Health, Safety and Environmental Management in Petroleum and Offshore Engineering

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Module No. # 01

Lecture No. # 10

FMEA (continued)

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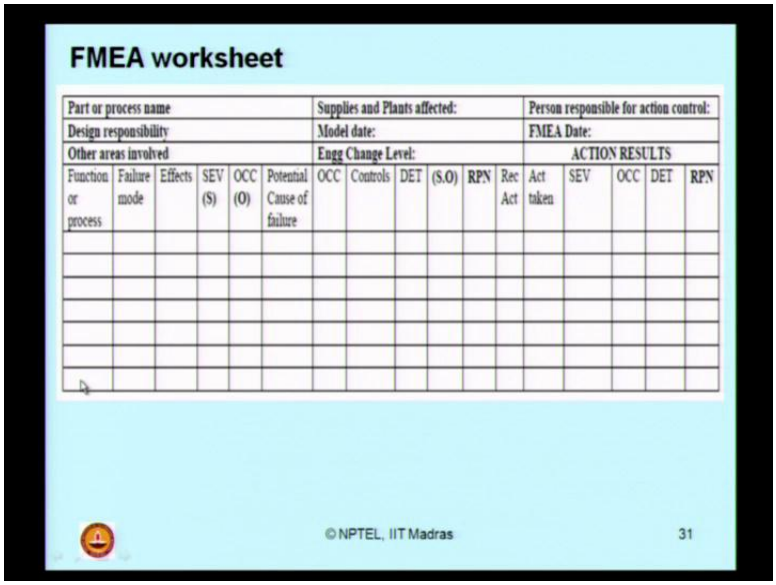

So, ladies and gentlemen, we will continue with the FMEA analysis which I am in doing. Say FMEA worksheet has the following layout. You will identify the function or the process in a given system. Then identify the failure mode. Look for the effects of that failure on the overall performance of the system. Then for that look for the severity and occurrence of those failure modes and also list the potentials causes of that failure. Also look at what will be the occurrence, what is the ranking of control do you have. Can you detect that failure mode in advanced then also try to give what we call as an risk priority number? Then based on these occurrence and controls and detections try recommend some actions, and mark or remark the actions taken on these issues.

Once you takes the relevant actions, severity or occurrence or detection may now change. Now, for the change severity occurrence and detection, find out the new RPN number is nothing but the product of these three. Compare the new RPN number with the old RPN numbers for every function or the process being identified.

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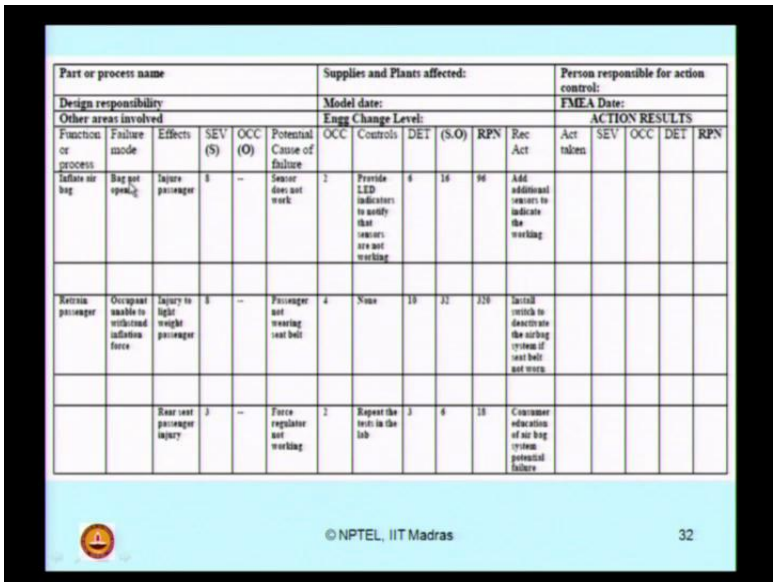

Here I have a sample, which is filled up for you on the exercise which I just discussed. For example one of the function what I am selecting here is inflate air bag. The failure mode will be the air bag does not open at all. What will be the effect of this the air bag does not open on impact it will injure the passengers. So, the severity will be eight on a ten point scale, but occurrence is very rare because generally inflated air bag is not present in a tested automobile vehicle. Therefore occurrence is not very frequent because accidents are not occurring frequently but what is the potential cause of failure, the sensor which us got to trigger the opening of the bag is not working properly that is why the bag is not inflated when it is required.

So, what would be the occurrence of that particular number let us say two on a ten point scale? What control can you give for that provide an LED indicator to notify that the sensors are not working? We can have LED indicator on dashboard, the driver or the passengers will understand that the air bag functioning is not effective, it is not working properly. So, the detection can be a six of ten points scale, because when you provide an LED the driver can easily understand well in advance before he starts the car that is air

bag system is not effectively in position. So, detection can be six out of ten. So, severity into occurrence can be a value of S into O you try to find the detection which will be this into detection which is a RPN number of 96.

Similarly, the other function is restrain the passenger from accident. The failure mode is occupant unable to withstand the inflations force, because the air bag gives an inflations force on the passenger. The passenger is not able to withstand that forces, may be he is a weak passengers. So, the effect could be injury to the light weight passenger is possible. If the passengers is not having enough strength, he may get injured because of the inflated air bag during accident. So, the severity is again eight on a ten point scale, but that kind of occurrence is very rare what will the potential cause of failure is the passenger is not wearing a seatbelt. Was his bodily thrown towards the dashboard; that is the potential cause of such kinds of failures.

