Health, Safety and Environmental Management in Offshore and Petroleum Engineering

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Module – 02
Operational Safety
Lecture – 11
Hazard assessment – I

Welcome friends, to the online course title Health Safety and Environmental Practices in offshore and Petroleum Engineering. We are talking about lectures on module 2, where we are focusing on Operational Safety.

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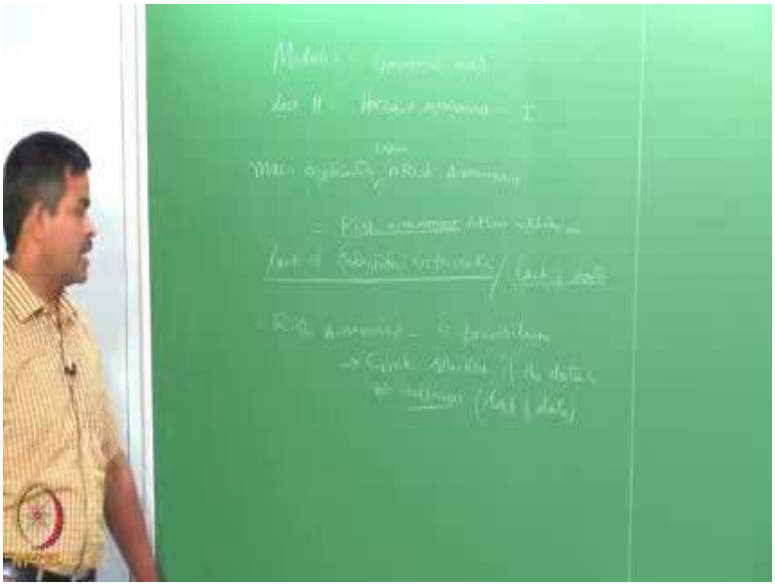

In the last lecture we discussed about the risk assessment tool, how risk can be circumscribed with economic terms. Today in lecture 11, we are going to start with the hazard assessment. We will discuss also this in detail in the coming module lectures. So, I call this as hazard assessment one. Before you move on to the hazard assessment which is only a scenario, let us talk about realization of this in terms of, let us say risk. There are some there is one main application issue, in risk assessment.

Of course, we did risk assessment quantitatively with an example problem yesterday, in the last lecture. But; however, there is a there is a very important application issue, in risk assessment. The main issue is that risk assessment often relies on, one important segment

which is the scientific information. Now I should put a condition here relies on lack of scientific information why I am saying lack of because first of all the information what you get as pose accident scenarios which are going to be useful input for risk assessment, all may not be scientific and all may not be authentic as well. Similarly in case of frank and Morgan analysis, whatever elements you are trying to convert from risk to economic terms in terms of composite exposure values, all may not be completely scientific.

So, there is a lack of scientific information, or in general lack of data. Because the complete breakthrough of an accident scenario or even hazard identification has not been developed to that level that all information you stack to understand the problem or diagnose the pose event of an accident does not remain completely scientific. Some of them are not even reported in a chronological order, some of them are anticipated, some of them are cooked up, and some of them are exactly the representation of what has actually happened.

But; however, when every data is being given for diagnosis, you know the data's always have the verification of the authenticity of the data. So, we can say risk assessment relies very often on lack of data. Now, one can ask me a question; how it is a serious issue we all know risk assessment. Generally is probabilistic in nature and, any probabilistic analysis if the data is not strong enough or the data is the ensemble is not sufficient enough, it can lead to erratic answers. If the data is not I should say gently sufficient, that is what we say as lack of data. So, that is one of the important issues what we have a risk assessment especially applied to offshore and petroleum engineering sector.

