Health, Safety and Environmental Management in Offshore and Petroleum Engineering

Prof. Srinivasan Chandrasekaran
Department of Ocean Engineering
Indian Institute of Technology, Madras

Module – 02
Operational safety
Lecture – 06
Risk assessment-I

Welcome friends to the online course on HSE Practices in Offshore and Petroleum Engineering at IIT, Madras. We are talking about the lectures on module 2.

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Module 2 lectures are focused on operational safety. This lecture is titled lecture 6. We are going to talk about risk assessment. Let us take 1 because I will talk about risk assessment in many lectures later. We talk about the first series of this lecture, if we recollect what we saw in last lecture. Let us slightly rewind back and see, we said risk can be expressed mathematically as actually the sum of the events or accidents sequences sum it to over i, where pi ci will be taken as the product of pi, ci is taken as risk, where pi is a probability of accidents or occurrence of accidents. Please understand; when I am including certain accidents which are going to count for the risk then these accidents are

above the hierarchy level because in offshore industry are something called risk acceptance level.

So, those accidents which are above the acceptance level are only recorded here and ci is a consequence of each accident, where i will be the sum over the number of incidence. So, we already said that this particular equation 1 is able to give the statistical look out for the risk definition. So, equation 1 gives the statistical look out mathematically, this is fine because this is giving me the probability of occurrence, it is also giving me the consequence. The product of this is what we say risk case is perfectly mathematically, but what is missing in this whole equation which as offshore engineering we are feeling important is the value in practice.

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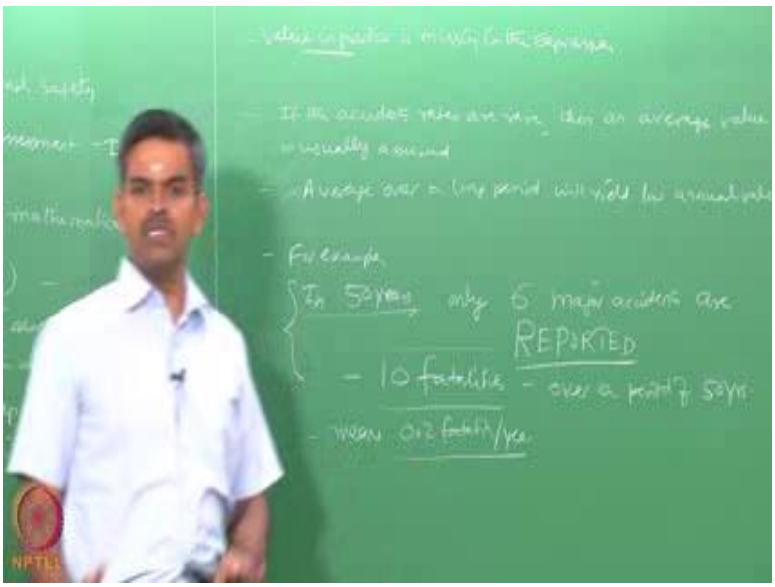

The moment I say value in practice, I am looking forward for an economical perspective of this particular risk because that is what is going to effect by industry in a whole. Now, the interesting argument of equation 1, if we looked at this in detail by giving an example you will know the seriousness of using this equation for understanding risk as an offshore engineer. For a mathematician these equations is fine, but let us gives an example and try to understand what actually we are missing through this equation.

As an offshore engineering, if the accident rates are rare it is very good to know that the accident rates in offshore industries are rare because of various precautionary measures taken by the industry, various safety followed by organizations in companies, various rules and regulations imposed by the local government or production explanation on the industries and of course, intensive dedicated training offered by the company to that employees to ensure and the practice safety. Thanks to all people are involved in safety group in inculcating safety culture in offer industry, hats off to all of them.

But; however, we can always proudly say my industry is got a very rare accident rate. So, the moment you have rare accident rate then mathematically it is accepted that an average value is usually assumed because a number of accident rates spread over a specific number years is very less than you look for an average. The moment you look for an average over a long period will yield low annual values. These we already know, let us take an example, in 50 years only 6 major accidents are reported and very carefully in writing the statement in block letters. There are many nearness events; there are accidents which remain unreported, non-documented. Therefore, let us say there are only 6 major accidents reported. This said there are only 10 fatalities over the period of 10 years during this period of consideration. There are only 10 fatalities it is good to know that they are on fatalities.

