NPTEL

NPTEL ONLINE CERTIFICATION COURSE

Health, Safety & Environmental Management in Offshore and Petroleum engineering (HSE)

Module 1
Safety assurance and assessment
Lecture 6
Safety in Drilling Operations

Welcome ladies and gentlemen, in the last lecture we discussed about safety in operations. We have now understood why safety assurance is an important aspect in oil and gas industries. In the term HSE why safety does not address only personal safety but also is focused on economic equipment loss control which are involved various other factors that lead to catastrophic or economic loss of the oil and gas industries. Safety can be seen in different perspectives, safety can be implemented in the design stage itself, safety can be a part in the operation stage itself.

When we say safety implemented in operation we call this essentially as process safety, managing process safety is a very important aspect which we discussed very briefly in the last lecture. I hope you will have no questions or doubts which I would like to require to clear it now if you have any questions please keep it poster to me so that we get to understand each other very clearly.

Now let us move on to the sixth lecture in the first module safety assurance and assessment. In this lecture today we will focus on safety in operations I will take up an exclusive example of safety in drilling operation. When I say safety and operation is not the question of focusing on training of personnel so that safety can be implemented, I am going to touch upon how safety can be implemented while even selecting the drilling equipments, drilling methodologies, drilling techniques etc, in this lecture.

(Refer Slide Time: 02:21)

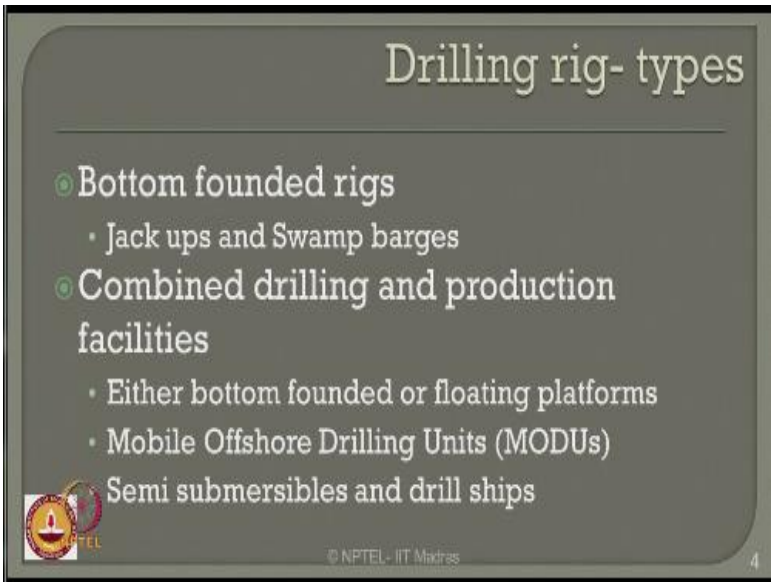
When we talk about offshore drilling we all understand that offshore drilling is highly a complex process it is technically challenging operation. It uses many innovative equipments and techniques so that drilling time is minimized and production is maximized. Therefore, it requires highly specially individuals to design or execute the drilling operations.

(Refer Slide Time: 03:02)

As we all understand drilling essentially comes from a major mechanical component what we call as a drilling derrick or essentially a drilling rig. The drilling rigs are designed for higher efficiency and mobility because drilling rigs are never a permanent fixture of any platform they are actually higher or there can be a part where the drilling rigs can be replaced by different kinds of rigs when you talk about second drivel, well completion etc…

Therefore rigs are essentially not designed to stay on location but to perform important stages of reservoir development and to build a drilling production structure.

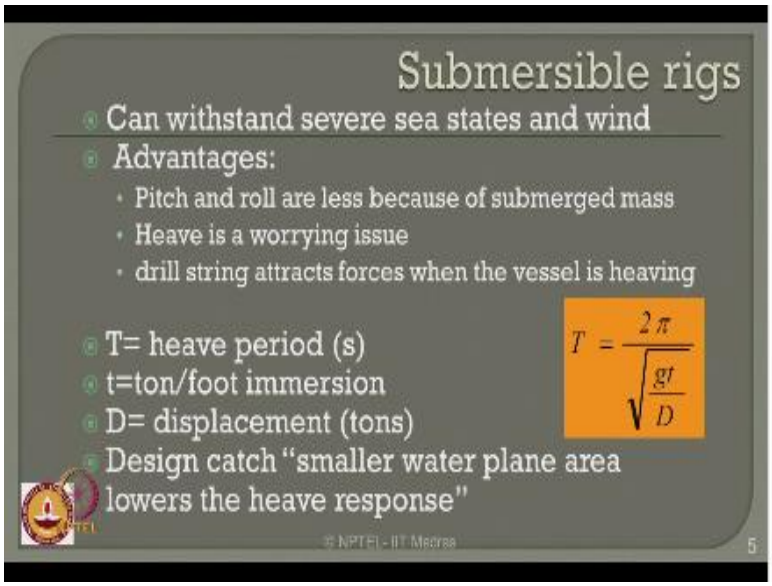
(Refer Slide Time: 03:50)



There are different types of drilling rigs which we should understand if we have got to carefully select a different specific type for that of a specific operation. There are bottom founded rigs which are essentially Jack ups and swamp barges, there are combined drilling and production facilities which are preferred by many offshore platforms. These kind of combined drilling and production facilities are either bottom founded or they can be commissioned on floating platforms.

The moment we talk about combined drilling and production facilities mounted on floating platforms, the 4 most important application comes to our mind is MODUs which is otherwise mobile offshore drilling units we have also seen how semi submersibles and drill ships can also be effectively used for exploratory and production drilling.