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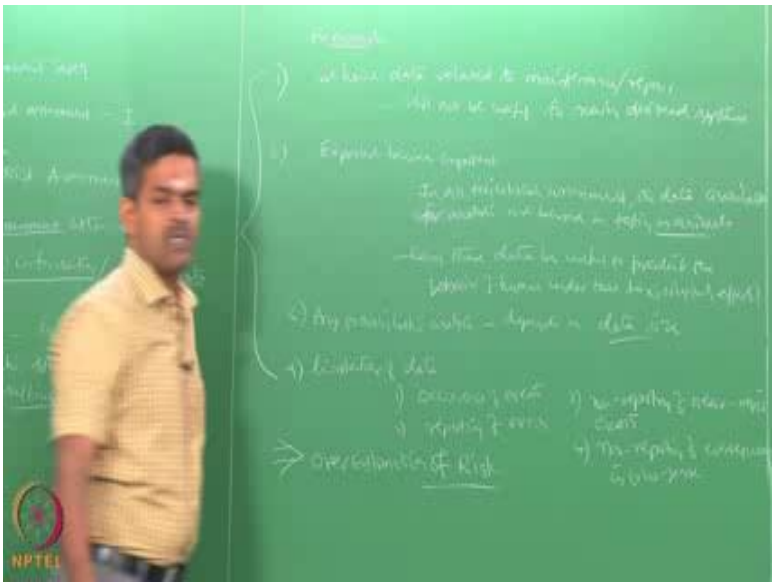

For example, let us say I have a data related to repair, we have let us say, data related to maintenance and repair which we have collected. Of course, you will understand this data though it is bulky and volumetric will not be useful completely for newly designed systems, because newly designed systems would also have an inbuilt update which may not or which would have already overcome the existing problems related to the old plants and equipments, for which maintenance and repair are being carried out. So, all the data related to this, becomes obsolete. It means even though we have a data which is available less in quantity still, all data what we have with us may not be completely qualified for risk assessment.

That is a very important issue; let us say we are more bothered about the fatality accident rate in individual as well as societal risk in terms of risk assessment. That is what the international regulations generally look at risk assessment as; however, we do agree as offshore engineer that risk assessment without economic perspective is of no use for us, it is alright then; when you talk about risk assessment. We have always understood that risk assessment is applicable to people or personal to who are directly exposed. So, exposure becomes important.

Now you need a data to do risk assessment based on which a set of human being or cluster of people should have been exposed for a threshold value of chemical release then you would know what them. So, which is not practical therefore, in all toxicological

assessment the data available for analysis or data related to relate data available for analysis are essentially based on testing on animals. Can these data be useful to predict the behavior of human under these toxicological effects is a big question?

So, the data what you have in terms of tests and results conducted on mammals or animals, to really understand the exposure effect of different chemical dispersion released in atmosphere, cannot be used directly as such on effects or consequences caused by this chemicals on human beings. So, we have another difficulty here; therefore, in order to do risk assessment one uses probabilistic tools. The moment you say probabilistic tool for every probabilistic analysis data size is a main issue so, any probabilistic analysis depends on or let us say, it is influenced by the data size. Due to the limited data available in terms of now, we have limitation of data let us see, where are the limitation of data one limited occurrence of events which is good limited reporting of the events which is bad, non reporting of near miss events which is bad. No reporting of consequences in true sense which is bad. So, all these limitations ultimately we to a very serious consequence what is that it will lead to over estimation of risk.

So, in general whatever mathematical model you use through statistical approach you will always land up in over estimating or being over conservative about risk estimation. It means any such risk estimate, which is based on statistical tools which is for sure going to lead to overestimate will unnecessarily cause panicity. Now, therefore, you cannot apply stringent regulations and punitive measures based on the risk results what you have estimated on the basis of statistical values which are over estimating. Now you have a procedure we very well know because of the following limitation this procedure overestimates risk in a given system, where as in reality the system does not pose that much threat to the environment, but you mathematically show that it is risky. So, based on that statement no stake holder, no owner, no company will agree to accept or to follow any stringent regulations or they cannot be abide by punitive measures suggested or recommended by international bodies.

Therefore, risk assessment is always challengeable you understand, that is why risk assessment should involve lot of feed forward and feed backward loops from the users. It should not remain purely mathematical, it should become user interfaced mathematics, it should have lot of human interventions in terms of data supply, in terms of correction in terms of preparing check list as we saw in the previous example of Frank and Morgan,

you know there are lot of human interventions which could try to correct the errors which otherwise fall in line because of the lack of data and because of limitations on statistical methods which are actually backbone for risk assessment because risk assessment is envisaging a problem. Therefore, you have to use probabilistic tools is that clear now what is an alternative for this? Now we have one issue is there any alternative for this alternative risk assessment is on the comparative scale.

