Elements of Ocean Engineering
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Lecture - 43
Floating Platform Design

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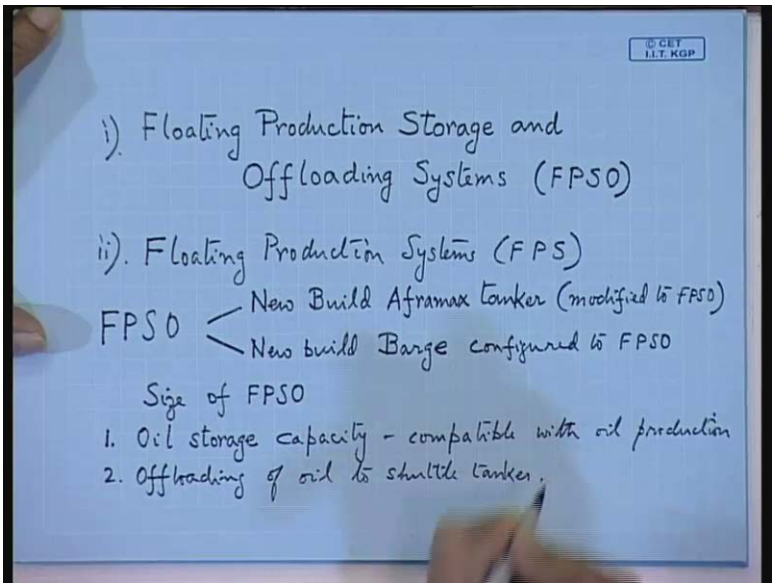

So, today we will begin our discussion on floating production storage and offloading systems and short these are called FPSO. Now, you may have simple floating production system they are called FPS. So, these are the two types of the other type you will find this called floating productions systems, they do not have any storage facility. So, floating production systems are called FPSS, so it is very common. So, you find that these 2 categories are normally in the offshore industry.

Now, there are certain features which we should remember about these two. So, we will discuss there before we go to or semi submersible. Now, the FPS are those there are basically 2 categories; FPSO you will find one is called the new build aframax tanker. So, this is essentially a tanker form you know, so this is modified tanker has been modified to FPSO.

So, when you go to industry you will come across this that most of you FPSO, they are modified aframax tankers and the other is there also called new build, but these are not be modified variety these are called barge configurations. So, these are configured to

FSO. So, you have two distinct; one is aframax tankers which are being comforted to FPSO and the other is barge which has been configured to FPSO, therefore the production system. Now, principles now size of FPSO, so when you design FPSO first thing as to make is the all sizing for the layout. So, first thing is as your FPSO says oil storage, oil storage capacity.

Now, this should be compatible with production rate, because your ship is also a production platform. So, as the names are is the production and storage; both these are impressed. So, oil storage capacity this is compatible with oil production. So, the here special types of ships; now this you have to figure out and the other one is offloading to shuttle tankers. So, they should have a offloading system; offloading of oil to shuttle tankers; the other point that is to be noted in the design is provision of topside facilities.

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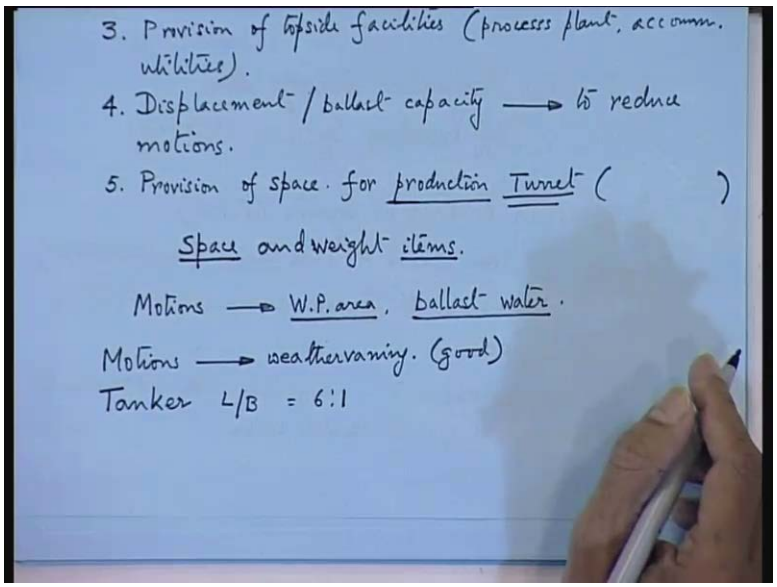

So, this I think have already discussed in detail provision of topside facilities. So, this includes process plant, accommodation and utilities. So, these are the all design; the other point is provision of displacement; the displacement they has to be sufficient. So, there your hull form is essentially what when you are doing a lines plan. So, FPSO hull form will be these 2 types; one is a tanker, other you can go for a tanker or a barge lines; tanker lines or a barge lines. So, your displacement motion stability will be as per the barge and the tanker configurations. Now, displacements and ballast capacity has to be provided. Now, we know by these are actually are job of the narrow light depth. Now,

you are the production in detail the production and process you have will be done by the chemical engineer or mechanical engineer but you have to configure all these. So, this displacement and ballast capacity is essentially provided to reduce motions.