(Refer Slide Time: 04: 56)



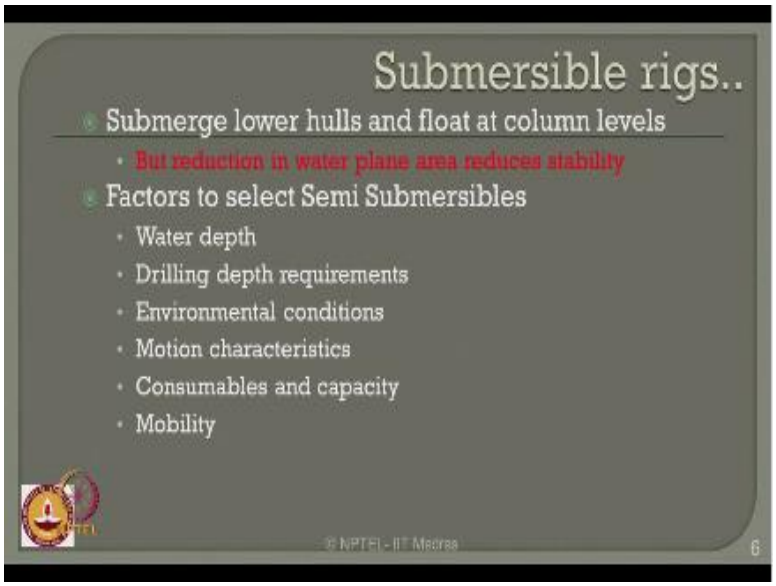
When we talk about semi-submersible rigs selection of a semi-submersible rig itself is a major challenge for optimizing the drilling parameters in a given situation. Semi submersible rigs should be designed or selected such that they can withstand even severe sea states and wind, they should not collapse even under severe sea states. There are many advantages these kind of rigs process they are pitch and roll or lesser because of the submerged mass heave of course the worrying issue who is drilling period in the heap degree of freedom is given by the equation on the right hand side.

The drill string attracts forces when the vessel is being heaved that becomes a major problem which causes instability to the semi submersible rig especially on the vertical plane. In this equation shown on the right hand side T stands for the heave period in seconds, whereas the small t stands for the foot immersion of the rig in water, and D stands for the displacement in tons. Now interestingly you must select the period of heave degree of freedom of the rig such that it does not resonate or it does not cause instability in the vertical plane.

So the designed catch in selecting or fixing the parameters that influence the semi-submersible rig is that, keep the water plane area as low as possible because smaller the water plane area

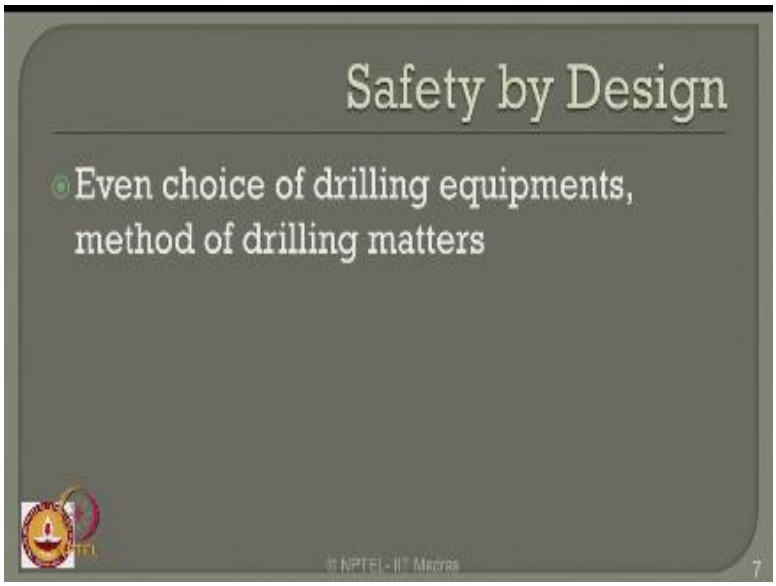
lower is the heave response of the rig, heave response of the rig will affect the performance of the rig and will challenge the stability of the rig significantly.

(Refer Slide Time: 06:54)



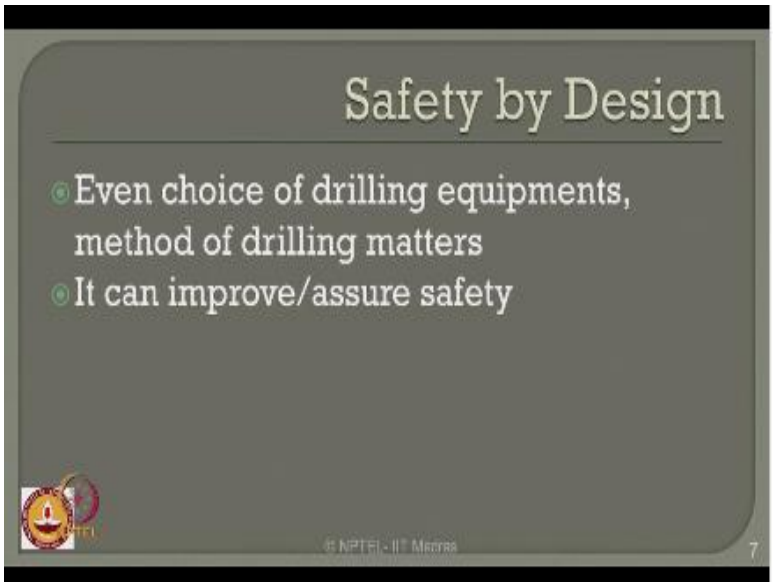
Submerge the lower hulls and float at the column levels because this can cause reduction in water plane area and the issue is once you reduce the water plane area it will challenge the stability point of the rig. So the factors which affect selection of a semi submersible rigs are the following water depth, drilling depth requirements, environmental conditions during operation, motion characteristics of the rig for a given sea state, consumable and capacity of the rig and the efficiency or mobility of the rig which is demanded during the operation.

