iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** VI **Month of publication:** June 2017

DOI:

Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

A Review on Planning for An Exploratory Well

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Abstract: A well is planned generally to ensure it is safe and economical in nature. It integrates engineering principles co-private or personal philosophies. Prospect development, data collection, pore formation, geology, casing design, mud program, cementing, bit program, drill string design, hydraulic &pressure loss, rig size &selection, logging, drill time projection and well cost d may be include.

Further a proper assembly of these disciplines to create a plan is essential hence it must be noted that without precision and decisive thinking a plan will never be successful.

In the current paper, the standards which were set in the industry are being displayed in full view, so as to give a detailed understanding to any amateur the different aspects as well as the complex nature of well planning. It incorporates various works of authors that we found highly intriguing. The conclusion is that a simple investment in planning a well and its personnel will go a long way in ensuring success.

Key words: Well planning, safety, economical, engineering principles, parts of well plan, the statistics.

I. INTRODUCTION

A proper plan is essential before commencement of any activity in today's highly demanding oil and gas industry. To comply with today's industry and its standards companies make sure to plan in advance any activity performed or to be performed .The objective is to provide the required sophistication to ensure that a well is completed in the safest and economical way possible, keeping safety prior [1]. Further to understand the interdisciplinary nature that exists in corporations and their hand in hand coordination between teams in successfully completing any job.

The idea of well planning involves the use of a comprehensive study of the different aspects of the whole drilling process right from prospect development to casing and drill string design to cost estimation. It makes use of simple reasoning and logical analysis of a field and assesses the data that is available to provide a plan that can be both productive and time saving.

Well planning formulates a program from many variables for drilling a well with the basic objectives.

A. Safe
B. drilled at minimum cost
C. Meet certain technical objectives.

The priority involves the safety of the well that should be designed to minimize the risk of blowouts and other factors that could create problems[2].

The two factors that most influence well planning are formation pressure and fracture pressure and this represent the limits within which drilling operations are able to continue - the "drilling window". Accurate estimates of both are required in order to optimize well design and perform operations in a safe and efficient manner.

II. METHODOLOGY

A. Activities before the Start of Drilling

These are following activities performed before the drilling takes place

1) Survey of surface/subsea location. Sometimes the cost can be reduced by a small change in surface location.
2) Civil works and foundation for onshore drill site and soil coring/sea bed survey in case of offshore well.
3) Preparation of Geo- Technical Order.
4) Preparation of complete well plan.
5) Preparation of bill of material and initiation of purchase procedure, if required.
6) Procedures from obtaining sanction for purchase to receipt of material.

The various input data are thoroughly analyzed and the Geo- Technical Order (G.T.0) is prepared which provides broad guidelines for drilling of the well.

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B. Data Collection

The collection of data is based on the objective of the well, seismic data, location map, structural map, expected pore pressures, offset and correlation logs and information on formation type, top and thickness. Offset and correlated drilled wells data consisting of bit record, mud reports. The reports are based on Mud logging, drilling r, well completion, complication and production/injection histories, Proposed logging, testing and coring Program, Government reflection and Company's policy.

C. GTO

The first step before spudding any well is the well program. It is an effective well program before drilling helps in knowing where to start all activities it serves as a guide in a tough environment[3]. This program of the well which covers all geological aspects and other technical data serves as a guide during the course of drilling is termed as a “geotechnical order” as shown in Fig.1 . It is also known as Blue print of well execution. It Contains data, likely to be encountered during drilling & precautions to be taken. It serves as guidance to Geologists, Drillers, Chemists & other Service Groups. It is Jointly prepared by Geology, Drilling, Mud services, Logging and Well Services team.

It carries

1) General data like well name, well number, Area, location, water depth, Elevation, well type, category, objectives of the well etc.

2) Geological data consists of following details:

a) Depth

b) age

c) Formation

d) Lithology

e) Interval of coring

f) Electro logging, Collection of cuttings, Angle of Dip

g) Oil/gas zones

D. Leak off Test (LOT)

Conducting an accurate leak off test is fundamental to preventing lost circulation. The LOT is performed by closing in the well, and pressuring up in the open hole immediately below the last string of casing before drilling ahead in the next interval. On the basis of the point at which the pressure drops off, the test indicates the strength of the wellbore at the casing seat, typically considered one of the weakest points in any interval. However, extending an LOT to the fracture-extension stage can seriously lower the maximum mud weigh0t that may be used to safely drill the interval without lost circulation. Consequently, stopping the test as early as possible after the pressure plot starts to break over is preferred[5].

