Risk and Reliability of Offshore Structures
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Module - 03
Risk assessment and Reliability applications
Lecture -17
Risk Picture

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Friends, welcome to 17th lecture in module 3, where we will talk about risk picture. This is lectures on module 3 where we are focusing risk assessment and reliability application. In last lecture, set of lectures, we saw that risk assessment has strong economic perspective; it of course also involves a serious engineering judgment. It has got very clever and intelligent way of human intervention; and it is mathematical or scientific method of foreseeing risk on the given system.

Of course, when we talk about risk assessment one is interested to know what is the risk of human life in terms of individual and society. What would be the effect of any specific foreseen accident on set of personal or group of public who are involved around or who are habited around the plan. So, let us discuss slightly in detail what we call in general as

risk picture; to understand risk picture first we have to understand the identification of hazards in a given system and high hazards what we call will lead to failure scenario.

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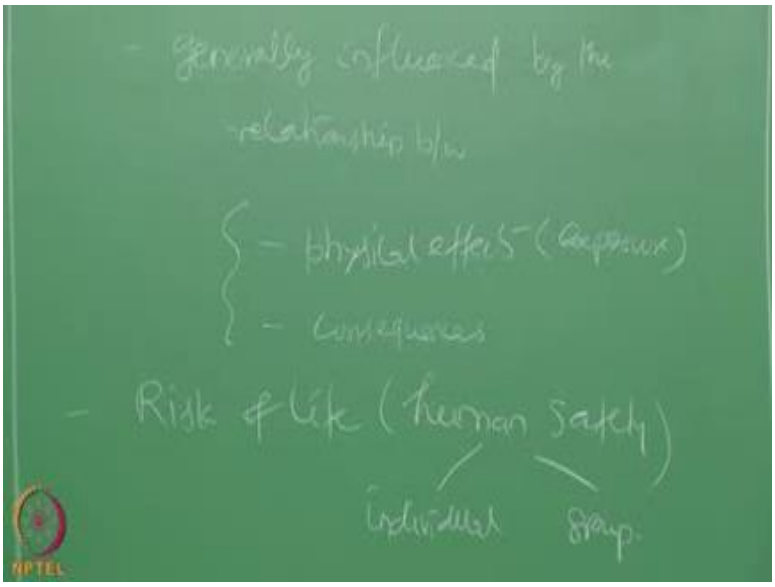

Let us talk about how to select the damage criteria. Suppose, if we have identified set of failure scenarios from the set of failure scenario identified, how we select damage criteria how do I know that this criteria is going to cause a serious damage or consequences in a given system. The damage criteria is generally influenced by the relationship between the extent of physical effect, what we can saw call as a exposure and the effect of the consequences. What is the relationship between these two parameters will govern what would be the dimes criteria which you got to choose for a given risk assessment model. Therefore, for assessing the effect of those damage criteria on human being, so one need to actually look at risk of life, what we call as human safety. It can be individual, it can group which will lead to societal risk.

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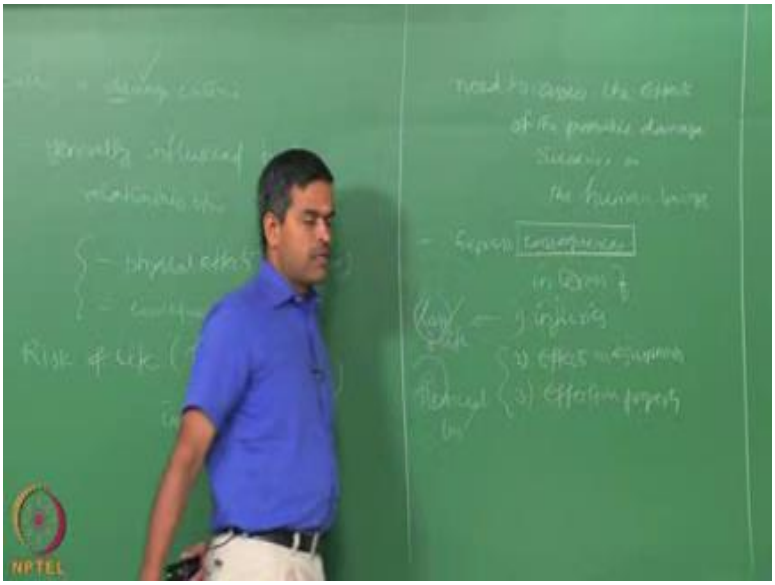

In both the case, we need to assess the effect of the perceived damage or let us say probable damage scenarios on the human beings. Therefore, it is always good to express consequences in terms of injuries, effect on equipment and plans, effects on property, which leads to these two leads to lets any financial loss. Of course, this will lead to loss of life. So, consequences in general are expressed only in terms of loss whether it is financial or loss of life. So, consequences are generally expressed in terms loss it can be human loss or a financial loss.

