Ensure adequate flow rate in clays. -Pump special pill as per Mud Company’s recommendation.
Unable to bring the cement to surface.	-Perform top job.
Total or partial losses while cementing / Casing collapse while cementing	-Use lead-tail slurry to decrease cement hydrostatic and ECD. -Keep pump rate as low as possible to reduce ECD. -Be prepared for top job.
Cement channeling to surface	-Condition hole and circulate with high flow rate prior to cement job. -The minimum volume of lead & tail to be pumped even if the spacer reaches to surface.
Casing lift while cementing	-Casing to be landed and chained down – not likely.

II.10.2 26" BHA

It's the planning and selection of the appropriate tools and components that make up the BHA based on the specific drilling objectives and well conditions.

The selection of Bottom Hole Assembly (BHA) equipment in a drilling program depends on factors such as formation characteristics, drilling objectives, wellbore conditions, drilling fluid properties, budget constraints, and operational experience. The goal is to choose BHA equipment that optimizes drilling efficiency, minimizes risks, and achieves the desired drilling outcomes.

The BHA of the 26" hole section shown in the table II.7.

Table II.7: 26" BHA

Item	Joints	OD (in)		ID (in)	Connection	
		Blade / TJ	Body		Bottom	Top
26" Tri-Cone Bit (TCI)	1	26		3 ¾		7-5/8 Reg P
Bit Sub (Totco)	1		9 ½	3	7-5/8 Reg B	7-5/8 Reg B
Shock Sub	1		9 ½	3	7-5/8 Reg P	7-5/8 Reg B
Drill Collar	2		9 ½	3	"	"
String Stabilizer	1	25-5/8	9 ½	3	"	"
Drill Collar	1		9 ½	3	"	"
XO	1		9 ½	2-13/16	7-5/8 Reg P	6-5/8 Reg B
Drill Collar	9		8	2-13/16	6-5/8 Reg P	6-5/8 Reg B
XO	1		8	2-13/16	6-5/8 Reg P	4 ½ IF B
HWDP	15	6 1/2	5	3.250	4 1/2" IF P	4 ½ IF B
Drill Pipe	Surface	6 1/2	5	4.276	"	"

II.10.3 26" BIT

The choice of the bit for drilling a well depends on several factors, including the type of formation being drilled, the drilling objectives, and the drilling equipment being used. Here are some key considerations:

Formation type: The composition and characteristics of the formation being drilled play a crucial role in bit selection. Different formations have varying hardness, abrasiveness, and fracture characteristics, which influence the choice of bit type and design. Common formation types include soft formations (such as clays and shales) and hard formations (such as limestone and granite).

Drilling objectives: The drilling objectives can vary depending on whether the well is being drilled for exploration, development, or production purposes. For example, an exploration well may prioritize drilling at a high rate of penetration to quickly gather information about the subsurface geology, while a development well may focus on drilling efficiently to reach target depths and maximize production potential.

Drilling method: The drilling method employed, such as rotary drilling or percussion drilling, affects the selection of the bit. Rotary drilling typically utilizes roller cone bits or fixed cutter bits (such as polycrystalline diamond compact or PDC bits), while percussion drilling may use a tricone bit or a down-the-hole hammer.

Wellbore conditions: Factors such as the diameter and inclination of the wellbore, the presence of deviation or doglegs, and any specific drilling challenges (e.g., lost circulation zones, wellbore stability issues) need to be considered when choosing a bit. Some bits are better suited for maintaining hole straightness, while others excel in more challenging conditions.

Drilling equipment: The capabilities and limitations of the drilling rig and associated equipment can impact bit selection. Factors such as the power of the rig, the rotational speed, and the weight on bit (WOB) capacity influence the compatibility of certain bit designs.

Cost considerations: Bit selection also involves cost considerations, including the cost per foot drilled and the overall economics of the drilling operation. While more advanced and specialized bits may offer improved performance, they may also come at a higher cost. The drilling team must balance performance requirements with budgetary constraints.

Drilling engineers and well planners typically evaluate these factors and conduct drilling optimization studies to determine the most suitable bit for a given drilling project. It's important to note that bit selection is not a one-size-fits-all approach and requires careful analysis based on the specific well conditions and objectives.

See Table II.8 for the informations of the 26" hole section's bit.

Table II.8: 26" BIT [10]

Bit		26" V515J new	
Manufacturer		Varel	
IADC		5-1-5	
BHA type		Rotary – Semi-Packed	
Interval	m	0 – 570	
Lithology		Sand, Dolomite limestone, Anhydrite, Claystone	
Flow rate	lpm	up to 3,500	
Nozzles	1/32 in	3 x 18 + 1 x 16 (Center Jet)	
TFA	sq in	0.942	
HSI	hp/in^2	0.3	
Pump pressure	psi	~1100 psi (with 3000 LPM @ TD)	
WOB	Tone	5 – 25	
RPM		80 – 110	
Expected ROP	m/hr	between 5 - 12 m/hr	

II.10.4 26" Section mud overview

The mud overview provides important information about the properties, composition, and management of the drilling mud, also known as drilling fluid.

Here are some key aspects typically included in the mud overview of a drilling program (Mud type, Mud weight, PH, ...).

The table II.9 shows the mud overview of the 26" hole section.

Table II.9: 26" Section Mud Overview

Parameters	Description
Mud System	Spud Mud PHB
Mud Weight (SG)	1.05 to 1.08
FV (Sec/qt)	60 – 80
PV (CPs)	ALAP
YP (lb/100 ft^2)	50
Gel 10sec (lb/100 ft^2)	20
Gel 10min (lb/100 ft^2)	30 – 40
API FL (cc/30 min)	No control ± 20cc before running 18 5/8"casing
LGS (% by volume)	< 5
PH	11 - 12
MBT (kg/m^3)	80 - 110

II.10.5 26" Section operations sequence

1. Hold safety meeting.
2. M/U 26" Bit and commence drilling.
3. Drill to 26" section TD @ ± 570m, which is ± 50m inside the Senonien Lagunaire.

• Recommended parameters for the drilling is as follows,

•• Drill with low parameters up to 120m until all DC in open hole (3-6 tones, 1,500-1,600 lpm, 60-80 RPM).

•• Drill 26" hole to ± 300m (14m inside Senonien Carbonate). 2,000 – 2,500lpm is recommended to allow forming a sufficient wall cake. ROP must be controlled to ensure proper hole cleaning with this Flow-rate.

•• Increase Flow-rate up to 3,000 – 3,500lpm. Continue drilling to section TD @ ± 570m (± 50m inside Senonien Lagunaire) with increased parameters. Control mud parameters to ensure that the annulus is not overloaded by continuously dumping of old mud and addition of new (@ 1m^3 to 2m^3 per every meter drilled) and diluting the mud system as often as required. If mud preparation or dilution is issues then control ROP to avoid overloading the annulus. (ROP $<$ 12m/hr). Adjust the section TD depth based on casing tally.

• Expect low ROP and high, torque while drilling the Senonien Lagunaire Anhydrite formation ($<$2m/hr).

• Optimize drilling parameters accordingly.

• In case of losses, pump LCM pills of 25m^3 as per mud company's recommendations. If a loss is more than 25m^3/hr, proceed with remedial cement job as described below:

a. RIH with 5" Drill Pipe to loss zone depth with XO and a mule shoe.
b. Pump 30m^3 of LCM at 950lpm and displace pipe volume at 200lpm.
c. POOH approximately 15m above loss zone.
d. Pump 30m^3 of 1.58sg cement at 700lpm and displace with water.

e. POOH filling up annular.

f. Wait on cement (as per cement lab test thickening time and samples).

g. M/U 26" drilling BHA without stabilizers & drill out cement. If no losses, POOH and run BHA with stabilizers and continue drilling.

4. At TD, pump hi-vis-pill and circulate hole clean.

5. Drop Totco. POOH, work out any tight spots **(if no tight spot while POOH run casing directly)**.

6. POOH to surface, L/D 26" STAB.

Note: Report times separately for POOH, reaming and/or back reaming on the Daily Drilling Report.

7. R/U Casing running equipment.

8. P/U 18 5/8" joint with shoe carefully, Baker Lock the connection. Check and verify that the floating equipment is functioning properly.

9. RIH 18 5/8" Casings. Fill up each casing joint with mud .Monitor well for possible losses.

10. L/D casing running equipment.

11. RIH 5" stinger on 5" drifted pipes by using “C” plate & double elevator.

• Stab-in stinger into stab in shoe, break circulation and test the seals.

• Chain down 18 5/8" casing & 5" DP (there is a risk of casing lift during cementation).

• Circulate at least two annular volumes; verify there are no returns from Casing-DP annulus.

12. Perform pre-job safety meeting with all the personnel involved in the operation. Discuss job data, procedures, safety, environment (cementing fluids disposal) and assign responsibilities.

13. Perform the 18 5/8" cement job as per final program (325m, 1.90sg tail and 1.58sg Lead to surface).

Program to be submitted to Well Site Supervisor.

• Due to the **low collapse margin** while cementing (300psi), special care should be taken for pack off, which might cause casing to collapse.

• Displacement to be made by mud, which is used in 26" section. Under-displace 3bbl.

Note: As per the current practices in the area, tail slurry is being pumped after observing the spacer at the surface. It is designed to switch to tail slurry as soon as 30-40% of pumped spacer volume is observed on the surface.

Note: As a contingency, have the Top Plug on the rig site to perform conventional cement job with a Top Plug in case of problems with Stab-in Shoe.

14. Un-sting the sealing nipple.

15. Pump 3bbl mud (or water) to displace the cement from inside the string.

16. R/D Cement Head.

• In the meantime flush the riser & flow line through the plug at the base of 42" conductor.

• Drain mud inside the conductor through the plug(s) to the cellar and pump the same out with cellar jet.

17. POOH DP’s,

Note: Perform top job in case the cement does not reach at surface or the

level at the surface has dropped. Cement for the top job should be pumped through 2 x 2" pipes, from the depth of loss zone to the cellar.

18. Disconnect flow line. Cut 42" conductor and lift the same. **(To be able to rough-cut the 18 5/8" casings, it might be required to open a window on the conductor.)**
19. WOC (if necessary).
20. Rough cut 18 5/8" casing and remove excess part of 18 5/8" casing.
21. L/D 30" Riser x 42" conductor.
22. Final cut 18 5/8" casing.
23. Install 20 3/4" x 3K – 18 5/8" Slip Lock Casing Head Housing (Section A) as per ITAG wellhead installation procedure.
24. Perform flange pressure test to 400 psi (limited by 80% of the collapse rating of 18 5/8" casing).
25. N/U 20 $\frac{3}{4}$" BOP Stack.
26. Install bell nipple and flow line.
27. Test the BOP Stack.
28. Install Wear Bushing (if available).
29. Lay down 26" BHA.
30. P/U 2000m 5" DP's.

II.10.6 26" Section Surveying and Deviation Control

The procedures and techniques employed to accurately measure and control the wellbore trajectory within a specific section or interval of the well; All these are shown in the table II.10 .

Table II.10: 26" Section Surveying and Deviation Control

Survey Method	Tool	Interval
Single Shot	Rig Totco Tool	At TD and prior to any trip out

II.10.7 18 5/8" Casing Program

The number and sizes of the casing in an oil well depend on various factors, including the depth and geology of the well, the reservoir characteristics, and the specific drilling and completion objectives. Here are some of the key considerations:

Well depth: Deeper wells typically require more casing strings due to the higher pressure and temperature conditions encountered at greater depths.

Formation stability: The casing is used to stabilize the wellbore and prevent the collapse of the surrounding formations. The number and sizes of casing strings depend on the stability of the rock formations encountered during drilling.

Reservoir characteristics: The properties of the oil or gas reservoir, such as pressure, fluid type, and formation strength, influence the design of the casing program. Casing is used to isolate different zones within the reservoir and control the flow of fluids.

Pressure and temperature: Casing must be designed to withstand the pressure and temperature conditions encountered in the well. As the pressure and temperature increase with depth, the casing sizes and materials may need to be upgraded to ensure well integrity.

Regulatory requirements: Regulatory bodies often impose certain casing requirements to ensure environmental protection and well safety. These requirements may vary depending on the location and jurisdiction of the well.

Well completion strategy: The specific completion strategy chosen for the well, such as the use of production tubing or additional liners, can impact the casing design. The number and sizes of casing strings may be optimized to accommodate the completion equipment and facilitate efficient production operations.

It's important to note that casing design is a complex process that involves collaboration between drilling engineers, geoscientists, and other industry experts. The specific casing program for an oil well is typically determined through detailed well planning and engineering studies.

For the 26" hole section, the casing program is shown in Table II.11.

Table II.11: 18 5/8" Casing Program

<table>
<tr><th>Desc</th><th>Nr. of Joints</th><th>ID in</th><th>Weight ppf</th><th>Grade</th><th>Conn</th><th>ID in</th><th>Drift in</th><th>Burst pst</th><th>Collaps psi</th></tr>
<tr><td>Casing</td><td>xx</td><td rowspan="2">18.625</td><td rowspan="2">87.5</td><td rowspan="2">K-55</td><td rowspan="2">BTC</td><td rowspan="2">17.755</td><td rowspan="2">17.568</td><td rowspan="2">2.247</td><td rowspan="2">623</td></tr>
<tr><td>Step-in shoe</td><td>1</td></tr>
</table>

Centralization

The primary purpose of centralizers is to prevent casing eccentricity, which occurs when the casing is not centered within the wellbore. Eccentricity can lead to several issues, including poor cementing, uneven wellbore pressure distribution, and potential casing damage. By using centralizers, the casing can be kept in the optimal position, allowing for effective cementing and well integrity.

