Health, Safety and Environmental Management in Offshore and Petroleum Engineering

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

Module – 03
Accident modeling, risk assessment and management
Lecture – 15
Risk in Marine Systems-I

Welcome friends, we will have the 15th lecture.

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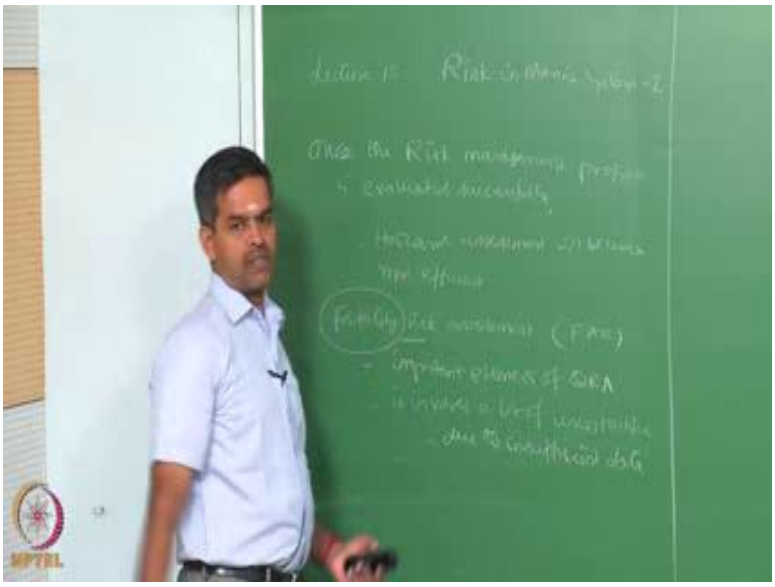

Today in lecture module 3, here we will talk about some of the risk modeling associated with some of the marine system. So, let us see risk in marine systems, we will actually have this in 2 lectures. So, this one in the last lecture, we said that risk management is always evaluated effectively by asking certain number of questions, have the control measure solve the problem? Did the control measures created any new hazards or any new control measures required as recommended by the local or legal authorities, and do the control measures are updated based on the recommendation need by the report.

So, therefore, once the control measures evaluated successfully or once the lets say, risk

management program on plan is evaluated successfully then one can say that hazard assessment will become more efficient. It becomes rather easy subsequently hazards identified from the hazard study or then rank that is prioritize according to the critical hazard points, and then focus is paid on the most hazards event or the instant excepted in the process line hazard controls are implemented to prevent the major accident, effectiveness of this control as such you can evaluated as just now we saw through inspection and safety review programs.

On the whole, we are also focused on fatality risk assessment what we call as FAR; Fatality Risk Assessment is one of the important elements of QRA of quantitative risk assessment. The unfortunate part about this is it involves lot of uncertainties; this is because due to insufficient data that is one of the important drawbacks here. Therefore, generally modeling fatalities is a very compress task, but; however, one can interestingly see if you look at the ratio of fatalities to ratio of injuries in offshore accident industries.

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Let us say, if you look at the ratio of fatalities to injuries one can easily see in exploration of production offshore and oil gas industries sector are able to control. This in the ratio of 1 is to 1400 injuries are of course, happening because of the unrepresented, unexpected, unwarranted issues which are happening in the process sector in oil gas exploration

production, but; however, it does not result in fatality the ratio is about 1 is to 1500 in the last 10 years. So, you can have the reference of this from one my book which have indicated in the list of references of this course.

Therefore, it is very clear, the injuries statistics are more than fatalities and focus should be on injuries which in return will reduce fatalities. If the fatality risk is assessed and focused on risk reducing measures then probably risk of having injuries will also get reduced significantly. So, one can do a statistical analysis on this statistical analysis of fatality risk is used, when there exist sufficient data base of accidents uncertainties are less expensive in the statistical analysis. Therefore, calculation fatality risk based on statistical analysis is often used for occupational hazards like offshore and gas industries. So, fatality accident rates are generally expressed in statistical sense in offshore industry, alternatively one can also do phenomena base analysis to estimate the fatality accident rate this type of analysis actually includes chain of events chain of events such as cause of fire, fire loads responses and effects on personnel because of fire.