The occurrence of that can be four on ten point skill because generally people may not wear a seatbelt. But for wearing a seatbelt you may not provided an LED alarm, but you can always give a siren or a system which is present, but here I am not taking any advantage of that control mechanism provided. But the detection can be physically ten out of ten scale because you really know whether you are wearing a seatbelt or not physically. So, the RPN number for this can be a very high order of 320.

Similarly, if the rear seat passenger having an injury that can be an effect of the restrain the passengers, and the severity can be three because his injury may not be as serious as the driver. The force regulator may not be possibly working. So, he has a priority number of 18. So, what would you do if you want really avoid this kind of accident. So, for example, let us say this kind of malfunctioning of the components. Install a switch to do activate the airbag system, if the seatbelt is not worked.

For example, the passengers does not wear a seatbelt, install a switch to reactive the airbag the airbag will not worked otherwise. Seatbelt is not worked. Otherwise, you educate the consumers the use of airbag potential failures etcetera. I am not filling up the action column here, this is for your exercise. You recommend certain actions after the actions are implemented in the design. See, what is the level of reduction in severity, what is the level of improvement in the detection then now what becomes your RPN.

This is a very simple format of doing an FMEA analysis for an airbag system which is one of the mechanical system for which an FMEA can be readily apply.

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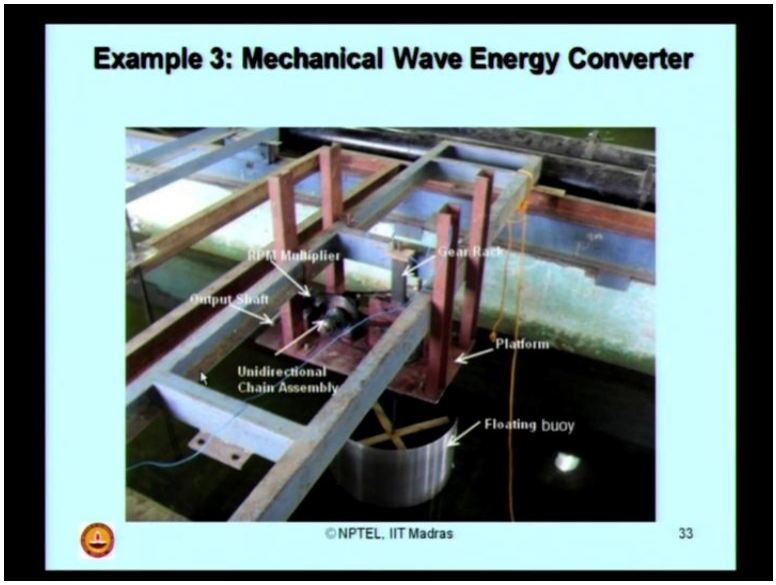

I have another example for you, which I call as a mechanical wave energy converter. Ladies and gentlemen, try to recollect an important note which is said previously. In the system definition, if you do not the system completely its components, its functions you will not be able to actually do an FMEA. So, I deliberately picked up an example here which is completely a newly developed and purpose system in our work place. So, you may not be aware of this system. So, let us see are we successful in educating you to write an FMEA for this new system which you never seen its working earlier, which is a mechanical wave energy converter.

It is a device which is housed on a platform with these four box sections which is suspending a float that is a floating buoy. It is got a platform, the platform has a gear mechanism which I calls an unidirectional chain assembly. So, there is the pinion gear rack here attached to this float, as the flow moves up and down this gear rack move up and down. This gear rack activates the chain mechanism rotates the shaft. There is an rpm multiplier here, which give the mechanical output to this shaft and is electrical output is taken from this shaft. In simple terms, it is a mechanical device which has got a floating buoy because of the wave action the buoy moves up and down. This up and

down motion of the buoy activates the rotary mechanism here. This rotary mechanism is converted to electrical energy. So, the system is defined.

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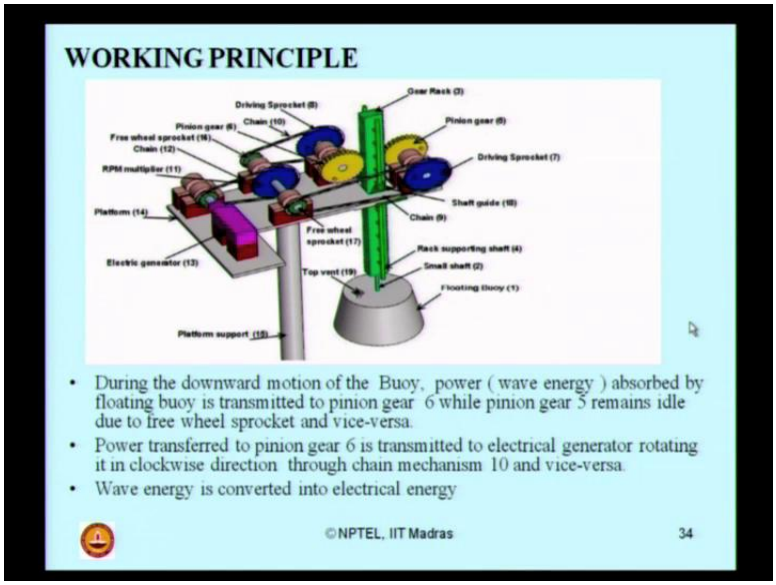

I have a conceptual figure of the system again. I have a floating buoy. It is attached to a rack. The rack has got a pinion arrangement. There are pinion gears six and five to the yellow one, which are present here. The blue ones are what you call driving sprockets, as the buoy moves up or down, I must get an output on the shaft here. Let see how does it work quickly. If the buoy is moving down, I have made an arrangement such a way that this will rotate clockwise, when this rotates clockwise this will activate the mechanism of the chain here, and the shaft is receiving a let us say a rotation in a specific direction.

