Elements of Ocean Engineering
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Lecture - 24
Drilling and Topsides

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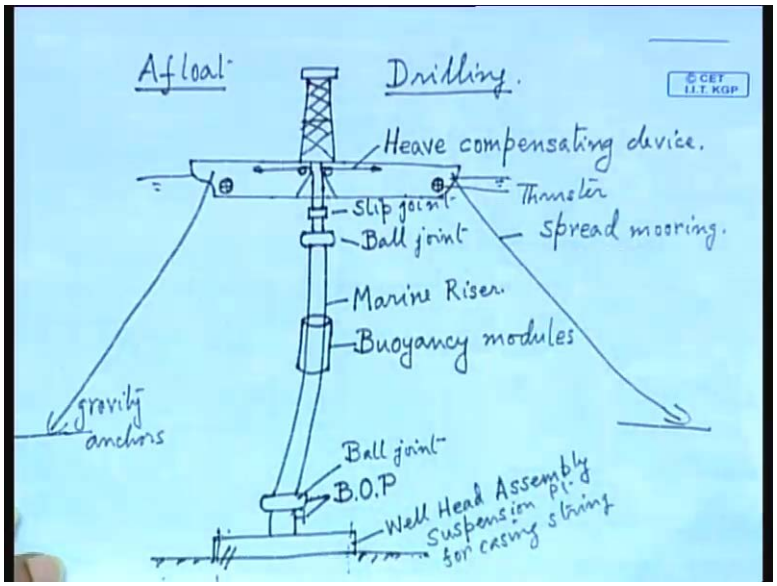

Today, we will study Drilling and Topsides and there are some features for the, which is to be noted for the floating platforms. So, here you can see I have drawn a semi submersible, this is a drill ship not a semisubmersible, this is a floating platform. Now floating platform there are number of points to be remembered, when you are drilling. One is that the marine riser will have lot of motions, now in order to accommodate that those motions I said the marine riser does not rupture or break then you have to have number of joints.

And you can see from this figure, and what is to be noted out here is the low preventer assembly is located on the sea bed, just on top of your well head. So, your well head will come somewhere here, on top you have the b o p stack and this is resting on the sea bed, so this is your sea bed. Now, this is your marine riser, and this is your water line the drill ship is floating, the marine riser or the conductor pipe has to be kept dock, that is the fundamental requirement, otherwise there is going to be a undesirable sag in the riser.

So, here you have to have buoyancy tanks or it is buoyancy modules, so in the figure I have shown only one, but there may be even more than one according to the weight. So, now the drills sting actually that is your drill pipe will go pass through the marine riser, down to the well head this is your well head, or sometimes this is called well head assembly. So, this is a suspension point for your casings strings, so this well is resting on the sea bed, and here the b o p stack, so while getting drilling this is called your blow out preventer assembly.

And after drilling is complete this is called a production Christmas tree, so that is placed on your well head. So, first what is done is this well head is lowered from the drill ship, on to the requisite site then it is pressed by gravity anchors or sometimes this is also piled, but piling under water is difficult. So, this is fixed to the sea bed, and then you connect the marine riser to the b o p by means of a strings or strings from the drill ship, this b o p is this one, and this one is a ball joint, you can make the correction actually on my drawing this is a ball joint.

So, there will be lot of motions coming from the drill ship on to the marine riser, so those have to be accommodated by number of joints. So, at the drill ship end you have a slip joint, and just below it you have another ball joint, so ball joint is a universal joint whereas, a slip joint will just give around motion in one direction. And the other point that is to be noted is a tensioning device on the whole of the marine riser, that is given by a heave compensating device, so I am not there is a winch actually.

So, this is a heave compensating device, so these are some of the salient features for afload this is called afloat drilling, now in the afloat condition I told you, you have lot of problems coming from ship motions. So, motions has to be accommodated by joints, and the universal joints and buoyancy modules are give also to give the upward force on the marine riser in order to support the weight, so this is your diagram.