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So, you try to understand the chain of events in a series and then based on each phenomena try to work out the fatality rate. So, this approach describe behavior of a person during a major accident that is an important advantage the important advantage is

this approach includes behavior of a person during a major accident one can be ask me a question where it is included that is what we call as the response psychology.

These analysis have various steps that a person underwent or has to go through in order to save his life in case of major accident for all mock drills near miss events are documented to summarize major steps a person has to undergo in case of an accident and this data is included in the analysis that is way called phenomena based analysis, but this of course, has one of the disadvantage as well one of the major disadvantage of this type of analysis is that there are uncertainties in each step there are uncertainties involve in each step which makes either the analysis inaccurate it makes it incomplete or it makes it highly complex. The third method by which one can do the fatality accident analysis or rate is averaging the F A R values.

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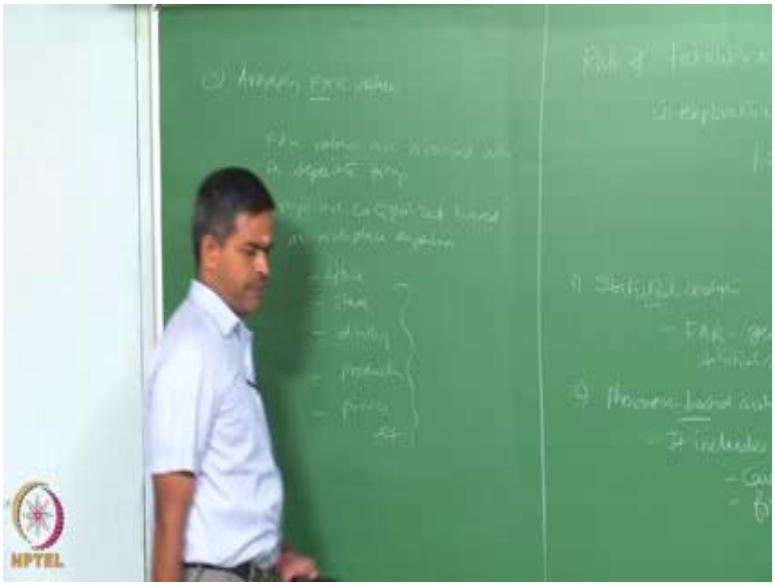

Fatality accident rate values are average over separate groups FAR values are average over a separate group over a period of time considering in the plan, the groups are categorized on the basis of the departments, such as office process production drilling categorized based on let us say the work place exposure like office let us say store drilling production etcetera process etcetera.

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And we agree that the fatality accident rate varies for each group, what is the main reason for this? The main reason for this is the number of work hour, exposure is not uniform that is number 1, number 2 the degree of hazard present in each work space present in each work space is not uniform, three possible near miss events control mechanism I would say even the some to some extent the training modules extend at work space are again not uniform.

Therefore, we all need to different FAR for different groups. So, it does not fair enough, to work out on fatality accident rate for the entire plant because there has been certain parameters which actually differentiate them. So, it is always better than judicious to group them and categorize them in such a form depending upon the work place exposure, then try to find out fatality accident rate of each exposed groups. Understanding this let us apply this concept, what you understood in this lecture on marine system risk modeling risk modeling.

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For marine system in the recent past one can agree with me strongly that there has been a huge development in the offshore industry in which the surface installations are taken over by offshore installation. Offshore installation mainly consist of floating or fixed installation which initiate high probability of failure common causes, which has been seen in the literature for these kind of values arises essentially from ballast systems anchoring systems or loss of buoyancy.

So, one can see here in the recent past a large number of offshore installation are taken place and their failure either during erection or production are mainly due to ballast system failure of an anchoring systems or failure of or loss buoyancy. So, let us quickly see what is the ballast system failure and what does it do? What is the consequence of this ballast system failure leads to loss of stability, even under static conditions it may lead to either a single point failure or multiple point failure which is more serious.

