What is CASING ?

- **CASING** IS LARGE DIAMETER PIPE THAT IS ASSEMBLED AND INSERTED INTO A RECENTLY DRILLED SECTION OF A BOREHOLE AND TYPICALLY HELD INTO PLACE WITH CEMENT.
- **CASING** IS THE MAIN PART OF THE WELL CONSTRUCTION. ALL WELLS DRILLED FOR THE PURPOSE OF OIL OR GAS PRODUCTION (OR INJECTING MATERIALS INTO UNDERGROUND FORMATIONS) MUST BE CASED WITH MATERIAL WITH SUFFICIENT STRENGTH AND FUNCTIONALITY.

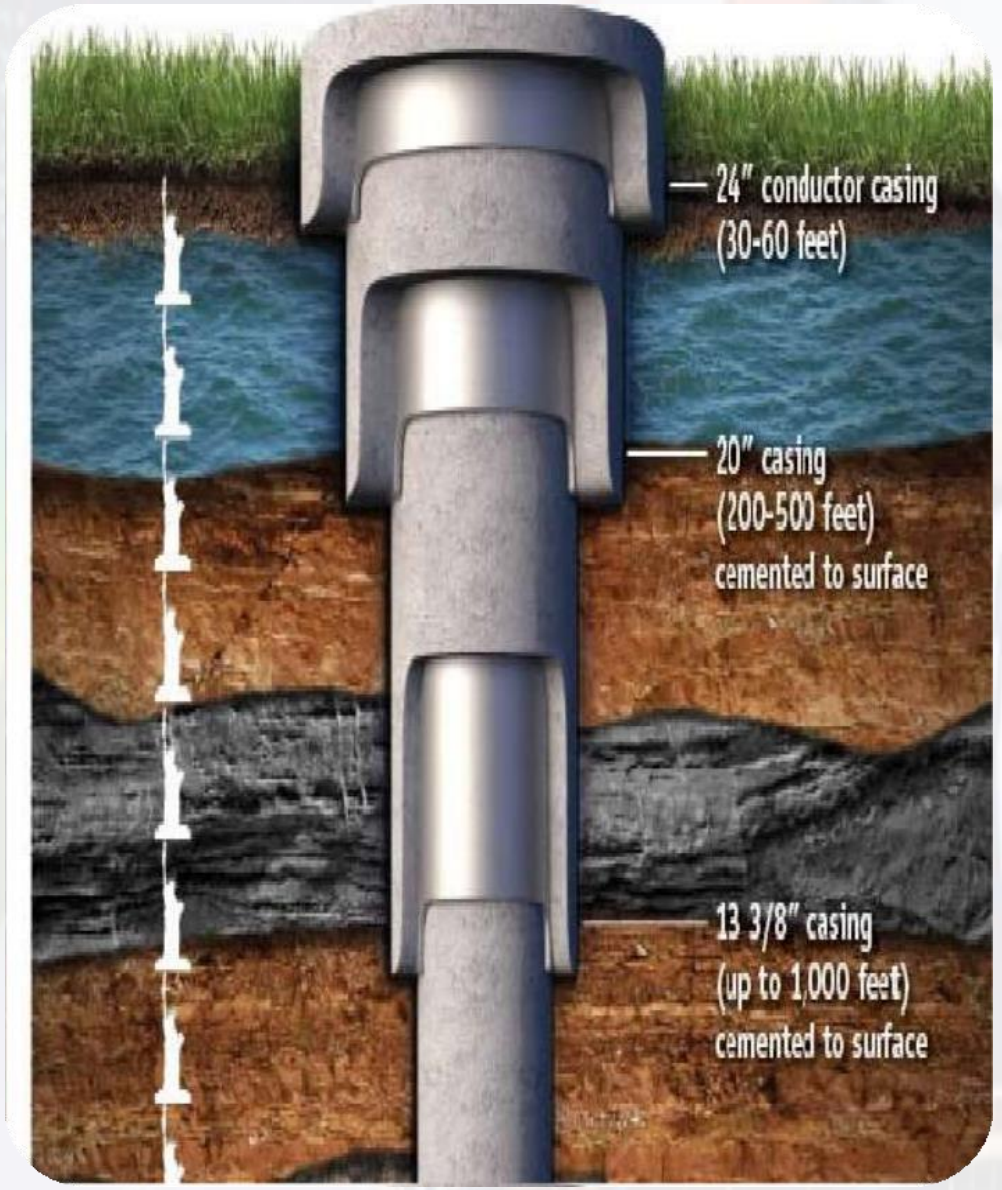
✓ Casing Functions

1. To keep the hole open and to provide support for weak, vulnerable or fractured formations. In the latter case, if the hole is left uncased, the formation may cave in and re-drilling of the hole will then become necessary.