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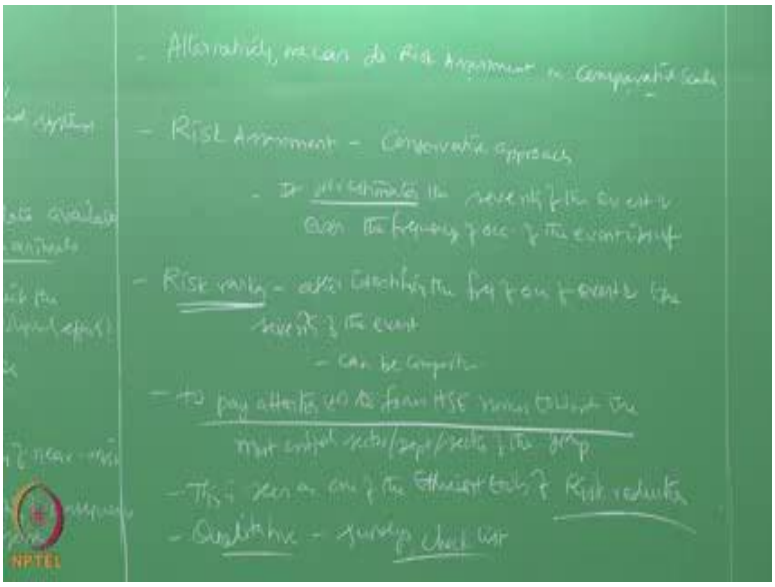

Alternatively, one can do risk assessment on comparative scale; you should have a referent structural system or a plant or an offshore industry. Take that as a reference base reference system compare your system with that reference system. Establish referents for your analysis and then compare and say your system is bad, worse, better, good, what you want to say, you can do a relative assessment as well. But this method is impractical in offshore engineering because, it is very rather difficult to establish a reference system at all, because every system inherently as hazards inbuilt implicitly in the system because of the nature of operation because exploration production drilling etcetera do have hazards implicitly present in the design it itself, you cannot eliminate them.

We already said that offshore industry cannot be associated with the 0 risk industry at all ever. What we can all do is how we can plan to minimize the consequences caused by the risk or to eradicate completely the hazard situation. You cannot say I am going to design a system which is non hazardous it is not possible because it is there are very parameters

we have discussed in the previous lecture modules etcetera, it is actually beyond the control of any human design that you can make an offshore engineering design or any plant or any production unit or any process unit which is completely non hazardous it is not possible at all.

In that case, the hazard can realize and mature to become a risk and therefore, risk is inevitably present in the system. So, when every system has a risk level present in the system you cannot actually establish a referent system, based on which you can compare with reference to which you can compare your own system and say your system is either inferior or superior or as bad as or as good as the referent system. Therefore, relative scare risk assessment on a comparative scale is not successful method for offshore industry. Now what we can understand here is risk assessment applied on offshore industry is a conservative approach it means, it overestimates the severity of the event and even the frequency of occurrence of the event. It overestimates; therefore, risk assessment done by a specific third party is always subjected to debate and deliberations, it is not accepted as a stand by value now after identifying the frequency and severity risk ranking is generally done.

So, risk ranking which is generally done after identifying the frequency of the event of occurrence of event and the severity of the event, if occurred can be a comparative one because, risk ranking is always comparative. What is the main advantage of this method of risk assessment? This method of risk assessment will be able to tell you to pay attention or to focus HSE norms towards the most critical sector or department or section of the group. So, that made it very advantageous it is very, very good because it helps you to pay attention relatively amongst the departments. Relatively amongst the industry, present relatively amongst the group, present in your given section you will know which group is highly vulnerable.