E. Formation Integrity Test (FIT)

To avoid breaking down the formation, many operators perform an FIT at the casing seat to determine whether the wellbore will tolerate the maximum mud weight anticipated while drilling the interval. If the casing seat holds pressure that is equivalent to the prescribed mud density, the test is considered successful and drilling resumes.

When an operator chooses to perform an LOT or an FIT, if the test fails, some remediation effort typically a cement squeeze should be carried out before drilling resumes to ensure that the wellbore is competent.

F. Hydrostatic Pressure

Hydrostatic pressure is the pressure exerted by a column of fluid and is calculated by multiplying the density gradient of the fluid by the true vertical depth at which the pressure is being measured. Most well control calculations revolve around this basic equation:

G. Hydrostatic Pressure = Fluid Density Gradient x True Vertical Depth

There are 3 units of measurement used by TSF world-wide, namely: Oilfield, SI and Metric. To convert a mud weight into a pressure gradient a conversion factor is required as follows:

Oilfield units: Ph (psi) = 0.052 x MW (ppg) x TVD (ft)

SI units: Ph (kPa) = MW (kg/m3) ÷ 102 x TVD (m)

Metric units: Ph (bar) = MW (kg/l) ÷ 10.2 x TVD (m)

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H. Formation Pore Pressure

Formation pore pressure is defined as the pressure exerted by the formation fluids on the wells of the rock pores. Formations are classified on the basis of the magnitude of their pore pressure gradients. In general, two types of the formation pressure are known Normal Formation pore pressure (hydro-pressure) which equals hydrostatic pressure of a full column of formation water. Normal pore pressure is usually of the order of 0.465 psi/ft. Then, Abnormal Formation pore pressure (geo-pressure) exists in regions where there is on direct fluid flow to the adjacent regions. The boundaries of such regions are impermeable, preventing the fluid from flowing, and trapping it, so that it takes a large proportion of the overburden stress. Abnormal formation pore pressure usually ranges between 08 to 1 psi/ft. Formation pore pressure can be predicted by a geophysical method before a well is drilled or by logging method after a well has been drilled.

I. Formation Fracture Gradient

In the process of the well planning, to ensure safe drilling operations, several key elements must first be evaluated. These are:

1) Formation pore pressure and in situ stress determination.
2) Casing design and casing death selection.

The accurate determination of formation fracture gradient is as essential to predict the formation pore pressure. This is because the fracture gradient provides data for casing design and the critical well bore pressure during drilling operations. By definitions, the formations fracture gradient is the process required to induce fractures in the rock formations at a given depths.

3) Two methods are used to determine formations fracture gradient,
a) The direct method relies on an experimental approach, by determining the pressure required fracturing the rock and then pressure required to propagate the resulting fractures.
b) The indirect method is based on analytical models which use stress analysis techniques to calculate a fracture gradient.

J. Direct method

In this method, drilling fluid is applied to pressurize the well until the rock formations fractures. The mud pressure at fracture, known as leak off pressure is recorded and then added to the hydrostatic pressure of the mud inside the borehole to determine the total pressure required to fracture the formation. The final pressure is known as formation breakdown pressure is established before determining the total pressure required to fracture the formation breakdown pressure. This breakdown pressure is before determining reservoir treatment parameters, while matrix stimulation treatments are performed with the treatment pressure safely below the formation breakdown pressure

The hydrostatic pressure is the normal predict pressure for a given true vertical depth (TVD), or the pressure exerted per unit area by a column of fresh water from sea level to a given depth, TVD is defined as the vertical distance from the final depth of a well in formation to a point at the surface. The lithostatic pressure is the accumulated pressure of the weight of overburden or overlying rock formation.

The propagation pressure or fracture propagation pressure (FPP) is the maximum pressure under which the rock formation will continue fracture propagation in response to increased pressure.

The shut-in pressure (SIP) is the pressure exerted at the top of a wellbore when it is closed, which may be from the formation or an external and intention source. The SIP may be zero, indicating that any open formation is effectively balanced by the hydrostatic pressure in the well, in which case the well is considered to be dead, therefore safe to be opened to the atmosphere.

K. Indirect method

There are several indirect methods that use stress analysis techniques for predicting the fracture gradient[6]. Some of these methods are given below:

1) Hubbert and Willis Method
2) Matthews and Kelly Method
3) Pennebaker Method
4) Eaton Method
5) Christman method

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L. Hubbert and Willis method