(Refer Slide Time: 07:37)



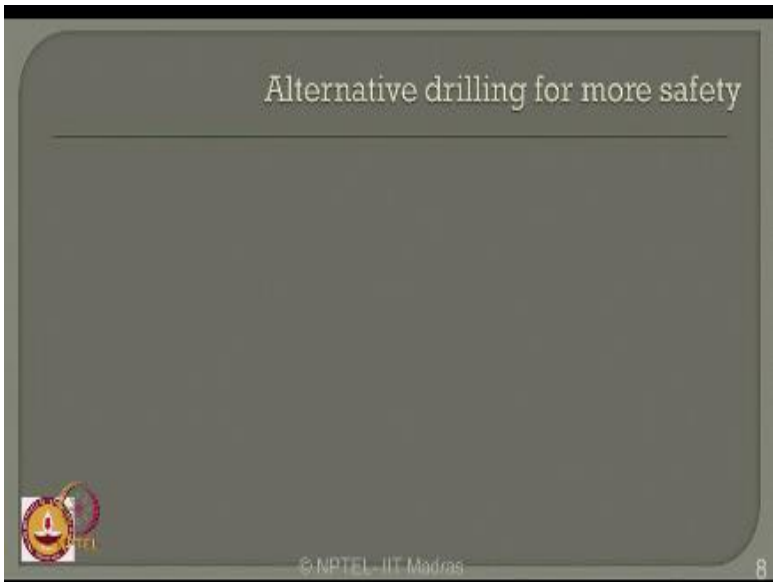
As I said in the beginning safety can be implemented emphasized in the operational stage. On the other hand safety can also be an inherent part in the design stage itself. So what is safety by design? Safety by design is focused on choosing the drilling equipment and method of drilling because these two aspects will emphasize on safety even at the design stage itself.

(Refer Slide Time: 08:09)



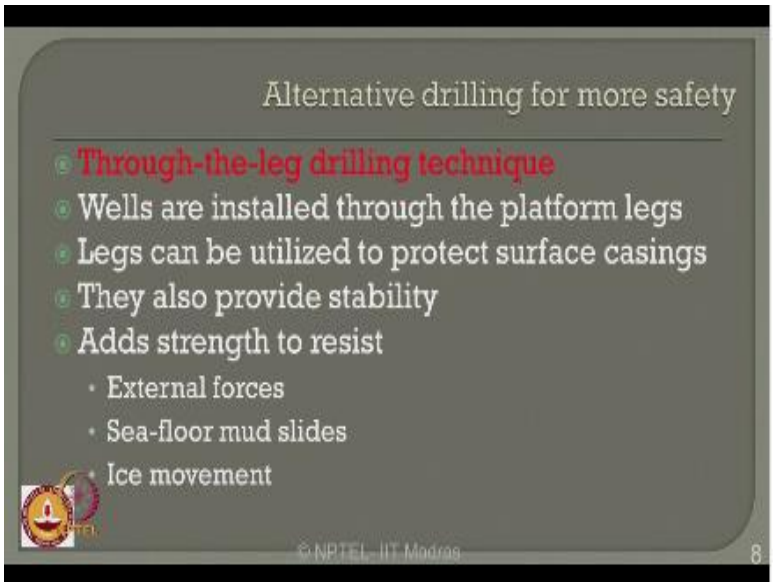
If you carefully select an equipment or the method of drilling it can improve or assure safety in a given drilling operation.

(Refer Slide Time: 08:19)



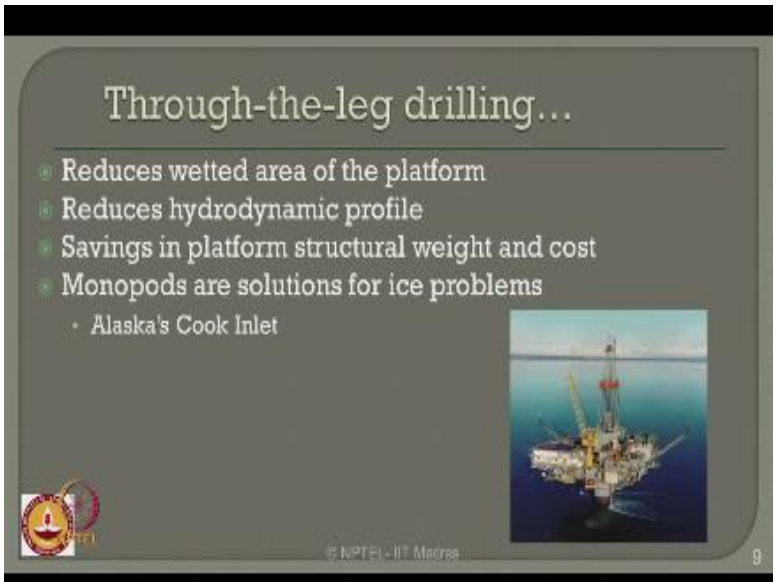
There are many kinds of alternate drilling which are available which can improve or improvise safety.