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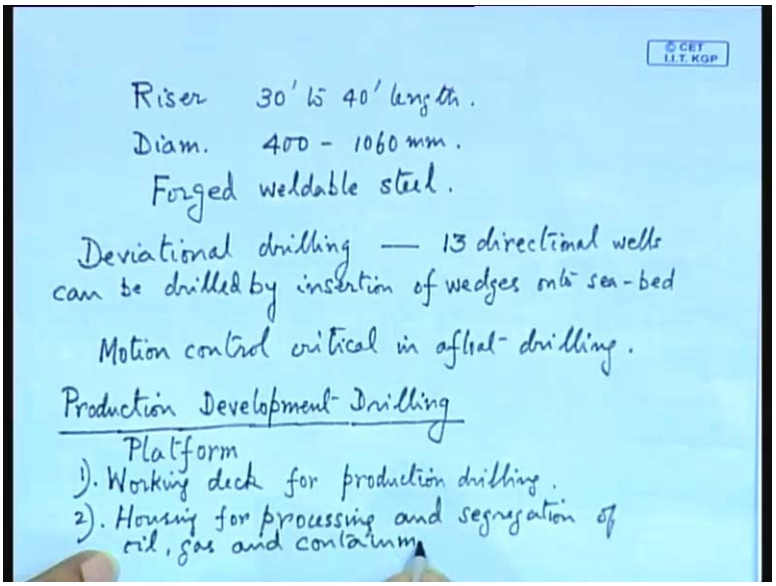

Now, the other point that is to be noted is the riser, the riser actually I told you it comes in lengths between 30 and 40 feet length diameter you can write, diameter varies, so diameter is from 400 to 1060 millimeter, so this is made of forged wieldable steel. So, these are the materials of the riser, and the riser is nothing but a connector pipe and inside the drills string will be ((Refer Time: 07:40)). Now, actually you can drill number of wells, because of the technique which is called deviational drilling, so you have deviational drilling mode, you can drill number of wells from the same vessel.

So, you in my notes I think you have studied 13 directional wells can be drilled, by insertion of wedges on to the sea bed. So, that means, you have to drive a wedge at this your drill string is coming out here, you have to drive a wedge through which it will pass. So, those things are quite complicated anyway, but you can do it, so this is one head serves as a casing and drills come from drill ships. Now, in the drill ship you will find if you look at the drawing now I told you last class that the moving of these vessels are very important, so after your exams I will talk about this moving lines.

So, you have this kind of this is called a spread moving system, and on the other end you have gravity anchors, now on top of that also I talked about the d p system, that is your directional positioning system. You can have 1 or 2 thrusters at the forwarded or at the opted, so these are called d p system, so these are automatic according to the motion of the vessel you can position, so this is called a thruster.

So, motion control is must in all these in your afloat condition, so motion control critical in afloat drilling, now after your exploratory drilling is over then you go for production development drilling. Now, after this I will talk about top sides, and you will find that if you have to accommodate both that is exploratory as well as production, you are going to make things complicated and according to that you have to size your platform, and generalize your drawing, so that is will be possible.

Now, drill ships normally they are not used for your production operation, so drill ships you will find they are more suitable for exploratory drilling. For productions you will find they are mostly done from t o p's and semi submersibles, so here you will find that deviational drilling also can be taking place, but the basic requirement is the platform, so this I will talk now what is the platform doing.

So, this provides number 1 to working deck, this we will discuss in detail when I talk about the generalize, so working deck for production drilling. Number 2 basically housing for processing, and segregation, so these are in a nutshell the equipments that are required segregation of oil and gas.

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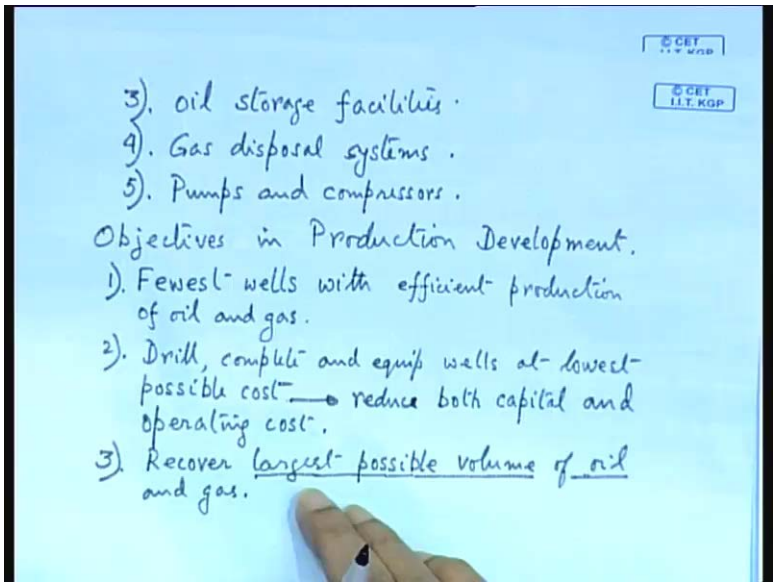