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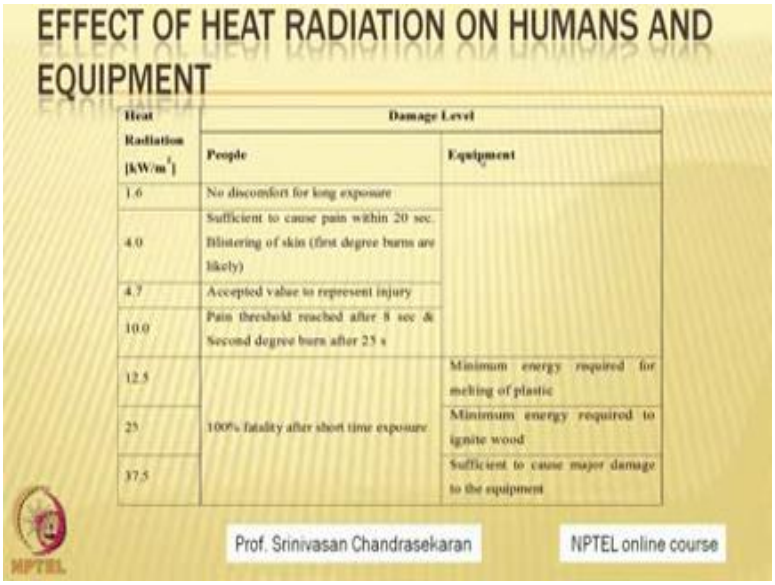

Kindly pay attention to the effect of different heat radiation on humans and equipment, which is given in the tabular form, pay attention to the table shown on the screen. Now, interestingly different level of heat radiation expressed in kilowatt per square meter varying from 1.6 to as highest 37.5, what would be the effect this heat radiation and causing a damage level to people or personal and equipment is what we are interested in because that is what we look at consequences in terms of effects of them on human as well equipment.

So if we look at the at the that radiation say 1.6 kilo watt per square meter say, it will cause no discomfort for a long exposure in personal of course it have no effect on equipment. Varying from 1.6 to 10.0, these heat radiations have no effect on mechanical equipment and tools and present in the plant. If the radiation goes above 10.0 and as close to 12.5 etcetera, there will be minimum energy require for melting of plastic which may result in melting of plastic components or composites present in the equipment so on so. However, if the radiation crosses 10.0, it ensures hundred percent fatalities even for the short time exposure.

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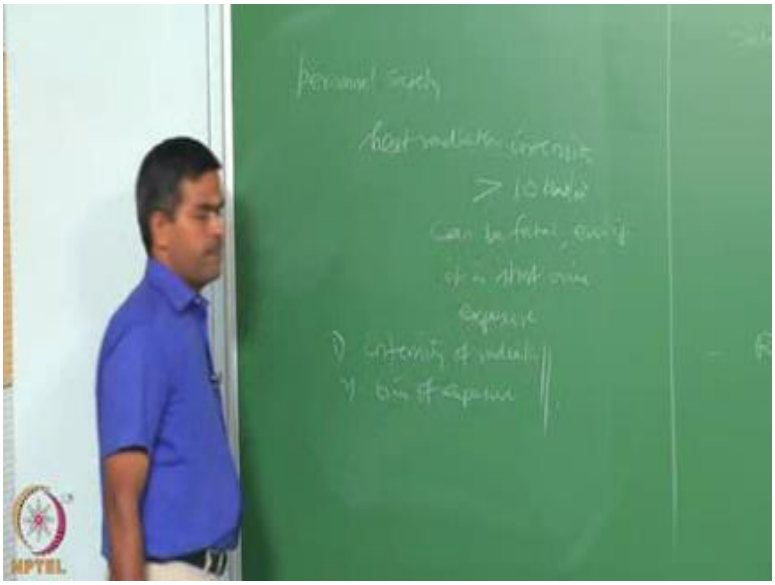