As the floating buoy moves up, this will be released because you know imagine a cycle chain. You are paddling a cycle, when you put a forward moment to the chain, the cycle moves forward. But when you make a reverse paddling the cycle does not moves reverse, because the free wheel basically does not give any action to the driving mechanism at all. Similarly, when the buoy moves up this rotates anticlockwise. So, this is released from the socket. Now, this rotates a specific direction that will activate the rear gear mechanism which will again make the shaft to rotate.

On the other hand, for both up and down movement of the floating buoy, you always have an unidirectional motion of the shaft. And I connect an electric generated to the shaft, I generate power from the ocean wave energy. So, the ocean waves hits the buoy,

the buoy moves up and down. The up and down causes rotary motion in this mechanism, ultimately the shaft is may to rotate the specific rpm. I also enhances this rpm by what I calls as an rpm multiplier. Then the enhanced rpm on the shaft is connected to an electric generator, I can get an output in electric power. So, the mechanical energy is converted to electrical energy by this system.

So, during the downward movement of the buoy, the power which is the wave energy observed by the buoy is transmitted to pinion gear 6. The pinion gear six, the pinion gears are what you see in yellow color here. Pinion gear 6 is marked somewhere here you can see here, where as a pinion gear 5 remains idle that is a mechanical design. So, this power transferred to pinion gear 6 is further transmitted to electric generator by this rotary mechanism, which will make the generator shaft rotate in a clockwise direction through a chain mechanism number ten this is activate. So, the (( )) motion that is up and down motion of the buoy is converted to an electric power in the generator shaft. That is the working principle of this mechanical wave energy converter. Now, the system is defined.

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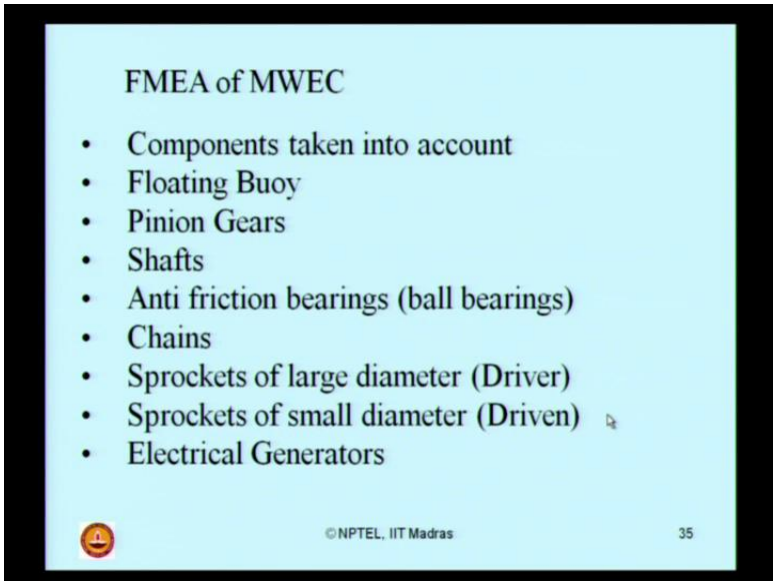

Let us identify now slowly the components, which component will you taken to account. I can list the components, I will give a past time of few second. Can you write down the list of components, which you now consider for an FMEA analysis of this mechanical wave energy converter.

(( ))

Yes very good. First component can be a floating buoy. The second component can be the pinion gears, very good. Third one good shafts are also possible to be identified.

(( ))

Yes, generally even an mechanical arrangement you are right, you may also have anti friction bearings what I call as a ball bearings. You are definitely having chain mechanism in the system good. You also have sprockets of larger diameters that we call as a driver mechanism of the system very good. You also have smaller diameter which is a driven mechanism which we call a sprockets of driven mechanism. And of course, you have electrical generator, very good. You have been able to identify the components of an mechanical wave energy converter.

I appreciate that you are able to understand the system working thoroughly and based on the working you are at least able to identify the functional components of the generator or the converter. Remember FMEA is only on the functional part of the component it is not on the physical part of the components at all.

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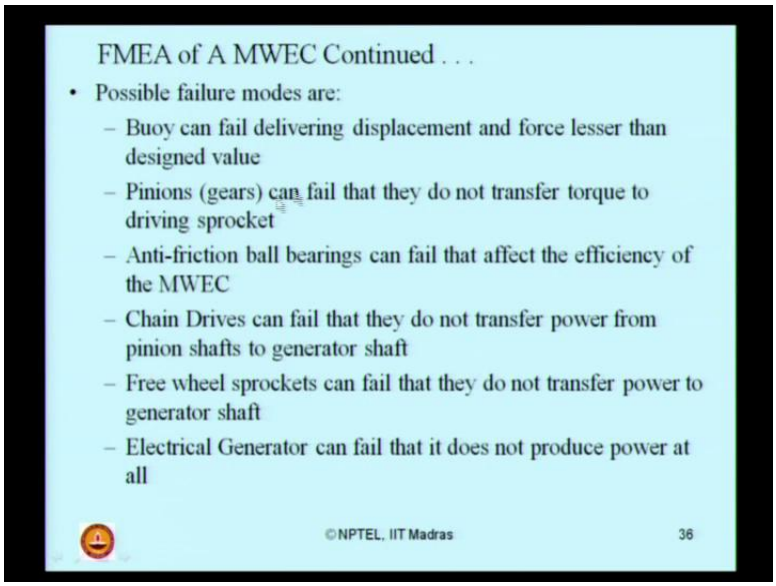

What are the possible failure modes? The buoy can fail delivering displacement and the force lesser than the designed value. The buoy may not give you a designed force; therefore, there is no design output in the generator - that is one possibility is a failure.