Therefore, comparative method of risk assessment is seen as one of the effective tool of risk reduction. So, this is seen as one of the efficient tools of risk reduction. So, we cannot simply rule out the comparative method of risk assessment, though there are some demerits in this, because it is a conservative approach, but risk ranking which is relative which is comparative will always help you to identify the most critical section within the given sector. Therefore, you can pay more attention you can improvise more stringent regulations of safety practices therefore, as a result of which you can land up in a very

good risk reduction.

So, comparison technique generally is qualitative, whenever you compare it is always qualitative you cannot compare quantitatively because the factors which led to that quantitative number may be different for two systems, you can qualitatively compare them generally for doing this you conduct surveys, you prepare checklist etcetera and so on. So, risk assessment on a comparative scale can also be easily done by simply conducting surveys and preparing checklist. So, based on the checklist prepared by you and comparing systems of a b c etcetera you can always risk rank them and then identify the most critical section or the most critical system or the most critical platform let us say like given system of gulf and Mexico.

For example, and pay attention more and more to that. So, that risk reduction can be discharged effectively. So, we also said in the last lecture that based upon the National Academy Standards. There are 4 ways by which you can do Chemical Risk Assessment, which is one of the important and serious threats to the environment especially from the process industries and oil and gas industries no exemption from that there are 4 steps. So, we will elaborate this slightly now and try to understand, how they can be influencing the end result in terms of risk assessment especially when you talk about chemical exposure risk assessment.

So, in that if you recall it in the last lectures notes you will see that dose response assessment is one amongst them.

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This involves describing the quantitative relationship this describes quantitative relationship between the amount of exposure and the extent of toxic injury, hazardous nature of various materials need to be assessed, before their effects are estimated. So, you need to conduct, lab level or lab tests scale tests to really understand what would be the consequence of hazardous nature of material on human beings or even on living creatures and organisms.

So, therefore, what is the outcome of this the primary outcome of dose response assessment is essentially a linear equation, which relates exposure to the disease which relates chemical exposure or dose exposure to the disease which is consequence of this exposure generally it is done by regression analysis, why regression analysis because exposure is affected or influenced by various factors temperature weather wind direction concentration of chemical etcetera response to exposure or any human being also depends on age, sex, weight etcetera.

If you have any primary infection etcetera, so both have many data, so, it is very difficult to really find out a linear relationship connecting these 2 on the surveys, you take various parameters and see which amongst these parameters influences or causes the maximum influence on the human being. Therefore, regression analysis is generally used for dose response assessment, the second one; what we saw is exposure assessment actually, this assessment deals with or describes. Let us say the nature and size of population which is

exposed to the dose agent of any chemical in terms of it is magnitude, which is usually expressed in parts per million and duration.

Usually expressed in minutes or sometimes even in seconds also. So, what are the data which should be included in exposure assessment the data should include analysis of toxicants in air water and food. So, you have to analyze all of them because it can disperse in any media having said this, lets say we are worried about the chemical risk assessment in that, we have got two components one is the dose response, what is the response of the human being or the population in the society, when exposed to a specific chemical of a specific dosage which includes or which outcomes as a linear equation between the quantity released and the extent of exposure and also depending upon the climatic conditions, the data otherwise in dispersion models etcetera. We also do exposure assessment based on these two I can do risk characterization.

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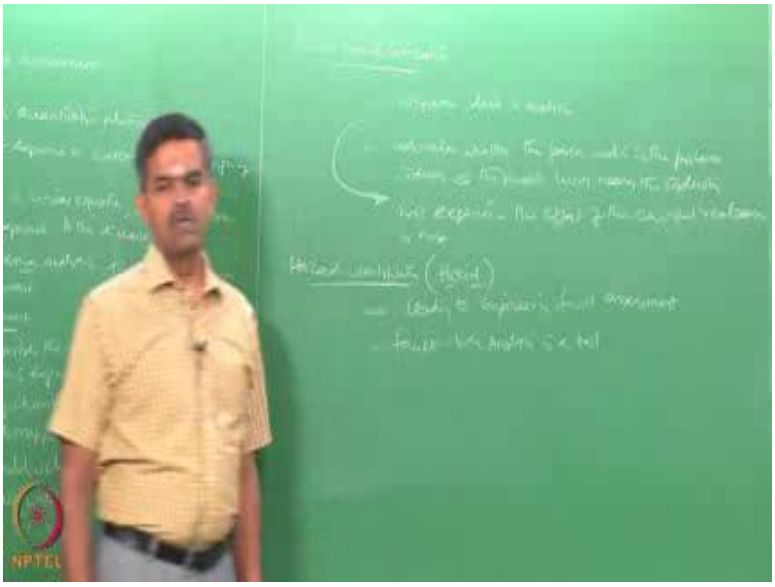