So, this is then you have to have storage facilities, number 3 is oil storage, then you have gas disposal, and then you have the other items that is pumps compressors etcetera. You know this I will discuss little bit in detail, in the g a configuration or in the g a drawing, so that brings us to the end of this drilling. So, what is to be understood is the other

points, that you will come across is in production development is objectives in production development.

So, you can see actually your exploratory drilling and production drilling, they are two separate entities altogether and there are number of points which are to be taken care of in the production stage. Now, here you find that number one is what you have to in production drilling is fewest wells, now you do not increase in the number of wells. So, that will create problem in the floaters, floaters means your drill ships or your semi submersibles and that is also not economic.

So, you try to find out the fewest wells with efficient production of so; that means, you have to striate economical flow rate in terms of barrels per day, so efficient production of oil; obviously, will come with oil and gas, so those have to separated. Now, number 2 is drill complete and equip wells at lowest possible cost, now what is done, because there is a time factor there you are drilling say number of wells from the same platform so; obviously, it will take number of months is not it to complete the drilling process.

So, the client is not ready to wait for such a long time, so there is a simultaneous production of oil is also taking place from the platform. So, you drill complete the well and equip wells at lowest possible cost, and this has to be done simultaneously, so you reduce, so drilling offshore production is more expensive than onshore location. So, that is why all these things have to be features have to be taken care of reduce both capital and operating cost, so this has to be done.

Now, the last one is you recover largest possible volume of oil and gas, gas normally you will find the volume is given in cubic feet, there are certain pressure and barrels are the capacity for the oil. So, these has to be done that is recovery of the largest possible volume of oil and gas, so this is normally done by what is called steam injection into the oil reservoir. So, in the conductor pipe from some of the conductor pipes will be carrying your oil and gas to the platform, and the other pipes will be carrying steam and mud.

So, mud circulation has to be maintained, and also steam injection has to be done to recover the largest possible volume of oil and gas. So, these are some of the objectives in drilling what is called your production development drilling, now let us go to the another very important topic that is called top sides or rather you call it topside layout.

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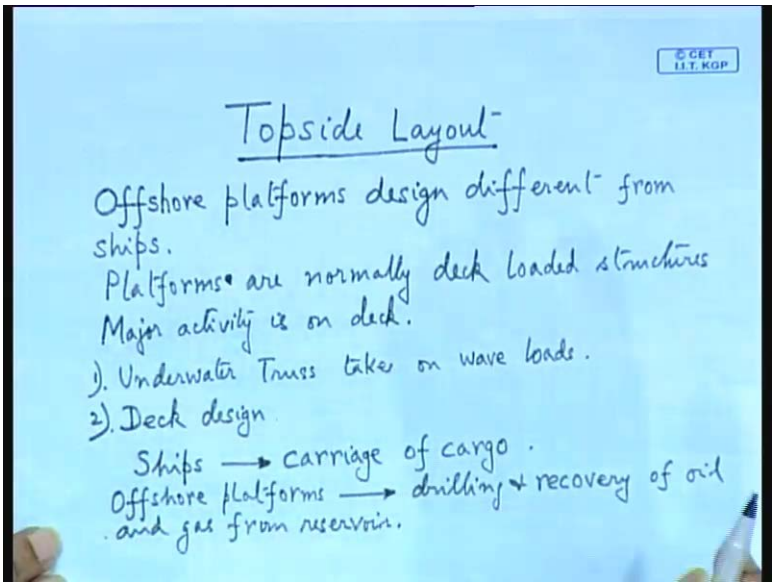

Now, this is similar to your jam arrangement drawing for ships, but the problem is the off shore platforms are not ship shaped is not it, so off shore platforms are rarely ship shaped and their mission requirement or design requirement is different. So, this is where your basic difference will come from ships, so offshore platforms, design different from ships, in some cases and some of the factors may have similarity design different from ships. So, now, all you are going to design them, so this is your fundamental difference, so these offshore platforms are normally they are called deck loaded structures.