The second failure mode can be the pinions, the gears basically can fail and they do not transfer torque the driving sprocket at all. The third failure mode could be the anti-friction ball bearings can fail and affect the efficiency of the converter. The fourth failure mode could be the chain drives can fail; they do not transfer power at all to the generator shaft. The next failure mode could be the free wheel sprockets can fail; they do not transfer power at all to the generator shaft. And the last failure mode could be the electrical generator itself; it does not work and therefore, no power is produced.

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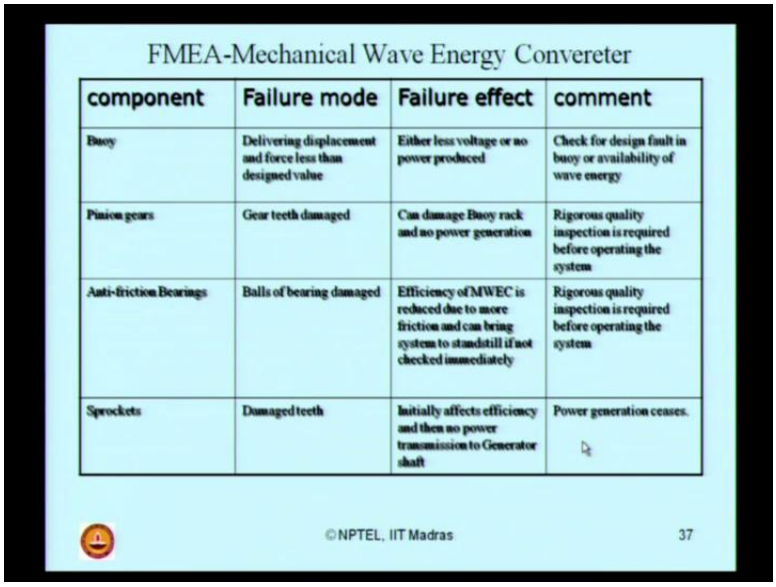

Now, can I simply tabulate what I discussed in the previous slide. What are the components? What are all the failure modes? What are its effects and what is a comment, I will just explain only one for your understanding.

Let us say talk about buoy. The buoy has to delivering displacement and force lesser than the designed value. What is effect of that either less voltage will be produced or no power will be there. What could be the comment? Check the design fault in the buoy or availability of wave energy. For example, the buoy should move up and down and that is possible only when you have a specific amount of wave energy present in this state. If the wave height is not sufficient, if the wave period is not adequate, the buoy movement may be very less. In that case the buoy may not produce the desired displacement, so that is the effect therefore, the no power is generated. Similarly, one can discuss for the pinion gears, anti-friction bearings, sprockets etcetera.

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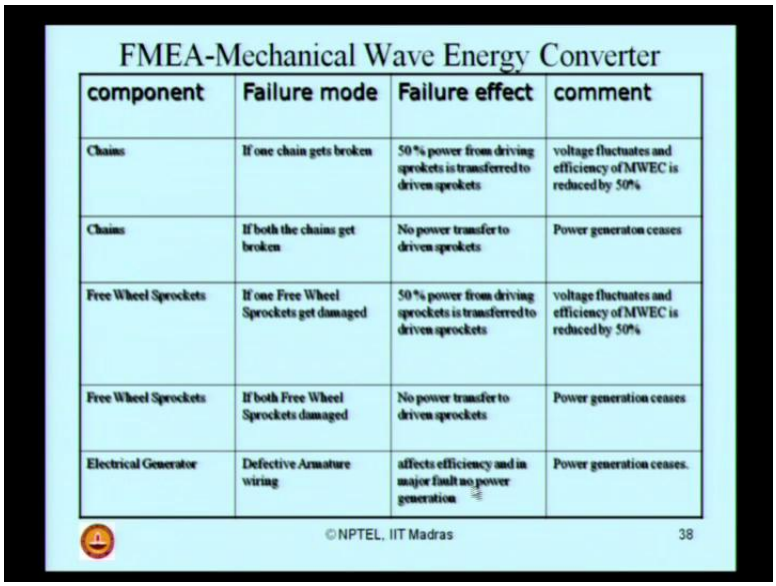

Chains, chain mechanism, free wheel sprockets, electric generator. For example, if you consider a component of electric generator, what could be the failure mode of electric generator? The generator can have a defective armature wiring, because it did not generating power at all. What would be the effect of that it affects the efficiency, and in major fault no power generation is going to occur. What would be the comment on that, power generation completely ceases, because generator is not working at all?