So, I told you earlier that offshore system; their main job is to reduce motions otherwise it will hamper with your production rate. And you have to shut down the plat form; the other point which is more crucial is provision of space for production turret. So, this is your part of your turret moving; this is your moving. So, that turret actually is a point for taking out the oil from the oil wave and also moving the tanker. So, with serves both the purpose. So, this is the now turret actually we will require lot of space; in the all the first thing you have to play around with space; now as never act a this is very important space so and what? Weight items, space and weight. So, these are the 2 items which you have to optimize.

Now, remember you cannot you are not supposed to have we use space; because that were also consume lot of cost we increase the all size enormously. So, that will also increase cost although you may reduce motions to some extent. But motions you will also find that it is very largely dependent on water plane area; water plane area and ballasts; motions you will find you come across those formulas is highly dependent on water plane area; in short I am writing this water plane area and ballast water. So, they never aggregates should be very careful about this. So, you have to have water plane area and also ballast water. Now, water plane area, if you keep on increasing you have a lot of yield motions.

So, then again you have to damped the motion by giving ballast is it not. So, these are some of the drawbacks some having a ships shepherd form. Anyway, so this is the have you designed parameter; the other part is the motions. Now, motions you will find motions is weather varing they call; now whether varing you will find or what is the L by B ratio of a tanker? So, whether varing should be good that is the ship should be friendly with the motions that have coming from the wind and waves. Now, tanker L by B tanker L by B is around 6 is to 1. Now, whenever we are doing lines plan this as to do not do it blindly; the lines plan that you have been drawing they are cargo ship lines plan; how much is your L by b? So, this actually you may be asked or you should be a at your fingertips.

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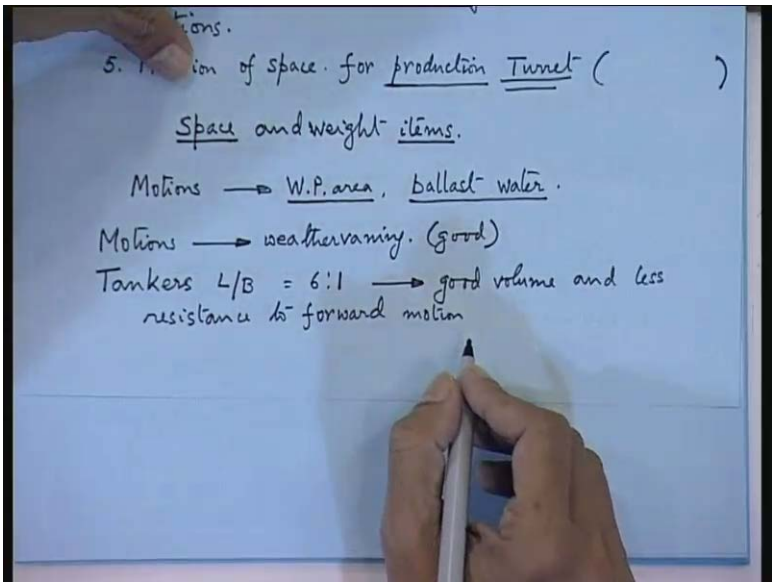

Now, this is necessary, because this gives good volume and less resistance to forward motion. So, these are some of the design parameters you know; but the design optimization you see and FPSO and tanker you have different design objectives. Now, this is essentially good for tanker your tankers what is that main job is tankers?

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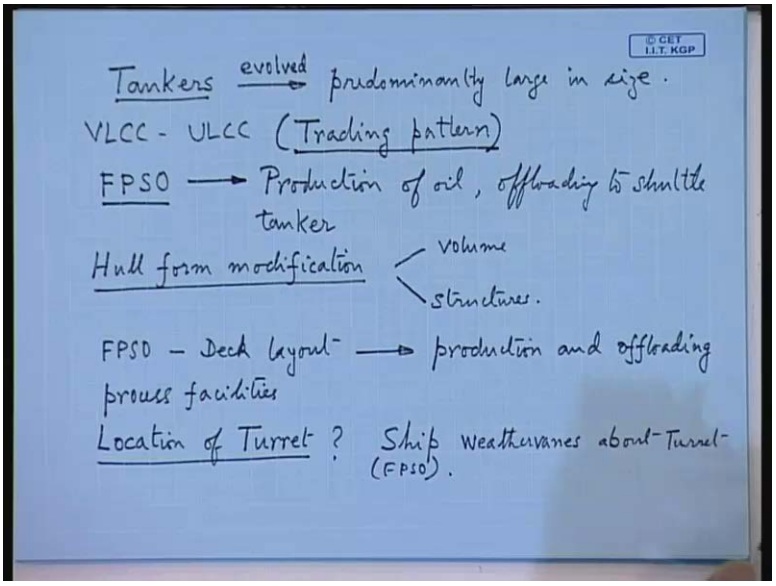

