Health, Safety and Environmental Management in Offshore and Petroleum Engineering

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Module – 02
Operational Safety
Lecture – 24
Exercises

Welcome friends to the 24 Lecture on Module 2, where we are going to discuses about some exercise on subjective and objective questions on Module 2.

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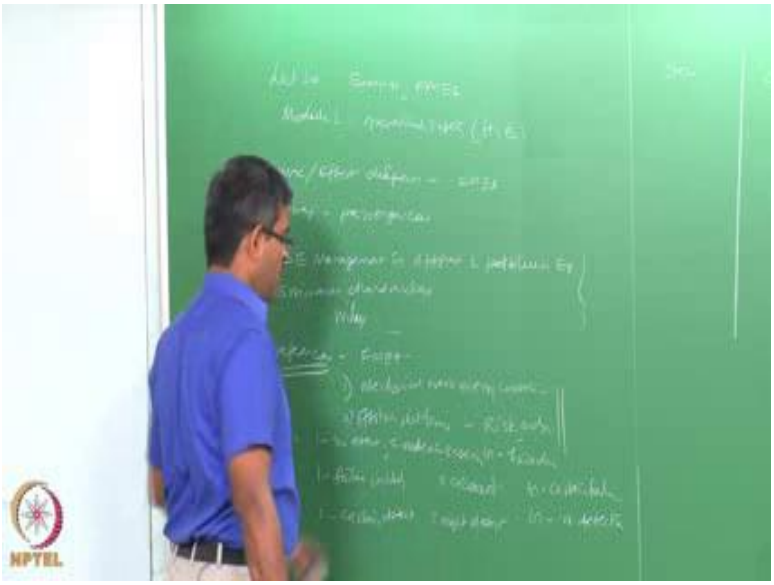

And of course you will also extend the study what we did in the last lecture on FMEA. This is on Module 2 where we are focusing on Operational Safety of HSE Practices in Offshore and Petroleum Engineering.

In the last lecture we discuses about the cause and effect diagram, which is important to carry out an FMEA study. We have been discussing an example of an air bag system in a passenger car. Why this example is taken because it can be easily understood and realized how comfortably an FMEA can be applied for a given problem of this order. Of

course, if one is interested to know more about the FMEA studies applied to other mechanical electrical systems please look in to the book which is authored by me HSE Management in Offshore and Petroleum Engineering, Srinivasan Chandrashekaran which is authored by me published by Wiley, it is available.

There are many examples which have been solved, there are many studies which have been also referred to the text book in addition to what we have covered and explain in this lectures. This also an outcome of the NPTEL studies what we did at IIT Madras. So, I urge that for more references and more detail understanding please go through the text book. Also I given you many references couple of them is closely associated to FMEA alone, where we discussed FMEA studies on mechanical wave energy converters which are very interesting, we have also discussed examples on offshore triceratops offshore platforms, FMEA and risk analysis has been indicated. So, please go through these references are available in NPTEL website to get more information on this.

Now let us continues with the discussion what we had in the last lecture. We have identified the causes and effects of an air bag system in a passenger car. Before we move on to FMEA study for this particular case let us try to review what do you mean by severity, what do you mean by occurrence, and what do you mean by detectability. Because it is important for us to really do a FMEA study for this, so let us see what this is.

I will write done the values here it is easy for me to use the other part of the black broad. Let us say severity, occurrence, and detectability. We already know severity 1 means no effect, severity 10 means very hazardous and one can have 5 as moderate and 8 as series. Similarly, for occurrence 1 failure is unlikely it will not fail at all in the service life of the system, whereas 10 failures is certain it is going to fail and 5 is occasional. Similar, detectability 1 my controls will certainly detect failure, if I have a scale of 10 then certainly will not detect the failure and in the case of 5 it might probably detect the failure that is the order here.

So, let us understand this and we already know them. Let us do an FMEA worksheet for this particular problem which will include the RPN as well. So, let us say that is open up

the table, this is the professional FMEA worksheet which is done for this kind of problems let us say part or the process. Instead of doing this I think you pay attention to the board and directly project this so we can explain this correctly. Please pay attention to the board. It is easy for us to really look at the FMEA worksheet in a specific order. So, we pay attention to the screen now.