So, remember this particular statement taken as an example accounts only for human loss of life. It does not account for an economic loss, where the machinery was burnt, where the platform was completely fired and exploded of. When I am looking into all those things, where this statement says there were only 10 fatalities on the reported accidents for the last 50 years which means 0.2 fatalities per year. So, looking at this number one will understand that the accident rates are very, very low and the fatality number is very minimum. Therefore, we are following very healthy safety practices in offshore industry as I said risk is a term associated and it should be associated with economics. I must look into the loss, consequences should not only address the loss of life it should also address the loss of economic value which has been occurred or resulted from these accidents which are reported.

So; obviously, this equation number 1 does not talk about the economic value at all even

in the mathematically applied where there is an example like this, where the number is so low for a large period, you are bound to take an average value. If you do that I get a picture which gives me a wrong convention about the whole risk picture involved in the offshore industry, you understand this is actually the problem. So, this particular understanding of risk does not lead to the real understanding of risk picture at all. So, risk assessment cannot be based only on statistical average of probability of occurrence and consequences in terms of fatality. It should also touch upon the economic value resulting from this accident which is not there, consequences should include the economic value. It means I should find out this particular numbers, somewhere in terms of billion dollars, etcetera.

In addition to fatality this is also important, I am not ignoring that this is not important what I am done to emphasize is this particular understanding of risk equation does not give me a clear picture about the economical value associated to risk that is the whole issue here, which is important in offshore industry because offshore industry is spinning around the economics of the entire nation risk. Therefore, should convert an experience into a mathematical term by attaching the consequences of the occurred events and the economic loss associated with these events. So, we have got two things here.

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One is a consequence of the occurred events and then the economic loss. Now, there are some keywords here, please understand risk therefore, is a post evaluation technique. My dear friends, it is a post evaluation of any event then what do we actually mean by risk prevention? What do you mean by this? Preventing measures are based on understanding of or diagnosing or post evaluation of occurring events.

So, for example, no accidents have been reported at all, you cannot estimate risk wherever there are problems with the ensemble of the data size statistical tools should be carefully used, I mean we all know this as engineers and mathematicians wherever there is a problem associated with the data size, you have to use the statistical tools very carefully to converge into a meaningful statement.

So, in the whole discussion the meaningful statement so called this is what risk is. So, therefore, to understand risk if you are only a statistician or a mathematician it is not sufficient, we have got to feel it, you have to experience it that is why I said risk should convert the expression not the knowledge. You can always seek the knowledge, gain the knowledge by reading text and understanding them, simulating them numerically, modeling them all is fine experience.

So, you should be trained to be associated with risk aversion risk, prevention post evaluation of risk, etcetera. Therefore, HSE training and practice does not stop only with the knowledge in part to a people about the accidents also to make them to understand how we evaluated them to associate the loss economically caused by the incidents. So, therefore, it is an experienced very, very important that is what we said in Srinivasan and Kiran, 2014. So, risk is a larger picture my dear my friends, it cannot be converted to a specific point talking about only a mathematical average, just get the data, find out the occurrence of number of events because frequency are probability of occurrence. This related to the number of occurrence of events over a spread of time, if the number of occurrence of events for a large spread of time number is very low.

You will always get very simple or the sample data problem in this statistical analysis therefore, it can give you a wrong picture as it as seemed in this example. It can give a wrong understanding of risk whereas, risk is something different than being projected by

this statement here, but please understand very clearly here, risk is not only about loss of life that is what we want to emphasize. Therefore, risk should cover property damaged to environment, all issues including fatalities or loss of life or human being on both. So, that is one part of risk assessment, but that is not only and does not end once we said this. Let us talk about how we do compare risk and safety? Where that is important?

One we need to understand, this was moment I say the environment or the location or on board training is unsafe. It means I am giving a hint about the risk involved in that whole activity. So, risk and safety should be collected, let see how they are connected.

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Safety and risk are actually contemporary safety is a subjective term, while risk is an abstract term. Safety cannot be qualified directly; it is addressed indirectly through risk assessment.