Table II.12: Centralization

From (m)	To (m)	Spacing	Number. of Centralizer	Type	Number of Stop Collar
0	150	1 C / 2 Jt	7	Bow	7
150	400	1 C / 4 Jt	8	Bow	8
400	570	1 C / 1 Jt	13	Bow	13

II.10.8 18 5/8" Casing Cement Slurry Design

Casing cement slurry design in drilling programs refers to the process of formulating a cement mixture that is pumped into the annular space between the casing and the wellbore during well construction. The purpose of casing cementing is to provide zonal isolation, support the casing, and protect the wellbore from formation fluids.

The design of the casing cement slurry involves determining the appropriate blend of cement, additives, and water to achieve specific properties and performance characteristics. The following factors are considered in the design process:

Wellbore conditions: The depth, temperature, and pressure of the wellbore influence the cement slurry design. Higher temperatures and pressures may require the use of additives to enhance the slurry's stability and set time.

Formation properties: The characteristics of the formations being drilled through, such as permeability and fluid content, impact the slurry design. Certain formations may require specific additives to prevent fluid migration or maintain stability.

Casing specifications: The size and weight of the casing, as well as the desired cement sheath thickness, dictate the volume and density of the cement slurry needed. The slurry must be capable of effectively displacing drilling fluids from the annular space.

Wellbore geometry: The diameter and irregularities of the wellbore affect the fluid displacement efficiency and the required properties of the cement slurry. The slurry design accounts for these factors to ensure complete coverage and bonding of the casing to the wellbore.

Environmental considerations: Depending on the well location and regulatory requirements, environmentally friendly additives may be incorporated into the cement slurry design to minimize the environmental impact of drilling operations.

The casing cement slurry design process typically involves laboratory testing and computer modeling to determine the optimal blend of materials. The properties evaluated include density, rheology (flow characteristics), thickening time, compressive strength, and gas migration resistance.

It's important to note that casing cement slurry design is a specialized field that requires expertise in drilling engineering and cementing practices. It is crucial to adhere to industry standards and best practices to ensure well integrity and operational safety.

Table II.13: 18 5/8" Casing Cement Slurry Design

Parameters	Unit		
Est. BHST	°C	37	
Est. BHCT	°C	31	
Pre-flush		25 m^3 White Spacer	
Slurry		Lead	Tail
Mix Water		Fresh water	Fresh water
Weight	sg	1.58	1.90
Excess	%	50% in Open Hole	35% in Open Hole
Top of Cement	m	Surface	470

II.10.9 Wellhead & BOP after 18 5/8" Casing

In a conventional drilling program, the Blowout Preventer (BOP) and wellhead configuration play crucial roles in maintaining well control and ensuring safe drilling operations. Here's an overview of the conventional BOP and wellhead setup:

Blowout Preventer (BOP):

Annular BOP: The annular BOP is a large, donut-shaped device that surrounds the drill pipe or casing. It can be hydraulically actuated to create a seal around the drill string and close off the wellbore during emergencies or well control situations.

Ram BOP: Ram BOPs consist of pairs of hydraulic-operated rams that can close around the drill pipe, casing, or other tubular components. They provide a positive mechanical barrier to shut off the wellbore and prevent the uncontrolled flow of fluids.

Wellhead:

The wellhead is the assembly of equipment on the surface that provides a secure connection point for the casing strings and other equipment. It is mounted on top of the casing and forms a seal to prevent fluid escape.

Conventional wellheads consist of a casing head, casing spools, and a tubing head. They provide a means for suspending and sealing the casing and tubing strings while allowing access for the BOP and other well control equipment.

The typical configuration of a conventional BOP and wellhead setup involves the following components:

Blowout Preventer Stack: This includes the annular BOP, which is usually placed on top of the wellhead, and multiple ram BOPs stacked above each other. The number and size of ram BOPs can vary based on the well design and operational requirements.

Choke and Kill Manifold: This manifold system is used to control fluid flow and pressure during drilling and well control operations. It consists of valves, chokes, and connections for circulating drilling mud, controlling well pressure, and diverting flow during emergencies.

Riser: A riser is a conduit that connects the wellhead to the drilling rig. It provides a pathway for the drilling mud, drilling fluids, and cuttings to be circulated between the wellbore and the drilling rig.

The specific configuration of the BOP and wellhead setup can vary based on the well design, drilling program, regulatory requirements, and industry standards. It is essential to follow established guidelines and safety protocols to ensure the proper installation, operation, and maintenance of these components throughout the drilling process.

We can observe all this in the Table II.14 below.

Table II.14: Wellhead and BOP Stack

Item	Equipment	Top Connection	Bottom Connection
1	21 ¼" x 2K Annular BOP		Flange – 2K
2	21 ¼" x 2K – 20 ¾" 3K DSA	Studded Flange – 2K	Studded Flange – 3K
3	20 ¾" x 3K Mud Cross Kill line : Manual Valve, HCR and Check Valve Choke line: Manual Valve and HCR	Flange – 3K	Flange – 3K
4	20 ¾" x 3K Spacer	Flange – 3K	Flange – 3K
5	20 ¾" x 3K Spacer	Flange – 3K	Flange – 3K
6	20 ¾" x 3K – 18-5/8" Slip Lock Casing Head Housing	Flange – 3K	18-5/8" Slip Lock

II.10.10 26" Section List of Equipment

The list of equipment for a specific section in a drilling program can vary depending on the specific well design, operational requirements, and drilling objectives. However, here are some common equipment items that may be included : Drill Bit , Bottom Hole Assembly (BHA) , Drill Pipe , Drill Collars, Surface Equipment, Well Control Equipment...

For the 26" hole section the list of the equipement is in the Table II.15.

Table II.15: 26" Section List of Equipment

Item	Description	Quantity	Comments
1	26" Bit Varel V515J equipped with Nozzles (3x18+1x16)	1 ea	New
2	26" Bit Varel (L115J-Varel) w/ Nozzles (3x18+1x16)	1 ea	Backup
3	9 ½" x 25-5/8" String Stabilizers (7-5/8 Reg P-B)	3 ea	1 as backup, check w/ rig cont. before ordering
4	9 ½" Shock Sub (7-5/8 Reg P-B)	2 ea	1 as backup
5	18-5/8" Stab In shoe 87.5 #, K-55, BTC	2 ea	1 as backup
6	18-5/8" Casing Joints 87.5 #, K-55, BTC	± 650m	± 75m as a back up
7	C-Plate for running stinger string	1 ea	
8	Circulating Head for 5 ½" DP (5 ½" FH)	1 ea	
9	Sealing Nipple (Stinger), 5 ½" FH Box	1 ea	w/ spare O-Rings
10	18-5/8" Top Plug	1 ea	Contingency
11	18-5/8" Circulating Swedge	1 ea	
12	5 ½ " x 18-5/8" Centralizer (Balloon) for Stinger	1 ea	
13	18-5/8" Centralizer, Bow Type	25 ea	2 as a back up
14	18-5/8" Stop Collars	25 ea	4 as a back up
15	Casing Dope	2	
16	Baker Lock	2	
17	20 ¾" x 3K CHH and accessories including Wear Bushing for next section	1 set	
18	36" Tri-Cone Bit IADC 1-1-1, open nozzles	1 ea	**Re-run (Contingency)**
19	At least 2 x 100m of 2" pipes to perform top up cmt job. 2" LP x 2" WECO x-over & "Y" to be able to connect cementing line to 2" pipes.	1 set	
20	**42" Pipe – 9m long (Gene civil work)**	1 ea	

II.11 16" Hole Section

For the main information of 16" hole section, See the Table II.16 below.

Table II.16: 16" Hole Information

From	570m
To	2,450m
Time Planned	13.25 days
Formation	Senonien Anhydrite (Lagunaire), Sénonien Salifere, Turonien, Cénomanien, Albien, Aptien, Barrémien, Néocomien, Malm, Dogger Argileux, Dogger Lagunaire, LD1

II.11.1 16" Section Objectives and Hazards

Objectives:

- No Lost Time Injury (LTI) during this phase.
- Drill with 1 PDC bits in one run to section TD @ 2,450m, which is ± 4m below the top of Lias Niveux H.
- Maintain well verticality.
- Maintain good hole condition.
- Run and cement 13 3/8" casing, ensure good zonal isolation for the Albian and Barremien formation, allowing safe drilling of 12 1/4" hole section.
- Raise top of cement to 200m inside 18 5/8" casing.
- Allow a safe drilling of 12 1/4" hole section.
- BJ cement Batch Mixer (2) might be used.

Hazards:

The table II.17 is showing the 16" hole section's hazards.

Table II.17: Hazards

Problem Experienced/ Expected	Proposed Solution
High torque while drilling Turonien, Barremien and Neocomian formations/ Severe stick slipsin Cenomanian	Ensure good hole cleaning, utilize weighted pills. Work tight spots before making connection. Reduce RPM (50 rpm) and flow rate (2,600lpm) until stabilizers pass the intercalated area. Increase the mud weight as hole condition dictates (Consult with office)
Stuck pipe, tight spots and hard back reaming while POOH – Mostly in the Cenomanian, Turonien and Senonien Salifere formations.	Adhere to good drilling practices. Back ream if required, (do it slowly, be patient). Make sure the interval is OK to running casing. Consider performing a short trip if the hole conditions dictates while drilling.
Influx from Albian aquifer (1.18sg to 1.25sg Pore-Pressure)	MW to be kept above 1.25sg Avoid swabbing by controlling the tripping speed. Isolate and/or treat mud in case of any influx.

Losses below Albian (Frac gradient as low as 1.50sg)	Manage ECD to stay below the Frac Gradient. Reduce surge pressures by controlling the tripping and casing running speeds. Treat with LCM pills.
Stuck pipe in Salifere due to swelling salt Back reaming, pumped water pill in Salifere @852m and stuck pipe @1033m while tripping got free by jarring (TOUP1) Reaming and back reaming at severa points.	Increase MW as the hole condition dictates (Consult with office) but consider Frac Gradient of the upper zones. Spot fresh water pill. Increase MW as the hole condition dictates (Consult with office) but consider Frac Gradient of the upper zones.
Casing not reaching TD	Do not reduce mud rheology until 13 3/8" csg get to bottom. Circulate with fill up and circulating tool. Spot weighted Hi-vis-pill on bottom prior to POOH for run csg (0.05sg over drilling MW)
Partial or total losses in cementing	Use lead-tail slurry, (Lead : 1.34sg) Reduce flow rate to manage ECD While RIH casing, break circulation for every 500m and before Albian.

II.11.2 16" BHA

The BHA of the 16" hole section shown in the table II.18.

Table II.18: 16" BHA

Item	Joints	OD (in)		ID (in)	Connection	
		Blade / TJ	Body		Bottom	Top
16" PDC Bit	1	16				7-5/8 Reg P
Near Bit Stab w/Totco ring	1	15-7/8	9 ½	3	7-5/8 Reg B	7-5/8 Reg B
Pony Collar	1		9 ½	3	7-5/8 Reg P	7-5/8 Reg B
String Stabilizer	1	15-7/8	9 ½	3	"	"
Drill Collar	1		9 ½	3	"	"
String Stabilizer	1	15-7/8	9 ½	3	"	"
Drill Collar	2		9 ½	3	"	"
XO	1		9 ½	2.813	7-5/8 Reg P	6-5/8 Reg B
Drill Collar	12		8	2.813	6-5/8 Reg P	6-5/8 Reg B
Jar	1		8	2.500	"	"
Drill Collar	2		8	2.813	"	"
XO	1		8	2.813	6-5/8 Reg P	4 ½ IF B
HWDP	15	6 1/2	5	3.250	4 ½ IF P	4 ½ IF B
Drill Pipe	Surface	6 1/2	5	4.778	"	"

II.11.3 16" BIT

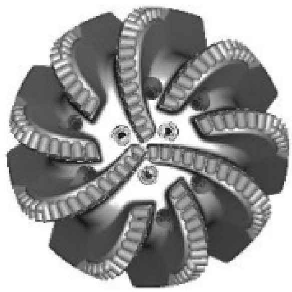
See Table II.19 for the information of the 16" hole section's bit of the upper part and Table II.20 of Lower part.

Table II.19: 16" BIT (Upper Part)[4]

Bit		**16" TFR913S-A2 – Reed New**
IADC		M423
BHA type		Rotary – Packed assy.
Interval	m	570 to +/- 2,450m
Lithology		Sandstone, Claystone, Dolomite, Anhydrite, Limestone and Salt
Flow rate	lpm	3,100
Nozzles	in	9 x 12
TFA	sq-in	0.994
HSI	hp/in^2	1.60
Pump pressure	psi	+/- 2500
WOB	tone	4 – 25
RPM		120 – 140
Expected ROP	m/hr	25 (Overall Average)

Table II.20: 16" BIT (Lower Part – IF NEEDED)

Bit		16" **MSi919LXP – Smith New** RR
IADC		S432
BHA type		Rotary – Packed assy.
Interval	m	----- Remaining
Lithology		Dolomite, Anhydrite, Limestone and Salt
Flow rate	lpm	3,100
Nozzles	in	9 x 12
TFA	sq-in	0.994
HSI	hp/in^2	1.60
Pump pressure	psi	+/- 2500
WOB	tone	4 – 25
RPM		120 – 140
Expected ROP	m/hr	2.0 (Overall Average)



II.11.4 16" Section Mud Overview

The table II.21 shows the mud overview of the 16" hole section.