So, your main activity is on the deck, so this is has to be designed, so your first design is your the supporting structure, that is the underwater truss which we have already talked about which you have to design form environmental loads. The next first is your underwater truss, now this is very crucial, so this has to take care of take or rather take one the wave loads, primary load is your wave load. For and other loads are there current wind, and all these thing are there, now number 2 is deck design, so these are actually distinctly different from your ship design.

Now, ships if you look at say oil tankers or cargo ships, they are not desk designed vessels; that means, you do not have any deck activity as such is not it. So, what is your main activity of the cargo ship of the oil tanker, so ships that are normally, that you have designed are primarily centered around carriage of cargo. This is where ships are radically different from offshore platforms, now offshore platforms if you design, so they

are basically centered around the process of drilling and recovery of oil and gas from reservoir.

So, this is your primary what is called the mission requirement difference between a cargo ship and a offshore platform, so your mission requirement or design requirement is different, so based on that you have to design. Now, the another point, so I told you start or design these are two important structures that has to be designed, one is the underwater truss, and the deck design, now underwater truss I have talked about we will come back to that later on.

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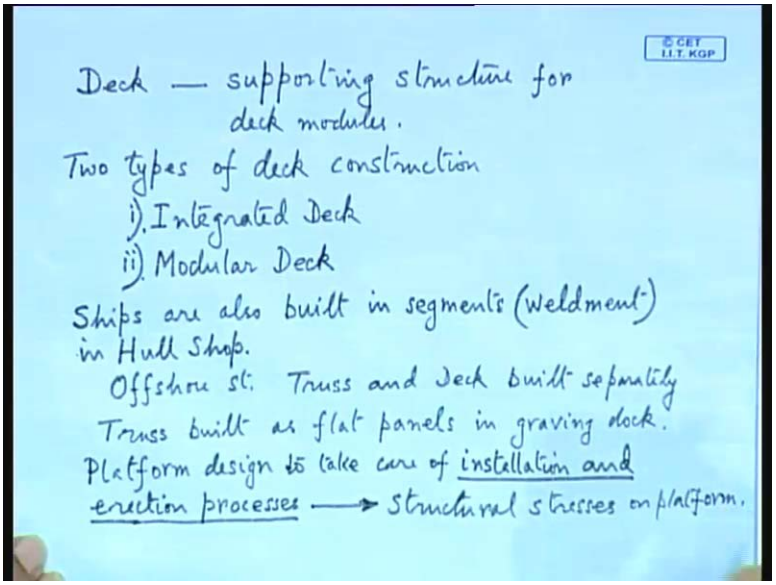

So, here the deck layout now deck is basically a supporting structure, for what, supporting structure for deck modules. Now, there is a whole concept of design which actually centered on what type of this deck modules, you are going to, so here actually the topsides are given you can have a look. So, they will be basically designed centered around this deck modules, and for that actually you have two types of decks, one is called there are basically two types of decks will come or other you write two types of deck construction.

Now if you happen to visit one of these offshore companies then you can see this, so number 1 this is called integrated deck, and number 2 it is called modular deck. So, these you come across in offshore, if you go platforms you will basically see these two types of deck construction. One is called the integrated deck design, and other is called is the

modular deck design, now when you go for integrated deck and when you go for modular deck.

Now, offshore structure is basically different from ships is not it, now ships how they are constructed ships also nowadays ships are also built in segments, now this in technical term this is called a wieldment in where in hall shop. So, if you go to hall shop at the end of third year, you can see the ship that is part of the vessels are being built and then they are joined and wielded. Now whereas, your offshore structures normally the underwater portion, that is your the underwater truss is built separately from the deck, you do not build the truss along with the truss along with the deck as in ships.

So, here truss offshore structures, so truss and deck built separately, in most cases or in none of the cases, you will find truss are is built along with the deck. So, they are built separately and the trusses are normally built in the horizontal I give you the diagram in your previous class they are built horizontally on the graving dock, and then they are upended etcetera and then they are wielded. So, these they are made in build in panels, they are trusses are normally built as flat panels, as flat panels in what is called graving dock.