Then, the actually the hull form design of tankers is build around; what tanker have evolved over the years. Because tankers normally you will find there predominant is very large in size there. Because this gives your economics in the transportation of oil from

one place to you transport large volumes at a time then obviously the cost is less. So, tankers you know the VLCC, ULCC evolved because of this. So, those are basically dependent on the trading pattern. Now, your FPSO actually they will not be asked to do this; FPSO are basically oil production system they are not involved in transporting hull form one place to another; this is called trading pattern or trading economics. Now, here actually the cost and the economics is basis of production of oil.

So, how do you calculate the cost and the profit from an FPSO not be the same as your tanker is it not; tankers you have the return on the investment is based on the large volume of oil; that you carried from one place to another there is it turn of around the profit. And here it is dependent on the production of oil and also offloading to shuttle tanker you calculate this. So, actually the objectives of these 2 categories of vessels are different; and with that actually you are designed will be the design objective is different.

But essentially the tanker you will find because of the very high cost of making a new build. So, they have converted tankers to FPSO. Now, this actually will entire lot of structural modifications. So, you have to do hull form modification; they if you happen to visit one of the Singapore yards you will find a doing lot of conversion work on tanker converting tankers to FPSO. So, you have to undergo lot of hull form modifications; these are basically this is you will do the what is called the volume and structures. So, you convert your tanker to an a FPSO major thing is in way of turret.

So, they actually your tankers of you will find but if you want to make an FPSO; first thing that you have to do is what your deck layout. Your deck layout is very tricky in case of a FPSO; because you how to the deck layout is guided by your production facilities; your production and offloading facilities. Now, this you have to have with horror knowledge of. Now, normal tanker will not have this kind of arrangement; but again you how to modify basically you have to modify the deck all the tanker.

So, that is one big job. The other big job is location of turret where you are going to locate the turret; your turret is actually if you look into the diagrams you will find that is a very large structure or ship actually weather vanes about turret ships, weather vanes about turret ship mean in this case FPSO not your tanker, so now where you are going to locate this turret. So, turret is a massive weight concentration and also point of shearing of a ship about turret. So, this is another measure items which you have to configures.

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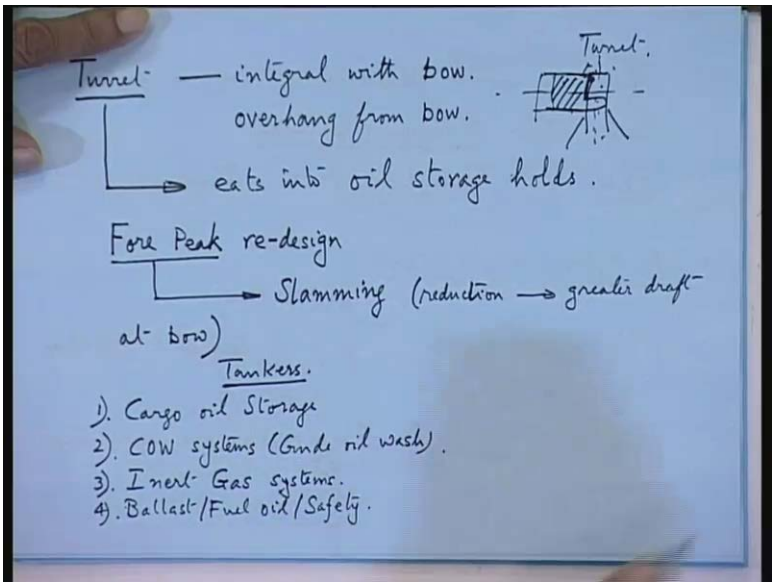

So, normally turrets you will find turrets this you will find integral with bow or you can go to over hang from bow; and these are the 2 configurations will come across FPSO. So, which one you choose will depend on now your there are 2 things; now turret actually you will find it will consume lot of space. So, turret actually it eats into your oil storage holds; your oil storage will be sacrifice. Because it might consume the volume of see one and half holds you will go.

Now, if you do not want that you will simply position the turret aware from the bow. So, you will find your now you have to the bow has to be modified if you are modifying a tanker. So, the bow you have to take care of the turret. So, here you have to make some modification and a turret will we harm from the bow. So, this is called a bow turret; the integrated turret is you take the turret inside the bow. Now, there are definite advantages and disadvantages you find that if you have the turret which is overhanging from the bow. So, that is not a very good when we design when the a sphere is going from one place to another where it is increased bow instance from the where?