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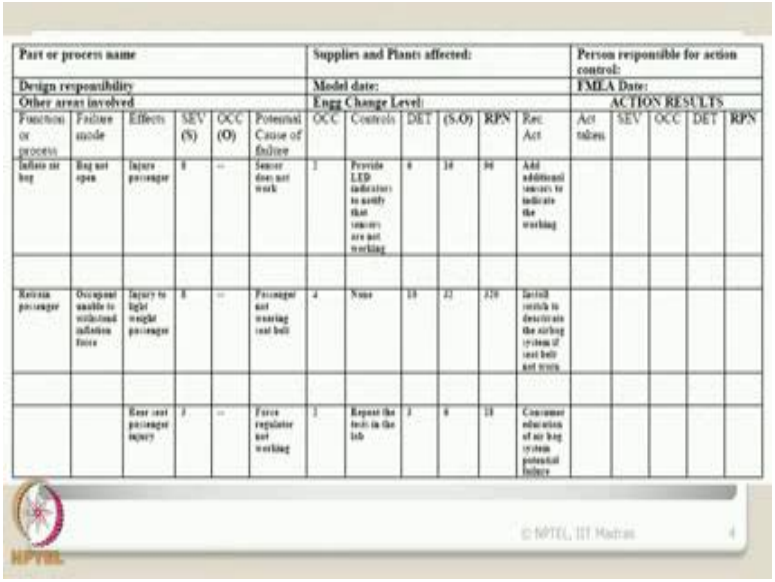

You will see that FMEA worksheet is projected there on the screen. So part or process name is entered here, the plant affected or the manufactures name is entered here, the person responsible for action control is entered here. So, who is going to follow of the action, his name is entered here, he is a professional worksheet. Who is the design responsibility officer? His name is entered here. What is the module number and date? That is entered here. And at what date you are doing FMEA is entered here.

Subsequently, if you have got any other parallel area involved in the designed you can mention them here. If you have got any engineering changes done in respect to this module you can always says what changes done, at what dates and what models, you can entered it here the details. And this is the summary where we are going to show the action results. Now a typical FMEA worksheet is same as what we had in the earlier one for anti-skid braking system which is qualitatively. Let us look in to the function or the

process.

Let us take in this case inflate air bag. Air bag has got be inflated because that so will protect the injury for the person in case accidents or heart breaking. One of the failure modes, we already seen about 6 failure mode for this problem in the last lecture, let us pick up one such failure mode what we say bag does not open. Let say the bag does not inflate at all. The effect could be it may injure the passenger. The severity if you look at the scale here, the severity says 1 there is no effect but a 10 is where hazardous, so let us go for a scale of 8. It an arbitrary number it can also change it to 10 if you want, but you will agreed that sense you will not injure the passenger any number beyond 5 is resemble correct here.

Let us say the occurrence is not trace in the beginning, because it is going to happen only when it is require to be inflated, air bags will inflate only in case of a specific shock receive by the car or the vehicle, so occurrence is not indicated here. The potential cause of (Refer Time: 08:12) why this air bag is not opening what could be the cause, which we can see from the cause and effect diagram. Sensors which could control the opening the air bag is not working that is the cause that is the potential cause for this failure.

After we understand that there can be a potential cause of this failure. Sensors may not work, sensors are check in the design and then we revisit this once again and say even if sensors are present there may be a possibility that it may fail and the occurrence of this failure in the lifetime of the vehicle could be an scale of 2. So, what we mean by 2. 1 failure unlike, so that can be an hypothetically that case that the manufactures says it cannot not happen in my designed that the air beg inflation will not be control at all. It means it will certainly work that guaranty though we can say hypothetically yes, but it always have a provision that it may not work sometimes in the enter lifetime of the vehicle or the service (Refer Time: 09:21) of the vehicle. So let us put a number 2 here, saying that it is closed to fairly unlikely but it may happen, let say the occurrence is there that is why we put the number 2 here.