(Refer Slide Time: 08:27)



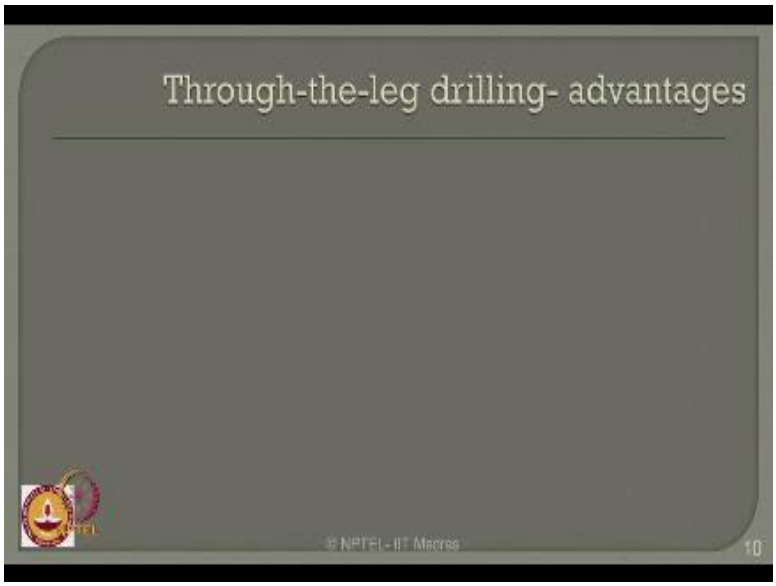
One such technique is through-the–leg drilling technique what do you understand by through-the-leg drilling technique? Wells are installed through the platform legs, legs can be utilized to protect the surface casings of the wells, they also provide stability because the wells will be through the platform legs and therefore not exposed to lateral loading at all, it add strength to resist external forces, sea-floor mud slides, and ice movement.

(Refer Slide Time: 09:02)



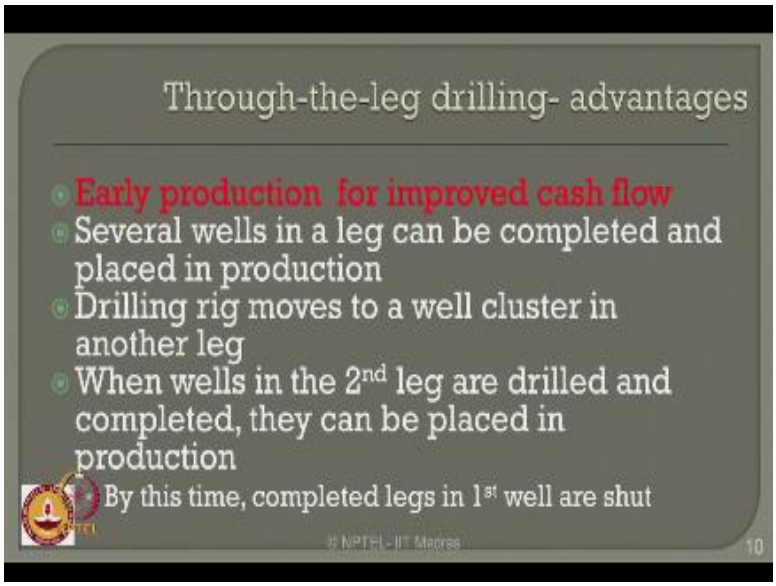
One such classical example is shown to you on the right hand side this reduces better area of the platform, it reduces hydrodynamic profile of the drilling segment, there is enormous savings in platform structural weight and cost, if you do through-the-leg drilling, monopods are considered to be identical solutions for ice problems, Alaska Cook Inlet is one example which is shown on the right hand side as a photograph.

(Refer Slide Time: 09:31)



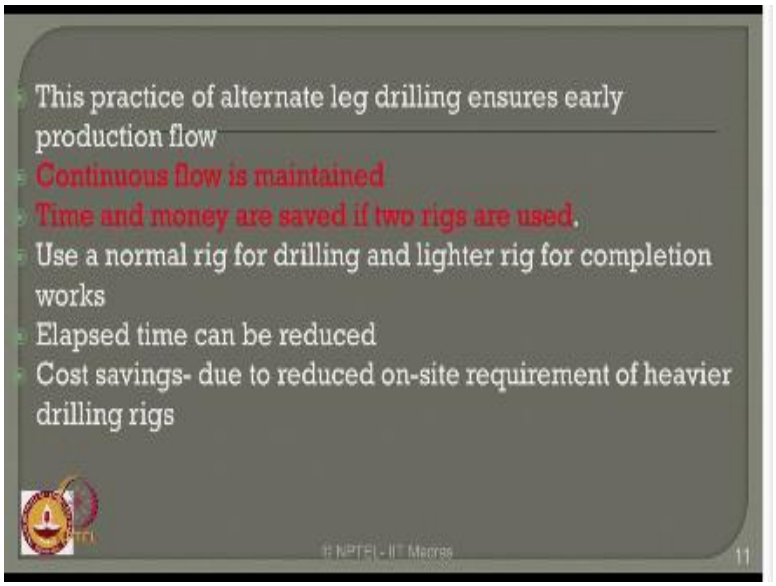
There are many advantages if you provide through-the-leg drilling, it emphasizes or assures early production.

(Refer Slide Time: 09:42)



And that emphasizes in turn an improved cash flow; several ways in a leg can be competed simultaneously and placed in production. So the rate of production per day or per annum will go higher significantly if I have several wells placed in the leg that produce oil or explore oil simultaneously, drilling rig moves to a well cluster in another rig therefore you keep on parallel activating many number of wells so that the drilling rig which is essentially configured for drilling cannot be retained and need not be retained in the same well, whereas you move the drilling rig from the well cluster and use another rig for well completion, by the time the completed leg is in the first well is there, the first well which is completed is shut and so on.