Now, I am discussing a little bit of this why, because your design of the platforms platform design, now you are basically engineers, you have to do some design work, you are a employee in one of these offshore companies. Now, platform design you has to take care of these two processes, whenever you design a engineering object or ship or offshore structure, they are very large object take care of installation process and erection processes.

And these are very important in offshore structure design because part of the installation will take take place in the water, the installation in land like ships the most of the ship is actually built in your ship way or the driving dock. You are out of water, but here actually I told you for large or tall offshore structures part of the structures are lowered on to the sea bed, and there is this position and then wielded more difficult tasks.

So, this installation and erection process is of paramount importance for offshore structures, and these are also related to your structural stresses coming to the platform, remember this. So, before you start any novel design, so there are number of designs of

offshore platforms which I have showed you, now there is a large element of risk involved in these platforms.

So, normally these platforms are built by experienced contractors big oil companies, they go in for these, because novel deigns when you go then you do not know all this no installation what are what are the problems you will face and all that is unknown. So, the designers they always prefer to walk in known territory, rather than the unknown first thing is because of the huge amount of capital cost that is involved in the the construction and design of this platforms.

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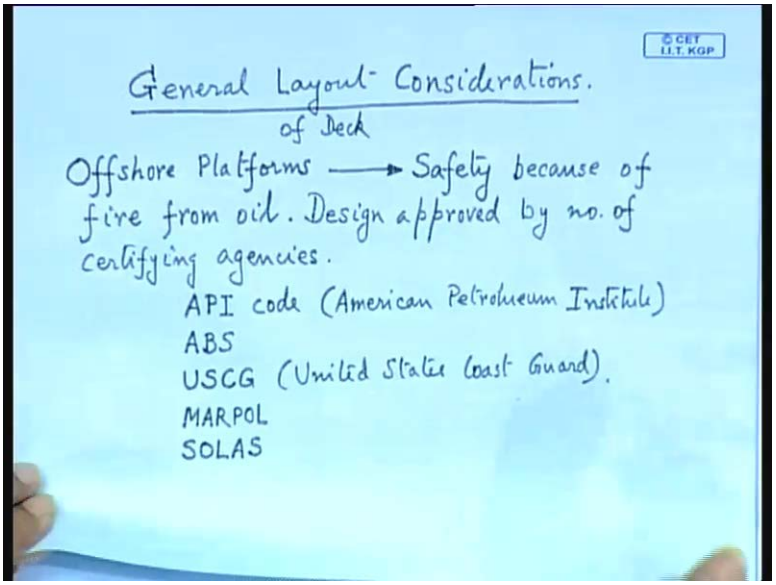

So, there we problems we will come up there, so anyway next coming to this, there are certain layout which is called layout or rather general layout considerations. General layout consideration are these g a of the deck, I am talking about the deck layout considerations of deck. So, this I have already talked about, there is the integrated deck and then the modular deck, now these offshore platforms, their overriding factor is what.

Now, in what way this is offshore platform design is different from your cargo ships, whenever you go for design of offshore platforms, tankers, etcetera your prime consideration will be safety, because you are dealing with oil, because of fire from oil. So, whenever you are dealing with this oil or natural gas, your design requirements become more complicated, and requires more thorough inspection also.

So, that is why offshore platforms are investigated or design approved by number of agencies or rather you write number of certifying agencies, and they prescribe the minimum design requirements. Now, one of the prime agencies they certify is the API code, API code has to be followed in case of offshore structure design, the American Petroleum Institute code for design, there are number of designs one is pipeline, structure, etcetera will come under this code.

Then you have ABS API full form stands for American Petroleum Institute, now if you platform happens to be positioned in gulf of Mexico, then you have to follow this code a b s you all know or should be knowing that is American Bureau of Shipping. This I am not writing other is USCG, USCG is stands for United States Coast Guard, now these are some of the prime agencies looking after the American site. And on the international you have, what you have MARPOL, then you have your SOLAS etcetera, all these rules have to be complied with.