So, what are the controls which are added after their moralize been revisited, we are provide LED indicators. LED indicators will be in the panel of the dashboard showing

that whether sensors are working or not working. For example, you have a sensor in the dashboard saying your seat belt is worn or not there may a sound also coming in some vehicles. So, one can have again provide an LED indicator in the control panel or in the front panel of the dashboard of the vehicle which tells me that air bag sensors are working or not; it may be blinking it may be gloving whatever may be the case. So, with that provision made in the model change a detectability of this failure mode is becoming higher. What does it mean is? You can certainly deduct it the failure, but it might detect 6. The sensors or the LED may also not work because of the battery improper functioning.

So, let us put a scale of 6 here on a scale 10. So now, the severity and occurrence is coming to be 16 and severity occurrence and deductibility is the RPN number which is risk priority number. Once risk priority number is higher than one should say add additional sensors to indicate the working, because we only provide LED but it says put some more additional sensors. That is the recommendation or the action to be taken against a latest model of this particular car.

Similarly, let us look in to the next function. Retrain the passenger the occupied is enable to withstand the inflation force. The reason could be he could be a lightweight passenger, in that case the severity cause on the passenger because of this particular cause will be very very high therefore it is 8. The passenger not wearing a seat belt can be one of the potential causes of this failure. So advice him to wear a seat belt, put a sensor saying that seat belt is not worn. In that the case occurrence can be a scale of 4 let us say. Occurrence scale of 4 indicates that still occasional that the passenger will be injured because of inflation of the air bag, it is still closed to occasional.

You need not have to provide any control for this except that you make a sensor showing seat belt is not worn. But the detectability is on the 10 it means the failure is certain, if you do not wear a seat belt you will be facing the injuring provided is a light weight passenger. That is way it is advisable not to actually house infants or children in the front seat of the car. If it is so then the detectability are 10 can say the failure is going to be occasional; detectability is going to be a scale of 10 it means you will not actually notice that such failure is going to happen. So, it is on a scale of 10. For sure it cannot be

detected at all, because nobody knows whether he is wearing a seat belt or not, or nobody is having control where the infant is sitting or not sitting in the front seat. Therefore, detectability for sure cannot be done; therefore it is a scale of 10.

Now, if you look at the severity and occurrence 8 and 4 32. Severity occurrence and detection risk priority number 320 which is fairly high relatively compared to inflation and air bag. One can easily understand from this table that relative scale of a risk priority number will exactly tell me which component or which failure mode is most critical in a given system then that can be an addressed. Once it is addressed then action results are been undertaken, then once again this can be conducted. What action has been taken? Therefore, now what is the severity occurrence and detection and what is an RPN. The one can always compare whether the RPN number availed made after the action taken is lower or higher. So obviously, it will be lower because you take an action and there is implemented in the design, therefore this will be lower.

So, these is going to be the summary sheet at the end which will show me what revision has been taken or what actions has been implemented after the model date, and therefore now the product is ready for released to the commercial market. So, all electro mechanical systems mandatory recovers an FMEA to be done or FMECA to be done which identifies the critical component or the critical failure mode. Does not always identified the component, because we are not talking about the component; we are talking about the failure modes that arise from the component failure. We are worried about the cause and effect. We are not talking about the component replacement. So, it is not actually a mechanical design revisit. It is actually the functional accept of the failure of mechanical design, therefore it is a failure mode effect analysis that is how it is done.

Friends in this module we have covered all topics as recommended and listed in the website of module 2 of this course. So, let us quickly see some exercises where some subjective and objective questions are posted and some answers are discuses then and there. Let us have a question here occurrence of a single or sequence of events that produce unintended loss.