2. To isolate porous media with different fluid/pressure regimes from contaminating the pay zone. This is basically achieved through the combined presence of cement and casing. Therefore, production from a specific zone can be achieved.
3. To prevent contamination of near-surface fresh water zones.
4. To provide a passage for hydrocarbon fluids; most production operations are carried out through special tubings which are run inside the casing.
5. To provide a suitable connection for the wellhead equipment and later the christmas tree. The casing also serves to connect the blowout prevention equipment (BOPS) which is used to control the well while drilling.
6. To provide a hole of known diameter and depth to facilitate the running of testing and completion equipment.

Design of casing

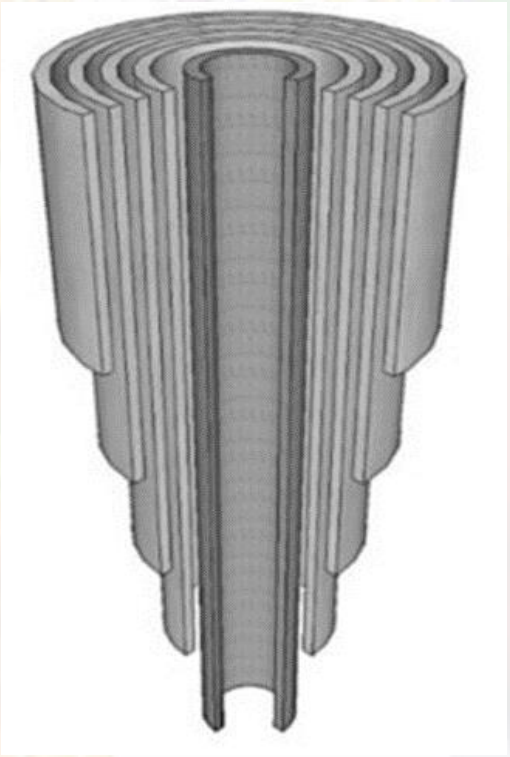
- This **casing string** is made up of joints of pipe, of approximately 40ft (12m) in length, with threaded connections.
- Depending on the conditions encountered, 3 or 4 casing strings may be required to reach the target depth.
- The cost of the casing can therefore constitute 20-30% of the total cost of the well
- Based on subsurface data such as formation pressures, strengths, makeup and balanced against the cost objectives and desired drilling strategy.
- Strategic depths at which the hole will need to be cased in order for drilling to reach the desired total depth.