But the advantage that you will be getting is larger storage volume in the forward region. So, fore peak has to be redesign. Now, if you will do fore peak redesigning then other fore peak actually the lot of forces that is coming in the measure forces, coming from slamming; that is you are pitching; bow pitching is very much predominant in this case. So, turret will be exposed to a lot of pitch and the bow. Now, the here actually so this

slamming if you want to reduce; then you will go for reduce or reduction, you go for greater emotion or greater draft at bow. So, that will reduce your slamming your all these things you have to encounter. So, if you want to your know go for increasing the that is you increase ballast what I has to be in this region or you just increase draft of the ship. So, here is some of the design configuration which there may be coming into phrase because of this turret molding.

Now, the from the where if I now tankers some of the systems are the common tankers will have so this system you can utilize. So, the main thing is how to be cost-effective when you are converting a tanker to an FPSO; in a tankers we always have cargo and storage. So, you can use that. So, the holds of the tanker can also be used but that the only problem that we are coming is with the turret measure where to place the turret. So, the this thing will always will be there then it may have other COW systems of crude oil wash. So, this also can be used this is called crude oil wash; other systems which you can use is inert gas.

Now, tanker design you how to very very cautious about the safety systems; inert gas is all this ((Refer Time: 23:09)) inerted; if you want to clean or do some work. So, welding or anything these there vented an inerted; then you have a ballast water system, crude oil system and safety system. So, these are orderly present. So, you can be used ballast fuel oil and safety system. So, tanker designs you have to be thorough about all this system. The other modification that will be coming is the turret design of what did you told you.

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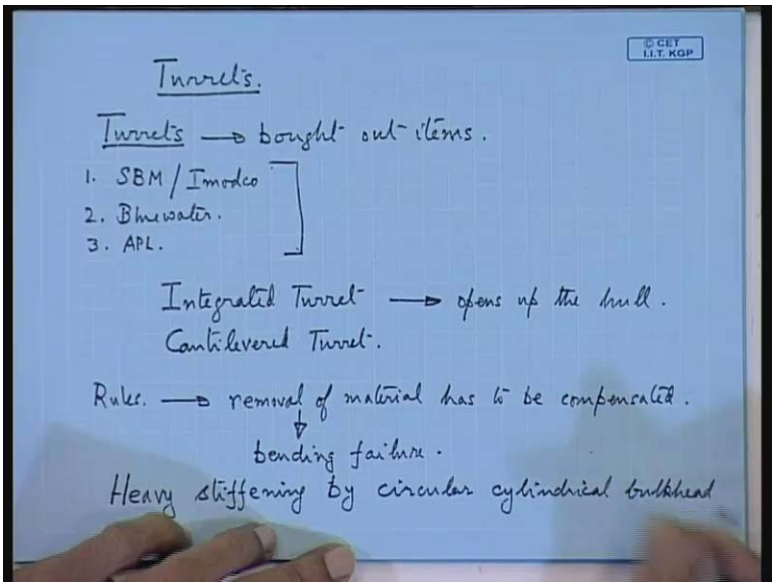

Now, you not be designing the turret. So, turrets are essentially bought out items. So, the shipyard will not be fabricating turret but it will give the contract to some other company. So, normally give are manufactured by SBM, imodco blue water then you have APL. So, they are given by the web sites you can see. So, these are some of the companies is manufactured turrets. So, you have to give your requirements to this people around with the hull form.

So, I have told you this is called over on this can be called a cantilever turret is called a cantilever turret, so integrated turret or a cantilever turret. So, these are the 2 types of turrets you will find. Now, this turret is actually going to open up the hull; if this is the integrated turret; so this opens up the hull. Now, if you want to open up the hull. So, that at that region you will find there is loss of strength especially regarding to how that are bending and sheer.

So, in rules actually specify if you move any material from the ship that has to be compensated; removal of material that has to be compensated, so because this will be to reduction in bending. So, this is reduction to now you causes bending failure actually; bending failure will avoid here they do not services and materials which is compensate below this turrets. So, heavy stiffening has to be done by now in the region of turrets obviously you cannot have a bulkhead or flat bulkhead. So, they will be a circular civil become bulkhead, singular bulkhead with radial stiffness.