Introduced by Hubbert and Willis (1957) the method assumes that fracture occurs when the applied fluid pressure exceeds the sum of the minimum effective stress and the formation pore pressure. This is shown by following formula:

$$G_f=\frac{1}{2}\left(\frac{\sigma}{d}+2\frac{P_o}{d}\right)$$

The main disadvantage of this method is that it predicts a higher fracture gradient in abnormal pressure and a lower one in subnormal pressure formations. The maximum calculated value for formation fracture gradient is given by:

$$G_f=\frac{1}{2}\left(\frac{\sigma}{d}+2\frac{P_o}{d}\right)$$

M. Matthews and Kelly method

Introduced by Mathews and Kelly (1967), this method is used for rock formation found in the northern region of North Sea and the Gulf of Mexico, where the Hubbert and Willis method is less accurate. This method is expressed by the following formula:

$$G_f=f_c\left(\frac{\sigma_v}{d}-\frac{P_o}{d}\right)+\frac{P_o}{d}$$

N. Pennebaker Method

The Pennebaker method (1968) uses seismic data, and is similar to the Matthews and Kelly method. Pennebaker noted that the overburden pressure gradient is variable and can be related to the geological age of the rock. In developing a set of curves for overburden pressure gradient versus formation depth, Pennebaker assumed a predictable relation between bulk density and velocity of sedimentary rock.

The Penne baker method is expressed by the following formula

$$G_f=f_p\left(\frac{\sigma_v}{d}-\frac{P_o}{d}\right)+\frac{P_o}{d}$$

This coefficient is estimated empirically from the fracture propagation pressure of the location of the interest.

O. Eaton Method

This method is basically a modified version of the Hubbert and Willis (1957) method, where both overburden pressure and Poisson's ratio are assumed to be variable (Eaton, 1969). Although most rocks tested in laboratory have a Poisson's ratio of 0.25 – 0.30, under field conditions this may vary from 0.25 – 0.5. The Eaton method, used widely in the oil and gas industry, is represented by the following formula:

$$G_f=\frac{\upsilon}{1-\upsilon}\left(\frac{\sigma_v}{d}-\frac{P_o}{d}\right)+\frac{P_o}{d}$$

P. Christman method

As a modification of the Eaton method, the Christman method is used to predict the fracture gradient in offshore fields where the depth consists of the water depth and the formation depth. Since water is less dense than rock, the G_f at a given depth is lower for an offshore well at the same depth. This method is expressed by the following formula:

$$G_f=f_p\left(\frac{\sigma_v}{d}-\frac{P_o}{d}\right)+\frac{P_o}{d}$$

Q. Casing Design

Fig 1 CASING PIPE

It isolates porous formations with different fluid-pressure regimes and also allows for isolated communication within the selectively perforated formations of interest shown in fig.1. It seperates troublesome zones (high pressured zones, weak and fractured formations, unconsolidated formations, and sloughing shale's) and it allows drilling operation to be carried out to the total depth[7]. and

1) Prevents the hole from caving in.
2) Serves as a high-strength flow conduit to the surface for both drilling and production fluids.
3) Prevents near-surface fresh water zones from contamination with the drilling mud.
4) Provides a connection and support for the wellhead equipment and blowout preventers.
5) Provides exact dimensions for running testing, completion, and production subsurface equipment.

R. Casing types

1) *Conductor Casing:* The setting depth can vary from 10ft to around 300ft.The normal size range for conductor pipe is from 20 to 36 inches(outside diameter).The conductor pipe must be large enough to allow the other casing strings to be run through it shown in Fig.2.
2) It isolates very weak formations.
3) It prevents erosion of ground formations below the rig.
4) It provides mud flow path.
5) It supports the weight of the subsequent casing strings and prevents washouts in the near surface area.

S. Surface Casing

Surface casing is usually set in the first competent formation. Normal size for surface casings between 20inch and 13-3/8inch (outer

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ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

diameter)[8].

1) Provides a means of nipping up BOP.
2) Provides a casing seat strong enough to safely close in a well after a kick.
3) Provides protection of fresh water sands.
4) Provides wellbore stabilization.
5) Provides a sufficient leak off test to be conducted.
6) Minimizesthe lost circulation into shallow and permeable zones.

T. Intermediate Casing

Normal sizes are between 9-5/8and 13-3/8 inches(outside diameter).The shoe selected for intermediate casing should be strong enough to withstand fracture during drilling. The next hole section and should be able to take a kick of predefined size.

1) It is also called as a protective casing and it is purely a technical casing.
2) The length varies from 7,000 to 15,000 ft.
3) Provides isolation of a potentially troublesome zone (abnormal pressure formations, unstable shale formations, lost circulation zones and salt sections).
4) Provides integrity to withstand the high mud weights necessary to reach TD or next casing seat.

U. Production Casing

The production casing is often called as 'oil string'. The size of production casing will depend on the expected production rate, the higher the barrel per day of production rate, the larger the inside diameter ofthe pipe,sizes are between 3 and 7 inch(outside).