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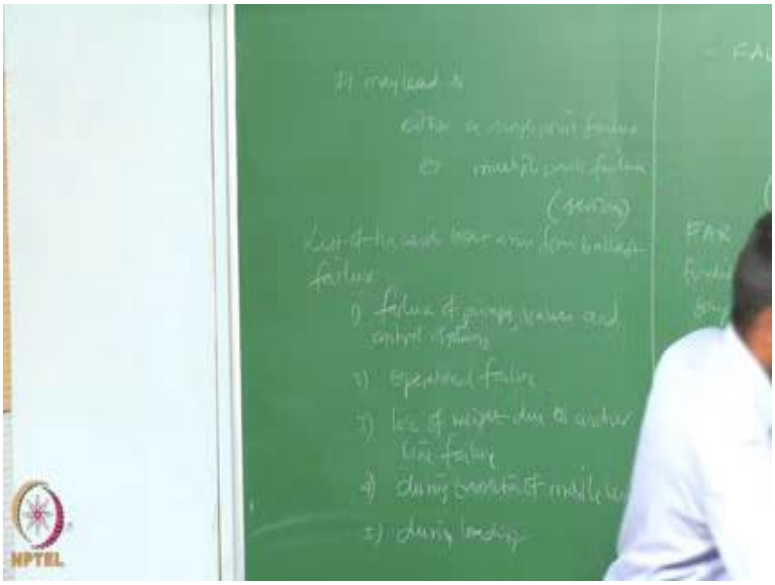

Let us quickly see what are the hazards which arise from ballast failure, it could be failure of pumps valves and control system. It also arise from operational failure, hazard could be also loss of weight due to anchor line, failure can also arise from or arise during transition of mobile units, etcetera can also arise during loading system failure can happen. During loading all this may lead to all of the above may lead to abnormal situations which affect the stability.

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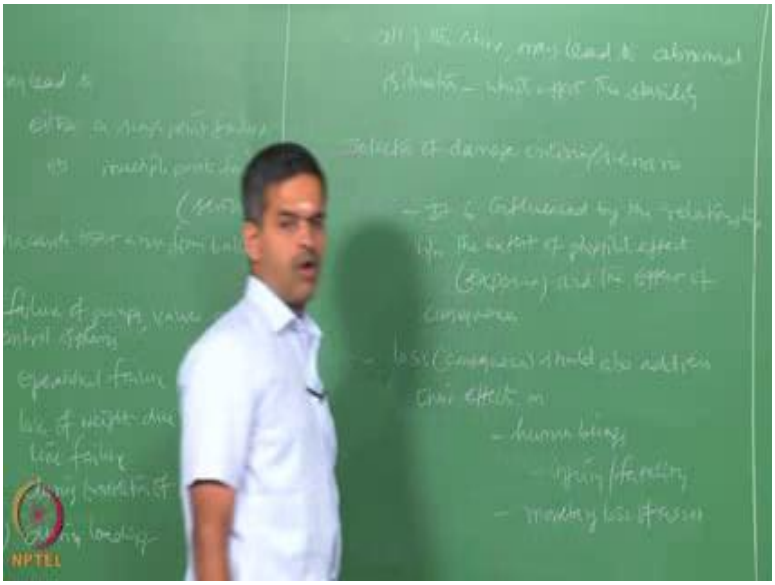

Having understood, what are the hazards which can arise from the ballast system failure? let us talk about how to select damage criteria or can even say scenario. The damage scenario is generally influenced by the relationship between the extents of physical effects. What we call exposure and the effect of consequences caused by this exposure therefore, while we are interested in assessing the damage scenarios, which can result in some loss our focus in fatality assessment rate or risk assessment in marine systems. Essentially, you should convert to effects on human beings. So, the damage scenario or the loss or the consequences should also address their effects on human beings working in the plant which may result in either injury or fatality. It can also result in monitory loss of asset or property; it can also damage third party property, etcetera. So; obviously, we already have seen that in case of any damage scenario occurring from the plant and marine system which will lead with production of hazardous chemical.

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The most important and the most common accident which could happen, if at all it happens would be fire or explosions of course, damages caused by impact of vessels on marine platform on offshore system are also possible, but their of a lower order compared that of the consequences caused by the or explosion accidents. So, moment I say fire and explosion one of the important consequence of this as we read earlier important consequence of fire and explosion is heat radiation.