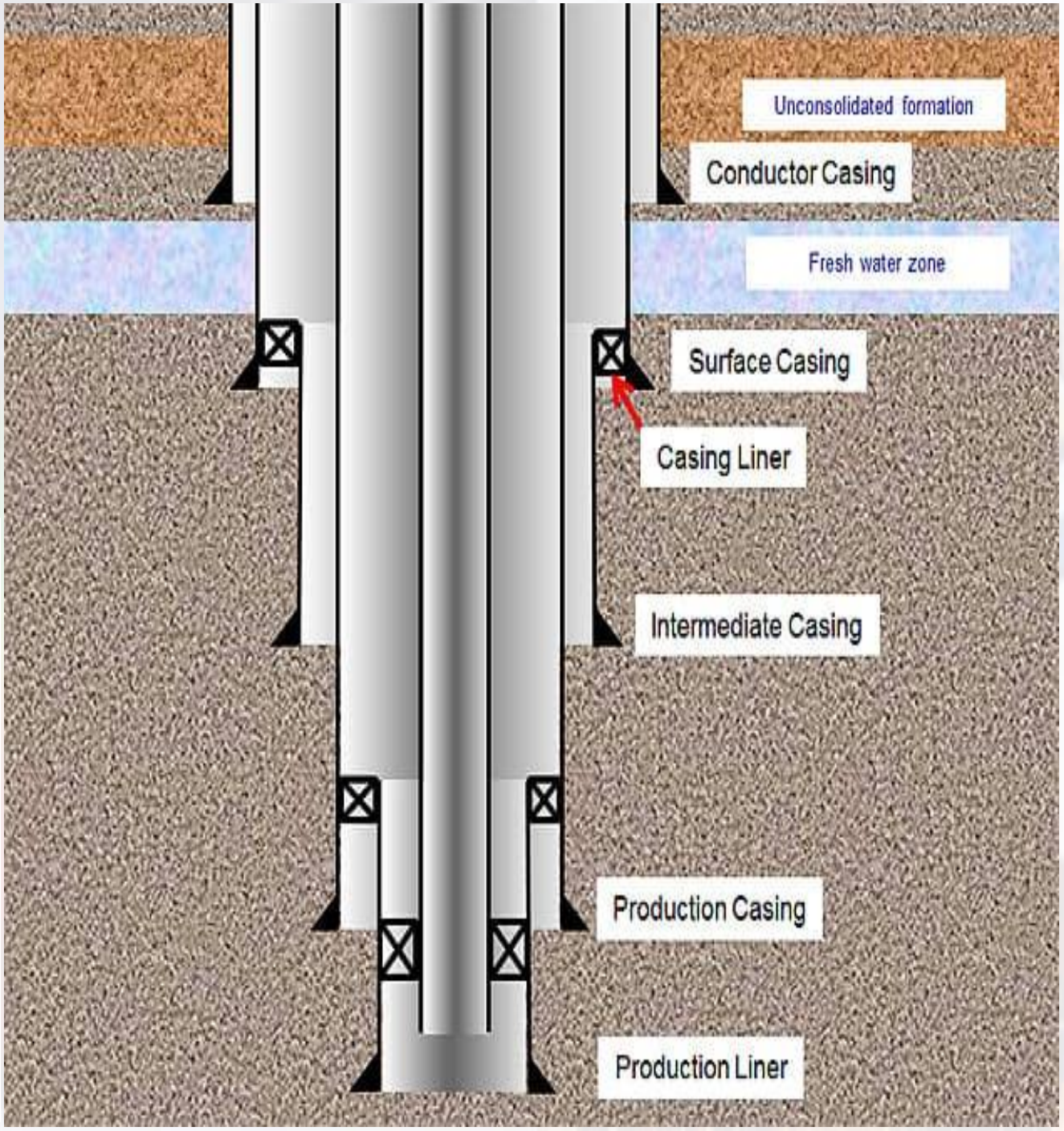


Types of Casing Strings

- There are different types of casing for different functions and drilling conditions.
- They are run to different depths and one or two of them may be omitted depending on the drilling conditions. They are:

1. **Conductor pipe**
2. **Surface Casing**
3. **Intermediate casing**
4. **Production casing**
5. **Liner string**





❖ Conductor pipe

- Run from surface to some shallow depth to :
  - protect near surface unconsolidated formations,
  - seal off shallow-water zones,
  - provide protection against shallow gas flows,
  - provide a conduit for the drilling mud and to protect the foundation of the platform in offshore operations.

- The normal size range for conductor pipe is from 16 to 36 inches (outside diameter). Consequently has the largest diameter Sizes [from **18 5/8 in to 20 in** (In the **Middle East**); and **26 or 30 in**.(In **North Sea**)]

- The setting depth can vary from 10 ft to around 300 ft
- In practical, It is 40 to 500 ft in length for onshore and up to 1,000 ft for offshore.

- Conductor pipe is always cemented to surface. It is used to support subsequent casing strings and wellhead equipment or alternatively the pipe is cut off at the surface after setting the surface casing

❖ Surface casing

❖The surface casing is run after the conductor and is generally set at approximately 300 - 5000 ft below the ground level or the seabed.

❖The main functions of surface casing are:
-to prevent caving of week formation encountered at shallow depths (i.e. Provides wellbore stabilization)

- to seal off any fresh water sands,
- support the wellhead and BOP equipment.
- Should be set in competent rock like limestone: to ensure that the formation will not fractured at the casing shoe by high mud weight used later in the next hole

❖The setting depth of this casing string is important in an area where abnormally high pressures are expected

❖A typical size of this casing is between **20** inch and **13-3/8** inch (outside diameter)[l3 3/8 in. in the Middle East and 18 5/8 in. or 20 in. in North Sea operations].