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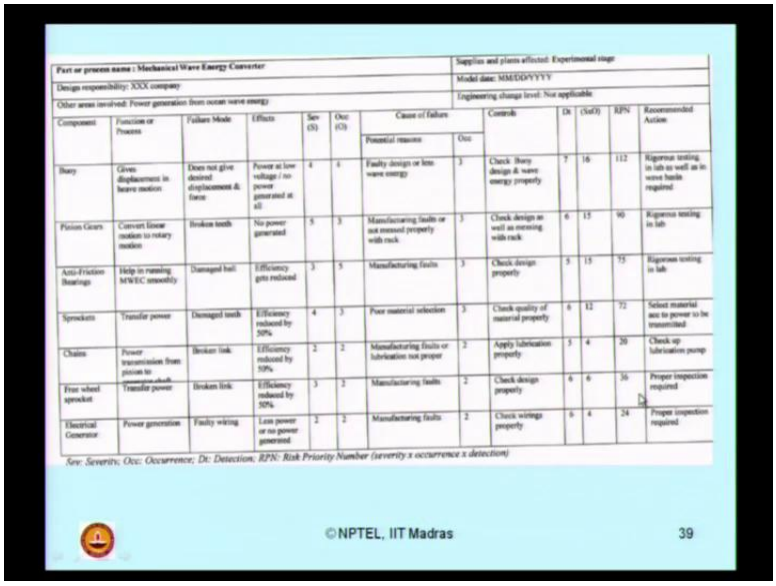

Can I write an FMEA table in total for a whole process? For example, the part or the process, what we understand is mechanical wave energy converter. The design responsibility of this converter lies within XXX Company. The model date is been given in this format in this sheet let us say. The other areas involved in the specific work are power generation using wave energy. The engineering change level is there in the design; it is not applicable, because it is a product development; there is no engineering advancement so for happening, it is only in the invention stage.

So, let us list the components what we discussed before the buoy, pinion gears, anti-friction bearings, sprockets, chain mechanism, free wheel sprocket, electric generator. Let us identify what function these components should do. The buoy actually gives displacement in linear motion. The pinion gears actually convert linear motion to rotary motion; these are all functions of these components. What will the possible failure mode of these components? The buoy may not give a desire displacement and the force. What would be effect of that, the power could be very low voltage or basically there could be no power at all generated.

So, let say the severity could be four on a ten point scale; the occurrence of this also can be a four on a ten point scale, and can I have any control measures to check this. Check the buoy design and wave energy properly. So, it is possibly detectable therefore, I can say it is seven on a ten point scale. I get a risk priority number related to buoy component as 112. What action do I recommend regress testing in the lab is required, before we basically design a product for its production?

Similarly, for every component, I can always ascertain the severity in occurrence and see whether it is detectable and tried to find the risk priority number and try to rank them. Fortunately in this table, there is priority number is maximum for my buoy itself. So, ladies and gentleman, what do we understand by a component having the maximum risk priority number, we discuss in the previous slide turn back, and see we must now do a component level analysis in detail for this buoy alone, is that right.

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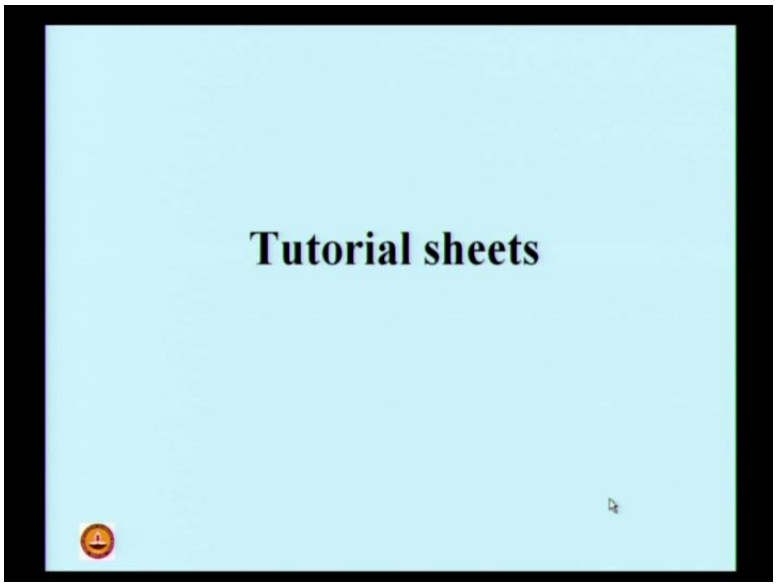

Now, with this discussion, we completed the first module almost in total. So, it becomes my essential job to carry through you, some tutorial sheets for yourself examination. There will be also some quiz papers given at the end of the presentation of all the modules. There will be an examination paper also been given for you. We of course, give you the solution sheet for all these tutorial sheets. Remember I have already given you tut sheet in the previous presentation.

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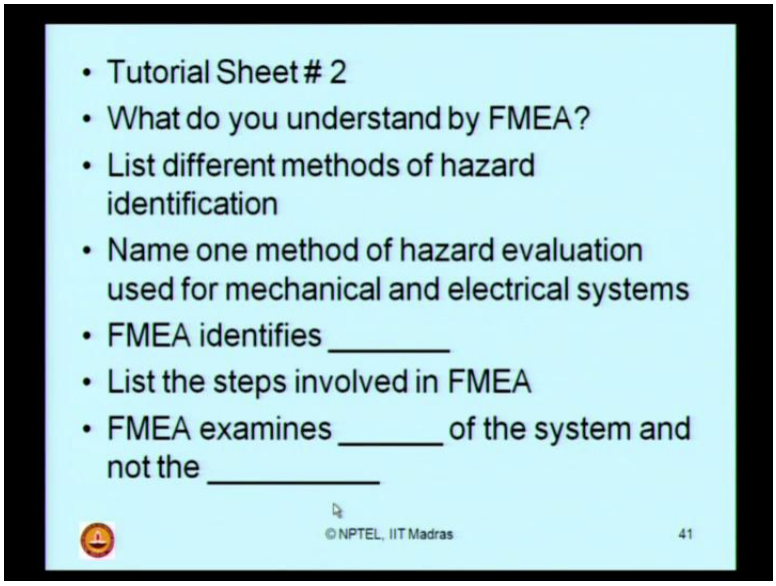

Now, let us discuss about few more tut sheets now. Let us say tut sheet number two. I have a humble request to all the listeners of this presentation. Take this tut sheet seriously. Do not look into the answers of the sheets, before you try to answer them independently. All these questions have been prepared based on the presentation may in the previous modules. Understand the question carefully. Try to listen to the presentation once again. Answers the tut sheets independently without referring back to the presentation. Consider this, as self-examination for you. If you are able to successfully answer all the tut sheets correctly or even partly correctly, I will be happy and I understand that my effort of giving this lectures to you through this electronic media is completely successful.