Now, risk characterization is actually integration of data and analysis, it integrates the data collected and the results of analysis it determines, whether the person working in the process industry and the general public nearly habited will experience the effects of exposure or not.

It actually determines whether the person working in the industry, I should say process industry or the public living nearby the industry, will experience the effect of the chemical release or not. So, risk characterization should answer this question, directly.

Off course, while doing so, it includes various uncertainties, which arise from the entire process involved in risk assessment the four stage followed by this could be hazard identification, which actually includes engineering fault assessment.

Essentially hazard identification is subjected to offshore and petroleum industry is leading towards or leading to engineering fault assessment, basically hazard assessments or identification essentially is used hazid, this is called Hazid. Hazard identification, Hazid is generally used to evaluate the reliability of specific segments of any process industry, which is in operation. So, what is the hazard caused when the industry is functional it doesn't talk about what would be the hazard caused, if the industry is not at remained functional. If you do not commission industry or process industry you cannot do hazard identification. Hazard identification is a live problem, it is only done on industry which remains functional it generally employs fault tree analysis, which we will see later in detail is a tool used for hazard identification once we said this, let us talk about hazard classification.

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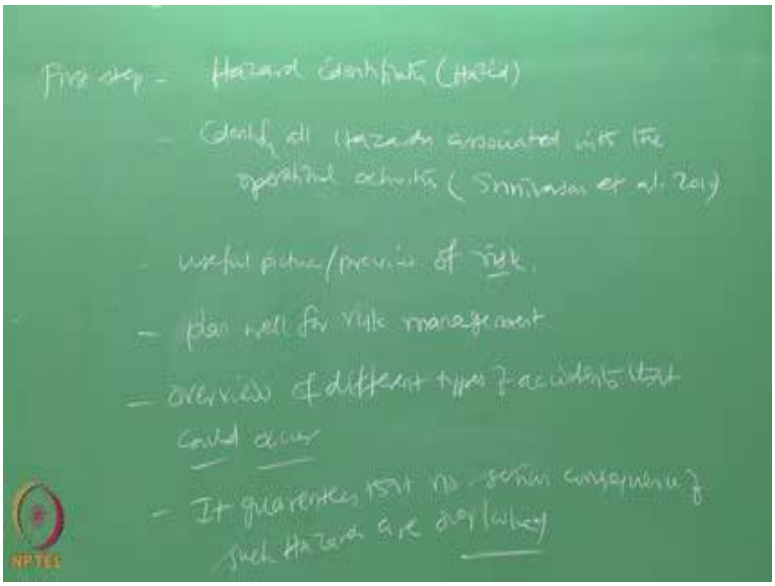

The first step in all risk assessments or in QRA is Hazid. So, the first step in all risk assessments or any quantitative method used for risk assessment is hazard identification. First you have to identify the hazard hazid the purpose of hazid is to identify all hazards associated with the planned operation activities. So, this should identify all hazards associated with the operational activities that are very important, so it is a very elaborate

analysis it gives a very useful picture or a preview of risk.

Therefore, one can plan well for risk management which includes risk assessment also it provides a very good overview of different types of accidents, that could occur please understand it is an anticipation, it guarantees that no serious consequence of such hazards are overlooked. So, hazid is a very important study so, while doing hazard assessment where you do the first step even in risk assessment as the hazard identification, because risk is nothing but realization of hazard. There are some terminologies which are commonly used in hazard classification and assessment let us see them now.