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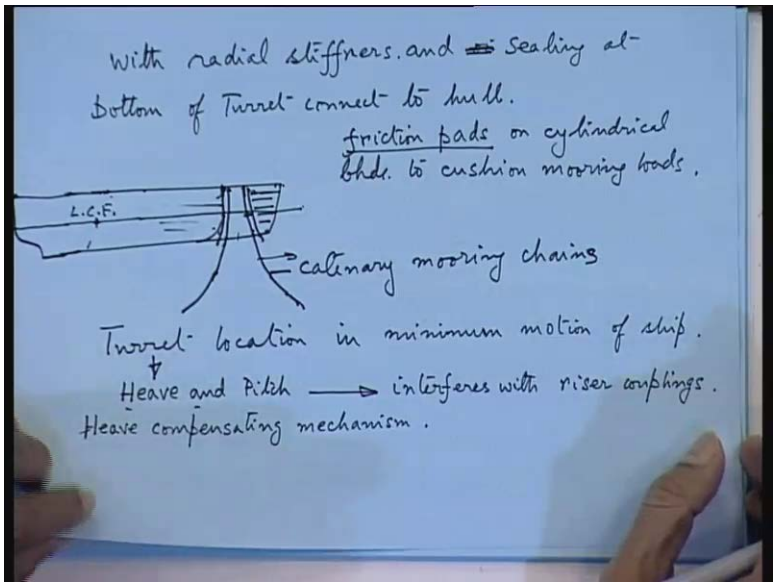

This is the structural computation way of turret with radial stiffness and oil civil and rather you write sealing at bottom of turret connection to hull. So, this is one measure design. So, actually your see this is your say ship; now suppose you have turret it out here. So, that means basically if you want to install turret you have to make a move pull that is in hull. Now, you are the mooring change come out like this. So, we have make provisions for what? So, this is your catenary mooring change. So, suppose of catenary mooring change is going in this direction is going to exact pressure on the bulkhead of the turret. So, turret bulkhead has to be you have to give very very stiffening at the above. So, there should be what is called friction pads. Friction pads on cylindrical bulkhead to cushion moving loads.

Now, this is as job of never agreed the turrets suppliers will just you giving the how configuration, how line plans we will give you suitable turrets according to your production rate and all that. And the moving also this is the very, very important calculation for never aggregates, so he as to order the correct. So, when you go to your so off sure of company see this is one of your job but then you have to do very heavy stiffening at the turret region, so your catenary away the removing the huge portion of the hull. So, you have to make up by giving lot of longitude runners, longitude guarders and extra stiffening near to do around this region; this one around other thing is we mooring loads are actually been transfer to the hull in way of turret. So, for that we have

to give friction pads an heavy stiffening around this region. So, this is normally done other portion is turret location.

Now, turret location actually the most favorable location is find is where say this is the stan of the ship; where you have to locate the turrets. Now, turret location should be turret location in minimum motion of ship. Now, if you want to do you will find this ship is having minimum motion at where ship which is about NCF point listened. So, minimum motion they will be the accurate is LCF minimum motion will occurs; where LCF region will there you have any pitching but here will be the still there.

So, the motions that will that are in important for turret the question for mainly heave and pitch. So, these 2 motions actually interferes with rises company with raiser conphings. So, you have to be very careful about this have to calculate; which the vocation of ship will give minimum heave and pitch we cannot compromise on this. So, sometimes all this moving will of course turret design is may not be possible; you have a heave compensated mechanism. So, the best phase will be to locate turret around LCF why around if it is LCF is not possible. Because mix shape you will find you will be getting larger cross section area.

So, you have to have sufficient volume and also sufficient sectional area; section area if you have large sectional area. So, at this regional you will get larger volume and also; you can have extra stiffening now the mid ship. But at the mid ship they will find as in your ship strength calculation; the bending moment is actually coming at the maximum bending over the mid ship. So, again we have to redesign the whole ship the end calculate what is where the rotation of your maximum sheer ship bending moment with turret. So, turret is the large weight at in the ship. So, this sort of things we have to do. So, interfere with raisers catenary. So, this has to taken care of in your design. So, turret size in; turret as to efficient in sorry this you have to give to the vendor.

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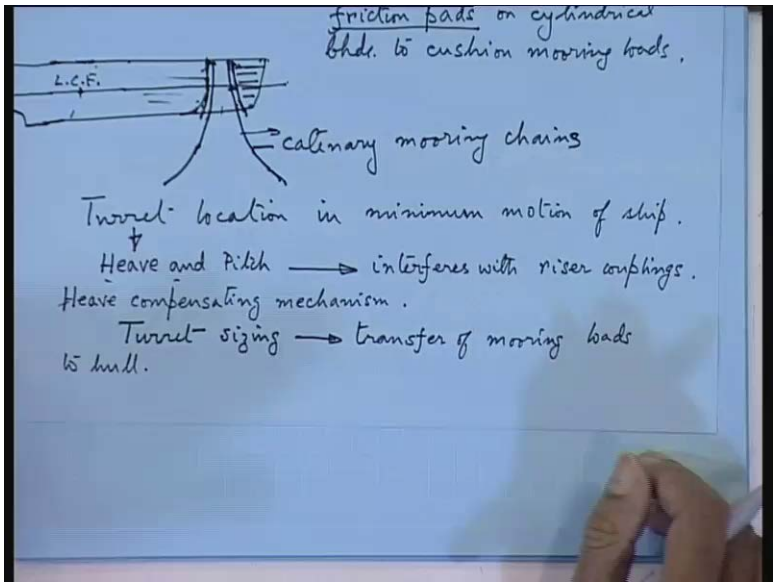

So, turret size in this is based on transfer moving the loads to hull this we have to do. So, like your propeller thrust; your propeller thrust is actually you have to transfer the propeller thrust you have by means of friction pads of friction bearing. So, they are called thrust bearing. So, likewise you have to similarly have major thrust bearing out here from the turret. Now, remember these are actually breach forces, so if you 100 terms of 1000 terms of coming at this area; so those have to kitted for.