So, it is very important that if you are looking at the personal safety then heat radiation intensity exceeding let say 10 kilowatts per square meters can be fatal even if it is a short time exposure. So, friends, you can recollect that there are two issues here what is the intensity of the radiation and what is the time of the exposure, how long you were expose to that radiation. So, even for the short exposure, if the intensity exceeds 10 kilowatts per square meters 10 kilowatts per square meters this can result in fatal 100 percent fatal for person.

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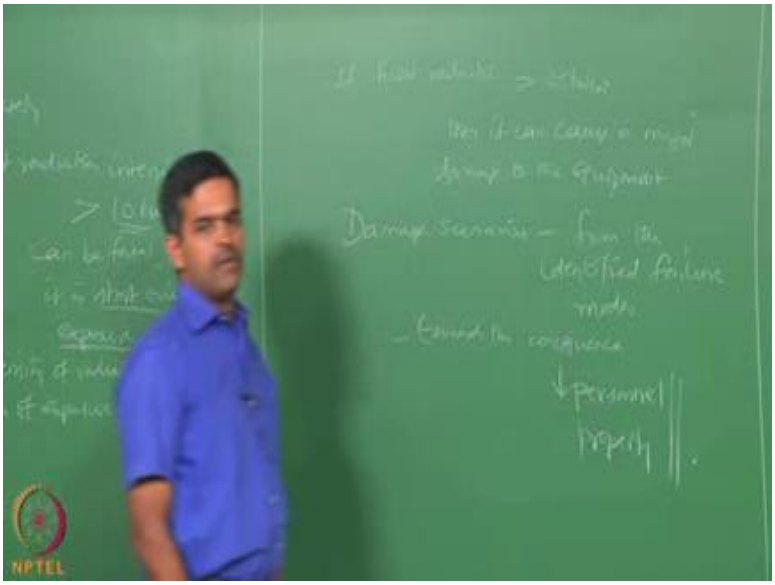

Whereas for equipments if the radiation close to 25 or 30, if the radiation if the heat radiation let say exceeds 25 kilowatts per square meters then it can cause a major damage to the equipment. So, selection of major scenario from the identified failure scenarios should be directed towards consequences in terms of personal and property. One can easily identify among the selected chosen failure modes what are those damage scenarios once the scenarios is been indicated here which is heat radiation. Similarly, there is another important parameter what we talk about time of exposure the table what I showed now earlier is talking about the effect of heat radiation in terms of intensity, because it talks about intensity in terms of damage to personal or damage to equipment.

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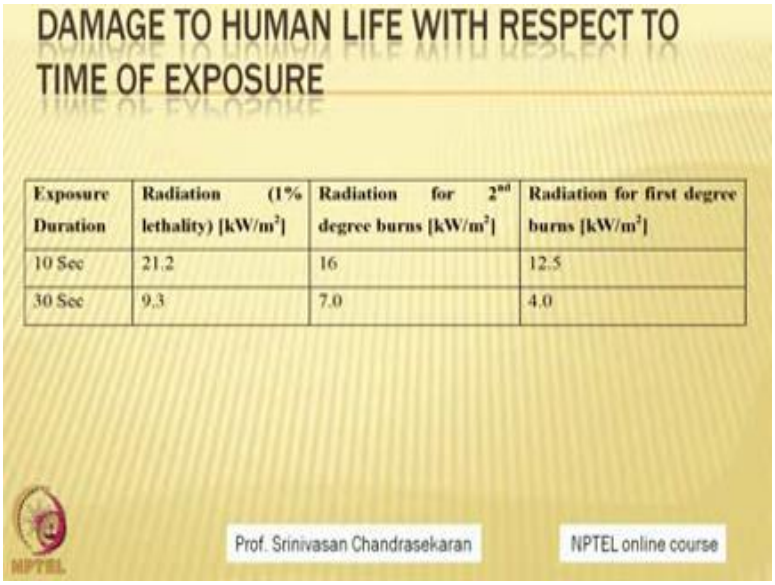

Now, please pay attention to the table shown on the screen now, this will talk about damage to human life with respect to time of exposure. So, if the exposure duration is closer to 10 seconds, and the radiation is about 1 percent lethality in terms of kilowatt per meter which is closer to around 21.2, even for 10 seconds this can cause 1 percent lethality. If the radiation is about 10 seconds, it can cause intensity around 16 kilowatt per square meters this can result in second-degree burns.