Let us look at the questions now on tut sheet number two. What do you understand by FMEA? Readily I can see some of them or answering them on the answer book, I am happy. List different methods of hazard identification. You have discussed different methods in previous module previous lectures on the same module. Please try to recollect them. Name one method of hazard evaluation which can be employed for mechanical and electrical systems interesting. Try to look at which method of hazard evaluation is suitable for mechanical systems.

I think we discussed the example on mechanical systems and electrical system as well. What do you understand by FMEA and FMEA identifies something, which you got through fill up with the blank? What does it identify? Can you list the steps involved in FMEA? Can you fill up these two blanks? FMEA examines this of the system and not this of the system.

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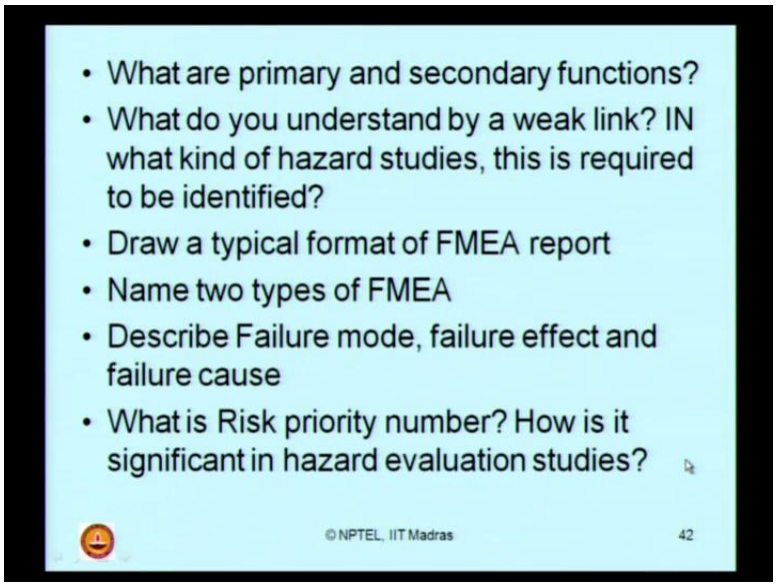

What are the primary and secondary functions you understand on hazard evaluation assessment? In a hazard evaluation what do you understand by a weak link? In what kind of hazard studies this is required to be identified? Can you draw a typical format of an FMEA report? Is it possible for you? Can you at least name two types of FMEA to be carried out? Can you describe what do you understand by a failure mode, failure effects and failure cause? Do you know what risk priority number is? How is it significant in hazard evaluation studies? All these questions pertain to tut number two. I give you a pass I hope and I believe strongly that you will try to answer these tut sheets independently without referring back to the lecture notes.

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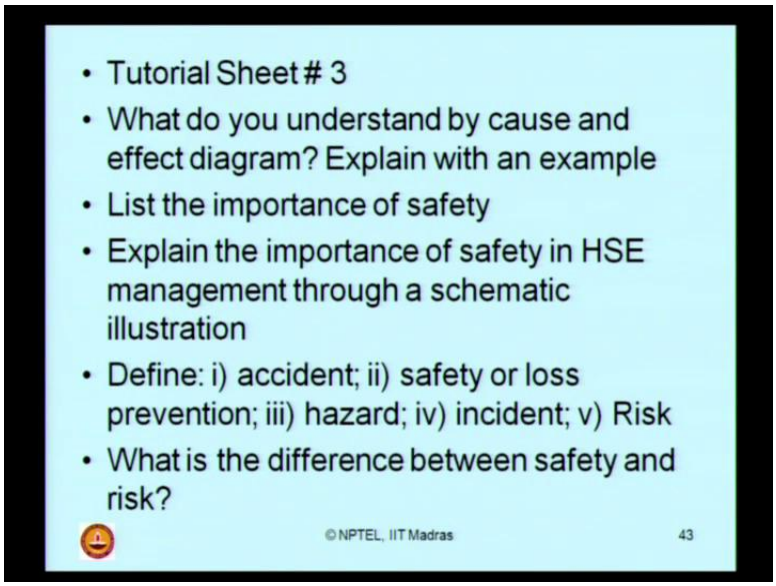

Let us see now tut sheet number three. What do you understand by the cause and effect diagram? Can you explain this with an example? Can you list the importance of safety which we have been discussing through on through in this first module lectures? Explain the importance of safety in HSE management. What do you understand by HSE - health safety and environmental management through a schematic illustration? Can you define the following, accident, safety or loss prevention, hazard, incident, risk? What is the difference between safety and risk? So, these questions comprise tut sheet number three. I want you to answer them I am seeing couple of students or immediately trying to answer these questions, I am happy you are able to follow the lecture intensively.