❖ Intermediate casing

- Intermediate (or protection) casing strings, it is purely a technical casing.
- It is set between the surface casing setting depth and the production casing setting depth.
- It is used to :
  - Provides isolation of potentially troublesome zones (abnormal pressure formations, unstable shales, lost circulation zones and salt sections).
  - Provides integrity to withstand the high mud weights necessary to reach TD or next casing seat

- The number of intermediate casing strings will depend on the number of such problems encountered.

- The size of intermediate casing, will depend on the size of the surface casing and the grade required to withstand the subsurface conditions. Normal sizes are between **9 5/8** and **13 3/8** inch (outside diameter).

Notes:

- Usually set in the transition zone below or above pressured formation (salt and/or caving shale)
- Need good cementing to prevent communication behind the casing between zones; multistage cementing may be used for long strings

❖ Production casing

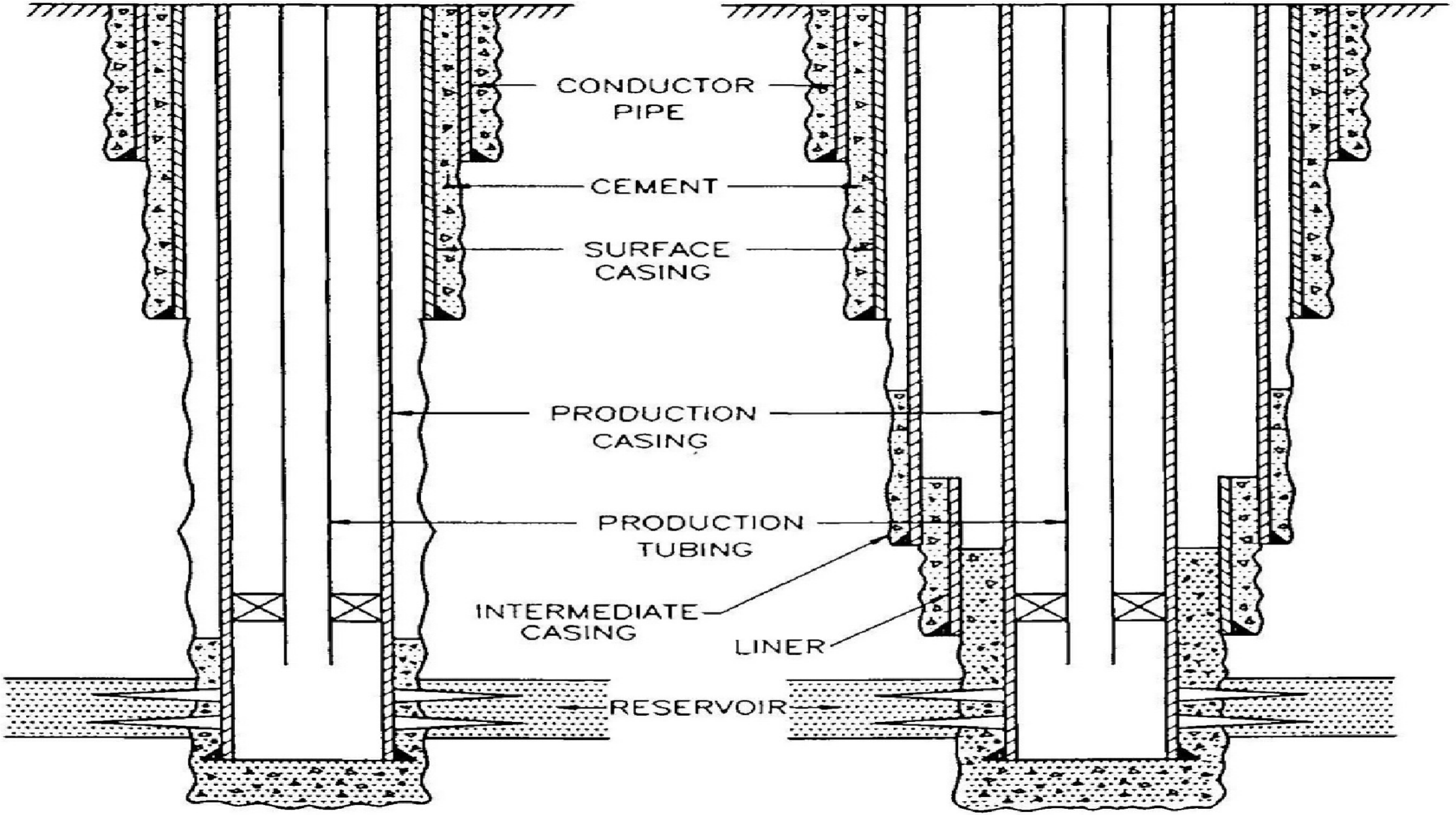
The production casing is either run through the pay zone (i.e. productive zone(s)), or set just above the pay zone (for an open hole completion or prior to running a liner).