Table II.21: 16" Section Mud Overview

Parameters	Unit			Parameters	Unit	
Mud System	OBM **Versa-Drill relax**			**HTHP Filtrate @ 200 ºF / 500 psi**	cc/30 min	+/- 10 cc
Mud Weight	sg	**1.30 / 1.33**		**O/W Ratio**	%	70/30- 85/15
FV	sec/qt.	45 – 55		**Electrical Stability**	Volts	> 600
PV	CPs	ALAP (20-25)		**Pm**	ml H_2SO_4 0,1 N	3.0 – 5.0
YP	lb/100 ft^2	18 – 25		**NaCl**	% by Wt	26.0
RPM 6		16 – 18		**Solids**	% by Vol	16 – 18
Gel 10 sec	lb/100 ft^2	10-12		**Sand Content**	% by Vol	< 0.5
Gel 10 min	lb/100 ft^2	16-18		**LGS**	% by Vol	< 5

II.11.5 16" Section Operations sequence

1. Hold pre-job safety meeting.
2. P/U 16" Bit (TFR913S-A2) on BHA and RIH on 5" DP. Wash down to tag cement inside the casing to avoid plugging the bit nozzles.
3. Drill out the cement and shoe with OBM. Displace 1.05sg WBM to 1.30sg OBM while drilling out shoe track.
4. Drill 16" hole to ± 1850m (±30m into Malm).
5. Pump hi-vis pill and circulate hole clean.
6. Perform wiper trip to shoe.
7. Drill the 16" hole section to section TD at ±2,450m (until the identification of Lias Niveux H). Maintaining the verticality and following the mud program. Final TD will be defined by geologist on site. Discuss the casing tally adjustments with geologist. Sharp decrease in ROP is expected on top of the Dogger Lagunaire (from 18m/hr to 8m/hr).LD1 is the formation below Dogger Lagunaire.

If the bit does not drill past the Malm or Dogger Argiluex, then do the following:

- Pump hi-vis pill and circulate hole clean.
- Drop Totco and perform flow check.
- POOH. Flow check at shoe.
- L/D 16" PDC bit.
- P/U another 16" PDC bit and RIH on 5 1/2" DP.
- Continue to drill to section TD as per parameters provided by the bit man.

8. At TD, pump hi-vis-pill and circulate hole clean.
9. Drop Totco and perform flow check.
10. POOH. Flow check at the shoe.

- Expect tight hole problems in Senonien Salifere, Turonien and Cenomanian. Pull the string slowly checking tight spots (overpull and torque). Do not overpull more than

10tons. Call WSS or Toolpusher. In case of tight hole, ream down and pump out with drilling pump rate.

• In case of stuck pipe in Senonien Salifere pump fresh water pill.

• In case of stuck pipe in Turonien it would be recommended to pump acid pills after consulting with the office.

• It is fundamental to be fully aware of the formation tops in order to pump the right pill in the right formation, i.e. acid pill in Turonien and water pill in Salifere.

Notes: Report times separately for POOH, reaming and/or back reaming on the daily report. Also report the Time of string reaching at the previous casing shoe. The 12 1/4" section mud should be prepared while 16" hole is being drilled.

11. Perform WL logging. GR-SONIC-DENESITY-CAL(4arm), Send PDF copies of all logs to the office.
12. Perform a wiper trip to section TD (this trip will be confirmed on time based on logging time).
13. POOH with breakdown 16" BHA.
14. Retrieve wear bushing (If installed).
15. Hold safety meeting with people involved and R/U casing running equipment. Shoe track must have been made up in town.
16. P/U the 13 3/8" shoe track, check the floats.
17. P/U and RIH with 13 3/8" casing, fill every 2joints. Monitor and record P/U and S/O and free-hanging weights. Compare with drag chart sent from the office. Monitor returns volumes.

• Wash down at least the last two joints or as per hole condition dictate.

18. Circulate to condition the hole and mud properties. Monitor well closely for mud losses.
19. R/U cementing head and cementing lines on rig floor.
20. Hold pre job safety meeting.
21. Test lines to 4,000psi. Perform the 13 3/8" cementing job as per the final program.
22. Displace cement with mud using the rig pumps. Slow down pumping rate to $3m^3$ prior to bump the plug. If at any time during pumping cement or displacement, losses are noticed, then reduce the pumping rate to the slowest possible rate as per thickening time of the cement. Discuss this in the pre-job meeting with the cementing supervisor so that the rates are agreed upon based on TT of cement slurry.
23. Switch to cement unit and bump the plug to500 psi over final displacement pressure, then gradually pressure up to 3,000psi to test the 13 3/8" casing for 10 minutes,

• Displace last 2 to $3m^3$ with the water. This is to be able to cut the casing in a safe way later. ($3m^3$ is about 40m inside 13 3/8" casings).

• If the plug does not bump at the calculated displacement volume, do not over displace more than half of the shoe track volume. In such case, casing pressure test to be performed after running with 12 1/4" BHA. To avoid creating micro annulus, make sure that the cement has reached desirable compressive strength before testing (Cementing Company to advice on time).

• Record operational data on cementing job chart. Bleed off pressure slowly & record the return volume, check the floats.

24. R/D cementing equipment.
25. Observe well for any flow. If no flow continue with the next step. Otherwise inform Superintendent/Drilling Engineer.
26. Open the Casing Head Housing outlet and empty/wash inside 13 3/8" x 18 5/8" casing annulus. After washing the slips area close the valve on the Casing Head Housing.
27. Disconnect flow line and bell nipple.
28. Clean cellar. Hook up BOP lifting system.
29. Open Annular BOP, Lift BOP Stack.
30. Install Casing Hanger Slips as per ITAG procedures and set the slips with "as cemented weight". Note that the activation of the slip seals requires minimum 30 tons for initial activation.
31. Perform final cut of 13 3/8" casings (required length above the 20 $\frac{3}{4}$" Bowl).

(As the mud in the system is OBM and flammable Ensure Weatherford External-Internal cold cutter is available to perform any cutting on the casing during installation of casing Spool).

32. L/D excess 13 3/8" Casing pipe. L/D Bell Nipple.
33. N/D 20 $\frac{3}{4}$" BOP stack.
    - Install the 20 3/4"-3K x 13 5/8"-5K Casing spool (Section B), 13 5/8"-5K x 13 5/8"-10K Adapter and spacer.
    - Pressure test secondary seals to 1,500 psi. (Test ports on the bottom flange of the Casing Spool).
    - Remember that collapse rating of 13 3/8" casings is 2,270 psi.
34. N/U 13 5/8" x 10K BOP stack.
35. Test BOP Stack.
36. Install wear bushing (if available).
37. Install Bell Nipple & Flow Line.
38. L/D 16" BHA.

II.11.6 16" Section Surveying and Deviation Control

For the 16" hole section the Surveying and deviation control information is in the Table II.22.

Table II.22: 16" Section Surveying and Deviation Control

Survey Method	Tool	Interval
Single Shot	Rig Totco Tool	At TD and prior to any trip out
**** Wireline Survey with 50 m to 100 m data intervals shall be sent to office after the logging.***		

II.11.7 13 3/8" Casing Program

For this hole section, the casing program is shown in Table II.23.

Table II.23: 13 3/8" Casing Program

Description	Nr. of jts	OD (in)	Weight (ppf)	Grade	Conn.	ID (in)	Drift (in)	Burst (psi)	Collapse (psi)
Casing	xx	13.375	68	N-80	BTC	12.415	12.258	5020	2270
Float Collar	1								
Casing	2								
Float Shoe	1								

II.11.8 13 3/8" Casing Cement Slurry Design

Table II.24: 13 3/8" Casing Cement Slurry Design

Parameters	Unit		
Est. BHST	°C	107	
Est. BHCT	°C	70	
Pre-flush		7 m^3 Chemical Wash @ 1.10sg + 4 m^3 Mud Push @ 1.30/35sg	
Slurry		Lead (LiteCRETE)	Tail "class G"
Composition		Specific Light Cement w/ CemNET	Class –G- with SALTBOND II
Mix Water		Fresh Water	Fresh Water
Weight	sg	1.35	1.90
Excess	%	25	15
Top of Cement	m	370	1,480

II.11.9 Wellhead & BOP after 13 3/8" Casing

ITAG well head installation procedure will be submitted separately.The Wellhead & BOP Configuration is in the Table II.25.

Table II.25: Wellhead and BOP Stack configuration after installing well Head

Item	Equipment	Top Connection	Bottom Connection
1	13-5/8" x 5K Annular BOP		Flange – 10K
2	13-5/8" x 10K Single Ram w/ 5" Rams	Flange – 10K	Flange – 10K
3	13-5/8" x 10K Blind Ram	Flange – 10K	Flange – 10K
4	13-5/8" x 10K Mud Cross - Kill line: Manual, HCR and Check Valve - Choke line: Manual Valve and HCR	Flange – 10K	Flange – 10K
5	13-5/8" x 10K Single Ram w/ 5" Rams	Flange – 10K	Flange – 10K
6	13-5/8" x 10K Spacer	Flange – 10K	Flange – 10K
7	13-5/8" x 5K – 13-5/8" x 10K DSA	Studded Flange – 10K	Studded Flange – 5K
8	13-5/8" x 5K – 20-3/4" x 3K Casing spool	Flange – 5K	Flange – 3K
9	20 ¾" x 3K – 18-5/8" Casing Head Housing	Flange – 3K	18-5/8" Slip Lock

II.11.10 16" Section List of Equipment

For the 16" hole section the list of the equipment is in the Table II.26.

Table II.26: 16" Section List of Equipment

Item	Description	Quantity	Comments
1	16" PDC Bit TFR913S-A1 (Reed equipped with Nozzles (9 x 12) and bit breaker	1 ea	New
2	16" PDC Bit– MSi919PX (Smith) equipped with Nozzles (9 x 12) and bit breaker	1 ea	RR
3	16" PDC Bit HC609Z equipped with Nozzles (9 x 12) and bit breaker	1 ea	Re-run, as a back up
4	**16" MT Bit (IADC 1-3-5)**	**1 ea**	**Contingency**
5	9 ½" x 15-7/8" Near Bit Stab w/Totco ring (7-5/8" Reg B-B)	2 ea	1 as back up – ENF
6	9 ½" x 15-7/8" String Stabilizers (7-5/8" Reg P-B)	3 ea	1 as back up – ENF
7	8" Drilling Jar (6 5/8 Reg P-B)	1 ea	No back up.
8	13-3/8" Float Shoe 68 #, N-80, BTC	2 ea	1 as back up
9	13-3/8" Float Collar 68 #, N-80, BTC	2 ea	1 as back up
10	Cementing Plug Assembly (Top-Bottom Plugs)	2 sets	1 Set as back up
11	13-3/8" Casing Joints 68#, N-80, BTC	2,910m	± 265m as back up
12	13-3/8" Circulating Swedge	1 ea	
13	13-3/8" Centralizer, Bow	70 ea	6 as back up
14	13-3/8" Stop Collars, Bow	140 ea	12 as back up
15	13 3/8" Centralizers, Rigid	17 ea	2 as back up
16	13 3/8" Stop Collars, Rigid	34 ea	4 as backup
17	Casing Dope		
18	Baker Lock		
19	13-5/8"-5K x 20-3/4"-3K Casing spool & accessories	1 set	
20	Cup Type Tester (18-5/8", 87.5 #)	1 ea	

II.12 12 1/4" Hole Section

Table II.27 shows 12 1/4" Hole's information.

Table II.27: 12 1/4" Hole Information

From	2,450m
To	2,850m
Time Planned	7.75 days
Formations	LD-2 (Horizon H), LS-1, LD-3 (Horizon B), Lias-Salifere, Lias-Argileux

II.12.1 12 1/4" Section Objectives and Hazards

Objectives:

- Drill with PDC bit in one run to section TD @ 2,850m, which is ± 11m inside Lias Argiluex, ensure good zonal isolation, especially the Horizon B (LD3) allowing safe drilling of 8 1/2" hole section in order to avoid penetrating the TAGS which can result in partial to total losses).
- No Lost Time Injury (LTI) during this phase.
- MWD-GR may be utilized for early detection of top of Lias Argiluex (contingency plan).
- Maintain well verticality.
- Maintain good hole condition.
- Run and cement 9 5/8" casing, ensure good zonal isolation, especially the Horizon B(LD3).
- Raise top of cement to 300m cement inside the 13 3/8" casing (Consider more excess in case of losses).
- BJ cement Batch mixer (2) to be ready for possible use.

Hazards:

The table II.28 is showing the 12 1/4" hole section's hazards.

Table II.28: Hazards

Problem Experienced/ Expected	Proposed Solution
Negative Shoe Bond Test (SBT) Experience dynamic and static losses at section TD in both TOU-11 & TOU-12	Do not exceed the required SBT value (2.20sg) Re-design cement program for next section if Leak off point is reached before reaching desired SBT value. Consider using fibrous LCM with cement for casing cement job. Consult with office for squeeze cement option. MWD-GR will be incorporated into BHA to detect Lias Argiluex
Pressure increases due to salt plugging inside the drill string	Pump 2m3 of water pills. Use diesel as a spacer to prevent mud contamination.

TOUP1, TOUW1; Pressure increase in two times due to: screen pipe plugging by solids, In the first time DP.	Visual check and inspection to be made and ensure API screen to be used.
Stick & Slip in Salt	Avoid bit whirl or bouncing by changing parameters.
Penetrating into Triassic Heavy losses prior to running casing, Heavy losses while cementing,	Make sure LCM pill are ready at surface The sample collecting frequency to be advised by Wellsite Geologist to pick up the proper casing seat.
Poor cement job / Micro annulus in cement. Displace cement with light mud, which is to be used in next section.	Pressure test casings as bumping the plug If the plugs does not bump, make sure cement has reached desirable compressive strength before testing.
Flammable mud during Casing Spool installation	Use Cold cutter (WFD External-Internal Cutter) to cut the casing.