So, one is interested to know what is the effect of heat radiation on human and equipment when it is occurring. So, what its effect or consequence on human and equipment when it occurs because that is how we can work out the economic class or the injury or the fatality which is one of the important assessment in risk modeling. So, please be attention with a table shown in the screen now

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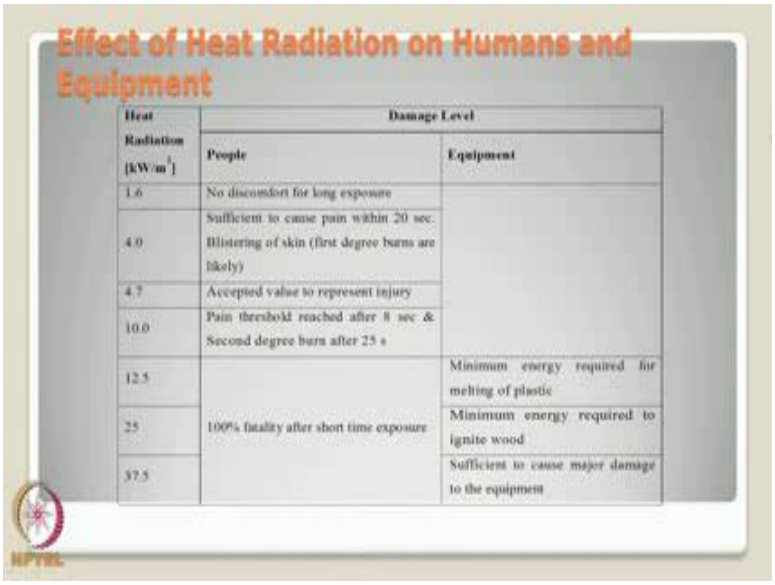

For different level of heat radiation varying from 1.6 to 37.5 what are various damage levels which can cause damage on people and on equipment are listed here, for example, heat radiation effect is 1.6 kilowatt the square meter. It will not cause any discomfort to people even under long exposure this absolutely have no effect on the equipment at all till about 10 kilowatt square meter radiation. However, if the heat radiation is increases further and as highest 12.5 from 1.6 may be closed around let us say 8 times of 7 times in that case it may result in 100 percent fatality even when you have a short time exposure. However, that kind of radiation will have a minimum energy required for melting of plastic it does not cause serious damage to the equipment, but; however, it can also cause sufficient damage to the equipment in the major if the heat radiation goes as highest 37.5 kilowatt per square meter. So, depending upon heat radiation emitted during the process of accident one can always see the consequence of this on human as well as equipment by taking guideline from the specific tabular data

The second issues could be the duration exposure this is intensity, intensity of heat radiation let us say in kilowatt per square meter, second factor could be duration of exposure on what would have consequence on human as well as plants please be attention to the slide shown in the screen now.

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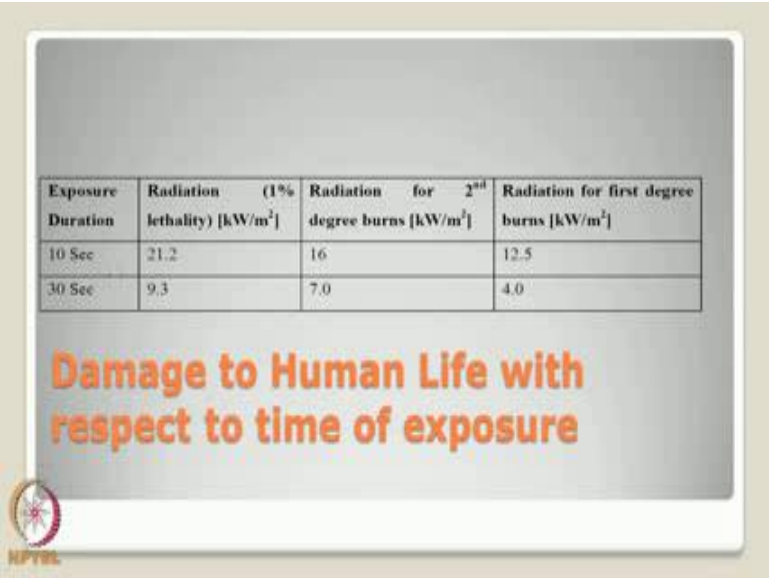