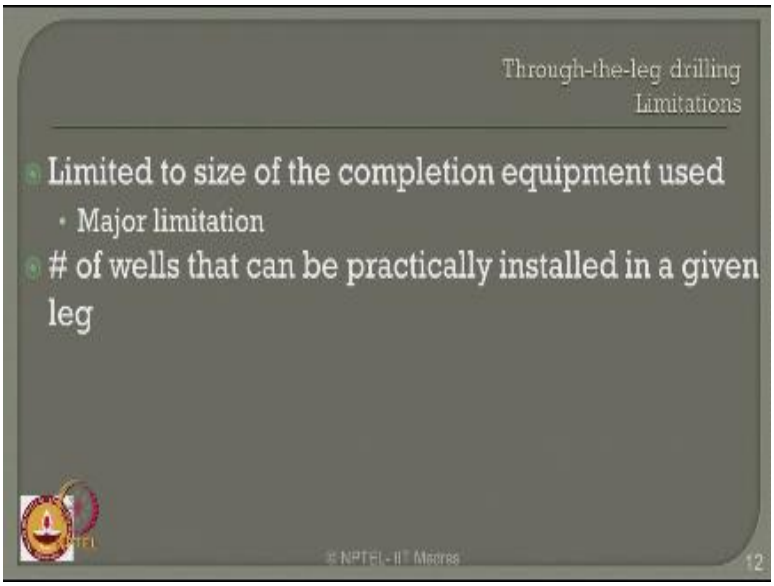
(Refer Slide Time: 10:43)



This practice of alternate leg drilling ensures early production flow, it also emphasizes continuous flow which is maintained which is the cash flow as well as oil flow, time and money are saved if two rigs are parallely involved, use of a normal liquid drilling and lighter rig for completion works are suggested as an idea coming out from the literature review, elapsed time between moving and recommissioning the rig can be easily reduced, it results in cost saving due to the reduced on-site requirement of heavier drilling rigs.

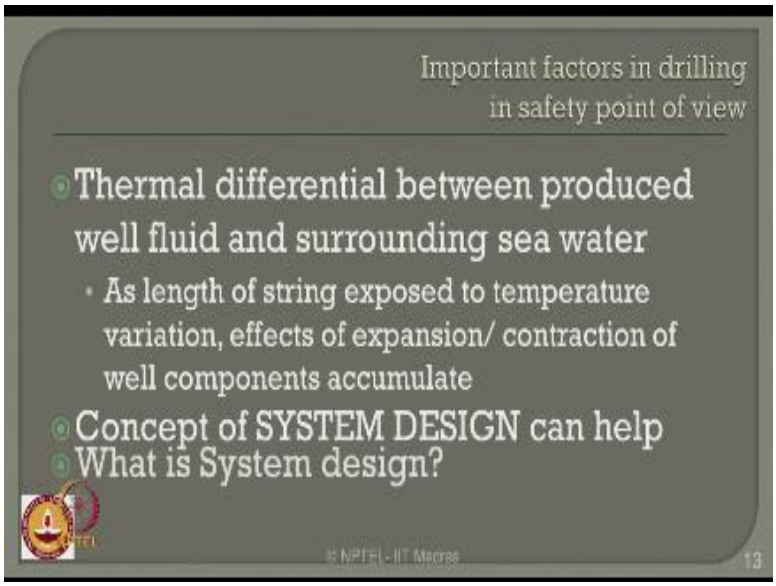
Ladies and gentlemen drilling rigs are even higher if they are very expensive in such cases a downtime of a drilling rig will act to the exploratory cost of the platform directly. Therefore cost saving can be seen as one of the aspect which is influenced by reduction on the on-site requirement of heavier rigs. Lighter rigs of course are not expensive by means of the commercial rate or rental facilities whereas heavier drilling rigs or expensive even if they are hired.

(Refer Slide Time: 12:05)



But through the leg concept has got certain limitations it is limited to the size of the completion equipment used which is generally considered as one of the major limitation of the problem. Number of wells that can be practically installed in a given length is one of the series limitation in case of through the leg concept.

(Refer Slide Time: 12:28)



There are important factors in drilling in safety point of view, let us see them one by one now. The thermal differential between the produced well fluid and the surrounding sea water is one of the major factor which influences the catastrophic failure of drilling rigs, as the length of the string exposed to temperature differential variation occurs, the effects of expansion and contraction of the well components accumulate and that causes series of disasters which has happened why the drilling operation is in progress.

In such cases what do we do, in such situation we can go for system design then the question comes what is system design.