II.12.2 12 1/4" BHA

The BHA of the 12 1/4" hole section shown in the table II.29.

Table II.29: 12 1/4" BHA

Item	Joints	OD (in)		ID (in)	Connection	
		Blade / TJ	Body		Bottom	Top
12 ¼" PDC Bit	1	12 ¼				6-5/8 Reg P
Near Bit Stab	1	12-3/16	8	2-13/16	6-5/8 Reg B	6-5/8 Reg B
Pony Drill Collar	1		8	2-13/16	"	"
String Stabilizer	1	12-3/16	8	2-13/16	"	"
Drill Collar	1		8	2-13/16	"	"
String Stabilizer	1	12-3/16	8	2-13/16	"	"
Drill Collar	12		8	2-13/16	"	"
Jar	1		8	2 ½	"	"
Drill Collar	2		8	2-13/16	"	"
XO	1		6 ½"	2-13/16	6-5/8 Reg P	4 ½ IF B
HWDP	15	6 1/2	5	3.250	4 ½ IF P	4 ½ IF B
Drill Pipe	Surface	6 1/2	5	4.276	"	"

II.12.3 12 1/4" BIT

See Table II.30 for the information of the 12 1/4" hole section's bit.

Table II.30: 12 1/4" BIT

Bit		12 ¼" **MKS58DG-Varel**	
IADC		M123	
BHA type		Rotary – Packed	
Interval	m	2,450 – 2,850	
Lithology		Claystone, Anhydrite, Massive Salt	
Flow rate	lpm	2,800	
Nozzles	in	9 x 16	
TFA	sa-in	1.766	
HSI	hp/in^2	0.9	
Pump pressure	psi	+/- 3000	
WOB	tone	5 – 15	
RPM		140 – 120 (In L. Arg)	
Expected ROP	m/hr	23 (Overall Average)	

II.12.4 12 1/4" Section Mud Overview

The table II.31 shows the mud overview of the 12 1/4" hole section.

Table II.31: 12 1/4" Section Mud Overview

Parameters	**Unit**		**Parameters**	**Unit**	
Mud System	**OBM Versa Drill Relax**		**HTHP Filtrate @ 200 ºF / 500 psi**	cc/30 min	+/- 10 cc
Mud Weight	SG	**2.03/ 2.05**	**O/W Ratio**	%	85/15 - 90/10
FV	sec/qt.	45 – 55	**Electrical Stability**	Volts	> 1000
PV	CPs	ALAP (30 - 35)	**Pm**	ml H2SO4 0,1 N	3.0 – 5.0
YP	$lb/100\ ft^2$	18 – 25	**NaCl**	% by Wt	26.0
RPM 6		12 – 14	**Solids**	% by Vol	28 – 30
Gel 0	$lb/100\ ft^2$	6 – 8	**Sand Content**	% by Vol	< 0.5
Gel 10	$lb/100\ ft^2$	10 – 12	**LGS**	% by Vol	< 5

II.12.5 12 1/4" Section Operations sequence

1. P/U 12 1/4" BHA. RIH and tag cement.
2. RIH and tag cement, drill out plugs + FC + cement to 3m above the float shoe.
    - Displace 1.30sg OBM to 2.03sg OBM. While drill out shoe track .Record slow pump rates.

3. Drill out shoe track and 3m of new formation.

4. Perform SBT to 2.20sg.

5. Drill 12 1/4" hole to ± 2,850m (11m into Lias Argiluex).

• 9-5/8" shoe is critical. TAGS must not be penetrated and casing is to be inside Lias argiluex. Final TD will be defined by geologist onsite.

• Mud rheology will be reduced when casing is run to bottom.

Note: The 8 1/2" section mud should be prepared while 12 1/4" hole is being drilled.

6. Pump hi-vis-pill and circulate hole clean.

7. Perform wiper trip to shoe.

8. At bottom, pump hi-vis pill and circulate hole clean. Drop Totco if MWD not is being used.

9. Perform flow check.

10. POOH. Flow check at shoe.

11. Note: Report times separately for POOH, reaming and/or back reaming on the daily report. Also report the time of string reaching at the previous casing shoe.

12. POOH.

13. Perform WL logging. GR-SONIC-DEN-CL, VSP (optional).

14. Perform CBL – VDL – GR – CCL (13 3/8" Casing) Send PDS and PDF copies of all logs to the office.

15. RIH to bottom to check hole condition. Circulate and POOH to shoe.

16. Circulate and homogenize the mud.

17. Perform OH FIT to 2.15sg. Stop at first sign of leak (FIT value to be confirmed by the office).

18. POOH for casing.

19. Retrieve wear bushing (If installed).

20. Hold QHSE meeting with people involved and R/U casing running equipment. Shoe track must have been made up in town.

21. P/U the 9 5/8" shoe track, check the Floats.

22. RIH 9 5/8" casing, in two sections (53.5# special drift, P-110, BTC from casing pt to +- 1500m then 47#,P-110,BTC from 1500m – surface). Monitor and record P/U and S/O and free-hanging weights.

• A surface Fill-up Tool to be used while running the Casing.

• Wash down at least the last two joints or as per hole conditions dictate.

23. Circulate to condition the hole and mud properties prior to cementing as per cement program. Monitor well closely for mud losses.

24. R/U cementing head and cementing lines on rig floor.

25. Hold pre job safety meeting. Pressure test cement lines to 6,000 psi.

26. Perform 9 5/8" cementing job as per final program. During displacement re-calculate mud pump efficiency.

• Slow dump pump rate for the last $3m^3$ of displacement. Displace last $3m^3$ with water.

This is to be able to cut casing in a safe way later. ($2m^3$ is about 50m inside 9 5/8" casings). Bump plug and pressures test casing to 3,500psi (Also cementing head rating to be taken into consideration) on plug bump.

• If the plug does not bump at the calculated displacement volume, do not over displace more than half of the shoe track volume. In such case, casing pressure test to be performed after running with 8 1/2" BHA.

• To avoid creating micro annulus, make sure that the cement has reached desirable compressive strength before testing (Cementing Company to advice on time). Pressure test to be performed with the light mud (1.23sg).

27. R/D cementing equipment.
28. Lift BOP stack and install casing hanger slips as per ITAG procedures and set 9 5/8" casing slips with “as cemented” weight.

29. Rough Cut 9 5/8" casing and for final cut see note below.

Note: Perform final cut (16cm) ONLY if 13 5/8"-5K x 11"-10K casing spool is available. If not rough cut casing to 50cm and proceed to install 13 5/8" 5K x 13 5/8" 10K Double pack-off).

30. L/D excess joint.
31. Install Casing Hanger Spool 13 5/8"-5K x 11"-10K (Section B).

Note: If 13 5/8" x 11" 10K CHS is not available, then install 13 5/8" 5K x 13 5/8" 10K Double pack-off (provided by SH). Install a 13 5/8" 10K Spacer spool above the double pack-off.

32. Test the secondary seals to 3,700psi. (Test port on the lower flange of the CHS/ double pack-off as per installation carried out).

33. N/U 13 5/8"-10K BOP stack.
34. Test BOP Stack.

Blind Ram will be tested after the scraper run to allow enough time to cement to set.

Note: Precautions to be taken while testing with Cup Tester. In GTP-1, casings collapsed as 9-5/8” casings parted at the slips area and the wing valve was not open prior to pressure test.

35. Install wear bushing. (If available).
36. L/D 12 1/4" BHA.

II.12.6 12 1/4" Section Surveying and Deviation Control

For the 12 1/4" hole section the Surveying and deviation control information is in the Table II.32.

Table II.32: 12 1/4" Section Surveying and Deviation Control

Survey Method	Tool	Interval
Single Shot	Rig Totco Tool	At TD and any prior trip out
Deviation Log	Wireline Directional Survey	At TD
*** Wireline Survey with 50 m to 100 m data intervals shall be sent to office after the logging.***		

II.12.7 9 5/8" Casing Program

For the 12 1/4" hole section, the casing program is shown in Table II.33.

Table II.33: 9 5/8" Casing Program

Description	Nr. Of Joints	OD (in)	Weight (ppf)	Grade	Conn.	ID (in)	Drift (in)	Burst (psi)	Collapse (psi)
Casing	Surface-1500m	9.625	47	P-110	N VAM	8.861	8.525	9440	5300
Casing	1500m - TD	9.625	53.5	P-110	N VAM	8.525	8.500	10900	7950
Float Collar	1	9.625	53.5	P-110	N VAM	8.525		10900	7950
Casing	2	9.625	53.5	P-110	N.VAM	8.525	8.500	10900	7950
Float Shoe	1	9.625	53.5	P-110	N.VAM	8.525		10900	7950

II.12.8 9 5/8" Casing Cement Slurry Design

Table II.34: 9 5/8" Casing Cement Slurry Design

Parameters	Unit		
Est. BHST	°C	104	
Est. BHCT		73	
Pre-flush		7m^3 Mud Push @ 1.85sg	
Slurry		Class G Conventional	
Composition		Salt 18% BWOW, Antifoam 2 L/T, Dispersant – 5 L/T and Retarder - TBC	
Mix Water		Fresh Water (~ 465 L/T)	
Weight	sg	1.90	
Excess	%	25%	
Top of Cement	m	2,250	

II.12.9 Wellhead And BOP Configuration after 9 5/8" Casing

For the 12 1/4" hole section the Wellhead & BOP Configuration is in the Table II.35.

Table II.35: Wellhead And BOP Configuration after 9 5/8" Casing with 13 5/8" 5K x 11" 10K Casing Spool

Item	Equipment	Top Connection	Bottom Connection
1	13-5/8" x 5K Annular BOP		Flange – 10K
2	13-5/8" x 10K Single Ram w/ 5" Rams	Flange – 10K	Flange – 10K
3	13-5/8" x 10K Blind Ram	Flange – 10K	Flange – 10K
4	13-5/8" x 10K Mud Cross - Kill line : Manual Valve, HCR and Check Valve - Choke line : Manual Valve and HCR	Flange – 10K	Flange – 10K
5	13-5/8" x 10K Single Ram w/ 5" Rams	Flange – 10K	Flange – 10K
6	13-5/8" x 10K – 11" x 10K DSA	Studded Flange – 10K	Studded Flange – 10K
7	11"-10K x 13-5/8"-5K Casing Spool	Flange – 10K	Flange – 5K
8	13-5/8"-5K x 20-3/4"-3K Casing Spool	Flange – 5K	Flange – 3K
9	20 ¾" x 3K - 18-5/8" Casing Head Housing	Flange – 3K	18-5/8" Slip Lock

Table II.36: Wellhead And BOP Configuration after 9 5/8" Casing without 13 5/8" 5K x 11" 10K Casing Spool

Item	Equipment	Top Connection	Bottom Connection
1	13-5/8" x 5K Annular BOP		Flange – 10K
2	13-5/8" x 10K Single Ram w/ 5" Rams	Flange – 10K	Flange – 10K
3	13-5/8" x 10K Blind Ram	Flange – 10K	Flange – 10K
4	13-5/8" x 10K Mud Cross - Kill line : Manual Valve, HCR and Check Valve - Choke line : Manual Valve and HCR	Flange – 10K	Flange – 10K
5	13-5/8" x 10K Single Ram w/ 5" Rams	Flange – 10K	Flange – 10K
6	13-5/8" x 10K – 13-5/8" 10K Spacer Spool	Flange – 10K	Flange – 10K
7	13-5/8"-10K x 13-5/8"-5K Double Pack-off	Flange – 10K	Flange – 5K
8	13-5/8"-5K x 20-3/4"-3K Casing Spool	Flange – 5K	Flange – 3K
9	20 ¾" x 3K - 18-5/8" Casing Head Housing	Flange – 3K	18-5/8" Slip Lock

II.12.10 12 1/4" Section List of Equipment

For the 12 1/4" hole section the list of the equipment is in the Table II.37.

Table II.37: 12 1/4" Section List of Equipment

Item	Description	Quantity	Comments
1	12 ¼"PDC MKS58DG (Varel) equipped w/ 9 x 16 Nozzles	1 ea	New
2	12 ¼" PDC SP619A (ALDM) equipped w/ 7 x 15 Nozzles	1 ea	Re-run, as a back up
3	12 ¼ Milled Tooth Bit (IADC 1-3-5)	1 ea	**Contingency**
4	8" x 12-3/16" Near Bit Stab w/Totco ring (6-5/8" Reg B-B)	2 ea	1 as back up
5	8" x 12-3/16" String Stabilizers (6-5/8" Reg P-B)	3 ea	1 as back up
6	8" Drilling Jar (6 5/8 Reg P-B)	1 ea	No back up.
7	9-5/8" Float Shoe 53.5#, P-110, **N VAM**	2 ea	1 as back up
8	9-5/8" Float Collar 53.5#, P-110, **N VAM**	2 ea	1 as back up
9	Cementing Plug Assembly (Top-Bottom Plugs)	2 sets	1 Set as back up
10	9-5/8" **Casing Joints** 47#, P-110, **N VAM**	1600m	100m as back up
11	9-5/8" **Casing Joints** 53.5#, P-110, **N VAM**	1450m	± 100m as back up
12	9-5/8" Circulating Swedge w/ **N VAM Connection**	1 ea	
13	9-5/8" Centralizer, Rigid	12 ea	2 as back up
14	9-5/8" Stop Collars, Rigid	24 ea	4 as back up
15	9-5/8" Centralizer, Bow	15 ea	2 as back up
16	9-5/8" Stop Collars, Bow	30 ea	4 as back up
17	Casing Dope	3	
18	Baker Lock	2	
19	11"-10K x 13-5/8"-5K Casing Spool & accessories	1 set	
20	BOP test plug	1 set	May not be available
21	11" Wear Bushing with running tool	1 set	May not be available
22	Cup Type Tester (9-5/8", 47#)	1 ea	
23	9-5/8" Casing scraper	1 ea	

II.13 8 1/2" Hole Section

The information for the 8 1/2" hole section is displayed in the Table II.38.