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Let us start from what we already know, hazard is a chemical or a physical condition it is a scenario which has a potential to cause damage to people property environment. So, hazard actually is a scenario, which is a situation resulting in more likelihood of an incident precincts, understand hazard is connected to incident risk is connected to accident then, what is incident? Incident refers to loss of contamination of material or energy please understand all incidents do not propagate to become accidents, all do not become accidents please understand then, in that case what is risk interesting? We already know that, but still risk is a realization of hazard in simple terms when, you are talking about risk at this level incidents have become have matured to become accidents. So, interesting risk connected to accidents hazard connected to incident it is very interesting then what is hazard analysis?

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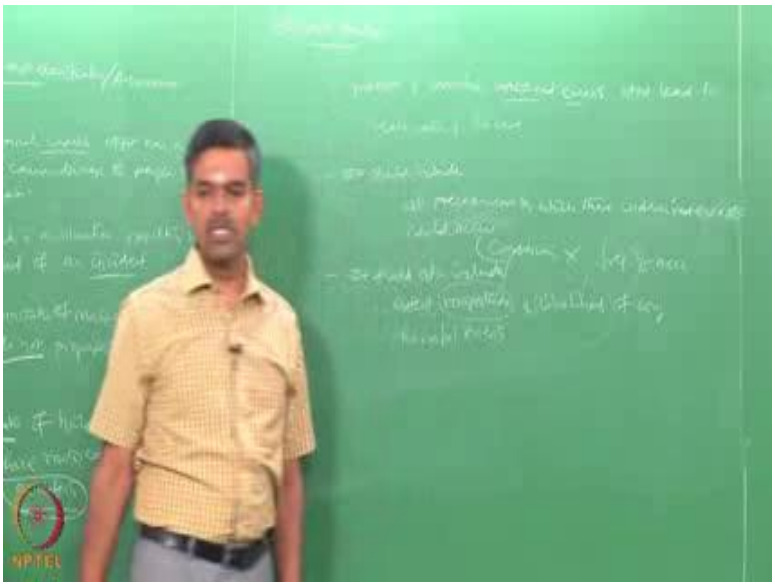

Hazard analysis is a method of identifying undesired events. Undesired events that lead to realization of hazard, it should include the following, all mechanisms, by which all mechanisms, by which these undesired events could occur, it should also include the extent, magnitude and likelihood of any harmful events.

So, one can see here hazard analysis it is an opening step of risk assessment, because even in hazard analysis you look for the likelihood, which is as same as frequency of occurrence. You look for magnitude, which is as same as consequence. So, the product of these 2, we already know is nothing, but risk. So, therefore, what is a classical line difference between risk analysis and hazard analysis? Hazard analysis is done on incidents which may materialize to become accidents and therefore, all processes are projected or likely to happen.

Where as in risk analysis it is always a posed accident scenario you have to have a previous data of a similar nature in kind to estimate risk on a given system. So, risk is nothing, but realization of hazard. So, it is an advance step of hazard that is why in hazard analysis we do not talk about a economic perspective because, that will definitely give you a wrong figure. Whereas in risk assessment you already know the damaged caused to the system. Therefore, economic perspective is very important in risk assessment. So, hazard identification coming back to the original problem deals with engineering failure.

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It evaluates the reliability of specific component or segment of the plant in operation that is very important. It gives the probabilistic results of it is operational and designed failure very commonly we use FTA for doing this Fault Tree Analysis for doing this. We all know that hazards are very common in oil and gas industry, because of it is nature of operation and it is very, very difficult to identify them, in advance until an accident occurs it is therefore, essential to identify the hazards if one really wants to do risk reduction.

Therefore hazard analysis will be based on certain frequently asked questions because, hazard analysis is nothing, but thought provoking process in the whole scenario, which is outcome of design deliberations, discussions, meetings, inspections, checklists, etcetera. Therefore, it should have a set of questioners; a set of fundamental questions, which should be answered. The answers of these questions will actually become a document of hazard analysis. So, what are these questions?