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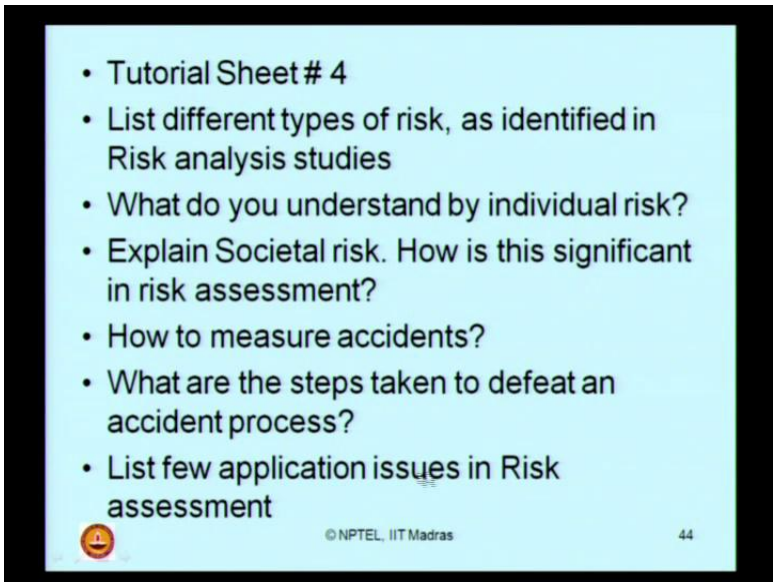

Let us look a tut sheet number four. Can you list different types of risk as identified in risk analysis studies? Next question, what do you understand by individual risk? Next question, explain societal risk how is this significant in risk assessment. Next question, how to measure accidents? Next question, what are all the steps taken to defeat an accident process? Last question in tut sheet number four, can you list few application issues in risk assessment?

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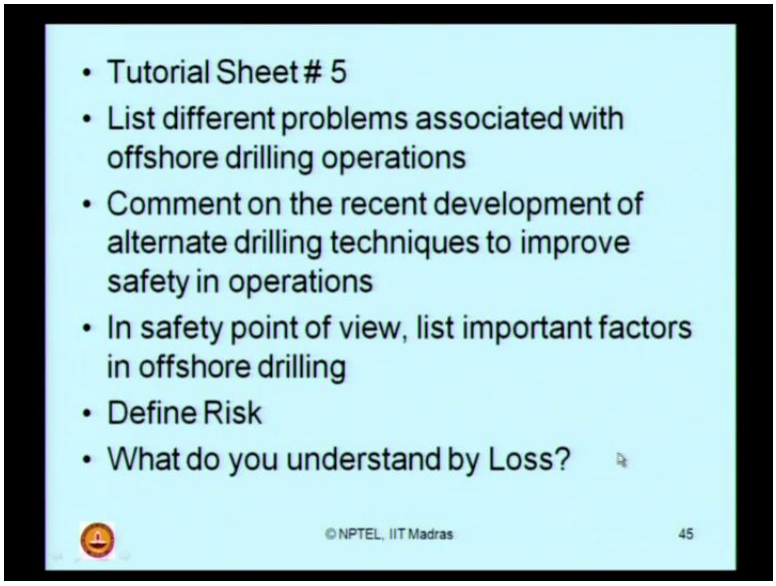

Tut sheet number five, I know you will be asking me repeatedly, sir how many tut sheets are left over, we are close to the coming to an end. Tut sheet number five, can you list different problems associated with offshore drilling operations. You can recollect ladies and gentleman. We discussed something in detail about offshore drilling one of the lectures in module one. We discussed about different types of drilling risk, the safety is associated with them different kind of risk in their operation etcetera in detail.

Can you comment on the recent development of alternate drilling techniques to improve safety in drilling operations? Do you recollect them? I am sure; I have discussed this in my previous lectures. Now in safety point of view, can you at least list important factors considered in offshore drilling? Can you now define what do you understand by risk? Do you know what do you understand by loss?

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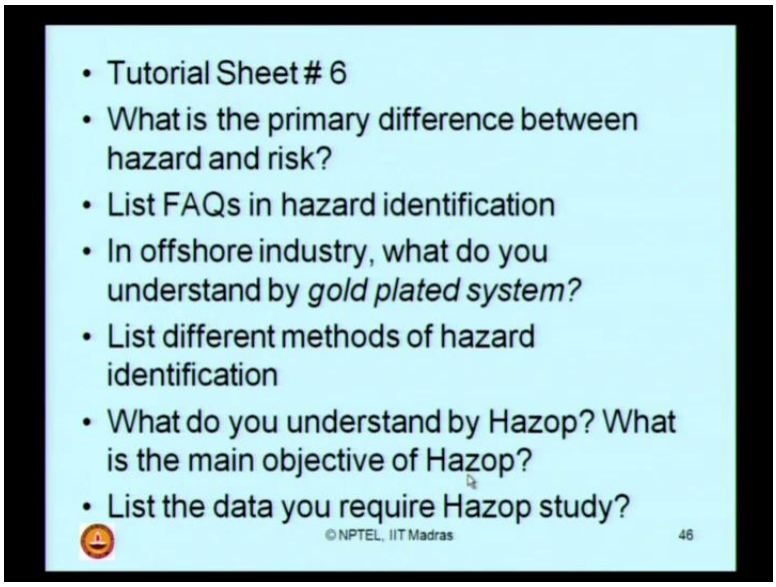

Let us look at tutorial sheet number six. The last tutorial sheet of module one. What is the primary difference between hazard and risk? List frequently asked questions in hazard identification. For a given problem if you want to identify the hazards, what frequent questions you will ask yourself to identify those hazards present in a system.