Table II.38: 8 1/2" Hole Information

From	2,850m
To	4,480m
Time Planned	39.00 days
Formations	Lias Argiluex, TAGS, Tags Sandy, Trias Carbonate, Argilo Moyen, Intermediaire, TAGI, Silurian, Argiles D'Azzel, 1m Gres Ouargla

II.13.1 8 1/2" Section Objectives and Hazards

Objectives:

- Drill 8 1/2" hole to top of 1m into Gres De Ouargla (4,480m).
- Maintain well verticality, might need for PDM and MWD (optional).
- Maintain good hole condition.
- If coring program will be advised later on as per RDI.
- Run and cement 7" CASING, ensure good zonal isolation.
- All Injection Gas wells has be shut-in prior to drilling 8 1/2" hole.
- BJ cementing to have Batch mixer (2) for 7" CASING tested and ready prior to job.

Hazards:

See Table II.39 for the 8 1/2" hole section's hazards.

Table II.39: Hazards

Problem Experienced/ Expected	Proposed Solution
Negative Shoe Bond Test (SBT)	-Do not exceed the required SBT value (1.60 SG). -Adhere to SBT procedure to avoid fracturing the shoe. -Stop at first sign of leak. -Re-design cement program if leak off point is reached before reaching desired SBT value. -Consult with office for squeeze cement option.
Influx from TAGS / TAGI	-Don't let MW drop below 1.20 SG. -The injection must be stopped prior to commencing the drilling. -Keep 30 m3 of 2.10sg kill mud. -Perform short flow checks prior to pipe connections & extended Flow checks (30 min) prior to POOH. Use trip tank for flow checking & move string to avoid diff. stuck Adhere to good tripping and kick procedures. -Avoid swabbing. Perform kick drills frequently. Be aware of fact that OBM can mask the indications of gas influx.

Wellbore stability problem in Trias Carbonate TOU12; Tight spot: 10T over pull at 2913m,2907m,2899m. TOUW1; Tight spot: 15T and over pull: 13T were observed @ 2983.	-Increase MW to 1.25sg upon reaching the TC or earlier if the hole conditions dictate.
Low ROP in Silurian F6-A2 & A1	-Use heavy set PDC with good gauge protection. -Formations should be PDC drillable. -Offset well has been drilled w/ 8-bladed 11mm cutter bit
TOUW1; Difficulties to maintain well vertically, at 3199m it was 6°	-Used a directional BHA to drop it to 1.17.
Possible gas influx from Silurian F6-A2 & A1	-Pore pressure can be as high as 1.48 SG. This is second well to drill Silurian sandstone layers. -MW shouldn't fall below 1.48 SG.Well head rating has been upgraded to10K.
Negative FIT in TAGI	-Consolidated by squeeze cementing.
Well flowing while logging	-Tight control on Trip Tank (sonde & cable displacement) -Have cable cutter available on Rig Site
Lost circulation while cementing 7" Liner - hole pack off / ECD	-Adjust pump rate to keep ECD below the Frac gradient. -Add fibrous LCM in slurry.
Poor cement job	-Decrease mud rheology prior to cement job once casing is at the bottom. -Ensure proper centralization (Suggested the use of spiral centralizers) -Reciprocate and rotate while cementing
Micro annulus / gas channelling in cement	-Pressure test casing as bumping the plug. If the plugs does not bump, make sure the cement has reached desirable compressive strength before testing -Include gas block in the slurry.

II.13.2 8 1/2" BHA

The BHA of the 8 1/2" hole section shown in Table II.40 for #1-Conventional Rotary Drilling & Table II.41 for #2-Turbine or HSM.

Table II.40: 8 1/2" BHA #1 – Conventional Rotary Drilling

Item	Joints	OD (in)		ID (in)	Connection	
		Blade / TJ	Body		Bottom	Top
8 ½" PDC Bit	1	8 ½				4 ½ Reg P
Near Bit Stab w/Float valve & Totco ring	1	8-7/16	6 ½	2 ¾	4 ½ Reg B	4 IF B
Pony Collar (spiral)	1		6 ½	2 ¾	4 IF P	4 IF B
String Stabilizer	1	8-7/16	6 ½	2 ¾	"	"
Drill Collar (spiral)	1		6 ½	2 ¾	"	"
String Stabilizer	1	8-7/16	6 ½	2 ¾	"	"
Drill Collar (spiral)	12		6 ½	2 ¾	4 IF P	4 IF B
Jar	1		6 ½	2 ½	4 IF P	4 IF B
Drill Collar (spiral)	2		6 ½	2 ¾	4 IF P	4 IF B
XO	1		6 ½	2 ¾	4 IF P	4 ½ IF B
HWDP	15	6 ½"	5	3.0	4 ½ IF P	4 ½ IF B
Drill Pipe	Surface	6 ½"	5	4.276	"	"

Table II.41: 8 1/2" BHA #2 – Turbine or HSM

Item	Joints	OD (in)		ID (in)	Connection	
		Blade / TJ	Body		Bottom	Top
8 ½" IM Bit	1	8 ½				4 ½ Reg P
Turbine or HSM	1	8-7/16	6 ½	2 ¾	4 ½ Reg B	4 IF B
Pony Collar (spiral)	1		6 ½	2 ¾	4 IF P	4 IF B
MWD	1	8-7/16	6 ½	2 ¾	"	"
Drill Collar (spiral)	1		6 ½	2 ¾	"	"
String Stabilizer	1	8-7/16	6 ½	2 ¾	"	"
Drill Collar (spiral)	12		6 ½	2 ¾	4 IF P	4 IF B
Jar	1		6 ½	2 ½	4 IF P	4 IF B
Drill Collar (spiral)	2		6 ½	2 ¾	4 IF P	4 IF B
XO	1		6 ½	2 ¾	4 IF P	4 ½ IF B
HWDP	15	6 ½"	5	3.0	4 ½ IF P	4 ½ IF B
Drill Pipe	Surface	6 ½"	5	4.276	"	"

II.13.3 8 1/2" BIT

For the information of the 26" hole section's bit see Table II.42 of The #1 Run ;Table II.43 of The #2 Run.

Table II.42: 8 1/2" BIT (BHA #1 Run)

Bit		8 ½" DSR713M (Reed) or M909PX (Smith)
IADC		M433
BHA type		Rotary-packed
Interval	m	2,850 to ± 4,274 top DMK
Lithology		Sandstone, Claystone, Dolomite, Siltstone
Flow rate	lpm	1,700 – 2,100
HSI	hp/in2	3.4
Nozzles	in	4 x 14
TFA	sq-in	0.601
Pump pressure	psi	2,600 – 2,900
WOB	tone	4 – 15
RPM		150 - 180
Expected ROP	m/hr	4 – 10 (Overall Average)

Table II.43: 8 1/2" BIT (BHA #2 run) [1]

Bit		8 ½" K505BEPX (Smith)
IADC		M432
BHA type		Turbine or HSM
Interval	m	4,274 - ± 4,480
Lithology		Sandstone, Shale
Flow rate	lpm	1750 - 2000
HSI	hp/in2	3.1
Nozzles	in	6 x 12
TFA	sq-in	0.662
Pump pressure	psi	2,900 – 3,100
WOB	tone	3 – 9
RPM		Turbine + 120
Expected ROP	m/hr	2.5 – 6 (Overall Average)

II.13.4 8 1/2" Section Mud Overview

The table II.44 shows the mud overview of the 8 1/2" hole section.

Table II.44: 8 1/2" Section Mud Overview

Parameters	Unit		Parameters	Unit	
Mud System	OBM Versa-Drill Conv		**HTHP Filtrate @ 200 ºF / 500 psi**	cc/30 min	10cc
Mud Weight	SG	**1.30 -1.35**	**O/W Ratio**	%	90 / 10
FV	sec/qt.	50 – 55	**Electrical Stability**	Volts	> 1000
PV	CPs	ALAP	**Pm**	ml H_2SO_4 0,1 N	2.0 – 2.5
YP	lb/100 ft^2	10 – 12	**NaCl**	% by Wt	26.5
RPM 6		8 - 10	**Solids**	% by Vol	16 – 18
Gel 0	lb/100 ft^2	5 – 8	**Sand Content**	% by Vol	< 0.5
Gel 10	lb/100 ft^2	10 – 12	**LGS**	% by Vol	ALAP

II.13.5 8 1/2" Section Operations sequence

Part 1:

1. Hold safety meeting.
2. P/U 8 1/2" Rotary pendulum BHA and new PDC bit. Fill up drill string each 15 stands. RIH and Tag cement.
3. Drill out shoe track + Drill out plugs +FC+ cement 2m above FS. Circulate and homogenize mud to 1.20sg.

Note: If the plugs were not bumped during the 9 5/8" cement displacement, then pressure test 9 5/8" casing to 3,500 psi.

4. Drill out shoe and 3m of new formation meanwhile displace 2.03sg by 1.30sg OBM.
5. Circulate hole clean until homogenize the mud.
6. Flow check and POOH to shoe.
7. Conduct SBT to 1.70sg.
8. Drill to top of top Silurian (± 3,216m).
9. Conduct FIT to 1.65sg.

Part 2:

1. RIH and continue drilling and/or coring to top of Dalle de M'Kratta (± 4,274m).
2. Circulate hole clean, Perform extended flow check.
3. POOH to surface & L/D Power-V tool.
4. P/U Turbine (or HSM) or rotary BHA (option), MWD and Impregnated Bit.
   - Perform surface tests of turbine and MWD.
5. RIH, have string filled completely with mud each 15 stands & break circulation at shoe.
6. Resume drilling to 1m inside Gres De Ouargla @ ± 4,480m 8 1/2" section TD.
   - Take surveys as per the surveying program.
   - It is expected to reach the section TD with this run.

7. Circulate, perform wiper trip, circ., perform extended Flow check.

8. POOH to surface.

9. Perform Wireline Logging as per program: NGT + Sonic + Density + Neutron + Caliper (4 arms) + Resistivity + Resonance + XPT for TAGS, Trias Carbonate (Intermédiaire I), TAGI and Silurian F6 + VSP(optional).

10. Perform CBL – VDL – GR – CCL (9 5/8" Casing). - Send PDS and PDF copies of all logs to office.

11. RIH to bottom with rotary assembly to check hole condition prior to running 7" casing.

12. Circulate, Perform extended Flow check and POOH.

13. Retrieve Wear Bushing (if installed).

14. Run 7" casing 32# to surface.

- Make sure that the casing joints are drifted to 6.04in.
- M/u guide shoe and float collar. Check and ensure that floats are working properly.
- At 9 5/8" casing shoe, rig up circulating head and circulate at least 1.5 the string capacity.
- Final tally including the actual length and weight of each casing joint should be sent to the office. Casing string characteristics should be included in the daily operations report.

15. Circulate to condition hole to reduce temperature and check mud properties prior to cementing. Monitor well closely for mud losses.

16. Hold pre job safety meeting.

17. R/U cementing head and cementing lines on rig floor.

18. Test all cementing lines cementing unit to 6000psi.

19. Cement casing with 1.90sg Class G slurry with Gas stop migration product.

- Use cementing unit to cement the casing and displace the cement.
- TOC to be at 200m above the 9 5/8" casing shoe.
- Pressures test the casing to 3,500psi on plug bump. If plug does not bump, do not over displace more than 50% of the shoe track volume. Monitor and record returns during bleeding off pressure.
- Ensure the floats are holding.
- If the floats do not hold maintain pressure on the cementing head for a minimum of 125% of the thickening time of the cement slurry Maintain last pumping pressure on the casing string.

20. R/D cementing equipment.

21. Disconnect flow line.

22. Lift BOP.

23. Set the 7" casing slips. The casing slips will be set with tension equivalent of the weight of the non-cemented part of the casing with 10% safety factor + 20tons tension.

24. Rough cut the casing about 12 inches from the casing head flange. L/D excess 7" casing.

25. Cut 7" casing about 6 3/4" (170mm) above flange surface and then bevel the cut. (Double check with 11" 10K x 7 1/16" 10K Tubing Head Spool (THS) for the height of final cut.)

26. Install 11" 10K x 7 1/16" 10K Tubing Head Spool (THS) and 7 1/16" x 13 5/8" 10K Adapter.

Note: THS will be delivered by Sonatrach RN DP. It is preferable and recommended to install this THS prior to drilling the 6" hole section.

27. N/U 13 5/8" 10K BOP. Change the variable rams (2 7/8" – 5" variable rams).
28. Test 13 5/8" 10K BOP Stack to the pressure as per the previous section, preferably with test plug.

Notes: If test plug is not available, SH testing BOP with tester cup procedures will be followed.