(Refer Slide Time: 13:18)

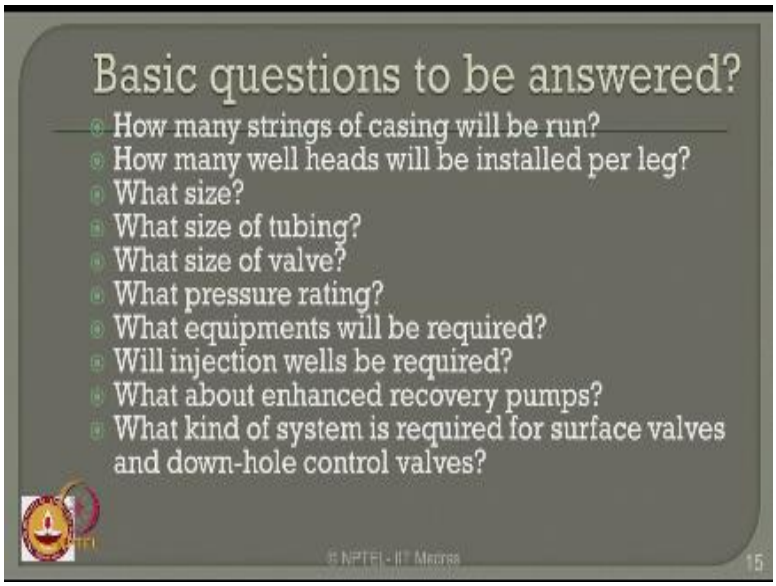
System design is a complete integration of all parts into the whole which should be considered in the beginning itself consultations of course are required between the working professionals who are field development engineers, equipment manufacturers, service engineers, maintenance engineers, drilling company executives, reservoir engineers etc. Based upon the common discussion and understanding of different professionals involved in drilling one can always think about integration of different components or parts in the drilling operation and plan that in the beginning we call this concept in oil drill as complete integration or system design.

(Refer Slide Time: 14:13)

(Refer Slide Time: 14:14)

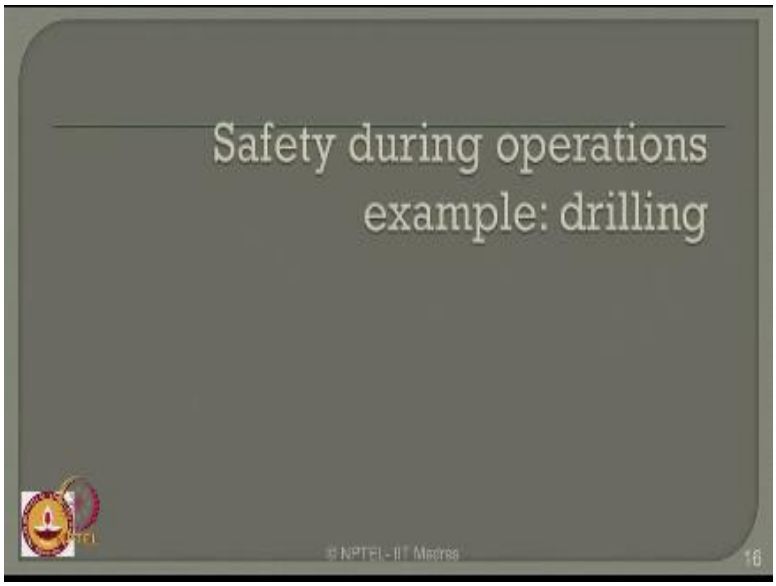
Now before you choose a system design or a complete integration of different parts of drilling to be accounted from there are basic questions which you like to ask based on which the drilling rig configuration will be selected.

(Refer Slide Time: 14:31)



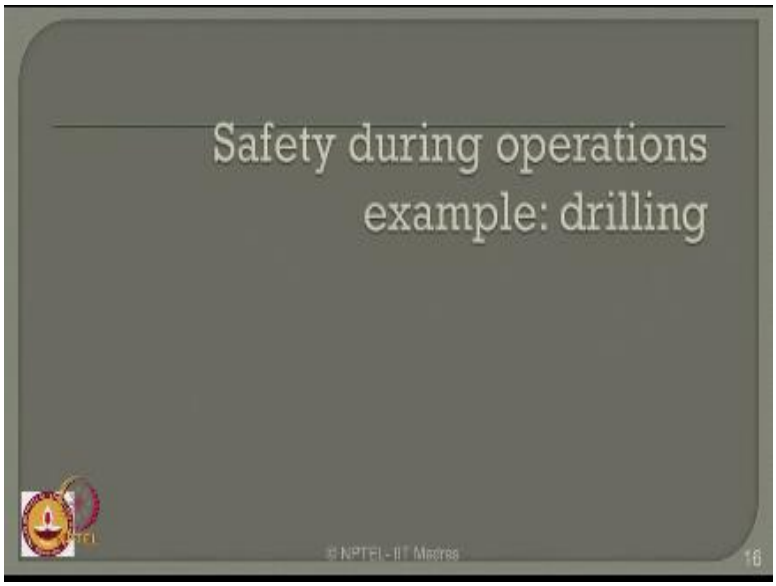
How many strings of casing will be run parallel? How many well heads will be installed in each leg? What will be the size of the wellhead as well as the drill string? What would be the size of the tubing? What would be the size of the valve? What pressure rating the valve is going to operate? What equipments will be required both for drilling and monitoring? Will injection wells be required for a given stratigraphy? What about enhanced recovery oil pumps which are required if you are is to be carried out from external source? What kind of system is required for surface valves and down hole control valves?