The main purpose of this casing is :

- To isolate the production interval from other formations (e.g. water bearing sands) (i.e. prevents migration of water to producing zones, isolates different production zones).
- Confines production to wellbore.
- Provides the environment to install subsurface completion equipment.
- Provides protection for the environment in the event of tubing failure during production operations and allows for the tubing to be repaired and replaced.

Note: Since it forms the conduit for the well completion, it should be thoroughly pressure tested before running the completion.

❖ The size of production casing will depend on the expected production rate, the higher the barrel per day production rate, the larger the inside diameter of the pipe. Common sizes are between 3 and 7 inch (outside diameter) [The usual sizes of this string are 4 1/2, 5 and 7 in.]



(a) HYDRO–PRESSURED WELLS

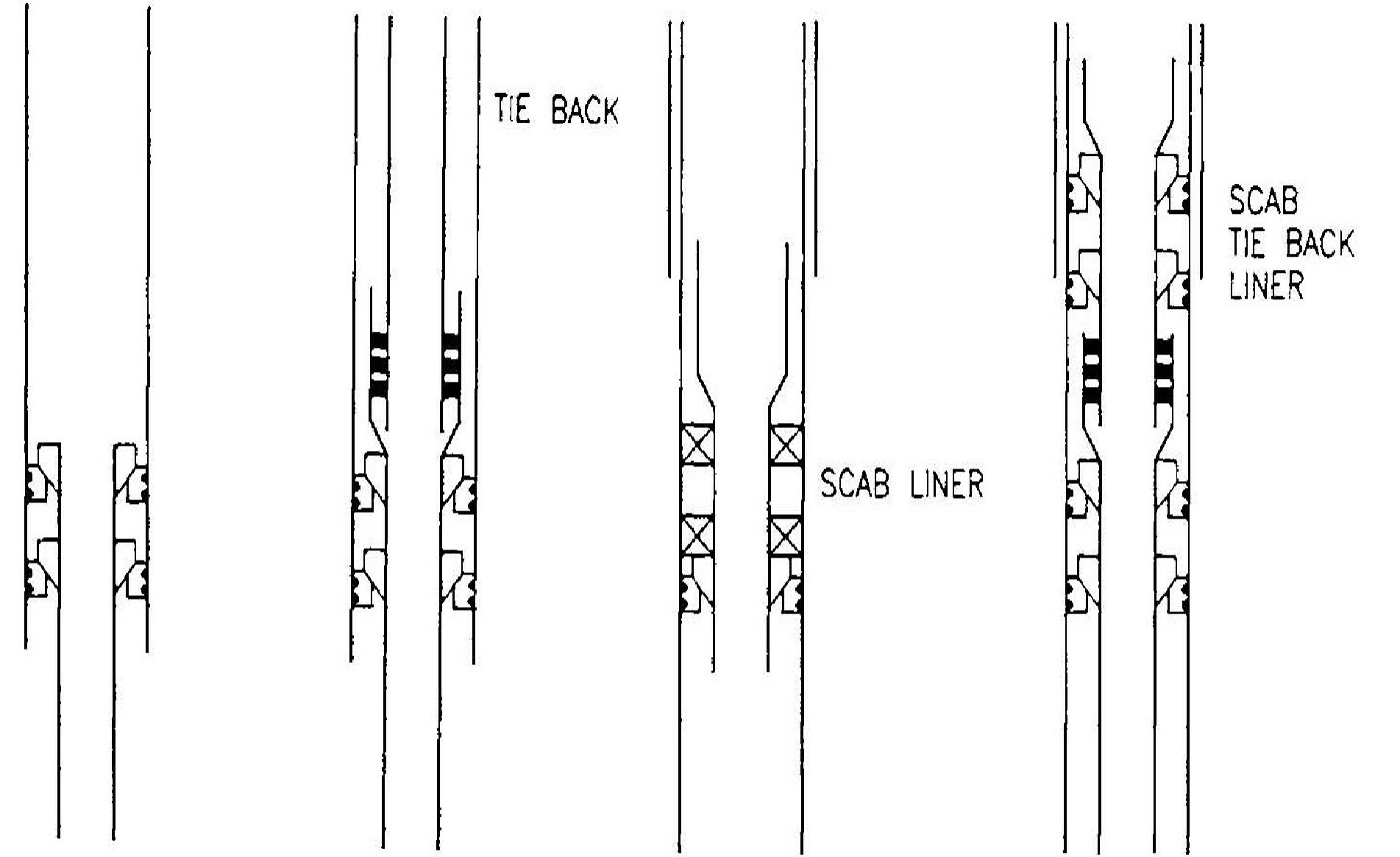
(b) GEO–PRESSURED WELLS

Liners

- They are casings that do not reach the surface.
- A liner is a short (usually less than 5000ft) casing string
- They are mounted on liner hangers to the previous casing string. The liner hanger consists of a collar which has hydraulically or mechanically set slips (teeth) which, when activated, grip the inside of the previous string of casing. These slips support the weight of the liner and therefore the liner does not have to extend back up to the wellhead .
- Liners may be used as an intermediate string or as a production 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).

❖ TYPES OF LINER

- ***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.
- ***Production Liner*** – Same as production casing. It is run instead of full production casing to provide isolation across the production or injection zones.
- ***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. It may or may not, be cemented in place
- ***Scab Liner*** – A section of casing that does not reach the surface used to repair existing damaged casing. It may be cemented or sealed with packers at the top and bottom.
- ***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 salt sectons in deeper portions of the well.



(a) LINER (b) TIE BACK LINER (c) SCAB LINER (d) SCAB–TIE BACK LINER

✓ Classifications to be considered are:

1- 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.

Casing & Liner OD (in.)	Length (in.)	Drift Diameter (in.)
≤ 8-5/8	6	ID – 1/8
9-5/8 – 13-3/8	12	ID – 5/32
≥ 16	12	ID – 3/16

2- Inside diameter (ID), wall thickness, drift diameter

- The ID is specified in terms of wall thickness and drift diameter.