Look at the exposure duration up to 10 seconds for radiation intensity of 1 percent lethality in terms of 21.2 kilo per square meter. Then, if you have an intensity of 21.2 it can result in 1 percent lethality. If intensity goes to 16, it can cause second degree burns if it is of the first degree then intensity require is about 12.5 for an exposure period of about Bharaev second; obviously, when exposure duration increases about 3 points then it can see here even at lower radiation compared to the above, we can always have lethality second degree or first degree burns on human body. So, depending up on the magnitude or intensity of exposure and duration of exposure one can estimate easily the damage cost or the loss on human life or the damage cost on human life because of such issues. Similarly, on the oth.er hand if you look at the explosion.

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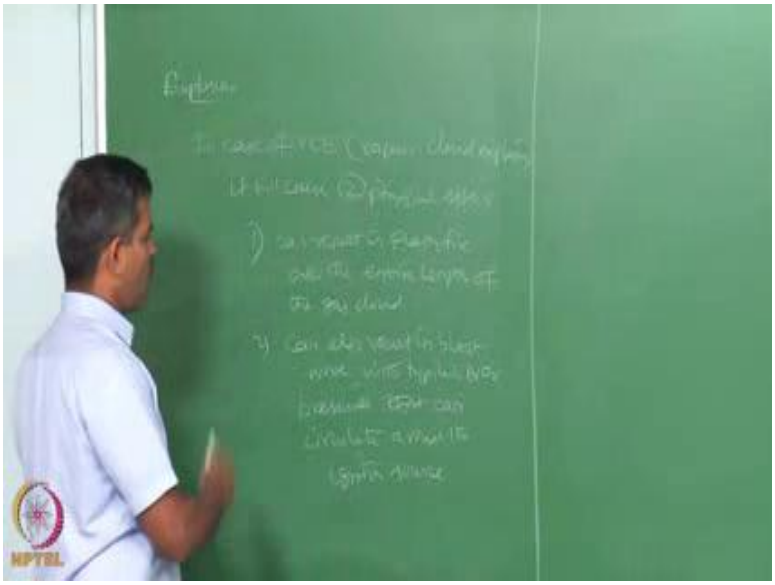

As an incident or an accident occurring in an offshore platform, in case of vapor cloud explosion in case of vapor cloud explosion, it will cause two physical effects; one it should result in a flash fire over the whole length of the explosive gas cloud. It can also result in a blast way with typical over pressures with typical over pressures that can circulate around ignition the source. That can circulate around the ignition source interestingly the over pressure which is caused because of the blast way will also have serious consequences of human.

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So, the consequences of over pressure on human would be one, it can have a direct effect of over pressure on human organs. There can be direct effects of human organs. Secondly, the effect of debris from the structure can also cause damage to human debris that come from the structure as a result of over pressure or the blast wave can also cause the human

However, if look at the direct effect on human organs is more significant, in case of over pressure interestingly, already seen this model that when the pressure changes sudden the pressure different that arises can lead to damage of the organ extend of damage varies with over pressure along with factors. So, what are those factors which can factors that influence effect on human due to over pressure? There are many factors which we have influences. This one position or proximity of person due to the blast, source two protections inside a shelter is inside a protected shelter, thirdly body mask of the person. So, it is very important that all people should also be trained in terms of their physical consequences. So, they should be able to maintain the physic in such a manner that emergency they should able to react faster, at the same time they should be able to save themselves in the minimum time of exposure.