(Refer Slide Time: 15:22)



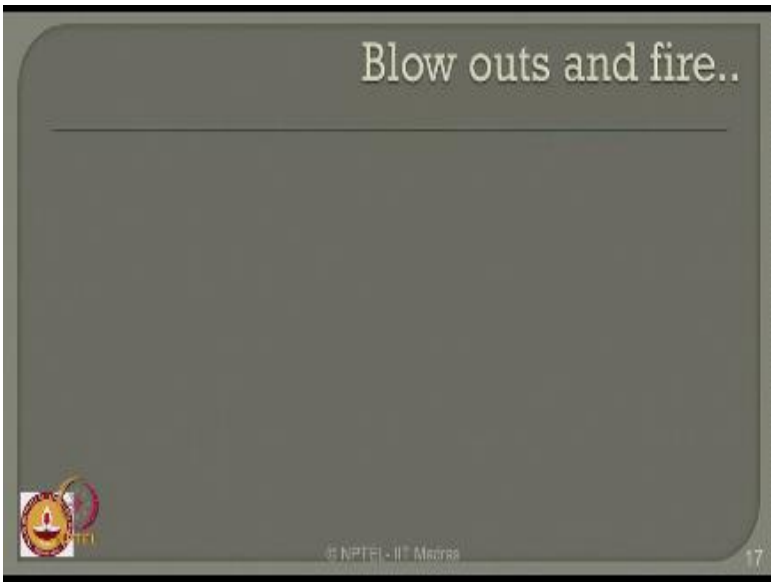
So these series of questions will lead to selection of a specific equipment which in turn results in selection of a drilling rig which can be based upon safety with a focus to its design.

(Refer Slide Time: 15:39)



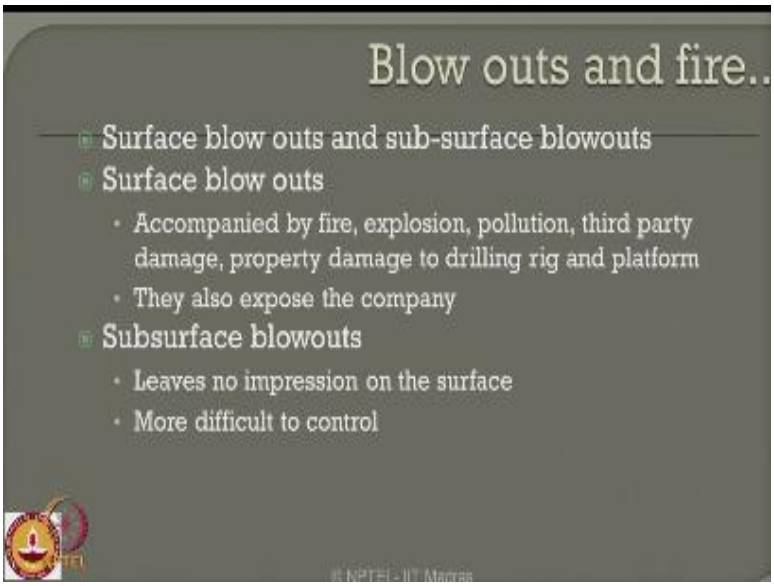
Now let us talk about example of a drilling in terms of safety during operations.

(Refer Slide Time: 15:44)



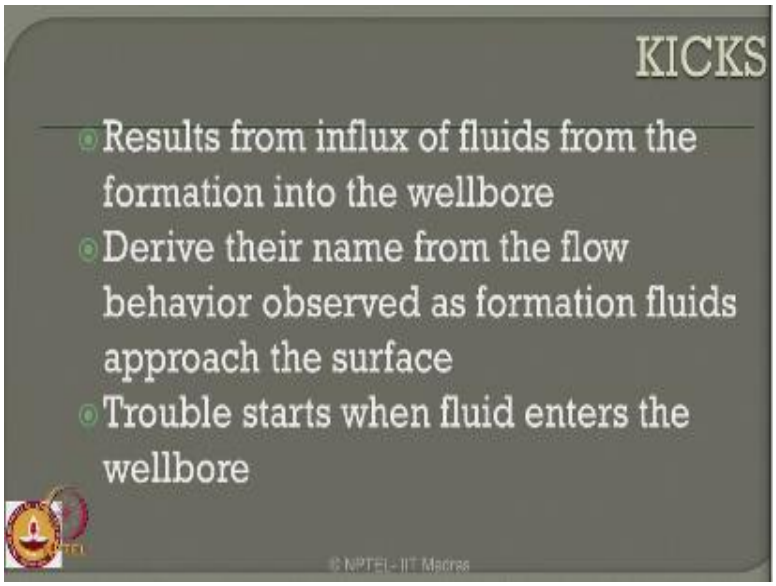
The moment we talk about safety in drilling operation the foremost problem which comes into mind is blowouts and fire.

(Refer Slide Time: 15:55)



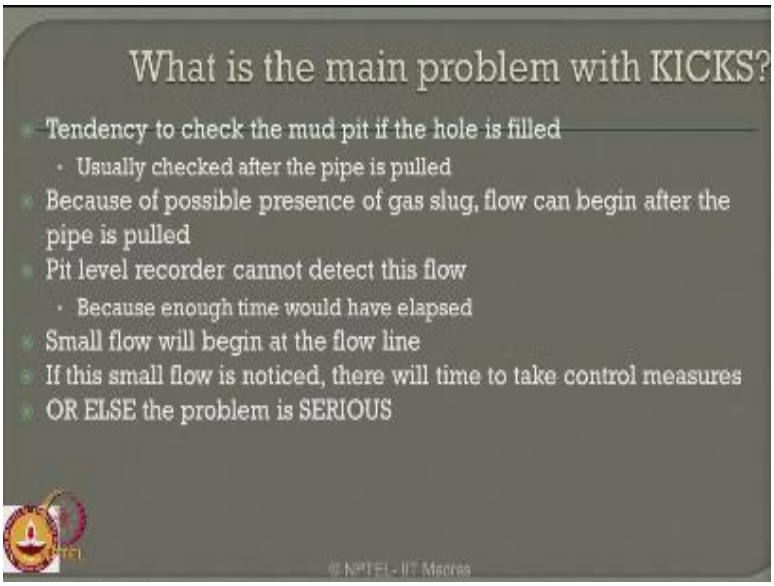
Surface blow outs and subsurface blowouts are two varieties of blowout accidents which are generally happening in drilling sites, surface blowouts are generally accompanied by fire, explosion, pollution, third-party damage, property damage to drilling rig and the platform as well. Surface blowouts if occur generally exposes the company in the public domain, whereas on the contrary subsurface blowouts are very difficult to control if they occur. But the advantage is they leave no impression on the surface and therefore in public domain they will not be known.

