Health, Safety and Environmental Management in Offshore and Petroleum Engineering

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Module – 02
Operational Safety
Lecture – 12
Hazard analysis – I

Welcome friends, to the module 2, lectures on the online course on HSE practices in an offshore and petroleum engineering.

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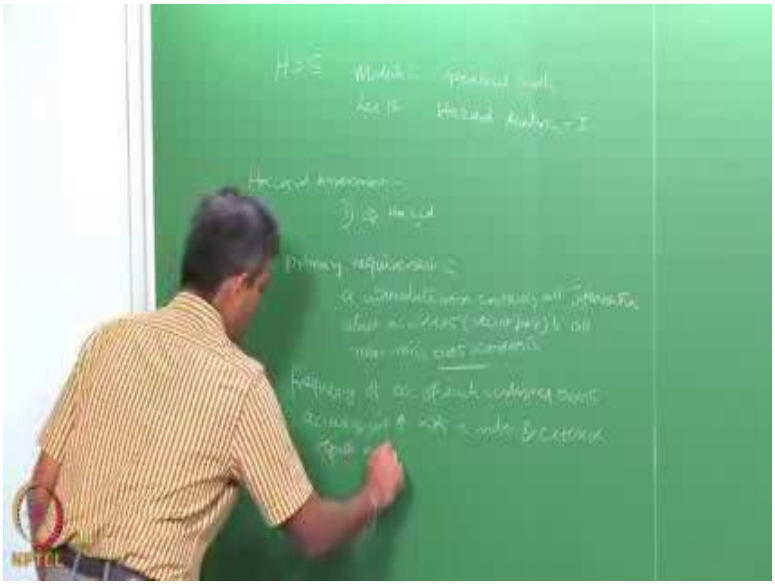

We are talking about module 2, lectures the focus is on operational safety and today in this lecture number 12. We are going to talk about hazard analysis, let us start with how to introduce hazard analysis qualitatively using what we call as a hazard analysis. In the last lecture we already said that hazard assessment is actually an answer to series of questions out of the actions asked and posted in the last lecture, you could see that the first question will indirectly lead to hazard identification what we call and the subsequently the questions will lead to slowly towards risk assessment.

Because it also discusses something on the magnitude of failure which is the consequences and of course, the probability of occurrence of an event, which is of course, the frequency of occurrence of an event the product of these 2 will actually give me the risk assessment and we said in the last lecture that risk assessment and hazard assessment actually coupled to each other in the wheel of round, you do not know which is leading what.

Therefore, it is important that you cannot actually separate them its only of a level of advancement hazard is more general and whereas, risk assessment is very, very specific, but in both these cases in particular to hazard assessment it is important to know that all documents related to accidents and near miss events should be available as wide data base.

For doing a successful hazard data assessment the primary requirement is a wider database containing all the information about accidents happened in the recent past and all near miss events with details that is very important. So, it is always a good culture in process industries in particular oil and gas sector that you must record all the near miss events with the chronological order what went wrong why it went wrong. What is the number of times these particular events? We keep on reoccurring all these are very important to get recorded. So, if your database is wider you can always expect to have a better hazard assessment. So, hazard assessment is very useful in estimating the frequency of such undesired events. So, it can always be useful to look at the frequency of occurrence of such undesired events the undesired events can be given a near miss the more you have the data on this the more the accuracy is, accuracy will improve with a wider and extensive report on the accidents or on the events, let us say and near miss. So, that is important.

So, therefore, by documenting the accidents and near miss events consequences are anyway identified the main advantage of documenting.

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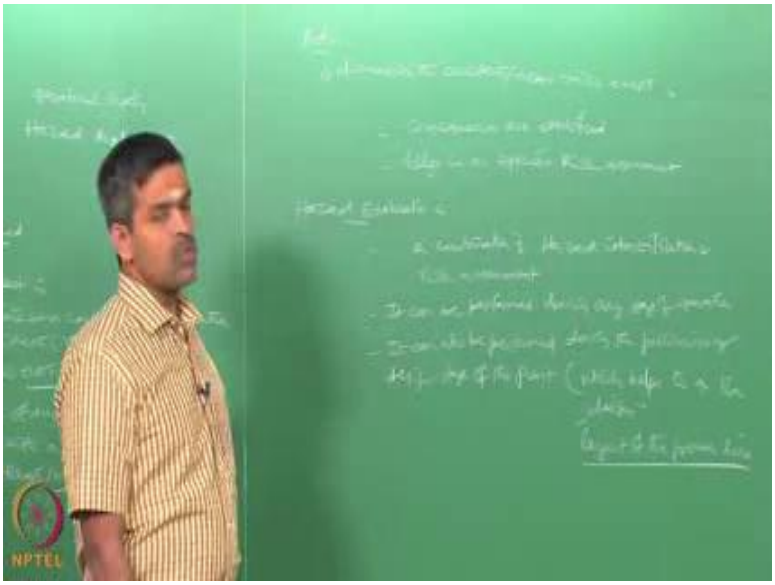