29. Install wear bushing (if available).
30. L/D 8 1/2" BHA and all 5" DP. P/U 3 1/2" DP to TD +- 4900m.
31. RIH with 6" RR PDC bit and slick BHA (Bit + BS + 9 x 4 3/4" DC + 15 x 3 1/2" HWDP) and 3 1/2" DP. RIH to drill the liner plugs and cement up to 3m above Float Shoe. Circ-hole clean and condition mud to 1.23sg while drilling cement. POOH to surface.
32. RIH with 6" Tri-cone RR bit on scrapper BHA (Bit + 7" scrapper + BS + 12 x 4 3/4" DC + Jar + 2 x 4 3/4" DC + 15 x 3 1/2" HWDP) and scrape 7" casing to 3m above float Shoe. Circulate & condition mud. POOH. This step will be canceled if cement went ok.
33. Perform CBL / VDL / USIT logging if cement job doesn't went normal otherwise postpone to run it with 6" open hole logging.
34. Install Wear Bushing.

II.13.6 8 1/2" Section Surveying and Deviation Control

For the 8 1/2" hole section the Surveying and deviation control information is in the Table II.45.

Table II.45: 8 1/2" Section Surveying and Deviation Control

Survey Method	Tool	Interval
Single Shot	Rig Totco Tool	At TD and any prior trip out
Deviation Log	Wireline Directional Survey	At TD
** Wireline Survey with 50 m to 100 m data intervals shall be sent to office after the logging.*		

II.13.7 7" Casing Program

The casing program of the 8 1/2" hole section is shown in Table II.46.

Table II.46: 7" Casing Program

Description	Nr. Of jts	OD (in)	Weight (ppf)	Grade	Conn.	ID (in)	Drift (in)	Burst (psi)	Collapse. (psi)
Casing	xx	7	32	P-110	N. Vam	6.094	6.059	12,460	10,780
Float Collar	1	7	32	P-110	N. Vam			12,460	10,780
Casing	2	7	32	P-110	N. Vam	6.094	6.059	12,460	10,780
Float Shoe	1	7	32	P-110	N. Vam			12,460	10,780

II.13.8 7" Casing Cement Slurry Design

Table II.47: 7" Casing Cement Slurry Design

Parameters	Unit	
Est. BHST:	Deg C	138
Est. BHCT:	Deg C	103
Pre-flush:		6 m^3 CW @ 1.02sg + 4 m^3 Mud Push @ 1.5sg
Slurry		IsoBLOK
Composition:		Silica CMT, GasBLOK & SALTBOND II
Mix Water:		Fresh Water
Weight: (SG)		1.90
Excess:		50% in open hole
Top of Cement:	m	2650

II.13.9 Wellhead & BOP after 7" casing with 7 1/16" 10K x 11" 10K THS

For the 8 1/2" hole section the Wellhead & BOP Configuration is in the Table II.48.

Table II.48: Wellhead & BOP after 7" casing with 7 1/16" 10K x 11" 10K THS

Item	Equipment	Top Connection	Bottom Connection
1	13-5/8" 5K Annular BOP		Flange – 10K
2	13-5/8" 10K Upper Ram (2 7/8" – 5 ½" VBR)	Flange – 10K	Flange – 10K
3	13-5/8" 10K Blind Ram - Kill line : Manual Valve, HCR and Check Valve - Choke line : Manual Valve and HCR		
4	13-5/8" 10K Lower Ram (2 7/8" – 5 ½" VBR)	Flange – 10K	Flange – 10K
5	13-5/8" 10K x 7 1/16" 10K DSA	Studded Flange – 10K	Studded Flange – 10K
6	7 1/16" 10K x 11" 10K Tubing Head	Flange – 10K	Flange – 10K
8	11" 10K x 13-5/8" 5K Casing Spool	Flange – 10K	Flange – 5K
9	13-5/8" 5K x 20 ¾" 3K Casing Spool	Flange – 5K	Flange – 3K
10	20 ¾" 3K x 18-5/8" Casing Head Housing	Flange – 3K	18-5/8" Slip Lock

II.13.10 8 1/2" Section List of Equipment

For the 8 1/2" hole section the list of the equipment is in the Table II.49.

Table II.49: 8 1/2" Section List of Equipment

Item	Description	Quantity	Comments
1	8 ½" PDC Bit (DSR713M) 4 x 16 Nozzles (Reed Hycalog)	2 ea	For rotary or PDM
2	8 ½" PDC Bit (M909PX) 4 x 11 Nozzles (Smith) - Motor 8 ½"	2 ea	For rotary or PDM
3	8 ½" IM HHS356G8G9Y Baker or (K505BEPX Smith)	2 ea	For rotary or PDM
4	8 ½" TCI Bit MX-55 or TC11	1 ea	Contingency
5	8 ½" Mill Tooth Bit FDGH	1 ea	Clean Out
6	6 ½" x 8-7/16" Near Bit Stab **(4 1/2" Reg B – 4 IF B)** - w/ Totco ring & seat for Float Valve	2 ea	1 as back up - ENF
7	6 ½" x 8-7/16" String Stabilizers **(4" IF P-B)**	3 ea	1 as back up – ENF
8	6 ½" x 8 ¼" String Stabilizer **(4 ½" IF P-B)**	1 ea	To be ordered fm WFD
9	6 ½" Drilling Jar **(4" IF P-B)**	1 ea	No back up
10	6 ½" Circulation Sub **(4 ½" IF P-B)**	1 ea	For PDM BHA
11	6 ½" Float Sub **(4 ½" IF P-B)**	1 ea	For Turbine BHA
12	7" Float Shoe 32#, P-110, New Vam	2 ea	1 as back up
13	7" Float Collar 32#, P-110, New Vam	2 ea	"
14	7" Landing Collar 32#, P-110, New Vam	2 ea	"
15	7" Casing Joints 32#, P-110, New Vam	4600m	± 120 m as back up
16	Casing Cross Over **(4 ½ IF B – 7" New Vam P)**	1 ea	Well control contingency
17	7" Centralizer, Bow	80 ea	6 as back up
18	7" Stop Collars, Bow	160 ea	12 as back up
22	7" Centralizer, Rigid	22 ea	3 as back up
23	7" Stop Collars, Rigid	44 ea	6 as back up
24	Casing Dope		
25	Baker Lock		
26	Test Plug	1 Set	May not be available
27	11" Wear Bushing	1 Set	May not be available
28	Cup Type Tester (9-5/8", 53.5#)	1 ea	Contingency
29	Special Drift for 7" casing 6.00"	1 ea	
30	7" Scraper	1 ea	

II.14 6" Hole Section/Completion

We summarized the information of the 6" hole section in the Table II.50.

Table II.50: 6" Hole Information

From	4,480m
To	4,847m
Time Planned	18.00 days till TD 40.00 days (Evaluation & Completion) .
Formations	Gres Ouargla, Quartez Hamra

II.14.1 6" Section Objectives and Hazards

Objectives:

- No Lost Time Injury (LTI) during this phase.
- Drill out 7" Float Collar, shoe track with PDC bit and perform SBT.
- Drill with PDC bit and Packed Rotary BHA.
- Coring program will be defined later on.
- Drilling 6" hole to 4,847m to final TD – 278m inside Quartzite Hamra as per RDI.
- Maintain well verticality, (Steering assembly to be under standby).
- Open Hole Logging as per program.
- Perform DST as per program which will be advised later on.
- Run 4 1/2" Liner perforated and blank with 180m overlap in 7" Liner as per final completion program from GT DP. It will be cemented with Gas-Block slurry to TOL to achieve good zonal isolation.
- BJ cementing to have Batch mixer (2) for 4 1/2" liner tested and ready prior to job.

Hazards:

See Table II.51 for the 6" hole section's hazards.

Table II.51: Hazards

Problem Experienced / Expected	**Proposed Solution**
Possible caving and hole enlargement in shale	Severe pack off incidents were recorded in TOU-QHZ-1 resulted in sidetrack after heavy back reaming & string twist off. MW can be increased above 1.5sg for shale stability. SPP trend should be monitored very carefully.
Well flowing while logging	-Tight control on Trip Tank (sonde & cable displacement) -Have cable cutter available on Rig Site
Micro annulus / gas channeling in cement	-Pressure test liner as bumping the plug. If plugs don't pump make sure the cement reached desirable compressive strength b4 testing. -Include gas block in the slurry.
Liner accessories & cement drilling	Check with liner service provider for PDC Drill ability of the liner floating equipment. Ensure to get specs sheets in advance.

II.14.2 6" BHA (Rotary Assembly)

The BHA of the 6" hole section shown in the table II.52.

Table II.52: 6" BHA (Rotary Assembly)

Item	Joints	OD (in)		ID (in)	Connection	
		Blade / TJ	Body		Bottom	Top
6" PDC Bit	1	6"				3 ½ Reg P
Near Bit Stab w/Totco ring and float valve	1	5 ¾"	4 ¾	2 ¾	3 ½ Reg B	3 ½ IF B
Pony Collar	1		4 ¾	2 ¼"	3 ½ IF P	3 ½ IF B
String Stabilizer	1	5 ¾"	4 ¾	2 ¾	"	"
Drill Collar	1		4 ¾	2 ¼"	"	"
String Stabilizer	1	5 ¾	4 ¾	2 ¾	"	"
Drill Collar	15		4 ¾	2 ¼	"	"
Jar	1		4 ¾	2 ¾	"	"
Drill Collar	2		4 ¾	2 ¼"	"	"
HWDP	15		3 ½	2-1/8"		
3-1/2" Drill Pipe			3 ½	2-1/8"	"	"

II.14.3 6" BIT

See Table II.54 for the information of the 6" hole section's bit.

Table II.53: 6" BIT (IM bit – Rotary or PDM) [12]

Bit		K505BEPX (Smith) or HHS352 (Baker)
IADC		M842
BHA type		Rotary
Interval	m	4,480m – 4,847m TVD
Lithology		Quartzite Hamra
Flow rate	lpm	750 – 900
Nozzles	in	Fixed TFA
TFA	sq-in	1.20
Pump pressure	psi	± 4,000
WOB	tone	2 – 9 Ton
RPM		50 + PDM
Expected ROP	m/hr	~2.5 m/hr (WOC)

Table II.54: 6" BIT (Rotary Assembly) [13]

Bit		MX-55 or equivalent	
IADC		6-3-7	
BHA type		Rotary BHA	
Interval	m		
Lithology		Silurien	
Flow rate	lpm	850 – 950	
Nozzles	in	3 X 14	
TFA	sq-in	0.451	
Pump pressure	psi		
WOB	tone		
RPM			
Expected ROP	m/hr		

II.14.4 6" Section Mud Overview

The table II.55 shows the mud overview of the 6" hole section.

Table II.55: 6" Section Mud Overview

Parameters	**Unit**		**Parameters**	**Unit**	
Mud System	OBM Versa-Drill Conv		**HTHP Filtrate @ 200 ºF / 500 psi**	cc/30 min	3 – 4
Mud Weight	SG	**1.3- 1.38**	**O/W Ratio**	%	95 / 05
FV	sec/qt.	40-50	**Electrical Stability**	Volts	> 1000
PV	CPs	25-30	**Pm**	ml H_2SO_4 0,1 N	1.0
YP	lb/100 ft^2	10 - 12	**NaCl**	% by Wt	26.5
RPM 6		4 – 6	**Solids**	% by Vol	24 – 26
Gel 10 sec	lb/100 ft^2	4 – 6	**Sand Content**	% by Vol	< 0.5
Gel 10 min	lb/100 ft^2	10 – 12	**LGS**	% by Vol	ALAP

II.14.5 6" Section Operations sequence

1. Hold PJSM and P/U PDM & MWD or 6" Rotary BHA.
2. Change BOP Lower rams to 3 1/2" and perform BOP test.
3. RIH with 6" BHA and heavy set PDC Bit and tag cement.
4. Displace 1.35sg mud to 1.30sg mud.
5. Drill out Shoe track: Landing Collar + cement + Float Collar + cement + Float Shoe, clean out rat hole.
6. Drill 2-3 m of new hole, conduct a SBT @ 1.70sg.
7. Drill to coring point in Quartzite Hamra top; continue drilling until geologist onsite calls for coring point if any. POOH 6" BHA.
8. RIH with coring assembly.

9. Take core from Quartzite Hamra (18 - 27m) if required.
10. POOH core to surface. L/D Coring Assembly.
11. RIH with 6" BHA and drill to final TD @ +-4,847m. POOH 6" BHA.
12. Circulate hole clean and drop Totco. POOH and L/D 6" BHA.
13. Run E-logs as per program: AIT - SONIC SCANNER (P & S) - GR + LDS - APS - HNGS UBI - OBMI - GPIT GR + MDT Dual Packer + VSP (optional). Confirm cement quality of the 7" casing.
14. RIH with Rotary Assembly to check hole condition before running 4 1/2" Liner.
15. Perform DST operations as per Rhourde Nouss DP requirement.
16. Run 4 1/2", P-110, 13.5 lb/ft liner (blank) made up on a 4 1/2" Hydraulic Liner Hanger. 4 1/2" TOL to be set at 4,300m as per RDI program, TOC +-4,250m.

- Once the liner is at bottom, set the hanger and release the running tool as per BOT procedure.
- Circulate and condition the drilling mud at 900 – 1000lpm.
- Rig up cement lines and pressure test to 5,000psi.
- Cement liner with a 1.90sg Gas BLOK slurry.

• Recommended TOC is to be 50m above the 4 1/2" TOL. Excess cement should be circulated out after the packer is set. (This should be checked with the office; depending on the Liner Top Packer utilization in the liner.)

- Drop the pump down plug and displace the cement.
- Reduce the rate to 2.00bpm for the last 2 m^3 of the displacement.
- Pressures Test the Liner to 2,500 psi on plug bump.