If the intensity is around 12.5 kilowatts per square meters and the duration is 10 seconds, which can result in first degree burns, if the duration is about 10 seconds. If you increase the duration from 10 to 30, you can see even that lower values of intensity of radiation can result in lethality or second degree or first degree burns as seen from the table respectively. So, time of exposure, intensity of radiation both factors have a direct effect in terms of consequences in terms of personal damage to people as well as property in terms of equipment and plants as one is interested in damage scenario.

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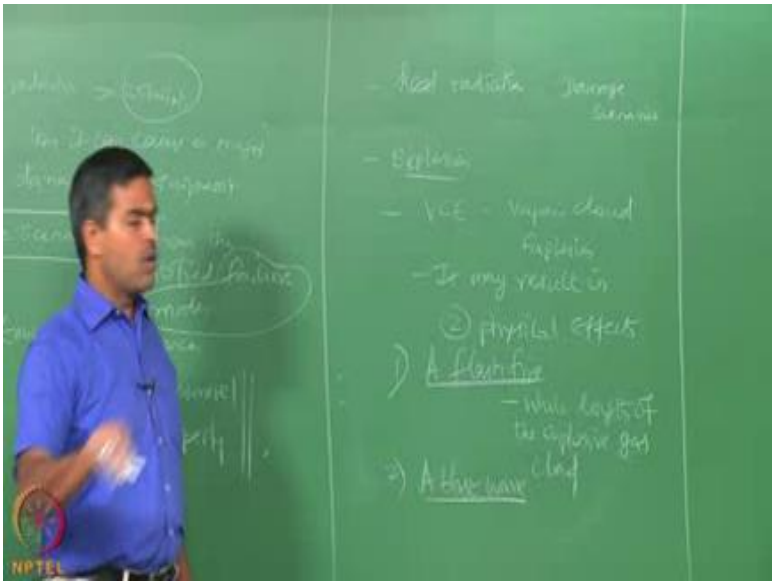

So, one damage scenario what we saw is the heat radiation is one of the damage scenario. The second what we saw now which will be the explosion which will discuss is another damage scenario in case of vapor cloud explosion because explosion can happen in many ways the famous or the common type of explosion which can happen in oil gas process industry is VCE where VCE stands for vapor cloud explosion. In case of vapor cloud explosion, two physical effects may occur; it may result in namely one your flash fire it may cause a flash fire over the whole length of explosive gas cloud this can result in over the whole length of the explosive gas cloud. A second effect could be a blast wave; and result in a blast wave with a typical peak over pressure circulating around the ignition source.

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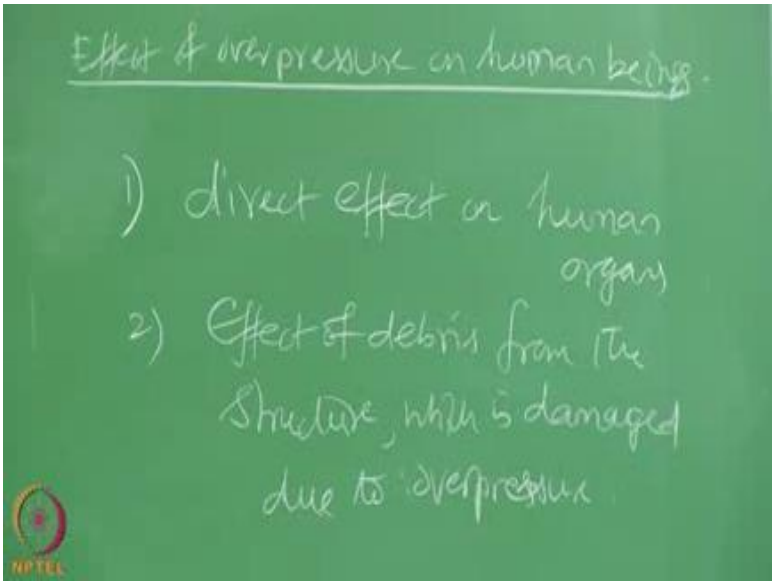