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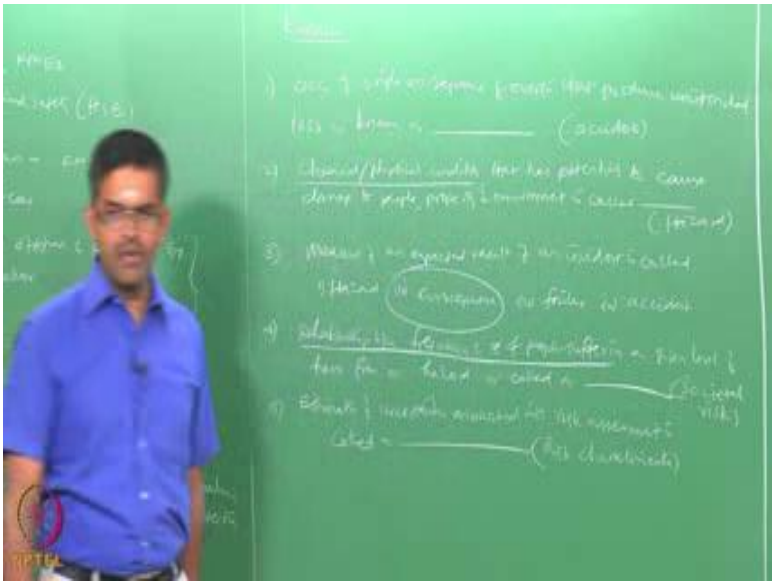

So, these are all objective questions let see you are able to answer them. Occurrence of single or sequence of events that produce unintended loss is known as; you can try to look into notes I will give the answer any way is called as accidents. The next question let us see you are able to answer, you take this exercise very seriously it is easy for you to really revisit all the lectures back again. Let say the chemical or the physical condition that has potential to cause damage to people property and environment is called physical or chemical condition scenario. So, the answer is as you correctly found out hazard.

Third, measure of an expected effect of the results of an incident is called; let say there are varieties of answers available here, hazard, consequence, failure, and accident. So, I am looking for the measure of an expected result of an incident nothing but the consequence. Fourth could be relationship between frequency and number of people suffering a given level of hams from the hazard is expressed as or is called as relationship between frequency and number of people suffering a given level of hamness from really section of a hazard is called as societal risk.

As I said friends in HSE practices the terminologies vocabulary a very important. All may alike, but it should precisely know what vocabulary it uses at very specific point it is very important. Estimation of uncertainties associated with the entered process of risk

assessment called as risk characterization, is not risk evaluation. Risk evaluation something different please look into the notes.

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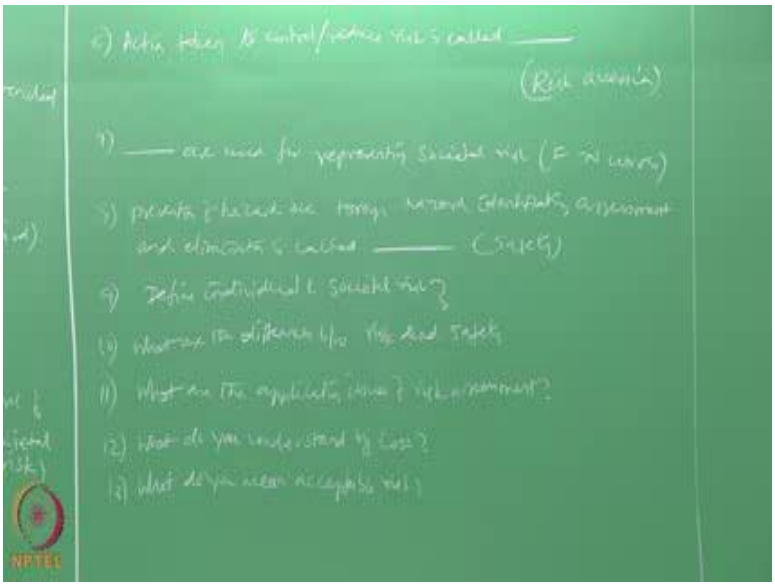

Sixth, action taken to control or reduced risk is called Risk aversion. Dash are used for representing societal risk, generally how (Refer Time: 20:32) are measured is using FN cures. Prevention of hazard occurrence though proper hazard identification, assessment, and elimination is called Safety. In fact, safety is defined like this.