(Check setting tool limitations prior to job)

- Bleed off pressure and check if there is return in displacement tank or not, Record volumes, pressure and rates during pumping and displacement.
- POOH with RT pumping at 300lpm inside PBR (after the pack-off is released) and circulate for 10 min.

17. POOH 10m above TOL and circulate at 1800 LPM until 1.25 times bottoms up to circulate excess cement out. Monitor surface returns for cement.
18. POOH Setting Tool.
19. RIH with 6" Bit to 4 1/2" TOL and POOH.
20. RIH with 3 3/4" PDC Bit, drill out cement and liner accessories. Continue RIH and TAG shoe. POOH.

Note: Run 3 3/4" RR PDC. MT / TCI bit is not recommended for this run.

21. M/U 3 3/4" PDC Bit, 4 1/2" and 7" Scrapers in tandem and RIH. Scrape 7" casing and 4 1/2" liner.
22. POOH and L/D Scrapers.
23. Perform CBL / VDL / USIT of 4 1/2" Liner and 7" casing.
24. Remove Wear Bushing and clean the Well Head.
25. Completion program prepared by GT Production Department will be issued and submit- ted separately minimum 2 weeks prior to start Completion.

II.14.6 6" Section Surveying and Deviation Control

For the 6" hole section the Surveying and deviation control information is in the Table II.56.

Table II.56: 6" Section Surveying and Deviation Control

Survey Method	Tool	Interval
MWD	Slim Pluse	Every 30m

II.14.7 4 1/2" Liner Program

Liner Program refers to the planned installation of casing liners during the drilling process, in the liner program we have some specifications: Weight, OD & ID, grade... The 4 1/2" Liner Program is shown in Table II.57.

Table II.57: 4 1/2" Liner Program

Description	Nr. Of jts	OD (in)	Weight (ppf)	Grade	Conn.	ID (in)	Drift (in)	Burst (psi)	Collapse (psi)
Liner Hanger w/ top Packer and PBR	1	4-1/2"	13.5	P-110	N.Vam				
Casing	xx	4-1/2"	13.5	P-110	N.Vam	3.920	3.795	12,410	10,690
PAC Valve									
ECP									
Landing Collar	1	4-1/2"	13.5	P-110	N.Vam			12,410	10.690
Perforated Casing	xx	4-1/2"	13.5	P-110		3.920	3.795	12,410	10,690
Guide Shoe	1	4-1/2"	13.5	P-110				12,410	10,690

II.14.8 4 1/2" Liner Cement Slurry Design

The Liner Cement Slurry Design is in Table II.58.

Table II.58: 4 1/2" Liner Cement Slurry Design

Parameters	Unit	
Est. BHST:	**deg C**	138
Est. BHCT:	**deg C**	120
Pre-flush:		3 m^3 CW (1.03sg) + 4 m^3 Mud Push II (1.65sg)
Slurry		Gas BLOK
Composition:		CLASS –G- Silica CMT, SALTBOND II, Gas BLOK
Mix Water:		Fresh Water
Weight	**sg**	1.90
Excess	**%**	50% over 6" open hole or (0 % with caliper log + 50m above TOL)
Top of Cement	**m**	3,250

II.14.9 Wellhead & BOP after 4 1/2" liner

Same as per previous 8 1/2" Hole (See Table II.48)

II.14.10 6" Section List of Equipment

For the 6" hole section the list of the equipment is in the Table II.59.

Table II.59: 6" Section List of Equipment

Item	Description	Quantity	Comments
1	6" IM Bit (Smith) – HHS352	1	For rotary or PDM
2	6" IM DD5560S (Reed) or K505BEPX (Smith)	1	As back up
3	6" TCI Bit – IADC -627	2	Contingency
4	6" Mill Tooth Bit	1	Plugs and C/O
5	5-3/4" Near Bit Stabilizer **(3 ½ IF P-B)**	2	1 as back up
6	5-3/4" String Stabilizer **(3 ½ IF P-B)**	3	1 as back up
7	4-3/4" Drilling Jar **(3 ½ IF P-B)**	1	No back up
8	3 ¾" PDC FM2533 SDBS (Re Run)	1	to drill floating eq.
9	**4 ½" Perforated casings if required**		
10	4 ½" Casing 13.5 #, P110 New Vam	630 m	80 m as b. up**
11	4 ½" Centralizer	TBA	
12	4 ½" Stop Collars	TBA	
13	4 ½" Rotating hyd. Liner Hgr Assy w/ TOP packer and PBR Profile-10' ext.	2	1 set as back up
14	4 ½" Cementing Plugs (LH Assy) + Darts	2 sets	1 as back up
15	4 ½" Guide Shoe	2	1 set as back up
16	4 ½" Landing Collar c/w Catcher tube	2	1 set as back up
17	4 ½" x 7" ECP w/ pup joints	1	
18	4 ½" PAC Valve	1	
19	4 ½" Liner Running Equipment – Setting tool	1	BOT
20	4 ½" Scraper	1	
21	7" Scraper	1	
22	7" Drillable Bridge Plug (EZ-Drill)	1	Contingency
23	7 1/16"-10K x 11"-10K Tubing Head	1	SH DP
24	11"-10K x 11"-10K Pack Off Flange	1	SH DP
25	Test Plug for C section and Tubing Head	2	
26	Wear Bushing for C section and Tubing Head	2	
27	Flat Bottom Mill	1	

** In case the liner top packer is not available, the 4 1/2" liner overlap will be extended to 150m.

Chapter III

Well Design

III.1 Rig Capability (ENF-6)

In a drilling program, rig capability refers to the drilling rig's maximum capacity to drill a wellbore to a defined depth, at a specific rate of penetration, and under specific drilling conditions. This covers the drilling equipment capability of the drilling rig, such as the mud pumps, drawworks, top drive, and drill string, as well as the power generation, mud handling, and well control capabilities of the rig.

The ENF6 is Pyramid Cantilever type with a 2,000HP draw works rated capacity. The draw works maximum line pull is 1,000,000 lbs with 12 lines. Casing load capacity of 800,000 lbs with a simultaneous setback capacity of 600,000 lbs. ENAFOR 6 Rig has 2 Oil well Type mud pumps, with 1600 hp rating. Mud performance data is given below.

Table III.1: 12-P-160 Pump Performance Data

Liner size, inches (mm)			7 ¼" (184.2)	7" (177.8)	6 ¾" (171.5)	6 ½" (165.1)	6 ¼" (158.8)	6" (152.4)	5 ¾" (146.1)	5 ½" (139.7)	5" (127)	4 ½" (114.3)
Max. Discharge Pressure, psi (kg/cm^2) with high pressure Fluid End†			3200 (225)	3430 (241.1)	3690 (259.4)	3980 (279.8)	4305 (302.7)	4670 (328.3)	5085 (357.5)	5555 (390.5)	6720 (472.4)	7500 (527.2)
Pump Speed spm	Input HP, HP (kW)	Hyd.** HP, HP (kW)	GPM** (LPM**)	GPM** (LPM**)	GPM** (LPM**)	GPM** (LPM**)	GPM** (LPM**)	GPM** (LPM**)	GPM** (LPM**)	GPM** (LPM**)	GPM** (LPM**)	GPM** (LPM**)
120*	1600* (1193*)	1440 (1074)	***	***	669 (2533)	621 (2349)	574 (2172)	529 (2002)	486 (1840)	444 (1682)	367 (1389)	297 (1124)
100	1333 (994)	1200 (895)	643 (2435)	600 (2270)	558 (2111)	517 (1958)	478 (1810)	441 (1668)	405 (1533)	370 (1401)	306 (1158)	248 (938)
80	1067 (796)	960 (716)	515 (1948)	480 (1816)	446 (1689)	414 (1566)	383 (1448)	353 (1334)	324 (1226)	296 (1121)	245 (927)	198 (750)
60	800 (597)	720 (537)	388 (1461)	360 (1362)	335 (1267)	310 (1175)	287 (1086)	264 (1001)	243 (920)	222 (841)	184 (697)	149 (564)
40	533 (397)	480 (358)	257 (974)	240 (908)	223 (844)	207 (783)	191 (724)	176 (667)	162 (613.1)	148 (561)	122 (462)	99 (375)
Volume/Stroke, gal. (Liters)			6.433 (24.35)	5.997 (22.70)	5.576 (21.11)	5.171 (19.58)	4.781 (18.10)	4.406 (16.68)	4.046 (15.32)	3.702 (14.02)	3.060 (11.58)	2.478 (9.38)

*Rated maximum input horsepower and speed
**Based on 90% mechanical efficiency and 100% volumetric efficiency
***Operation over 675 gpm could result in reduced valve life
†5,000 PSI Fluid End configuration available

III.2 Casing Pressure Test

The casing pressure test evaluates the mechanical integrity of the well casing. The well casing has mechanical integrity if there are no significant leaks in the casing. The mechanical integrity of the well casing is evaluated by conducting a hydraulic pressure test and monitoring for a pressure loss.[9]

All casing string pressure tests to be performed as per Sonatrach standard procedures.

Table III.2: Casing Pressure Test

Casing Size	Depth		Mud Weight				Surface Pressure for testing
	Shoe	Next Section TD	Current	Next Section	Test Green Cement	Test After Cement Set	
(in)	(m)		(sg)				(psi)
18-5/8	509	1,678	1.05	1.30	N/A	N/A	**N/A**
13-3/8	1,678	1,965	1.32	1.75	1.32	1.32	**3,000**
9-5/8	1,965	3.231	1.75	1.20	1.75	**1.20**	**3,500**
7	3,231	3,591	1.35	1.23	1.35	**1.23**	**3,000**
4-1/2	3,591	3,591	1.27	1.27	1.27	1.27	**2,500**

Note: Testing pressures to be confirmed with the office prior to operation.

III.3 Well Control

Well Control means methods used to minimize the potential for the well to flow or kick and to maintain control of the well in the event of flow or a kick. Well-control applies to drilling, well-completion, well-workover, abandonment, and well-servicing operations. It includes measures, practices, procedures and equipment, such as fluid flow monitoring, to ensure safe and environmentally protective drilling, completion, abandonment, and workover operations as well as the installation, repair, maintenance, and operation of surface and sub-sea well-control equipment.[6]

Table III.3: Wellhead & BOP Test Pressures

Casing Size	Stack Size	Rating	Low Pressure	High Pressure
(in)	(in)	(Psi)	(Psi)	(Psi)
18-5/8	21 ¼ Annular	2K	300	1,000
	Choke / Kill Lines		300	1,000
	Choke Manifold		300	1.000
13-3/8	13-5/8 Annular	5K	300	2,500
	13-5/8 Pipe Ram	10K	300	3,000
	13-5/8 Blind Ram	10K	300	**1,000**
	13-5/8 Single Ram	10K	300	3,000
	Choke / Kill Lines		300	3,000
	Choke Manifold		300	3,000
9-5/8 – 7 – 4 ½	13-5/8 Annular	5K	300	3,500
	13-5/8 Pipe Ram	10K	300	6,500
	13-5/8 Blind Ram	10K	300	**1,500**
	13-5/8 Single Ram	10K	300	6,500
	Choke / Kill Lines		300	6,500
	Choke Manifold		300	6,500

- Pressures to be hold for 15 min (Low P for 5 minutes and High P for 15 minutes).
- Pressure tests and operational checks for BOP equipment shall be made as follows :

- When installed or repaired.
- Every fourteen (14) days.
- Before entering to high pressure zone.

- In case of not having a test plug, blind rams will be tested before drilling out the plugs, subjecting the cement to the test pressure. In this case:

- Blind ram will only be function tested after drilling the plugs.

- Schlumberger WSS shall witness BOP pressure tests. Test charts shall be sent to office after the test.
- Ensure Casing–Casing Annulus Wing Valve is opened prior to BOP pressure tests.

Conclusion

For successful and safe drilling operations, drilling programs are a necessity. A well-designed drilling program can increase drilling efficiency, reduce costs, and ensure better safety outcomes by carefully considering a number of drilling program development factors, such as site selection, drill bit selection, drilling fluid preparation, and safety considerations. More research is needed in areas such as the integration of cutting-edge technologies and the creation of new drilling risk assessment techniques in order to improve drilling program's design and implementation.

Additionally, there is a growing need for the development of sustainable drilling practices that minimize environmental impact and reduce carbon emissions. As the demand for energy continues to increase, it is crucial to prioritize the advancement of drilling technologies and practices that promote both efficiency and sustainability.

Overall, this paper has highlighted the importance of drilling programs for the oil and gas industry, and the need for continued attention to drilling program design and execution. The findings presented in this paper can serve as a valuable guide for drilling engineers and industry stakeholders seeking to improve drilling operations and maximize drilling efficiency while maintaining safety. Ultimately, the importance of drilling programs cannot be overstated, and it underscores the need for continued investment in research and development to advance drilling program design and execution.

Finally, it is important to consider the environmental impact of drilling activities and to develop strategies for minimizing this impact. By addressing these factors, the efficiency and effectiveness of drilling programs can be improved while also ensuring responsible and sustainable practices.

Appendix A

Recommendations for Cementing 18 5/8" Job

- The amount of cement and additives should be calculated based on the final cementing program.
- Take a sample of mix water (2gals).
- Take a sample of cement.
- Double check calculation with the Company Man (volumes, displacement) before the job.
- Inspect thread connection on the wellhead.
- Perform risk assessment and discuss contingency plans with the Co-Man.
- Use a pressurized mud balance to physically check the density.
- Make sure that the yield point is dropped below 30lbf / 100ft^2 while circulating prior to cement job.
- A minimum standoff of 75% is recommended for better cement coverage in the annulus.
- Have a pressure sensor on the rig floor to record the pressure during circulation and displacement.
- Pump the lead slurry until the return is observed at surface, then, start pumping the tail slurry.