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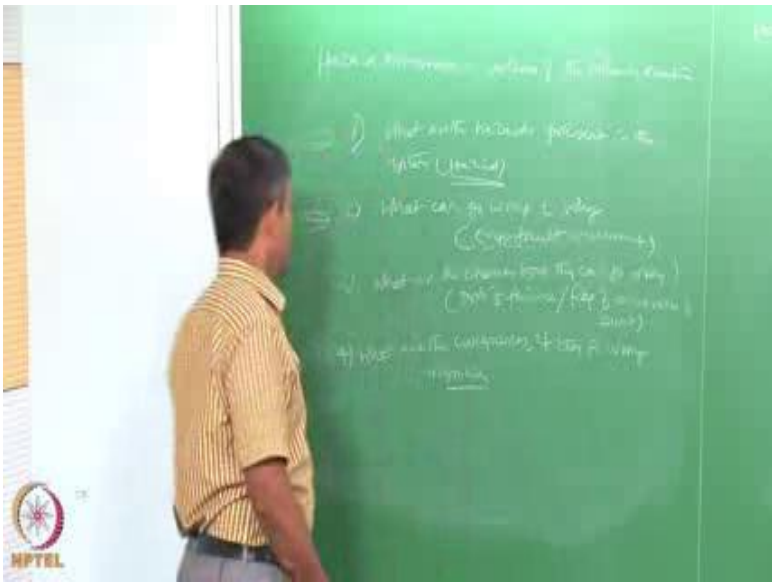

So, hazard assessment is nothing but an outcome of the following questions. Let us see what are these questions? First what are the hazards present in the system, which we do generally from hazard identification? What we call hazid, second question once you do identification then, what can go wrong and why? So, this is about engineering fault assessment because, you have to give a reason if you say the equipment can go wrong, you must say under the following temperature and pressure the equipment can become malfunctional, you have to give a reason.

So, it is an engineering fault, assessment the third question which will also lead to hazard analysis or assessment is that, what are the chances that they can go wrong? This is an extension of hazard analysis, where we are talking about the probability of failure which is made frequency of occurrence of an event, which is actually a part of risk assessment fourth could be, what the consequences are? If they go wrong, here we are talking about the magnitude of the problem. Therefore, this is also a part of risk assessment. So, the first question deal with hazard identification the second question leads towards engineering fault assessment.

For example, fault tree analysis is one amongst them, there are other many more we will talk about that later the third and fourth are extension features of hazard assessment, which actually leads to risk assessment. So, hazard assessment and risk assessment are analysis cannot be actually separated you cannot say, I am only doing hazard analysis by

doing hazard analysis effectively you will also be implicitly doing risk analysis.

If you have done risk analysis, you must have done hazard analysis as a part of risk analysis it itself. Therefore, these two cannot be actually separated, but unfortunately please understand; one is qualitative, one is quantitative, which is qualitative hazard analysis is qualitative risk analysis is quantitative hazard analysis, does not include the projected consequences in economic loss risk analysis. If does not include the projected cost effect on the problem is of no use to oil and gas sector. So, there are very interesting differences and deviations between these 2 analyses about one generally follow the other.

In fact, they are in the same circle. So, you really do not know which is following what. So, one cannot really have an line separation between hazard analysis and risk analysis. Off course, by definition risk is realization of hazard, hazard is envisaged risk; one is futuristic risk, and one is posed accident diagnosis. So, you can write down millions of differences between these two; however, both of them follow one on the other in the wheel of a circle, which we do not know, which is leading, which is trailing depending upon the direction. What we look at it by the tools used for both of them is different.

So, it is very interesting in this lecture we covered about interaction hazard assessment. We talked about the hazid tool, which is very important we also talked about the chemical risk assessment partially in this lecture, four factors they are very important. We spoke about risk characterization, which are the factors which are helpful in characterizing risk.

We also compared very quickly the risk analysis and hazard analysis and we said why they cannot be separated? Why they are inherently coupled to each other because of it is nature of analysis, please understand hazard analysis is a mandatory method to be done as a preliminary set of analysis in any new operational plant. Risk assessment is regulatory mandatory by legal agencies which must be done in all plants remaining functional at least once in a year. So, one is legally bound one is part of the design, but both of them are integrated and coupled for a successive health safety environmental practice in an offshore industry

Thank you very much.