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So, risk assessment will lead to safety assurance or safety evaluation. So, somebody says I am going to evaluate safety of the whole system, it means he is actually doing risk assessment of the system. Having said this, risk assessment can be classified into 2 as expected by you all, as we have been anticipating this definition risk can be classified broadly into 2, one is about individual risk other is about societal risk.

Individual risk is actually defined as frequency at which an individual may be expected to sustain a given level of hammers from realization of hazard. Let us see the key words in the definition, individual is the term related to single person, may be a group of people who are directly connected individuals or those who are directly connected or one can say associated with a hazard.

For example, people working on board building engineers, mechanical engineers, turbo generator operators, etcetera who are working on board in building platform, who are working on processing platform, who are directly connected to the processes and production, we call them as individuals. What is the risk they are associated with? It is an individual who expects to sustain, who is expected to sustain a given level of hammers. So, therefore, we got predefine the given level of harmness in a given work environment, you must say what is the acceptable level of harmness? What is unacceptable level of

harmness? We have got a predefined, this you cannot say whether the harmness is acceptable or not, after the harmness as been realized. So, every process industry, especially in offshore industry, all these cases are exactly predefined, my dear students is very, very clear about a predefined for every chemical.

What is the acceptable level of harmness? What is the threshold value beyond which a human being or individual cannot sustain? Who is directly associated with that process? I am not talking about the indirect people at all I will come to that later. So, you are directly involved in the process, how much can be sustained for example, you have involved in hydrocarbon production methane is leaking, CH 4 is leaking, what is the dosage or threshold value you can sustain for many minutes when you are continuously exposed that is actually the level of risk? So, if a read that with the knowledge, it is frequency at which an individual may be expected sustain a given level of harmness, when the hazard is realized.

It means hazard has become a risk now, hazard is a scenario it is a situations it is an environmental condition. It is a working arena, all conditions do not cause any harm to people at all unless otherwise the hazard situation present in that arena is realized to become a risk. But always there is a probability that hazard is situations can be become a reality and can cause risk to the post threat of risk to the situation that is true, but the statement is not reversed.

So, it is always better to assess risks not the hazards. The moment I say hazard analysis I cannot do it quantitatively, I can only do it qualitatively because there is only session number, there is no picture, there is no data. Therefore, I cannot do it mathematically, I cannot do it using statistical tools, you understand hazard is a qualitative assessment; realization of hazard is a realistic assessment which we call as risk in offshore industry. therefore, if an individual who is directly connected to the cross industry, if we want the quantified the frequency at which is expected to sustain a given level of harmness, that is an acceptable level of harmness then we called as individual risk.

This usually account for risk of death usually. So, we can predefined the statement frequency at which an individual is unable to sustain a threshold value of harmness

caused by an exposure resulted in fetal end. So, usually accounts for risk of death expressed in terms of far, where as far stands for fatalities accident rate. So, the average individual risk, why I am saying average because when the number events are accounted for a large period then I have to average. This is actually a number of fatalities divided by the number of people at risk. Let us say this equation interestingly, let us try to pay attention to the numerical and denominator of this equation. The average individual risk accounts for the number of people who are involved who are at risk.

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It means they are directly connected and associated with the hazard situation. So, people working on industry, out of which how many people die? How many people are injured? How many people are suffering from lung infection? They are not counted in a whole mathematics unless and until you die, you cannot be in the numerator, but if we are an employee, you can be the denominator; obviously, when people are not declarative death because the consequences of the accident the numerator will be lower and lower.

So, this will give me a picture saying that the average individual risk is lower; obviously, it does not look for the economic perspective still. So, this may not be a far may not be the correct way of understanding risk because it is only talking about the fatality accident rate the moment I say rate it is always divided over a period of years. So, when we look

at the population over a period of years, and also look at their fatalities over the period of years you will see average including risk for the year will be different from the top. Average individual risk for the past 10 years into further lower because a number of fatalities may be same every year, but the number of people involved will be more and more. Now, how does the comparison of societal risk in society the number of fatalities may be higher or lower, but the denominator is phenomenally large because those are people who are not directly connected with the risk.

The societal risk then should be defined as a relationship between the number of peoples suffering a given level of harmness and the frequency of that is kind of harmness. Please understand, here the people refers to those who are not directly connected with hazard that is why we say the societal, it is individual please do not be confused, individual is also part of the societal you know.