The accidents and the near miss events are consequences are identified that is the first advantage which anyway helps in an efficient risk assessment. Therefore, one can make a general statement hazard evaluation is a combination of hazard identification and risk assessment. So, you look at the flow chart of this subsequently. Now, therefore, hazard evaluation can be performed in any stage of operation that is very important it can be performed during any stage of operation it can also be performed at the preliminary stage or during the preliminary design of the process plant or of the plant, which helps to improve the design essentially it improves the design indirectly by addressing the layout of the process that is what exactly hazard does.

So, if you look at the flow chart of hazard and hazard evaluation.

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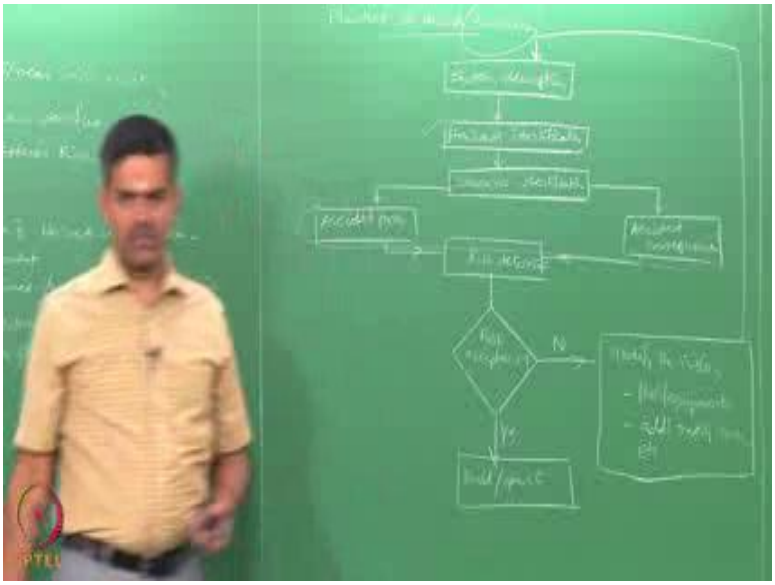

To start with we should have a system description I should have a complete system defined in alphabets for the given system I should be able to do hazard identification by forming series of questionnaire which I call as hazit then based on this I will try to find out what is called scenario identification the scenario identification can be now grouped into 2, 1 is the accident probability other is the accident consequence these 2 of course, will lead to risk determination once you know the risk then check the acceptance level. If the acceptance level is built in the system and operate the system if it is no then, one should look for modifying the system in terms of change of plants and equipments additional safety norms etcetera once it is changed once you modify the system the system has to again undergo the same algorithm and do the same thing back again.

So, hazard evaluation as we just now said is a combination of identification and assessment of risk. So, identification is done here assessment of risk is done here and both of them together is what we call hazard evaluation. So, hazard and risk actually cannot be separated very widely of course, they are interconnected very closely now the question comes; what? How can I do hazard identification in the beginning at the design stage itself because I am just planning for the system I have no idea about the flow lines I have no idea about the product production line I have no idea what would be the hazard scenario caused during the production. Because during the production the operational

temperature and pressure can be keep on varying which can lead to hazard situations in process industries in particular oil and gas sector.

So, without knowing that how do I get this therefore, friends hazard evaluation is done by an expert team it is not done by a wrong person who does not know or who has no experience about the whole process line. So, it compiles the various mechanical electrical chemical structural naval architects engineers as a group which is led by the HSE safety professionals and you form a hazard team who actually does the whole diagnosis of the problem even at the design stage itself.

Now, let us see what are those advantages and disadvantages. If you do hazard analysis in the design stage itself now the question is can we do hazard analysis at the design stage.