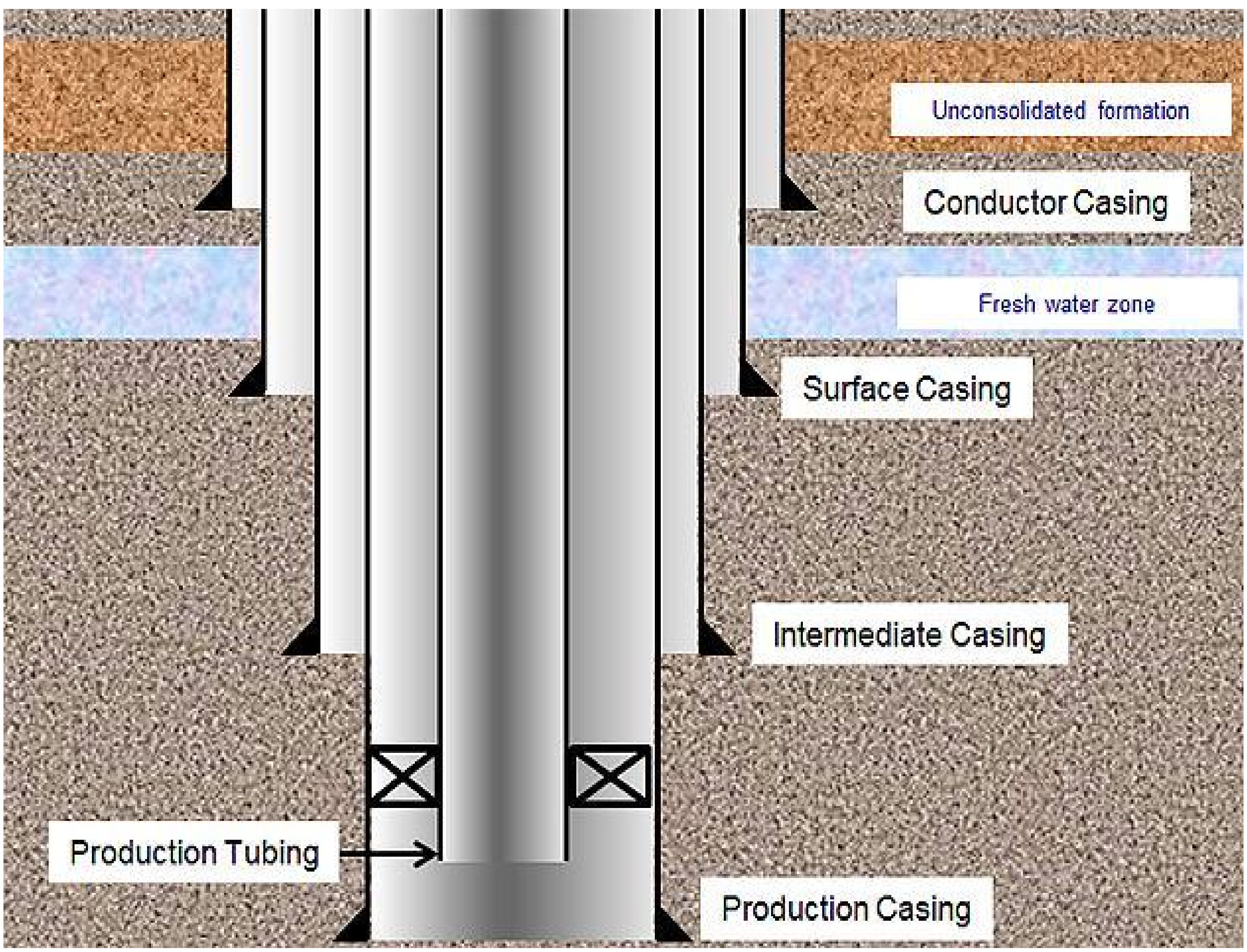

Fig 2: Casing diagram

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V. Liners

These are casings that do not reach the surface. They are mounted on the liner hangers to the previous casing string. Usually, they are set to seal off troublesome sections of the well or through the producing zones for economic reasons (i.e. to save costs).

1) *Drilling Liner*: Same as intermediate/protective casing. It overlaps the existing casing by 200 to 400 ft. It is used to isolate troublesome zones and to permit drilling below these zones without having well problems[9]
2) *Production Liner*: Same as production casing. It is run to provide isolation across the production or injection zones.
3) *Tie-back Liner*: It is connected to the top of the liner with a specially designed connector and extends to the surface, i.e. converts liner to full string of casing.
4) *Scab Liner*: A section of casing used to repair existing damaged casing. It may be cemented or sealed with packers at the top and bottom.
5) *Scab Tie-back Liner*: A section of casing extending upwards from the existing liner, but which does not reach the surface and normally cemented in place. They are commonly used with cemented heavy-wall casing to isolate the salt sections in the deeper portions of the well shown in Fig.3.