Here the individual means people working in the industry who are responsible for really session of hazard. As I said as well all now agree at least risk will occur only when there is human negligence. So, therefore, these people are responsible for realistic of hazard which is firmed risk therefore, what is their risk. So, individuals are not part of the society cannot individuals because they are independent no they are employees of the company which actually results in the session of hazards, whereas societal people are living around in the vicinity where there is a gas leak accrued in the gas dispersed in the environment as we saw in the first module in different mathematical models available.

So, they realized some suffocation they realized certain lung injury etcetera. So, people suffering from the harmness, we will not talking about, again the direct connection the event generally this is expressed societal risk is expressed in terms of f n curves, where f stands for the frequency and n stands for the number of fatalities

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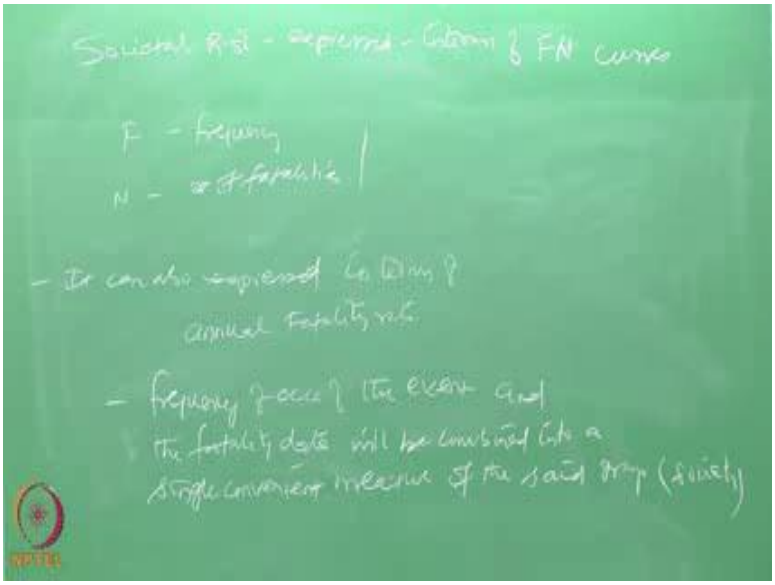

It can also be expressed in terms of annual fatality rate, in such cases the frequency of occurrence of the event and their fatality data will be combined into a single convenient measure of the said group. The said group here is the society say that two different ways that explaining risk individual directly involved society indirectly. This is commonness between these two; please understand, what is the commonness between these two whenever I talk about risk?

So, far classically mathematically, statistically it is always bothered only about the fatality, it is not bothered about the people who are actually, let say become blind, having some lung infection, having some throat infection, having some loss of eye, limbed, etcetera. They are not counted in a numerate at all or in the f n curves. So, under survives you report fatality risk is not influenced by your statistical measures. So, I think and you also have to agreed with this statement that is not giving a real picture because it does not talk anything about the economical loss, which is the very serious consequence as seen from the case studies and the previous lecture modules, etcetera that economically the hazard situation can effect a serious causes and serious damaged not only to the society, but to the whole environment.

So, where that is been accounted here mathematically when use the statistical tool as we

saw in equation 1 and the equation 2 subsequently. So, there is something missing in the whole understanding of risk assessment as applicable to iron gas industries. Therefore, it becomes important countrified risk because risk estimates are attractive only when the consequences in economical terms are associated with this, but unfortunately if we look at the consequences they still remain as a statistical number, but one will be seriously interest to know the estimate of the loss because risk leaves to financial applications which arise from this consequences this should be reflected in the company balance sheet.

So, friends in this lecture, we try to understand, how risk picture can be quantified in the individual and societal? What are different factors which can account for risk assessment? What are different rules and regulations, intrinsic agencies, which prescribes and defines risk? Why the risk picture as understood today in this given definition have ambiguity because there is an economic loss mentioned are occurred in the whole system. So, there should be some method by which we should encounter or include the economic loss which is a very serious consequences occurring because of realistic session hazard, which should be a part of risk assessment which we will see in the subsequent lectures.

Thank you very much and bye.