I will also post you some questions for yourself learning. Can you define individual and societal risk? Interesting question, what are the differences between risk and safety? What are the application issues of risk assessment? What you understand by loss? What do mean by acceptable risk? The answers for these questions are available in the lecture note itself we got to only revisit them and keep referring to your notes back to get the answers; very interesting question.

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What are 3 systems commonly used as measure accidents. One can easily recollect them; OSHA is one which is used system is used to measure this, other can be Fatality Accident Rate, third can be fatality rate per person per year. Now the question is 14 b, what is the most important common feature between them? The most important common feature between them is, all 3 methods report number of accidents and in fatalities for a fixed number of working hours. To be very precise fixed number of exposure hours during a specific period, so both are fixed period and number of working hours. Both are fixed in all the 3 methods. That is very important, interesting and very important for you to remember.

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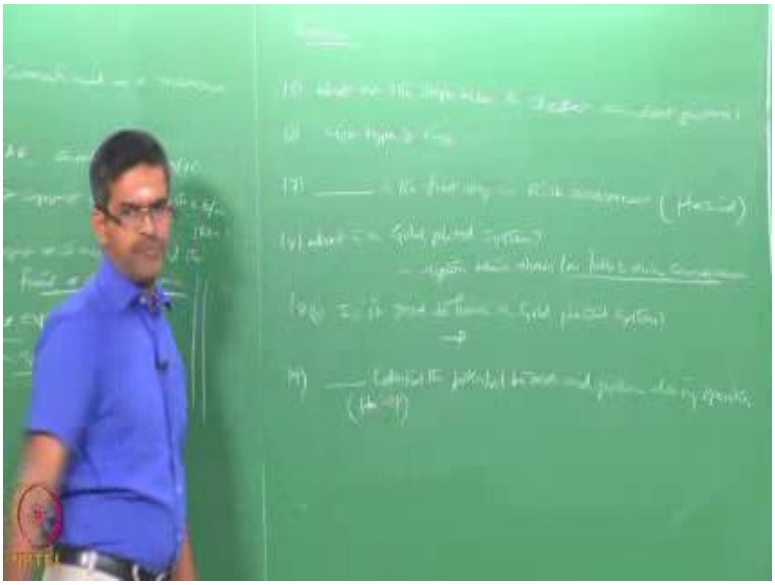

What are the steps taken to defect an accidental process? List types of risk. Let us says dash is the first step in risk assessment; what could be the first step of risk assessment? It just hazid, you have to identify the hazards first. What is the goal plated system? It is that system which shows low probability minimum consequence.

The question asked this is it good to have your goal plated system. The system which shows low provability minimum consequence always the best no doubt about it, but this is indication that unnecessary budget has been spent on system to retain as a goal plated system that is the problem. 19th dash identifies the potential hazards and problems during operation; I think all of you will be able to answer this hazop, list different hazard identification methods.

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What do you understand by hazard control, hazard evaluation, and hazard monitory? What is hazard analysis? Dash is the rating corresponding to seriousness of an effect of a potential failure in electro mechanical systems. The movement I see failure detection or failure analysis in electro mechanical system I will always recollect FMEA or FMECA. In FMEA or FMECA the one which is corresponds the seriousness is severity. FMEA is dash level analysis; it is a component level analysis.

Main objective of FMEA is dash and not dash. It is actually failure prevention and not failure detection. So, it is not a post accident scenario. It is perceive deviation from the design intent which is carried even at the designed stage itself so that FMEA studies are construct to be very very powerful and effective to control hazards even in the manufacturing stage itself for the design components. Because mostly in many cases in process industries accidents are originated from the faulty maintenance of equipments; from faulty maintenance of control mechanism like sensors, sprinklers, fire fighting system, etcetera which (Refer Time: 30:59) to become very serious accidents.

Therefore, FMEA has been recommended as mandatory study as a part of hazard analysis for every chemical processes industry which encompassed by lot of electro mechanical system in terms of control, process, manufacturing, production, etcetera.