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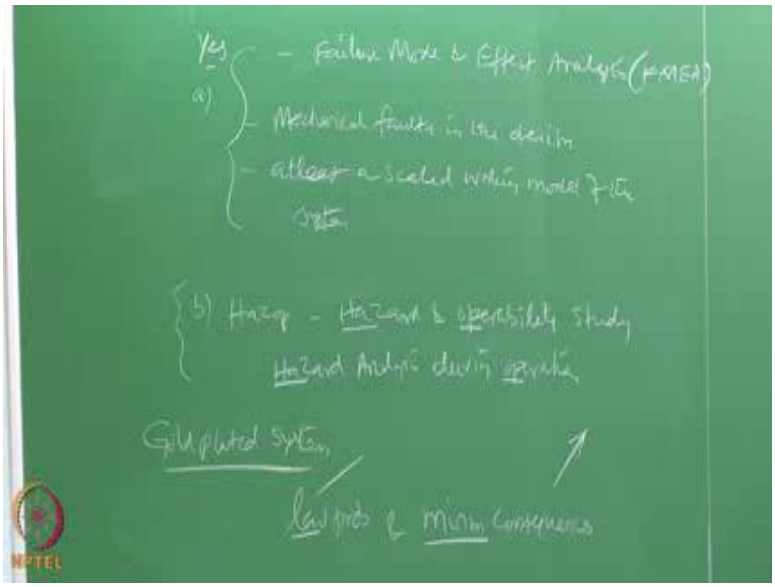

That's the question now the answer is yes we can do the study is named by a specific character that is called failure more and effect analysis what we abbreviate as FMEA, FMEA will be able to analyze the mechanical faults in the design, but it requires at least a scaled model a scaled working model of the system now I want to actually analyze in the in the design stage itself a process line, how do I do it then in that case you can do

what we call hazard study hazard stands for hazard and operability study hazard, hazard and operability study is nothing, but hazard analysis during operation that is why it is called hazard so; obviously, one can do hazard analysis even in the design stage itself before the production starts or before the product is released for commercial production can also do at the preliminary stage of production itself to correct any errors in the flow rate.

Now, interestingly if both of this evaluations and studies show low probability and minimum consequence then the system to which it is applied is called goal plated system. So, now, the question comes what is called a globe gold plated system a system which shows low probability and minimum consequences low probability and minimum consequence now see both are qualitatively in a scale they are subjective the one which is considered to minimum for me may be maximum for you. So, it is predesired, preagreed upon that what you mean by low probability what do you mean by minimum consequence.

So, the moment I introduce consequence I must give a financial figure to this the moment I introduce probability I must give an algebraic number to this maybe some number on a scale of ten some number on a scale of hundred does not matter, but this is a numeric value this is an economic linking or coupling all the numeric value. So, more or less if you look at this is nothing, but risk because I am talking about probability of occurrence and consequence. So, it is more less risk. So, in general a goal based system is that system which on application of hazard analysis in the preliminary stage itself shows low probability and minimum consequences, interestingly, if you have a gold plated system which has been identified in existing plant as we have seen in the example of Frank and Morgan.

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Let us say on the departments a to f we said f has been seen as the department in the plant whose risk index is the lowest. So, by the definition of classical hazard analysis technique just now we discussed if this value is lower than the preagreed value of the company or for the plant then I can always call the department f in the given plant as a gold plated system.

So, hazard analysis will help you to identify for sure a gold plated system now what are the advantages of having identified a gold plated system having identified within the department or within the plant a gold plated system this department can act as a referent can act as a base department all other departments can be compared qualitatively for risk index with respect to this department and they can always set the gold plated system as the base reference to which level other departments should improve the safety. So, you set competition within the departments within the industry in a given system identify one as the best amongst all and remaining all will compete to become better than the best. So, you can always improve safety by identifying a gold plated system.

There are some disadvantages of this a gold plated system is that system where expenses are diverted unnecessarily towards unwarranted safety. Let us say for example, the risk acceptance level for the plant which is preagreed upon as per the international norms is

ten on a hundred point scale when you do the analysis your risk index for this specific system comes to eight.

So, you will always say my system is gold plated because this is the lowest risk index of all the departments what you have in a given plant very good the disadvantage is you must understand that you are spending more money towards unnecessarily maintaining safety in a system which can go which can relax till the level of 10, but you are controlling it to 8, it means for the past few years your economy has been diverted unnecessarily to keep a system in safety which is much beyond even the acceptable level of safety it does not mean that a gold plated system should be discouraged and the safety norms should be relaxed I do not mean that what I mean to say is if you identify a gold plated system you will always get a warning is the gold plate system is unreasonably expensive to maintain safety or not because we already said risk level in offshore industry should touch what we call as ALARP level as low as reasonably practical it is not possible practical.