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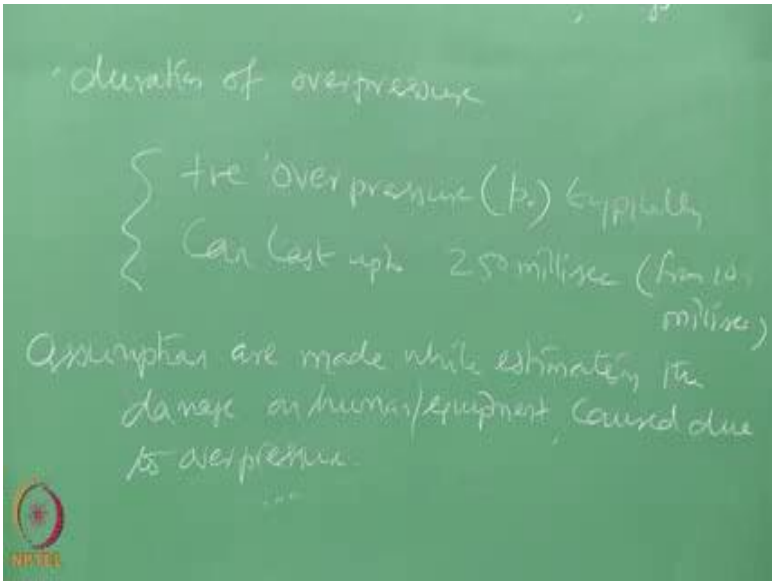

The common organs that are affected because of blast wave of human could be ear drum and lungs as we all agree and understand now duration of over pressure it is also an important factor, duration of over pressure is also an important factor look at the consequences caused by this on human organ. Interestingly, if we look at a typical data the positive over pressure which we say in the literature as p 0, we already seen this model of in the earlier lectures positive over pressure p 0, typically last typically can last up to 250 milliseconds from minimum duration of 10 milliseconds of course, this can have a remarkable effects on human body while making the estimate of effects of over pressure. Generally, people make you assumptions few assumptions are made while estimating the damage on human or equipment caused due to over pressure, let us see, what are these assumptions?

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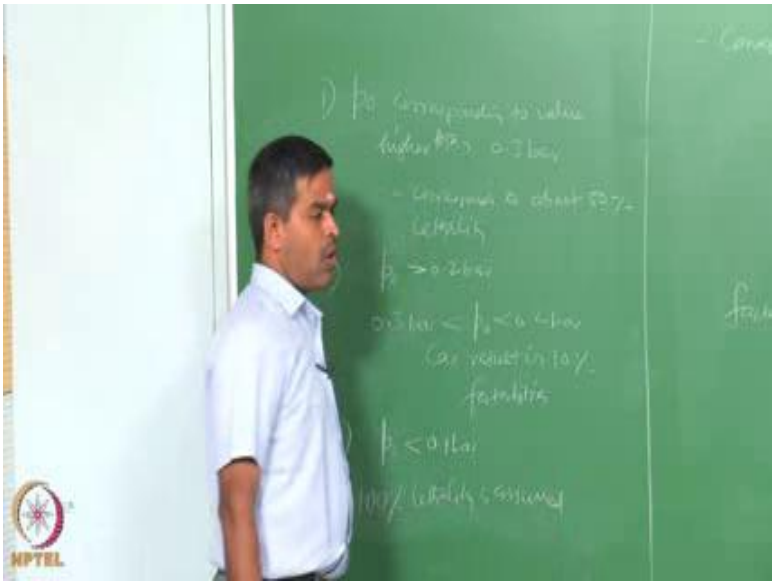

Firstly over pressure corresponding to value higher than 0.3 bar corresponds to about 50 percent, lethality the second assumption is p 0. Let us say above 0.2 bar, but within 0.3 bar that is 0.3 bar less than p not less than 0.2 bar can result in above 10 percent fatality p 0 less than 0.1 bar would not cause any effect on the public at all. Interestingly, 100 percent lethality is assumed for all people of for all present under this vapor cloud during explosions.

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So, please be attention to the damage description caused on human and equipment.