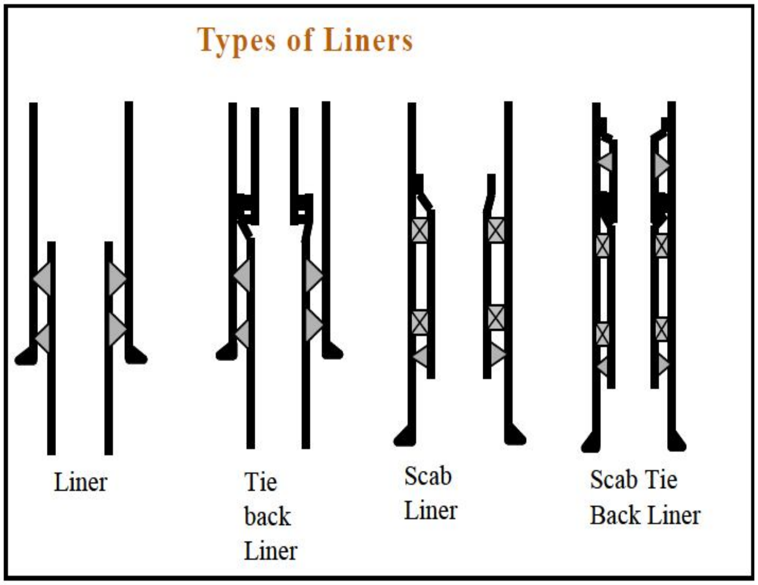

Fig 3: Liners diagram

W. Classifications to be considered are

1) Outside diameter (OD)
2) Inside diameter (ID)
3) wall thickness
4) Drift diameter
5) Length (range)
6) Connections
7) Weight
8) Grade

X. Outside Diameter (OD)

Casing manufacturers generally try to prevent the pipe from being undersized to ensure adequate thread run-out when machining a connection. Most casing pipes are found to be within ± 0.75% of the tolerance and are slightly oversized.

Y. Inside Diameter (ID), Wall Thickness, Drift Diameter

The ID is specified in terms of wall thickness and drift diameter shown in table 1. The maximal ID is controlled by the combined tolerances for the OD and the wall thickness [11]. The minimal permissible pipe wall thickness is 87.5% of the nominal wall

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thickness, which in turn has a tolerance of -12.5%.

The minimal ID is controlled by the specified drift diameter. The drift diameter refers to the diameter of a cylindrical drift mandrel that can pass freely through the casing with a reasonable exerted force equivalent to the weight of the mandrel being used for the test. A bit of a size smaller than the drift diameter will pass through the pipe.

Casing & liner OD (in)	Length (in)	Drift Diameter (in)
≤8-5/8	6	ID-1/8
9-5/8	12	ID-5/32
≥16	12	ID-3/16

Table 1: Inside Diameter (ID), Wall Thickness, Drift Diameter

Z. Connections

Most of the casing pipes are connected together by means of couplings. Different types of the threads are cut on the ends of the pipes. Depending upon the types of the threads at the ends of the casing pipes, they can be specified. The connections must be leak proof but can have a higher or lower physical strength than the main body of the casing point.

The standard types of API threaded and coupled connections are

1) Short thread connection (STC),
2) Long thread connection (LTC),
3) Buttress threads connection (BTC).

AA. Short Thread Connection and Long Thread Connection

Both STC and LTC casing have 8threads per inch cut on them. Strength of LTC coupling is 30% more than the STC in tension shown in table 2.

BB. Short Thread Connection (STC)

Casing size O.D(inch)	Coupling size O.D(inch)	Length (inch)	Weight per coupling (lbs)
5 ½	6.050	9.250	14.14
7	7.656	10.000	23.22
9 5/8	10.625	10.625	50.99
13 3/8	14.375	10.625	69.95
20	21.000	10.625	110.33

CC. Long Thread Connection (LTC)

Casing size O.D (inch)	Coupling size O.D (inch)	Length (inch)	Weight per coupling (lbs)
5 ½	6.050	8.000	14.03
7	7.656	9.000	23.67
9 5/8	10.625	10.500	55.77
13 3/8	14.375	*10.500	*76.63
20	21.000	*11.500	*126.74

*NOT API SPECIFICATION

Table 2. Short Thread Connection (STC)

DD. Grade

The steel grade of the casing relates to the tensile strength of the steel from which the casing is made[12]. The steel grade is expressed as a code number which consists of a letter and a number. The letter is arbitrary selected to provide a unique designation for each grade of casing. The number designates the minimal yield strength of the steel in thousands of psi. For example, K-55 has yield strength of 55,000 psi.