So, you have to only maintain safety to that level which is practical, but you have been maintaining safety in this department which is impractical though you may be proud that my department is a gold plated within the departments of a to f, but you should always say instead of spending money on 8 against 10 at department f divert that fund divert that investment towards probably department a or b which requires more funding towards safety assurance in comparison to department f.

So, hazard evaluation or hazard analysis always give me gives me a very interesting indication in a given system how much I budget allocate counteract or to improve or to relax the safety norms in a given set of or in a given group of systems. So, goal plated systems are examples of implementation of potential unnecessary in expenses safety equipments I should say this

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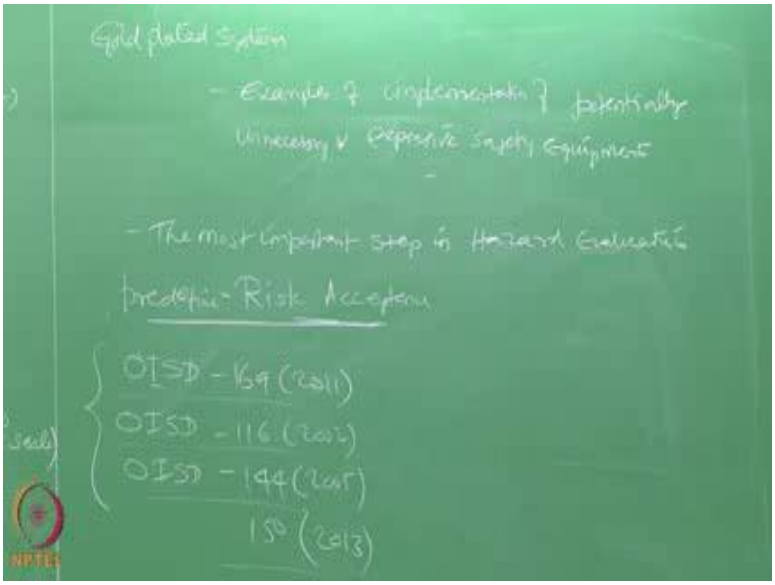

So, gold plated system can be considered as examples of implementation of potentially unnecessary and expensive safety equipments. So, therefore, if you look back the hazard evaluation chart what we just now discussed the most important step in hazard evaluation is risk acceptance. Now to fix up the risk level of acceptance is very complex you cannot predefine a risk acceptance fortunately oil industries follow international standards to define or to determine the level of risk acceptance they are given by oil industries safety directorate 169 - 2011 it helps you to predefine the acceptable level of risk for process industries in particular oil industries oil industries safety directorate 116 year 2002 oil industries safety directorate 144 - 2005, 150 - 2013 and so on. So, there is couple of standards which helps you to predefine the risk acceptance which oil industries can follow which is one of the crucial and vital steps in hazard evaluation.

Now, hazard evaluation can be performed for the whole process or it can be performed in stages of the process as well it can be performed initial stage during the design itself it can be done during the ongoing stage or production it can be done whenever there is a problem encountered in the production line of the system and. So, on if you do this at the initial design stage itself hazard evaluation is renamed as FMEA which is failure mode and effect analysis. So, there are various advantages of FMEA as said by Chandrashekaran Harindan 2011, 2014 there are many advantages of doing an FMEA,

which we will discuss when we talk about FMEA later, but for your initial reading you can look at these papers and initially you will see hazard evaluation done at the initial design stage gives many advantages in terms of facilitating mechanical faults in a given system when you specially you apply on a scaled model studies of a given mechanical systems if you try to apply this during operation the project is non line then we call this an hazard study.

So, hazard study will help you to identify a gold plated system which has got couple of merits and of course, serious implementations of demerits because, gold plated system will land up in unnecessary and unwarranted expense towards safety maintenance. So, in the whole issue of hazard evaluation risk acceptance criteria or risk acceptance level itself is a challenging procedure it is very complex to actually preaccept the risk level. Therefore, international courts and regulations help you to predefine the risk level as you see here. So, let us quickly see what are those hazard identification methods - which are hazit which is one of the primary steps involved in hazard evaluation or in risk assessment.