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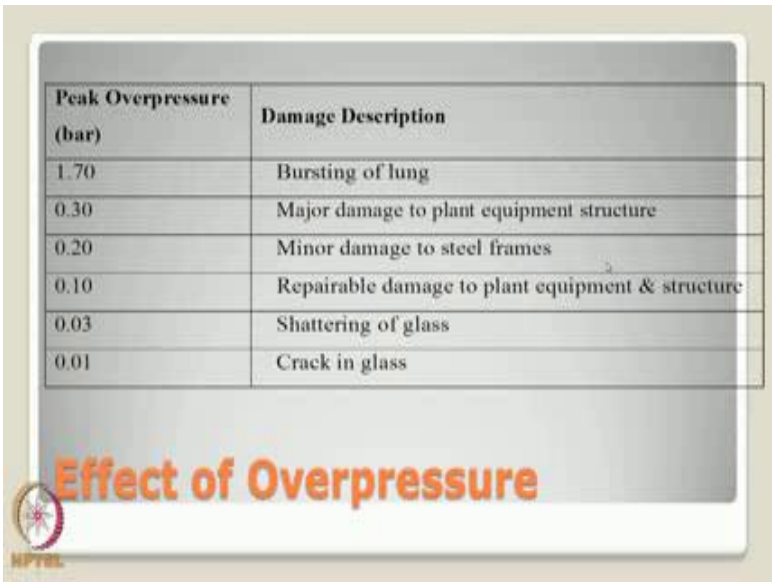

As a result of over pressure to the table explains the peak over pressure values in bar and the damage description, for example, the peak over pressure of 1.7 bar then result in bursting of lungs whereas, a very low value of 0.01 bar then only cause simple cracks in

a glass and so on so forth.

After understanding the damage effect on equipment and human being caused because of one of the important source of accident, which is fire and explosions which can occur an offshore drilling platforms and production, platform 1 is ultimately interested in landing up in what is called risk picture. We all know that risk is defined as a measure of potential economic laws or human injuries in terms of probability of loss or injury occurring to the public and of course, the minute of the loss or injury.

It will occur risk assessment depends on many factors which characterized quality of assessment the factors that make or that characterized risk assessment could be population at which the plant is located that could be one important data. Secondly, ignition probabilities it is necessary that we should know the density of population in a specific area to estimate the consequences and the risk resulting from an incident the expose population is often defined using what we call population density.

Population density is a therefore, important part of risk assessment for various reasons the most notable is that the density is typically used to determine the number of people effected by a given incident within a specific hazard area the population density is a very important parameter which effects the quality of risk assessment. Sometimes population data are also available in sketchy forms, for example, population density can be average over the whole area, which may be effected alternatively can divide the area in the sub groups and then a number of segments and find out density for each segment and for individual groups, the second area of interest which will control the character of risk assessment is ignition probability which actually depends upon the energy of the material released during explosion and during fire or during chemical exposure index.

So, interestingly one should also look into the material storage and handling systems because this will also have the relatively high probability of immediate ignition, if they have the source of ignition. So, one should also check whether the ignition possibilities is immediate or delayed because immediate ignition will have high probability of accident, whereas delayed ignition can also be determined as a function of cloud area or the location in general as the size of the cloud increases the probability of delayed ignition

decreases. Once we lead to assess risk, risk can be now done in two ways one is individual risk on a human being.

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So, one can have individual risk which can have an assessment of combining all possible consequences arising from the events from each failure case. In human impact criteria even frequencies for a particular event are determine the financial compounds of risk is also involved, which leads to high economic clause in case of major accident while risk can be classified as personal environmental asset risk. So, one can do risk classifications as personnel economic and asset risk impairment risk; however, immediately one is interested to know the personnel view what we called as a part of individual risk.

Asset risk of course, can also be subdivided into material damage risk and production delay risk. So, asset risk can be again having two groups; one is the material damage risk. What is the risk that material will get damage? And what is the risk that your production will be delayed? However, when you focus on personnel risk, one is interested to know the fatality risk because one can have two kinds of damages, one is the injury other is fatality; fatality risk is further classified into plat form fatality individual and societal risk.

So, friends in this lecture we discussed about the different factors that can add to the qualitative characterization of risk assessment, how risk management can be evaluated? What are the factors which we look into the risk picture? What are the different kinds of risk assessment which generally done in offshore industry? Or in risk on marine system fatality risk which is one of the worst kind, which one is interested to know can also again have subdivision plat farm fatality. This individual risk and societal risk will also see them in detail in detail in the next lecture.

I hope you have understood that how risk management can be handled successfully and it can be interesting provided your hazard assessment and hazard identification details are accurate and are able to create a large descriptive data base by conducting various types of service and reports which are discussed in the previous lectures.

Thank you very much.