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EE. Weight

The pipe weight is usually expressed as weight per unit length in lb/ft.

1) The three types are:

a) Nominal Weight.

b) Plain-end Weight.

c) Threaded and Coupled Weight or Average Weight.

FF. Nominal Weight

Based on the theoretical weight per foot for a 20-ft length of the threaded and coupled casing joint is

$$W_n = (10.68(OD-t)\,t) + (0.0722*OD^2)$$

The nominal weight is not the exact weight of the pipe, but rather it is used for the purpose identification of casing types.

GG. Plain-End Weight

The weight for the joint of the casing without the threads and couplings is

W_{pe} = 10.68(OD-t) t ppfOr W_{pe}= 0.02466(D-t) t kg/m

HH. Threaded and Coupled Weight or Average Weight

The threaded and coupled weight is the average weight of a joint including the thread at both ends and a coupling at one end when power tight. It is based on a 20 feet long pipe measured from the outer face of the coupling to the end of the pipe and is calculated by the following formulae:

$$W = \frac{1}{20}[Wpe\{\frac{20-(N1+2j)}{24}\} + \text{weight of coupling} - \text{weight removed in threading threading two pipe end}]$$

II. Mechanical Properties of Casing

Casing is subjected to different loads during landing, cementing, drilling, and production operations. The most important loads which it must withstand are tensile, burst and collapse loads.

JJ. Tension

1) Under axial tension, pipe body may suffer 3 possible deformations.
2) Elastic – The metallurgical properties of the steel in the pipe body suffer no permanent damage and it regains its original form if the load is withdrawn.
3) Elasto-plastic – The pipe body suffers a permanent deformation which often results in the loss of strength.
4) Plastic- The pipe body suffers a permanent deformation and breaks.
5) The strength of the casing string is expressed as pipe body yield strength and joint strength.
6) Pipe body strength is the minimal force required to cause permanent deformation of the pipe.
7) Joint strength is the minimal tensile force required to cause the joint to fail.
8) For API round threads, joint strength is defined as the smaller of minimal jointfracture force and minimal jointpull out force.

Tensile force = weight in ppf * 1.48 * length of casing in m

KK. Bending Force

Bending force is the force acting in tension on the outside of the pipe and compressive force on the inside of the pipe and it will be causing the deviation in the well, resulting from side-tracks, build-ups and drop-offs or from sagging of casing caused by lack of centralization wash-outs. Casing is subjected to bending force when run in deviating well. The lower surface of the pipe stretches and is in tension. The upper surface shortens and is in compression. Bending calculation is done with the given formula:

$$B_e\,F = 29 \times RC \times D \times W_n \text{ (kg-f)}$$

LL. Shock Loads

Shock loads is exerted on the casing string because of

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1) Sudden deceleration force, example if the spider accidentally closing or the slips are 'kicked in' on moving pipe or pipe hits a bridge/ledge.
2) Sudden acceleration force, such as picking the pipe out of the slip or if the casing momentarily hangs up on the ledge then slips off it.
3) Any of the above will cause a stress wave to be created which travels through the casing at the speed of sound.
4) Magnitude of shock load can be calculate as follows

   Shock load = $1.55 \times 10^3 \times V \times W_n$ (kg f)

MM. Burst Pressure

Minimum expected internal pressure at which permanent pipe deformation could take place, if the pipe is subjected to no external pressure or axial loads. It is calculated by using the formulae:

$$P_s = \frac{P_b}{e^{0.0001138 \times \rho_g \times D}} \ kg/cm^2$$

NN. Axial Strength

The tensile stress required to produce a total elongation of 0.5% per unit length.

$$F_{10} = \frac{\pi}{4\sigma_{yield}}(d^2{}_k - d^2)$$

OO. Collapse Pressure

Minimum expected external pressure at which the pipe would collapse if the pipe were subjected to no internal pressure or axial loads.