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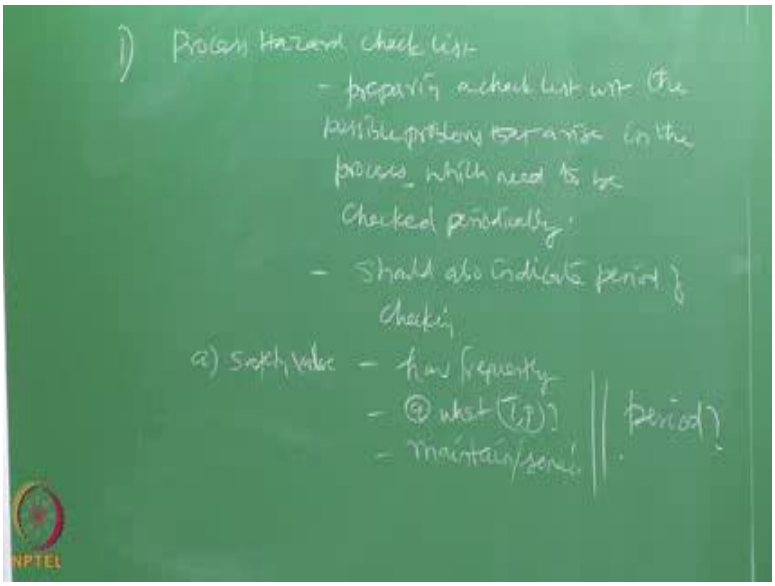

Hazard identification methods the first and foremost and easiest method in hazard is preparation of a process checklist process hazard checklist. So, this method refers to

preparing a checklist with respect to the possible problems that arise in the process which need to be checked periodically. In fact, the process hazard checklist along with a list of those items should also indicate the period of checking it means how many times. For example, let us say let us say safety valve maybe one of the important item to be checked or inspected how frequently you will have to check the safety valve you got to check at what operational temperature and pressure you must check this and how frequently you have got to maintain or service this. So, all should be equal if mentioned in the checklist itself with respect to its periods.

The second could be hazard service.

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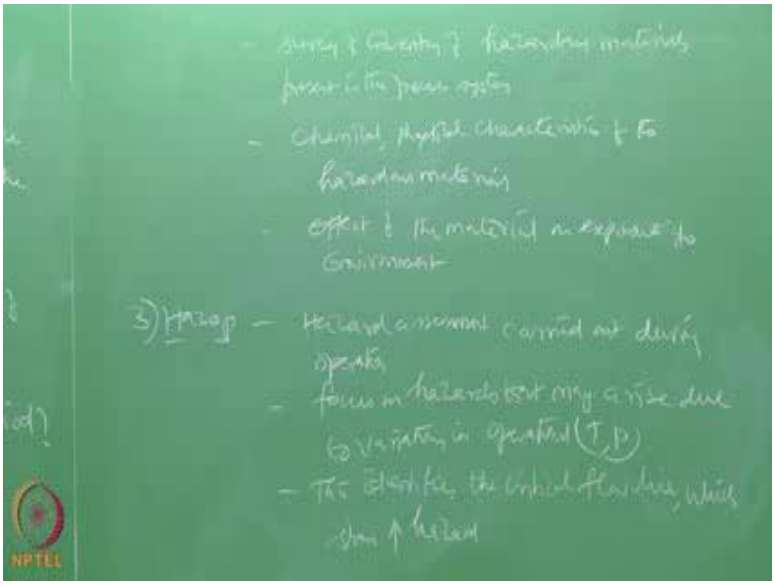

Hazard service actually refers to survey of inventory of hazardous materials present in the process system. So, it should include the chemical physical characteristics of the hazardous materials it should also include the effect of the material on exposure to environment the third could be hazard during operation which we call hazard study this refers to hazard assessment carried out during operation. So, this actually focus on hazards that may arise due to variations in operational temperature and pressure this identifies the critical flow line which shows highest hazard we will discuss hazard with an example later the next is safety review.

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It is actually similar to hazard, but less formal hazard is more a formal study now interestingly the results of safety review depends on experience of the person conducting the review the outcome can be highly subjective .