(Refer Slide Time: 16:40)



The second major problem if you consider safety in drilling operation is kicks, it results from influx of fluids from the formation into the wellbore, they derive their name from the flow behavior observed as formation fluids approaches the surface, the trouble starts when the fluid enters the wellbore.

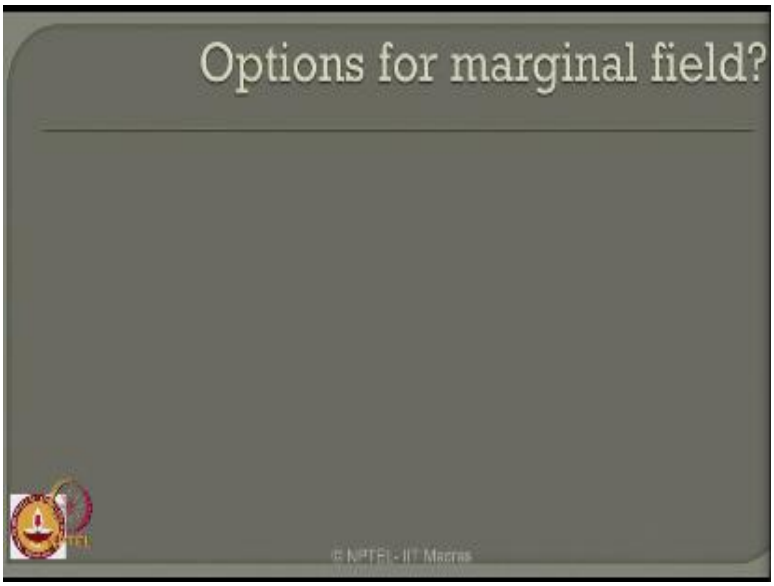
(Refer Slide Time: 17:07)



One can ask a question what would be the main problem with the kicks. The tendency to check the mud pit if the hole is filled is a better option to avoid the occurrence of kicks but usually it is checked only after the pipeline is pulled out. Now because of the possible presence of gas slug in the existing pipeline flow can begin even after the pipe is pulled off, pit level recorder cannot detect this type of flow.

Because enough time would have been lapsed by the time when this kind of flow starts occurring, small flow will begin at the flow line you will be able to notice that in your monitoring device, if the small flow is noticed there will be time to take control measures, if it is not noticed then the problem becomes serious that result in a kick which a result subsequently in a fire or explosion.

(Refer Slide Time: 18:06)



Now we choose about drilling equipments either we design or way operation we have to also answer a major question what would be the options available for marginal field.

(Refer Slide Time: 18:18)

Now for the benefit of people what is a marginal field? Marginal field is defined as an offshore reserve that cannot economically support installation of fixed drilling platforms and production platforms there are many kinds of wells which identify but certain wells the yield is so low they will not afford to support the permanent drilling facility like a fixed set type or a production platforms these whales are called marginal fields.

(Refer Slide Time: 18:50)

Multi well subsystem or subsea completion system are suggested for these kind of marginal wells this employees floating drilling vessel that drills the wells through a subsea template.

(Refer Slide Time: 19:03)

What is a multi-well subsea system there are many advantages of a multi well subsea system it emphasizes on early installation as template can be built faster and installed in lesser time than that of a fixer platform installation is prior to the scheduled in general, cost is not sensitive to the water depth at all, it offers very high flexibility the design there is no flexibility, it accommodates many satellite wells, most wells are located on the fixed template on the sea floor, therefore major components can be retrieved for reuse in case of any accidents, final location in the template can be determined after reservoir is defined by delineation operations.

(Refer Slide Time: 19:58)

So in this lecture ladies and gentlemen we talked about safety improvised on operations as well as safety by design you can select a drilling rig equipment depending upon its safety parameters, you can also select a well depending upon how the subsea template is laid and what kind of production facility is laid or initiated in a given system of production units. So safety is not a part which only comes to operation, safety can be even started at the design stage itself, safety of course ensures loss prevention, cost control, and many other economic factors which we saw in the last lectures, thank you very much.

Online Video Editing /Post Production

K.R. Mahendra Babu

Soju Francis

S. Pradeepa

S. Subash

Camera

Selvam

Robert Joseph

Karthikeyan

Ramkumar

Ramganesh

Sathiarai

Studio Assistants

Krishnakumar

Linuselvan

Saranraj

Animations

Anushree Santhosh

Pradeep Valan .S. L

NPTEL Web & Faculty Assistance Team

Allen Jacob Dinesh

Bharathi Balaji

Deepa Venkatraman

Dianis Bertin

Gayathri

Gurumoorthi

Jason Prasad

Jayanthi

Kamala Ramakrishanan

Lakshmi Priya

Malarvizhi

Manikandasivam

Mohana Sundari

Muthu Kumaran

Naveen Kumar

Palani

Salomi

Senthil

Sridharan

Suriyakumari

Administrative Assistant

Janakiraman .K.S

Video Producers

K.R. Ravindranath

Kannan Krishnamurty

IIT Madras Production

Funded by

Department of Higher Education

Ministry of Human Resource Development

Government of India

www.nptel.ac.in