- The maximal ID is controlled by the combined tolerances for the OD and the wall thickness.
- The minimal permissible pipe wall thickness is 87.5% of the nominal wall thickness, which in turn has a tolerance of -12.5%.
- The minimal ID is controlled by the specified drift diameter.
- The drift diamater 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

3- Length (range)

The lengths of pipe sections are specified in three major ranges:

- R1, R2 and R3.

Range	Length (ft)	Average Length (ft)
1	16 – 25	22
2	25 – 34	31
3	> 34	42

4- Connections

API provides specifications for four types of casing connectors:

- ***CSG* – Short round threads and couplings** – offer no pressure seal at internal pressure, threaded surfaces get further separated.
- ***LCSG – Long round threads and couplings*** – same basic thread design as CSG but offers greater strength and also greater joint efficiency (though less than 100%). Often used because it is reliable, easy and cheap.
- ***BCSG – Buttress threads and couplings*** – offers a nearly 100% joint efficiency. Not 100% leakproof.
- ***XCSG – Extreme line threads*** – design is an integral joint, i.e. the coupling has both box and pin ends. Much more expensive.

❑ CSG and LCSG are also called API 8-Round threads because they have eight threads per inch

5- Weight

Pipe weight is usually expressed as weight per unit length in lb/ft. The three types are:

- **Nominal Weight:** Based on the theoretical calculated weight per foot for a 20 ft length of threaded and coupled casing joint.
- **Plain End Weight:** The weight of the joint of casing without the threads and couplings.
- **Threaded and Coupled Weight:** The weight of a casing joint with threads on both ends and a coupling at one end.

6- Grade

The API grade of casing denotes the steel properties of the casing

Casing properties are defined as:

•Yield Strength: The tensile stress required to produce a total elongation of 0.5% per unit length

• Collapse Strength: The maximum external pressure or force required to collapse the casing joint

•Burst Strength: The maximum internal pressure required to cause a casing joint to yield

API Grade	Yield Strength (min), psi	Tensile Strength (min), psi
H-40	40,000	60,000
J-55	55,000	75,000
K-55	55,000	95,000
C-75	75,000	95,000
L-80	80,000	100,000
N-80	80,000	100,000
C-90	90,000	105,000
C-95	95,000	105,000
P-110	110,000	125,000

Note:

- 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 deisgnates the minimal yield strength of the steel in thousands of psi. For example, K-55 has a yield strength of 55,000 psi