The next is what we call what if analysis this is applied what if logic to a number of investigations. So, you apply what if logic to the investigations answers to the questions to what if question will be the report. For example, one can ask me question what if the power stops what if the temperature arise what if the valve functions what if the sensor does not work. So, all questions can be raised and the answers to these questions will form the report interestingly what if analysis will focus more on consequences this will focus more on consequences and of course, lead to efficient solutions.

So, what if analysis is seen that is seen as one of the effective tools for hazard evaluation because this directly focuses on consequences what if the power fails. So, you have a list you start attacking or solving those problems. So, you will find solutions to them. So, it nothing, but a questionnaire which poses basic questions on the functionality of the various product line and the solutions are answers to these questions are this what if scenarios will lead to interesting recommendations towards safety assurance which will form as efficient solutions for advising against this consequences.

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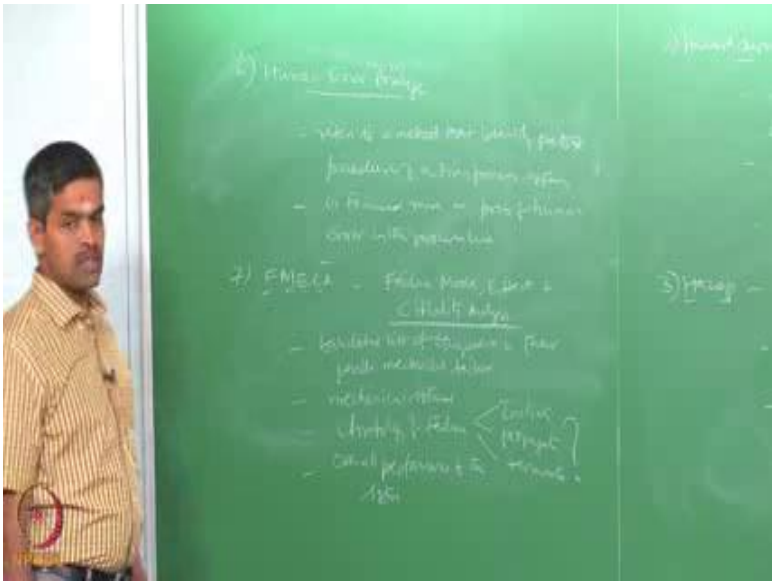

The next could be human error analysis it refers to a method used to identify parts and procedures of a given system. So, in a given process system if human intervention is erratically done what would be the consequence that could be the outcome of this kind of analysis in general this is focused more on probability of human error in the process line for example, if the fire alarm or the process system in the control panel fails what could be the reaction or what could be the immediate advice of the person who is incharge of the cabin, human error analysis.

The next could be FMECA failure mode effects a criticality analysis this method actually tabulates the list of equipment's and the possible mechanical failure. So, this tabulates list of equipments and their possible mechanical failures. So, it is more or less applied to mechanical systems of course, you can also apply to chemical systems or process systems is called process FMEA this study is capable of identifying the possible failure of each system in terms of the failure mode if at all the failure occurs it gives you the chronology of failure I mean where it will initiate where it will propagate how can you terminate it will give you all this data in a sequential manner it will assess the overall performance of the system for its efficiency in terms of the process.

Out of all these studies which are all hazard analysis studies methods hazard is found to

be very very useful for qualitative risk assessment and FMECA and FMEA are found to be very useful for quantitative risk assessment for mechanical systems. So, hazards arise because of deviations present in the normal process we all know in a given system and process system deviations do exist from the design intent. So, we must first identify what are the design intents of the given system what are the perceived deviations from the design intent of the given system in a given process line therefore, if the design intent is deviated what would be its consequences to avoid the deviation what safeguards we must apply. So, these are all in a chronological manner discussed in hazard study which we will discuss in the next lecture. So, out of these methods what we studied in the lecture today hazard analysis or in general hazard evaluation is having a close coupling with risk analysis.

We have also seen the lecture the risk assessment identifies helps to identify the gold plated systems there are many advantages of identifying a gold plated system in the given mechanism or in a given group. But there are some demerits which will prompt you towards unnecessary expenditures spent on gold plated system to maintain unwarranted safety which can be diverted to other systems, which needs more investment towards safety assurance I hope this lecture started with hazard assessment and analysis very clearly in the next lecture, we talk about hazard in detail we will also take up a live example from the industry and do hazard analysis, show you how it is done using a software. Then we will try to conclude very easily how hazard can be a useful qualitative risk assessment tool which can be used in process industry never the less in particular oil and gas industry.

Thank you very much.