In case of the blast wave, the over pressure will circulate around the ignition source. Now, what would be the effect of the over pressure on human beings that what we are interested in because ultimately risk analysis should deal with the physical effect or consequences on personal or property. So, what could be the effect of over pressure on human beings? We have already seen the effect of radiation on human being in terms of intensity in terms of times short of exposure. So, effect of over pressure on human being is again having two parameters; the first one would be the direct effect on human organs it will have direct effect on human organs; a second physical effect could be effects of debris from the structure which is damage due to over pressure. Amongst these two physical effects cause by over pressure on human being the direct effect is more significant compared to the other one.

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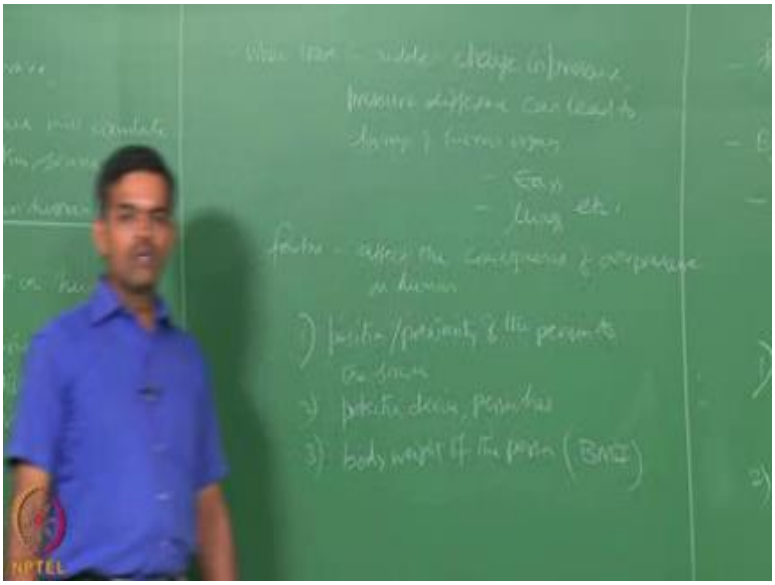

Therefore, whenever there is a sudden change in the pressure, the pressure difference can lead to damage some organs in particular ears, lungs etcetera. Of course, extent of damage caused on human being varies with over pressure along with other factors. So, what are those factors which contribute or affect the consequences of over pressure on human beings; one could be the position of the person or let us say position or proximity of the person to the source. Of course, the second could be protection inside a shelter. What is a protection device the person has may be a helmet or may be jacket or maybe. Thirdly, very interestingly, the body weight of the person; even to some extent the body mass index also plays a role in terms of the effect of damage caused by the over pressure on human beings, that is very interesting but that is the fact.

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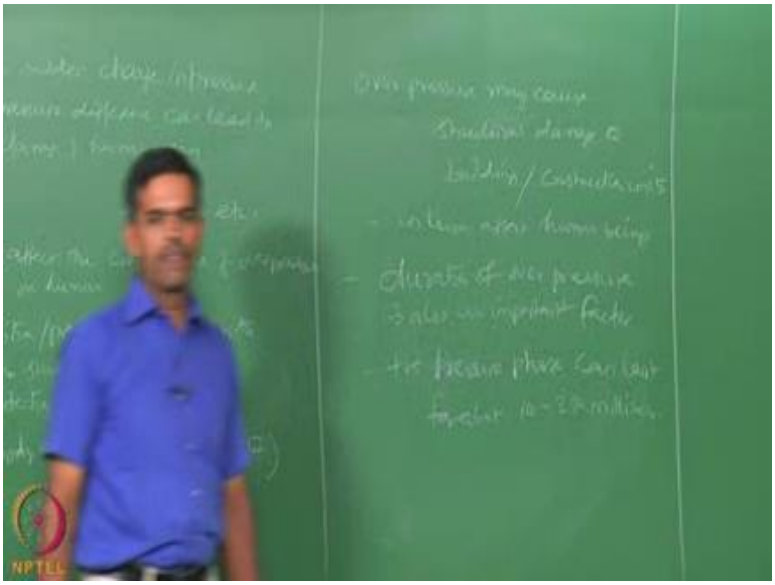

The second aspect which can cause the damage to the human being is the effect of debris because the over pressure may cause structural damage to buildings or construction units, because we have dwelling units, we have cranes we have derricks on the top the platform. So, over pressure can cause permanent damage to these kind of permanent infrastructure and they will in turn affect humans beings because the debris may fall on them they get hurt etcetera.