So, like this you have a set of rule governing certifying agencies, and their inspectors and come and approve your design that is all the drawings that you will be doing g a arrangement drawing they have to be approved by all these people. So, you have to be constantly when you go into or employed in one of these offshore companies. You also have to have a rapport with the people or inspectors from these certifying agencies, so because you are dealing with oil, so oil actually creates more problem if your oil and natural gas.

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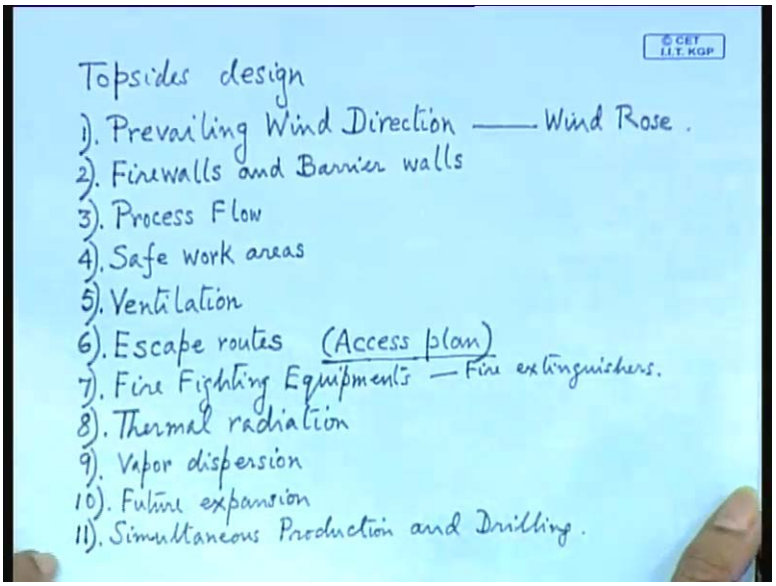

Now, topsides are actually centered around these facilities topsides design, so these are some of the certifying and on top of that you have the minerals, and there is another US mineral management service. So, MMS stands for this is in the US Mineral Management Service, so fortunately most of the Indian shipyards, they are not building your offshore platforms neither larger oil tankers. Especially, if you are building offshore platforms for the US or tankers for the US you are asking for trouble so; that means, you have to the tanker or the platform is to whereas, confirm to all these codes.

So, that will shoot your cost Indians are not accustomed with all this is not it, so relating with these surveyors from these in our country most of the survey work is done by ABS, Lloyds, and then also you have to survey with IRS. So, that means, you are familiar with these kind of people, but these peoples they are very exacting, if you are building any vessel for the U S.

So, remember that and that is why you will find the Japanese Korean, now also Singapore has come they are more efficient in building all these structures, most of the offshore structures, you will find they are built in Singapore. So, topsides design is centered around number 1 prevailing wind direction, so this normally you do not care in ship design is not it. Why, we will come to that, because of the spread of fire, so prevailing wind direction, now this is studied normally from a diagram, which is called wind rose, you a diagram of a wind rose prevailing wind direction.

So, I told you most of these structures are erected, because to prevent this spread of fire, so you have to erect firewalls and barrier walls. So, normally in ships you will not find all these firewalls and barrier walls, this you have process flow, you have to have sufficient piping to enable process flow to your various pumps compressors and all these thing safe work areas.

So, normally you are the crew or the personnel on board, they will not like to be exposed to two things, one is risk of fire is not it. So, he will not like to go to close to a equipment, which suddenly catches fire ignites, number 2 is what, so these are the two frightening aspects for human safety, number 2 is motions. So, human beings they are very much susceptible to motions, you will feel more sea sick, where your platform especially for floating platforms.

You will find you are always having the surge motion surge and heave is continuously, you will rowing and pitching you can rested by moving, but to some extent the platform will be having surge and heave motion. So, that will cause motion sickness or sea sickness will come so; that means, you are the personnel on board will not like to work, say after few days you will you will become home sick and try to leave the platform. So, that is why personnel on working on platforms they are given extra money, large sum of money is given to the because of two things.

One is the risk factor, and the other is the environment, because of the environment, you get the unsafe working environment, so safe work areas have to be designed. Then you have problems in ventilation now why, because the accumulated gases should not accumulate in closed areas, so you are dealing with natural gas, so you can see pockets of natural gas collecting in certain corners. So, they are the potential sources of fire and explosion so; that means, you have to drive away all these gases.