Next question, in offshore industry, what do you understand by gold plated system? I am seeing smiling faces people are able to identify immediately a gold plated system. I am happy you are recollecting an your following my lecture very closely. Can you list different methods of hazard identification? Now, can you tell me what are we understood

by a HAZOP? What is the main objective of HAZOP study? Can you at least list the data you require to carry out an HAZOP study?

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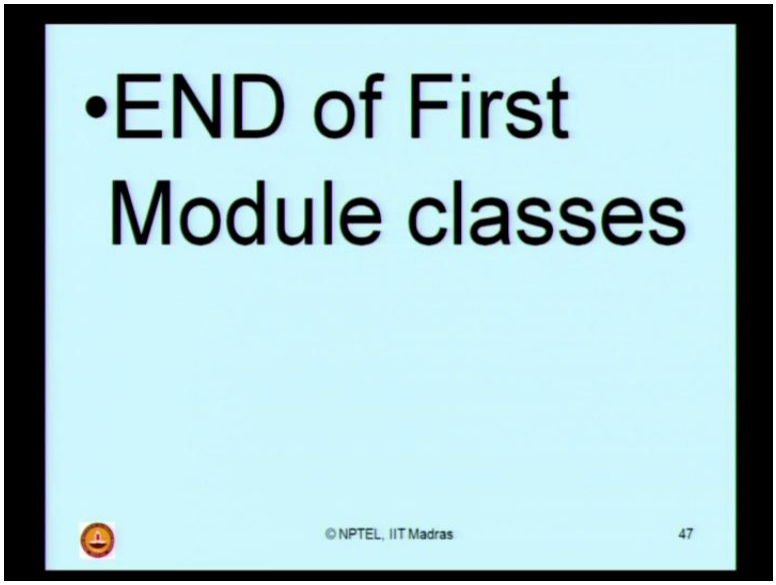

Now, ladies and gentlemen, we are ending the first module classes on HSE. The classes compressed of ten and add lectures by which we are able to cover up in detail some of the parts of the syllabus, which I have been scheduled in the beginning for you. For you is interest I am showing that slide once again where we have defined a scope for first module of lectures.

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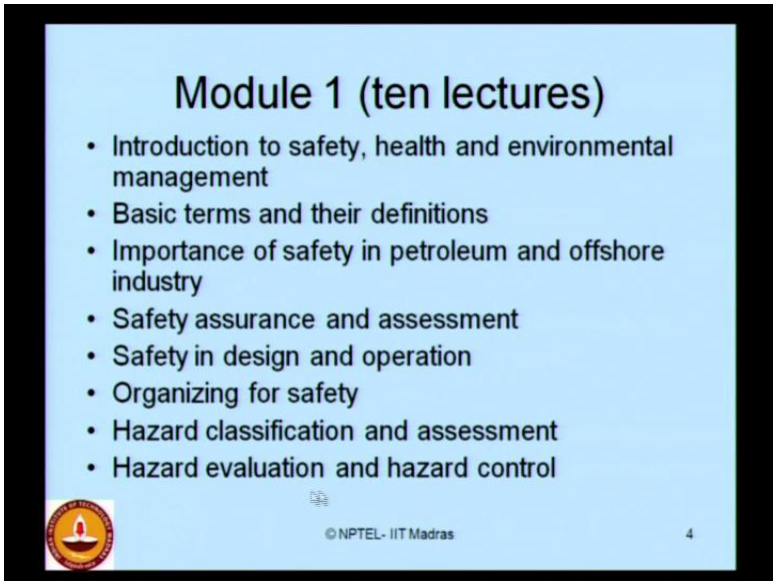

The first module of lectures should be covering introduction to safety health and environmental management. Basic terms and the definitions in HSE, importance of safety in petroleum and offshore industry, safety assurance and assessment, safety in design and operation, organizing for safety, hazard classification and assessment. Hazard evaluation hazard control and ofcourse some case studies related to this.

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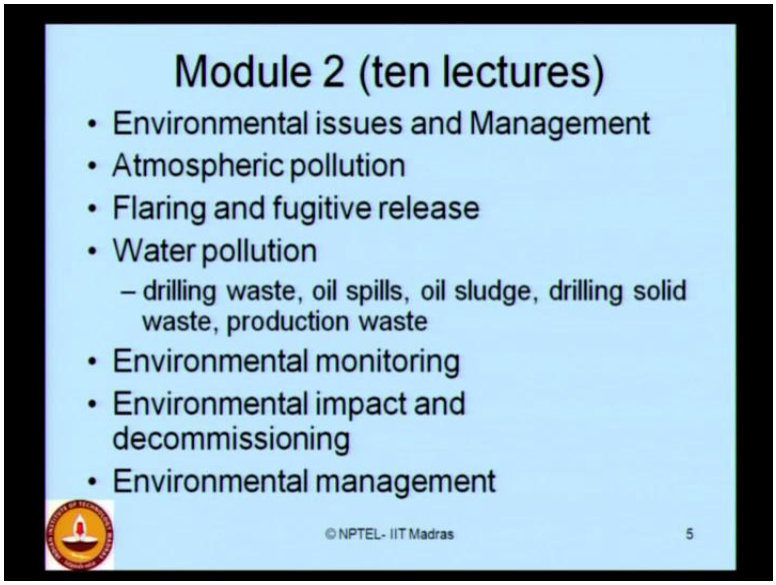

Now, ladies and gentlemen, we will take you forward to the next module, which will be again compressing of ten lectures, where we will discuss environmental issues and management, atmospheric pollution, flaring and fugitive release models, water pollution, environmental monitoring, environmental impact and decommissioning, and environmental management.

Thank you.