$$P_s = mud\ weight \times \frac{depth}{10} kg/cm^2$$

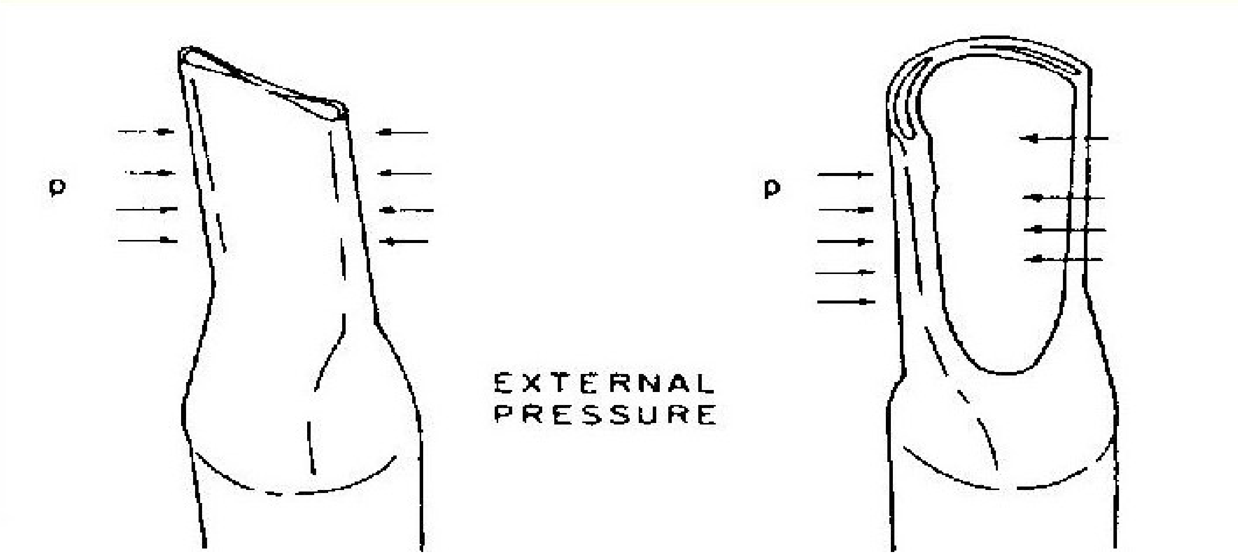

Fig 4.5: COLLAPSE PRESSURE

PP. Safety factor

Casing design is not an exact technique because of uncertainties in determining the actual loadings and also because of the change in casing properties with time resulting from corrosion and wear. A design factor is used to allow for such uncertainties and to ensure that the rated performance of the casing is always rated higher than the expected resultant loading. In other words the casing strength is down rated by the chosen safety factor. Most commonly used design factor for casing design are:

Collapse – 1.00 to 1.125

Burst – 1.00 to 1.20

Tension – 1.60 to 1.80

Safety factor can be defined by as the ratio between rated capacity and actual load.

$$SF_{collapse} = \frac{Ratedcollapseresistanceofcasing}{Actualresultantcollapsepressure}$$

$$SF_{burst} = \frac{Rated\ burst\ rating\ of\ casing}{Actual\ resultant\ burst\ pressure}$$

$$SF_{tension} = \frac{Ratedyieldstrength}{Actualresultanttensileload}$$

QQ. Biaxial Effect

Burst and collapse resistant of casing are alteredwhen the pipe is under tension or compression load. These changes may, but do not unnecessarily apply to connectors. The coupling manufacturers should be consulted in stringent operating conditions. The qualitative changes in the pipe are as shown in table 3.

Types Of Loads	Result
Tension	Collapse – decrease
	Burst – increase
compression	Collapse – increase
	Burst – decrease

Table 3: Biaxial Effect

RR. Casing Seat Selection

Accurate knowledge of pore pressure and fracture gradient plays a major role in the selection of proper casing seats which would allow the drilling of next hole without fracturing. The Pore pressure, mud weight, fracture gradient are used collectively to select proper casing seats shown in Table 4.

Table 4 : Casing Table

Outside Diameter (inch)	Nominal Weight (lbs/ft)	Grade	Collapse pressure(psi)	Burst Pressure (psi) BTC	Wall Thickness (inch)	Inside Diameter (inch)	Drift Diameter (inch) API
7”	35.00	P-110	13020	13700	0.498	6.004	5.879
	29.00	P-110	8530	11220	0.408	6.184	6.059
9”5/8	47.00	P-110	5300	9440	0.472	8.681	8.525
	43.00	N-80	3810	6330	0.435	8.755	8.599
	47.00	N-80	4760	6870	0.472	8.681	8.525
13”3/8	68.00	N-80	2260	5020	0.480	12.415	12.259
	68.00	P-110	2340	6910	0.480	12.415	12.259
	61.00	J-55	1540	3090	0.430	12.515	12.359
16”	84.00	J-55	1410	2980	0.495	15.010	14.822
	97.00	N-80	2270	5030	0.575	14.850	

	133.00	K-55	1500	3060	0.635	18.730	18.542
20”	94.00	J-55	520	2110	0.438	19.124	18.936

SS. Drilling Fluids

Drilling fluids are fluids that are used during the drilling of oil wells[13]. They provide primary well control of subsurface pressure by a combination of density and of any additional pressure acting on the fluid column. They are most often circulated down the drill string, out the bit and back up the annulus, to the surface so that the drill cuttings are removed from the wellbore.