So, ventilation is another very crucial here, and in the event of fire taking place, you have to device suitable escape routes. So, in normally in ship g a you will find after you have segregated all the areas for cargo accommodation engine room, basically you first to calculate the volume, and then you design the areas or the volume design. What about this escape routes, another important area for naval architecture or ship designers is your escape or sometimes this is called a access plan.

Access plan has to be shown in your g a drawing, you are designing a large ship or offshore platform, now all the enclosed areas and spaces have to be accessed is not it. Tasulars should be able to go and operate, the equipments or for other service suitable access plan has to be done. So, here actually naval architecture, you see I have found they are not very good at the access plan, access has to be provided to all the areas escape routes.

Next is fire fighting or fire fighting equipments, now you have to decide on two things, the nature of the equipments and also the number of these equipments, and location where you are going to locate them. Fire fighting equipments are number first one you have fire extinguishers, now fire actually in ships also you come across, there are two types of fire extinguishers. One is the portable variety, and the other is the non portable, one or grounded fixed fire extinguisher, there is a particular installation you have the extinguisher.

So, anyway that is talking about that will take a lot of time, so the number 8 is what, thermal radiation, now why this is taking place, because of gas flare. So, you are igniting the gas, which is coming from you know while you are recovering the oil that is ignited the flash that. So, people should not go near that, and at that place you will find large amount of heat is coming on to the platform, because of the flare from the stack.

So, these are the other one I have already told you is vapor dispersion, that is the inflammable vapor or the poisonous vapor has to be dispersed by good ventilation, this is related to your ventilation. So, deck design, top topsides design the other one is if you have future expansion, suppose you want to have drill more wells or production facility has to be enhanced.

You have to have segregated area for that you have to keep aside the area, the last category is quite troublesome, this is called simultaneous production and drilling. So, this will actually increase your deck area, because of the difference in the nature of the equipments which are related to production and drilling, so your deck area design has to take care of all these activities.

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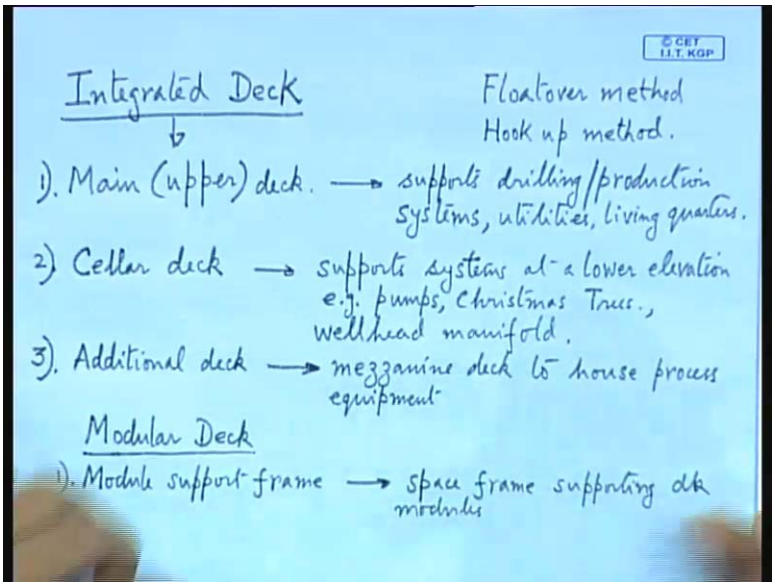

They are in nature and two basic decks are what is called the integrated deck and the other is the modular deck, now in the integrated deck. So, you have to decide, which one is going to be installed in the platform, whether you are going for the integrated deck and other the is the modular deck. Now, two important considerations are installation, normally you will find that the deck is installed on the platform after you have located the underwater structure on the sea bed.

And these depends on there are two methods by, which this is done one is called the float over method, these we will come talk about later on and the other is called hookup method. Now, float over method you will find they are actually done by barges, so your deck is actually carried that is the integrated deck is carried on barges, and then they are positioned on the jacket, that is called the float over method. The hookup method is the modular construction, where deck modules are actually taken up by the cranes and positioned on the deck of the platform, so that is called hookup method.