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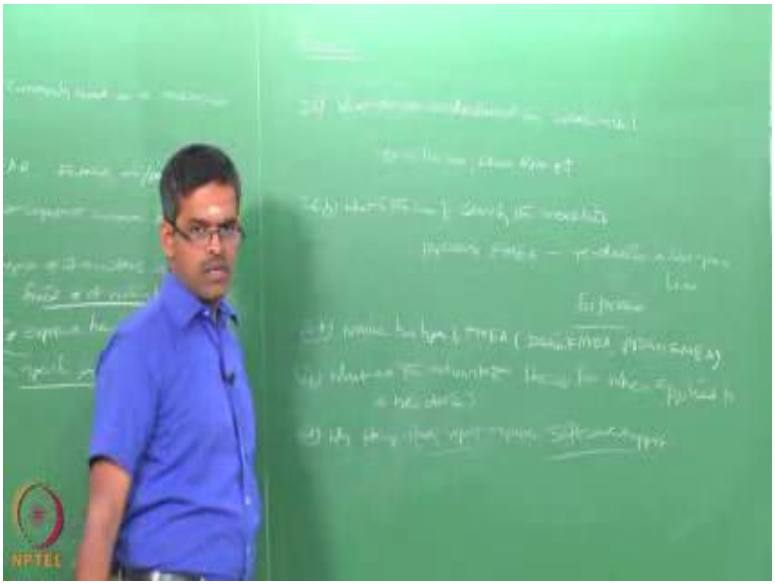

What do you understand be weak link? Weak link is one of (Refer Time: 31:42) the one whose risk priority number is a maximum or the highest rank of failure. What is a use of identifying the weak link? One can always redesign the system if it is a mechanical FMEA or if it a design FMEA. If it is a process FMEA, then one should redesign a bypass line for the process. It should avoid the presence of weak link in the product line. They are two types of FMEA one can carry. So name two types of FMEA? We all know design FMEA and process FMEA. Interestingly, what are the advantages hazop has when applied to new design? I mean that is a very interesting question which we have to (Refer Time: 33:30) from an experience.

Why hazop study report requires software support? In the next module I am going to show you the use of software for writing an hazop report, where I am going to specifically dedicate couple of lectures on use of software handsome expression for HSE there I will show you how this can be easily used for doing an hazop report. But we already realize that software support is essential for hazop report because creating interlinking between the segments of a plan to understand the failure of the overall system.

So friends, in this lecture we discussed about the details cause and effect diagram applied

to an example case of FMEA. We revisited the FMEA variables severity, occurrence, and detectability. After understanding them and applying an cause effect diagram for an air bag system we prepare it real worksheet of FMEA, identified the critical failure modes of an air bag system in a passenger car, and set an example to understand how FMEA can be carried out and how FMEA can convert the qualitative understanding of failure modes to a quantitative realization of risk priorities. We also understood certain the exercises in terms of objective and subjective questions which will make you do revisit all the lectures in this module and I am sure that the module 2 lectures would have been very useful for you to understand the basics of operational safety which was the main focus on theme of objective 2 in modules.

So, Module 1 and Module 2 have to be revisited, you have got listen to all the lectures back again. Module 1 focused on environmental management and HSE practices related to environment management and control. Module 2 focused on operational safety where we have completed about 24th Lecture today on Module 2.

So, friends before you move on to the next and the last module of this particular course my sincere request to you all is please look into all the references given in NPTEL website. Please have an access to the text books referred by me in the due course of the lectures. Read more parallel materials apply simple examples in your real life practice to understand how comfortably a hazop study carried out.

How an FMEA study can be applied to an existing design in your office so that the day you get the comfortably applications of hazop study or hazard analysis and risk analysis on your particle table problems, I will glade that my objective of delivering this course online to the n mass of mock listeners is fulfilled and I will be very happy and it will be one of the important mission of this particular program as NPTEL. And through this course I will glade if you post questions and if you also ask me or demand me for more illustrative examples in sense to make their concepts make clear.

Thank you very much and bye.