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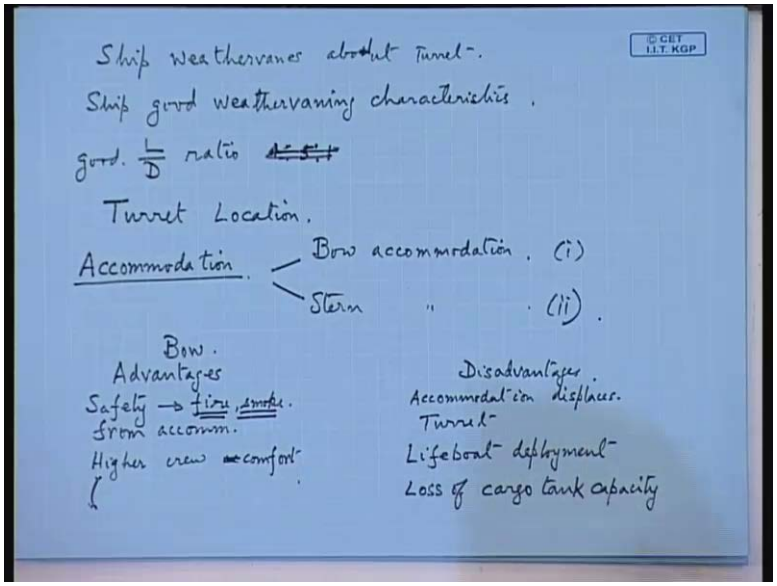

And, the weather willing criteria the weather ship actually weather when some of turret; whether when is the most of your moving around this region. So, you have a chain table we are all this moving are moving change are attached. So, ship weathervanes sorry about turret; ship good weathervaning characteristics, now weathervaning characteristics given by your L by d ratio.

Now, this L by d ratio this optimum value which is given here I think it is 1 by 5 and just check out that; either ratio should be around 1 is to 5 or something sorry this is 5 is to 1; I will give you I will just check and give you this not here. Anyway these are some of the things which should be denote the good write; the good is the ratio; this value are give you later this is. Now, one region one is turret location; this we have finished. Then next is accommodation the accommodation to the important; there are 2 types of accommodation which you can go for is bow accommodation the other is stern accommodation.

So, which one you preferred? This is the first category, this is the second. Now, bow accommodation has certain advantages. Now, here actually disadvantages; the advantages are safety because fire smoke you keep them away from accommodation. So, accommodation lay out which is job of never agreed. So, is the centre around your debt planning debt lay out. Now, this accommodation disadvantage is accommodation actually displaces turret.

Now, where your having this turret you cannot have accommodation are where your having accommodation you cannot have turret. So, this is one of the main reason. Now, turret we will get this place the other is bow is actually is higher crew comfort; I do not know why plus bow will have lot of pitching also; pitching is not very good for the crew. But here it is crew comfort in the view of this is because of this I think 5 fire and smoke. So, accommodation has to be kept away from this 2 and each that the main reason this advantage can lifeboat deploy. Now, this is one of the disadvantage if you have lifeboat bow accommodation.

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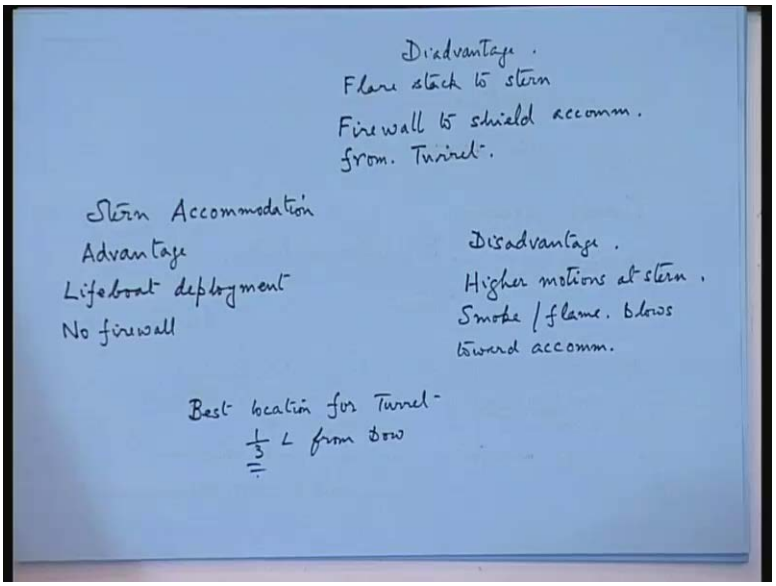