Now, coming to the integrated deck, here you will find, you have a main deck or sometimes this is called main upper deck. Now, this function of this deck is supports drilling production systems, these are the main function, and what are the others drilling production systems, then you have utilities and living quarters, this is called the main upper deck. So, you have to your the ship, now on top of that you have another deck, this is called a cellar deck, this is similar to your twin deck in cargo ships.

Now, this actually supports systems at a lower elevation, now the previously I talked about the air gap requirement, do you come across that. So, that means, the decks also has to be positioned at a certain elevation over the mean several; that means, how is that your waves do not come and crash on the deck, is not it otherwise there will be a havoc to your person on board the vessel. So, this is called a cellar deck, and this support systems needed to be at a lower elevation, now these are these are examples, you can write these are pumps.

Then you have production Christmas trees, suppose you Christmas trees in case of floating platforms they are not positioned on the deck, but on the sea bed, but for fixed platform you will find these are to be on the deck itself. Then you have well head manifold, manifold is where these pipes are connected to a structure, this is called a manifold, so some of these these are some of the equipments on cellar deck.

Now, what has happened? Nowadays is that decks previously were of the open type that is the truss type, but nowadays you are going for closed type of deck. In order to give buoyancy, when the structure actually, any accident occurs or to give writing up in the stability. So, anyways the cellar deck is positioned, and you may have additional decks, so these are called mezzamine deck to house process equipment

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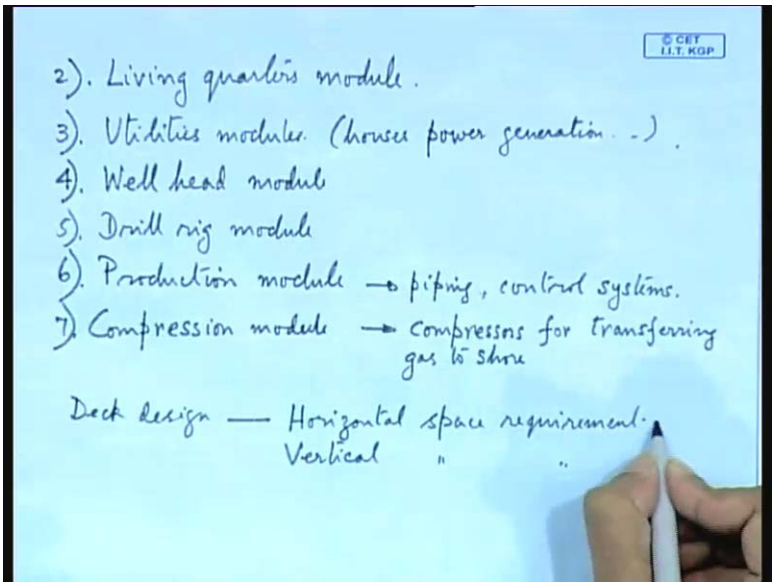

These are some of the cases of integrated deck, now the modular one here is the other one other variety is called a modular deck, so this is quite interesting study you have to

decide on what, before we discuss modular deck. Anyway, modular deck is a consists of first one will be a module support frame so; that means, here the deck is split up into a number of modules, which are hooked up by cranes. And then displaced on the deck now; obviously, those single items are to be positioned at a particular area of the deck, which has to be strengthened that is why you you have to have a module support frame.

So, this is actually your space frame structure supporting deck modules space frame supporting deck modules, now next you will have the modules the different modules. So, one is a module support frame, there is a different deck modules that are to be support a living quarters module, then you have utilities modules. So, this actually houses power generation other equipments etcetera, then you have well head, this is one word and the last one is drill rig.

So, you have to have separate modules, and these modules are actually carried by your offshore cranes and positioned in the deck on the module support frame. So, these are to be taken care of and I said there are two more modules, one is the production module and compression module. So, these are compression module, I think it takes care for compressors for gas injection, so compressors for transferring gas to shore. So, this is required production module is production, basically counts for piping, piping is also a very important contribution to your ships and offshore structures.

I do not know whether you have learned something about piping, the in offshore piping is tremendous, so piping and control systems. And these of course, so these are some of this and I think, I require one more class or after the mid sem finish, I will start with your moving. Now, the I think that is required is how many decks and extent of decking that is the design requirement, so deck design you have to do two things, one is horizontal and vertical, horizontal space requirement and there is vertical space requirement.