Appendix B

Recommendations for Cementing 13 3/8" Job

- Make sure the blend is transferred several times from one silo to another.
- The blend must be transferred on the field.
- Do not open the jet to fluff the blend.
- This will induce particles segregation.
- Make sure the thread of the casing and the cement head are compatible.
- Ensure O-rings are available on the cement head.
- Co-Man is to witness plug loading.
- Physically check the type and condition of the plugs.
- The cement head should not be more than 3m above the rig floor.
- Install a pressure sensor on the rig floor to record the pressure during circulation and displacement.
- The amount of cement and additives should be calculated based on the final cementing program.
- Double check calculation with the Co-Man (volumes, displacement) before the job.
- Double check the brine's density with a pressurized mud balance before adding other chemicals.
- Prepare mix fluid as soon as casing running is started.
- This will allow having the result of confirmation test before starting the job.
- Review the total amount of additives used with the Engineer (amount of chemicals, water, salt, etc).
- Send a sample of mix fluid (2gals) to the base for confirmation lab test.
- Send also a sample of blend.
- Confirmation lab test should match pilot test result.
- Get the confirmation test result before starting the job.
- Perform risk assessment and go through contingency plans with the Co-Man.
- Use a pressurized mud balance to physically check the density.
- A minimum standoff of 75% is recommended for better cement coverage in the annulus.
- Check mud rheology during circulation.
- Keep an eye on circulation process to make sure the recommendations are followed.

- Note pumping rate and record pressure.If the plug does not bumped at the end of theoretical displacement, check with the Co-Man and pump half of the shoe track volume. Once the plug is pumped, keep the pressure for 15 min before bleeding off.

Appendix C

Recommendations for Cementing 9 5/8" Job

- Make sure the blend has been transferred several times on the field from one silo to another.
- Do not open the jet to fluff the blend. This will induce particles segregation.
- Double check the brine's density (1.13sg - 1.14sg) with pressurized mud balance before adding other chemicals.
- Prepare mix fluid as soon as they start running casing in order to have the result of confirmation test before starting the job.
- Make sure the thread of the casing and the cement head are compatible.
- Ensure O-rings are available on the cement head.
- Co-Man is to witness plug loading.
- Physically check the type and condition of the plugs.
- The cement head should not be more than 3m above the rig floor.
- Install a pressure sensor on the rig floor to record the pressure during circulation and displacement.
- The amount of bulk and additives should be calculated based on the final cementing program.
- Double check calculation with the Co-Man (volumes, displacement) before the job.
- Review the total amount of additives used with the Engineer (amount of chemicals, water, and salt).
- Send a sample of mix fluid (2gals) to the base for confirmation lab test.
- Get the confirmation test result before starting the job.
- Perform risk assessment and go through contingency plans with the Co-Man.
- Make sure that the mud rheology is lowered ALARP.
- Make sure the mud coming back on the shaker is free of cutting.
- Use a pressurized mud balance to physically check the density of fluids.
- Note: If losses occur at the end of 12 1/4" section, fiber material should be added to the slurry to minimize losses.

Appendix D

Recommendations for Cementing 7" Job

- Double check calculation with the Co-Man (volumes, displacement) before the job.
- The displacement should be done with the cement unit.
- Perform risk assessment and go through contingency plans with the Co-Man.

For example:

    - Do not store mud for displacement in cementing unit tank until the liner is set.
    - This is to avoid mud settling since the tank does not have agitator Split the displacement volume in two parts: the volume required to shear the top dart and, the displacement volume of the liner itself.
    - This will enhance the chance to bump the plug.

- Make sure the returned mud on the shaker is clean and free of cuttings.
- If the pressure is high, review Risk assessment and contact the base for advises.
- Use a pressurized mud balance to physically check the density.
- Although the slurry is batch mixed, it must be passing through the NRD in order to record its density.
- Execution of the job at the end of mud circulation, hold a pre-job meeting on the rig floor (without stopping circulation) to review job procedure and contingency plans.
- Review all pressure picks expected through out the job. Batch mix the slurry.
- Fluids sequence during displacement should be as per the program to avoid contamination at liner hanger when pulling out to reverse circulate.
- Slow-down at the end of displacement to witness the increment of final pressure.
- If the plug does not bump, check with the Co-Man and pump half of the shoe track.
- Once the plug is bumped, hold the pressure for 15 min before bleeding off.

Appendix E

Recommendations for Curing Mud Losses

Normal Formation Losses

Seepage Losses

- In case of drilling the WBM section, sweeps with high Bentonite content can seal off the formation.
- In case of intermediate OBM sections 14.25 to 28.5 Kg/m^3 of fine and medium LCM pills can be used to sweep the hole.

Partial Losses

- The hole should be swept with pills comprising 99.75 to 114Kg/m^3 pre-hydrate Bentonite followed by pills comprising 71.25 to 85.5Kg/m^3 coarse and medium LCM (Mica, Nut Plug, and Kwik Seal) in the WBM section.
- In the intermediate OBM sections spot or sweep the hole with 71.25 to 85.5 Kg/m^3 of medium to fine LCM pills.

Complete Losses

- Pills comprising 142.5 to 171 kg/m^3 various grades of LCM (Mica, Nut Plug, and Kwik Seal) should be spotted on bottom and allowed to squeeze into formation.

Production Zone Losses

Partial Losses 2 to 10m^3/hr

Mix and sweep hole with 8m^3 LCM pill formulated with:

1. 30kg/m^3 CaCO3 (50micron).
2. 30kg/m^3 CaCO3 (150micron).
3. 30kg/m^3 Mix II or Ultra Seal XP.
4. 3kg/m^3 VG-69.

NB: The pill will be pumped through the MWD and bit.

Heavy Losses to Complete Losses Over 10 m^3/hr

Mix and spot 12 m^3 LCM pill formulated with:

1. 150 to 250kg/m^3 CaCO3 (50micron).
2. 250to 450kg/m^3 CaCO3 (150micron).
3. 150kg/m^3 Magma Fiber M or Ultra-Seal C.
4. 3kg/m^3 Vg-69.

NB: The pill will be pumped through open ended drill pipe.

Displacement Procedure:

1. Pump the pill with 1000l/min.

2. As the pill reach the bit; lower the pump rate again to approximately 700l/min.

3. This will allow time for an effective seal to be made across the thief zones.

4. Prior to tripping, pull out slowly to casing shoe, and resume circulation with 400l/min for 2 hours, then the pumps can be slowly increased to their normal speed while observing the level.

5. Should full returns be achieved, run back to bottom and continue drilling whilst observing the pit level.

Water well, water tanks & water transfer pumps have to be in good order all time.

Appendix F

Pumping Procedure for Acid Pill

- Place the pumping units and the trucks, ensuring safe exit routes.
- Perform the pre-job safety meeting with all personnel on location:
  - Explain risks related to the operation.
  - Explain the roles in the operation.
- Rig up all equipment.
- Pressure test lines to 5,000psi for 15min.
- Pump 2m^3 of diesel (gas-oil).
- Pump 1m^3 of inhibitor (992lts of water + 8lts of inhibitor).
- Pump 10m^3 of HCl acid at 15% (550lts of water + 434lts of acid 33% + 10kg of sequestrate 0.03in agent + 10lts of corrosion inhibitor + 5lts of demulsifier).

Note: The volume of acid to be pumped will depend on the formation length to be dissolved (Turonien 100 to 130m). To dissolve 1m^3 of limestone, 12.269m^3 of 15% acid is needed.

- Pump 1m^3 of tail pill (950 lts of water + 50 lts of surfactant).
- Leave the pill in the open hole to actuate for 2hr (1hr minimum).
- Circulate the fluids with high Flowrate (reduce the Flowrate when the pill is at surface because the reaction produced by the formation might produce carbonic gas).
- If the string is free, continue operations as planned, otherwise, prepare and pump a second acid pill.

Safety Remark:

- Request the MSDS (Materiel Safety Data Sheet) of the products to be used.
- Prepare a safety perimeter around the operational area.
- PPE utilization is mandatory.
- Limit personnel movement around the working areas.

Appendix G

Pumping Procedure for Fresh Water Pill

- Pump 2m^3 of diesel.
- Pump 8m^3 of water.
- Pump 2m^3 of diesel.
- Spot water across the stuck pipe in salt zone.
- Displace 50liter every 5min.
- Circulate out the pill and dump it at surface.

Appendix H

Recommendations for Lifting BOP

- Disconnect flow line and remove bell nipple through the rotary table as follows.

- M/U an additional joint on to casing string and hold entire casings on elevator. (Special attention must be paid while lifting BOP after 7" Tie Back in order not to un-sting the tie-back string).

- Remove slip spider and master bushings.

- Lift bell nipple above the rotary table.

- Re-install slips on to casings.

- Un-latch elevator and remove the bell nipple.

- B/O and L/D last joint.

- Lift BOP.

Appendix I

General Recommendations

- **Mud logging**

The mud-logging unit plays a key role in the data acquisition program. For this reason, all sensors have to be calibrated for accurate recordings. For a better follow up of the performance of the drilling bits, the different equipment and the well trajectory, it is necessary to keep a daily record of the following in the daily operations report.

- **Drilling bits**

- Record real rotation time on bottom.

- Report ROP for each geological section, with and without connections.

- Prepare hydraulic and torque & drag simulations before running in hole any equipment.

- Check the bit nozzles, wrenches and bit breaker every time a bit received at the Well site.

- Back-load all accessories to the base together the bit.

- **Wellhead**

- Check all wellhead components upon receiving them at the Well site. Casing spools must be delivered with the bolts for the UPPER flange.

- Ensure spare sealing elements are available at the Well site in case of a leak.

- **Floating Equipment**

- Check all floating equipment and ensure that they have the required range. i.e. grade, ID etc.

- Function tests the floats upon receiving.

- Always witness when the cement head is being loaded.

Appendix J

SHOE-TRACK Drillout Guidelines

1. The last 4-6 casing connections float shoe and collar threads should all be thread-locked.

2. The top plug should be released while still pumping to put at least 3m (10ft) of cement above plug (tailing-in). This precaution may not be necessary if a non-rotating plug is being used, and the crews are confident that the plug will set correctly.

3. Excessive weight on bit and rotary speed can both promote shoe joint failure as well as damaging the bit.

4. Insufficient mud flow rate can allow debris to build up on the bit face.

5. Normally a short tooth roller cone bit should be used to drill out conventional float equipment, but bear in mind the materials that have to be drilled out and the properties of the formation beneath shoe.

6. Use 1 tone per inch of bit diameter & 40 to 60rpm with steel tooth bit, TCI bit may need slightly higher WOB.

7. The mud flow rate should be 130 to 190lpm per inch of bit diameter.

8. Raise the string several feet of the bottom frequently while circulating and rotating to clear debris from bit.

9. Avoid running high weight on bit until the stabilizers are out of the casing and in fresh hole.

10. The reduced stabilization can allow the bit and drill string to vibrate in a way that is damaging to the bit and/or down hole tools.

11. Plug spinning can be a problem when drilling out, particularly with fixed cutter bits. Non-rotating plugs are preferred.

12. Risks of getting stuck though cement caving. It is good practice not to drill out plug and float equipment through the cement in the rat hole and into fresh formation in one pass. If this is done, there is potential for getting stuck should a block of cement become dislodged and fall on top of the bit.

13. Pulling back into casing and circulating after drilling ahead for one meter, can reduce the potential of this happening.

Bibliography

[1] 17-BDT-310907. *Product Catalog SMITH Bits*. Schlumberger. 2018. URL: https://bit.ly/3HRBXzf.

[2] W.J. van Beest. *Casing cementing design program guidelines*. Drilling Manual, Sept. 2022. URL: https://bit.ly/44z63Bk.

[3] *Drilling Pre-spud Checklist*. Drilling For Gas.com, 2022. URL: https://bit.ly/42j0ULO.

[4] *Groundbreaking PDC Drill Bit Technology*. Ulterra, 2015. URL: https://ulterra.com/groundbreaking-pdc-drill-bit-technology/.

[5] *Health, Safety And Environment In Drilling Industry*. Drilling Mentor Pvt. Ltd. Feb. 2019. URL: https://bit.ly/3nWgXR6.

[6] iadclexicon. *Well Control*. Oil, Gas, and Sulphur Operations in the Outer Continental Shelf, 30 CFR 250. 2013. URL: https://iadclexicon.org/well-control/.

[7] Nasr Elsayed & Shalaby Mohamed. *TOU-15 Drilling Program V1 & 2*. Sonatrach. Hydra, Algiers, Algeria, Aug. 2011.

[8] *Onshore drilling site basis of design*. Wellperform. URL: https://bit.ly/3LUfmnZ.

[9] *Procedure for the Pressure Mechanical Integrity Test for the Casing of an Underground Hydrocarbon Storage Well*. Jan. 2011. URL: https://bit.ly/3ps2RHx.

[10] *Roller cone bits catalog compress*. Varel Energy Solutions. Feb. 2015. URL: https://bit.ly/3LSU6il.

[11] Devereux. Steve. *Practical well planning and drilling manual*. PennWell Books, 1998, p. 18.

[12] *TCI bit 8 1/2" IADC 537*. Baker Hughes. 2023. URL: https://bit.ly/3nZa8hy.

[13] Snow Zhao. *6" bit iadc 637 tci rock drilling bit*. Hebei Ranking Bit Manufacture Co., Ltd. 2020. URL: https://rankingbit.com/tricone-bit/.