Drilling fluids have a number of alternative names, and slag terms used within the industry. The most widely used name is “mud” or “drilling mud”.

When the formation pressure exceeds hydrostatic pressure there is an influx of formation fluid in the borehole this influx is termed as kick. So the drilling fluid has to be designed very intricately by considering the formation pressure and fracture gradient.

When the drilling fluid weight is greater than the formation pressure by some margin it leads to formation damage. So all design parameters need to be very accurate and precise.

TT. Types of Drilling Fluids

1) Water – based fluids (WBF)
2) Oil – based fluids (OBF)
3) Synthetic – based fluids (SBF)
4) Pneumatic – based fluids.

UU. Functions of Fluids

1) Promote Borehole Stability
2) Mechanical Stability
3) Chemical Stability
4) Remove Drilled Cuttings from Borehole
5) Cool and Lubricate Bit and Drill String
6) Control Subsurface Pressure

VV. Mud density

$$\textit{Mud Density (ppg)} = \frac{Pressure\ (psi)}{TVD\ (ft) \times 0.052}$$

WW. Surge Pressure

When pipe moves downward with mud circulation through drill string, additional bottom hole pressure called “Surge Pressure” is created. If surge pressure is too much, many problems will occurs as formation brake down, partial mud loss and lost circulation.

XX. Swab Pressure

If a drill string, casing string or logging tool is being pulled out of hole too fast, due to bigger diameter almost same hole size, BHA/bit, casing or logging tool will possibly swab mud out of hole, like pulling a small piston of syringe. For this reason, hydrostatic pressure of bottom hole will be reduced. Pressure reduction is created by this situation is called “Swab Pressure”. If swab pressure is too much, kick (wellbore influx) may be into the hole and well control must be conducted in order to secure well.

XX. Trip Margin

It is an increase in the hydrostatic pressure of mud that compensates for the reduction of bottom pressure due to stop pumping and/or swabbing effect while pulling pipe out of hole.

III. CONCLUSION

It has been said time and time again that if we tend to neglect a plan, the ratio of success for any project jumps drastically to the negative. In order to gain an advantage in a success based environment the oil and gas industry is embracing the well planning procedure. To achieve completion of a well plan there are various intricate details which have to be executed perfectly and in synchronization so as to create a safe well. Plans have existed in the past and the time has come for them to be embraced in the future of every field.

There have been numerous statistics thrown around hat show the benefits of well planning in fact there are no records available anywhere about well failure due to prior planning. This project emphasizes our belief in this system of planning prior to drilling a well. Off course time is consumed in planning a well but to be honest the time taken is worth the investment. There can be horrendous outcomes that might happen if a field is exploited recklessly. Which would cost the company in the millions of losses. Hence to prevent an unavoidable disaster it would be worth it to make a plan. Further we would hope that someday every well that is drilled will make use of well planning prior to drilling keeping in mind that safety and human responsibility is of the uttermost priority.

IV. ACKNOWLEDGEMENT

I would like to thank the Mr.Angelino Henry and Mr. Dinesh Raj for contributing in this paper. My sincere thanks to head petroleum engineering department Dr.P.N.Ananthanarayanan who has been instrumental in conducting this work.

A. Nomenclature

Ph = Hydrostatic pressure.
MW = Mud weight.
TVD = True vertical depth.
G_f is the formation fracture gradient (psi/ft) (representing the minimum calculated value).
$\sigma_v$is the overburden stress (psi), d is the formation depth (ft).
P_0 is the formation pore pressure (psi).
f_c is the stress ratio coefficient, and is found from the actual fracture data of a nearby well.
f_p is the stress ratio coefficient, and is a function of Poisson's ratio and the long term deformation.
f_f is the stress ratio factor and must be calculated using the fracture data.
OD=outside diameter (in).
T= wall thickness (in).
W_{pe} = plain weight (ppf or kg/m).
D = diameter (inch or mm).
t = wall thickness (inch or mm).
W = threaded and coupled weight (ppf).
N1 = coupling length (inch).
J = distance from end of pipe to centre of coupling in power tight position (inch).
V = peak velocity while running in m/sec.
W_n = casing nominal weight in ppf.
P_s = Surface pressure considering a gas kick from depth D.
ρ_g= Gas gravity respect to air.
RC = radius of curvature in a degree / 30 m.
D = outside diameter of a pipe in(inch).
W_n = casing nominal weight in ppf.
F_{10} = Axial strength (lbf).
σ_p = Minimum Yield Strength (psi).
d_n = Nominal OD of pipe (in).
d = Nominal ID of pipe (in).
TVD – True Vertical Depth
0.052 – Constant Factor

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