This obviously will be we have to sacrifice your cargo tank for providing accommodation; flare stack to sterm your flare stack that is your gas flare. So, that is if your natural gas flare we have to remove with this arrive from accommodation review otherwise that we cause lot of heat and fire as on to the crew. Next we will require fire wall to shield accommodation from turret. So, turret is a like we point for fire. So, is better not to accommodation next to turret; it will both are ago first on a accommodation go for an accommodation; stern accommodation advantages and disadvantages. Now, this points are to taken care of when your ((Refer Time: 43:36)), so main advantage of this lifeboat deployment.

So, normally you will find the lifeboat of ships are located at this sterm of the ship; that disadvantage is higher motions, no firewall. Disadvantage is if you have accommodation then smoke flame actually blows towards accommodation; it is the major risk; if you are accommodation at sterm and the turret at the above. So, turret caches fire; that means a flame an reaching will go to the accommodation region. But if you have accommodation follow and turret of that will not occur. Now, best location of turret you will find is one third L from bow. So, this has been form from good design.

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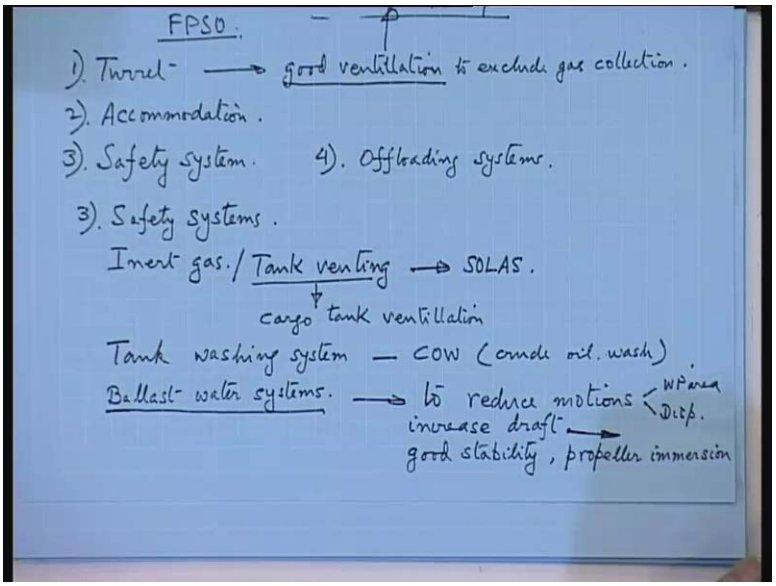

Now, F P so first thing is you concentrate on turret; next accommodation, safety system this is very crucial. Now, under safety system we have the under third category. And the finally is number 4 is offloading system, inert gas/ tank venting. Now, this you have to provide in ships according to solar required; you look up solars; and it will give you the inert gas what is the inert gas tank venting everything is fine. So, what is the requirement for ventilation here cargo tanks? So, this is tank venting is cargo tank ventilation. Now, your cargo tank will carrying oil same it will liquid.

So, FPSO is they have to ventilate the pockets. So, turrets in that cases also turret as to have ventilate good ventilation to exclude gas formation, gas connection this also we should be taken care of design; when you design your turret and the portion of the ship where turret is come out there is called moon pool; the turret actually goes with moon pool design. Now, this 2 turret and moon pool should be should have good ventilation; otherwise should enable gas will start collecting in your trapped volume. And that is potential source or fire sun night to midnight.

So, this you better take care of; the other is when you design the deck clay out. So, another thing I told you that suppose your turret catches fire on your production this in production and catches fire; when should not spread to accommodation very quickly. So, you have to barrier the aggregate the accommodation area from production areas by means of firewalls. The other is safety system this inert gas, time bending system in

cargo tank. Then you have tank washing system; your tanks. So your tanks have to be we are called this is many done by COW system or crude oil wash then ballast to water system.

So, these are the provisions we have to keep many a design in FPSO. And now this ballast why you require ballast water? Suppose your FPSO have transfer all the oil shuttle tanker why this ballast water is required to reduce. Now, remember this is sort of question you can be ask the interview; ballast water is a essentially to giving reduces motions and what increase draft. Suppose you are asking in interview why you give ballast water? Reason that you should do is reduce motions. Motions are primarily depend on 2 aspects I told you these are dependent on water plan area and what displacement water plane area and displacement. So, these are 2 of prime consolation to reduce motions increase draft for what?

Now, in your interview you know they do not ask in any complicated formulas they will simply ask for how this questions; draft is increase for what? Good stability and propeller emotion they remember this points propeller emotion is required when you where the verses actually sales from one point another. Otherwise you may not required this; good stability that is why in tanker actually tankers empty tankers have very large free mode. And that is not very good for your dynamic stability. Because large wind is area g will go hire of, g m will be reduce and all this shorts of thing having. So, that is why good emotion is required ballast water.

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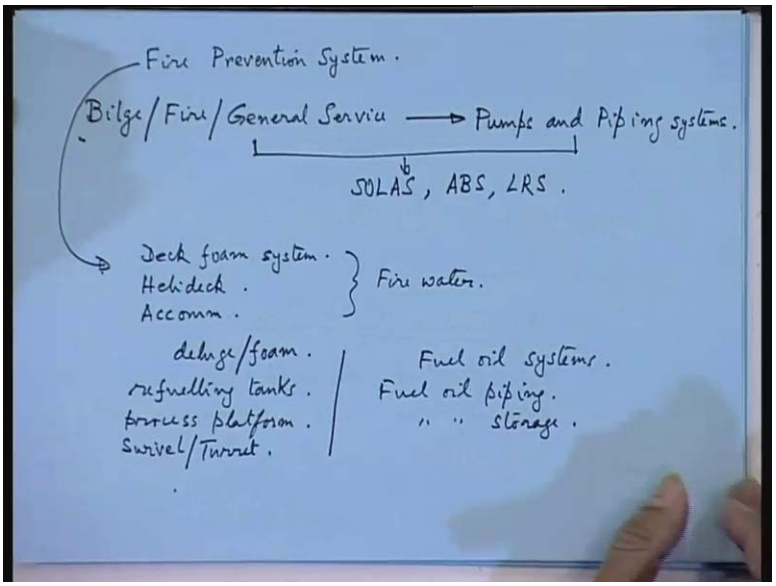

So, this is some of the system we have to study. Next is fire prevention system. Now, this also the in this class I cannot go into details. Now, when you go for shift system you study this bilge normal shift have bilge come fire come general service, so pumps and piping system. So, when you design you design a bilge which is service your piping will common to both bilge come fire general services. So, this conforms to we should conforms to SOLAS. SOLAS we look up this bilge come fire come generous service and ABS, LRS especially you be care full with tankers and FPSO also tanker when FPSO is there very complicated bilge and fire and general services, pumps and piping system in the ship.

So, this we have to think about. Then the coming to this fire prevention you have deck foam quickly that we finish whether time is up. Deck foam system is a most primary thing; then Heli deck, then your accommodation. So, this is fire water then you have a deluge come foam. So that means the whole here is engulf with foam. So, refilling tank process platform, surivel stoke/ turret then the these are the main stream. So, relation of fire and water then fuel oil system. So, this is fuel oil piping, fuel oil storage. So, this you have to think about; the last that is to discussed is a offloading system. So, this is you will not find this system in conventional tankers.

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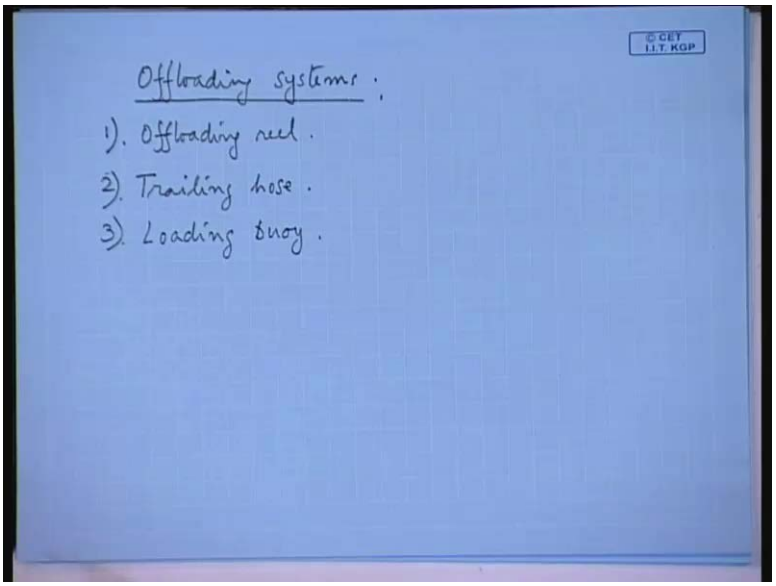

So, here we have number 1 offloading reel; this is a very large the offloading wholes is warm that is called a trailing hose to shuttle tanker and loading wire. So, these are some of the parts of offloading system in FPSO this unique to FPSO. So, with this come to the design of APSS and next will go to semi summer others. So, semi summer able TLP and parts that.