Now, interestingly another important factor is the duration of over pressure is also an important factor. So, positive pressure can last for about 10 to 250 milliseconds it has been seen in the literature that positive surface can last for about 10 to 250 milliseconds. Even the same over pressure has remarkable effect depending on duration of this application. While making the estimates of effects over pressure on human beings few assumptions are generally made.

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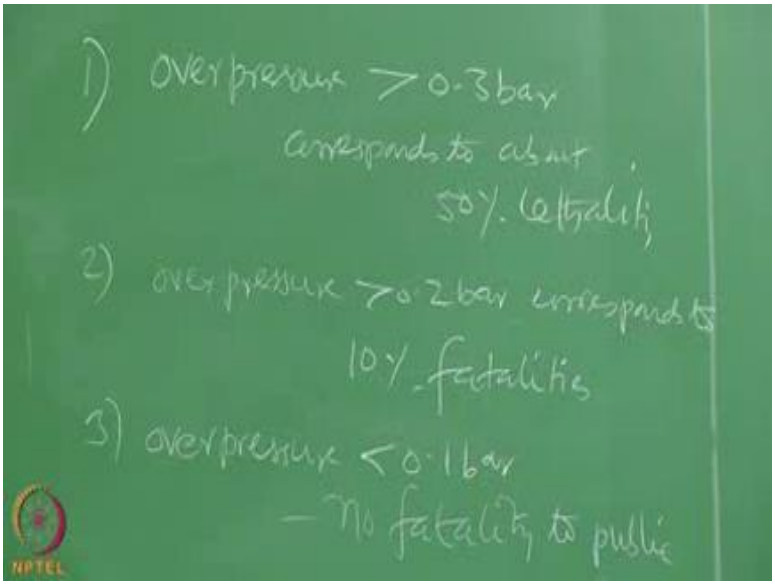

So, assumptions may while estimating the effects of over pressure on human. One could be over pressure more than 0.3 bar over pressure corresponds about 50 percent of the lethality that an assumption of course which has been verified also from the case study of accidents conducted in earlier platforms. Over pressure above, 0.2 bar result in or corresponds to 10 percent fatality; over pressure less than 0.1 bar would not cause any fatality.

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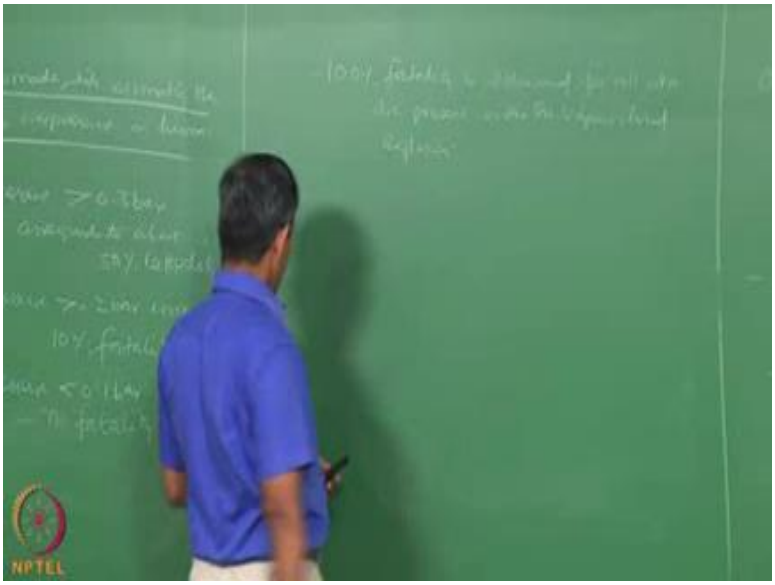

It is interesting that 100 fatalities are assumed in the analysis for all who are present within the vapor cloud. These are some assumption made when you estimate the effect of the over pressure on humans.

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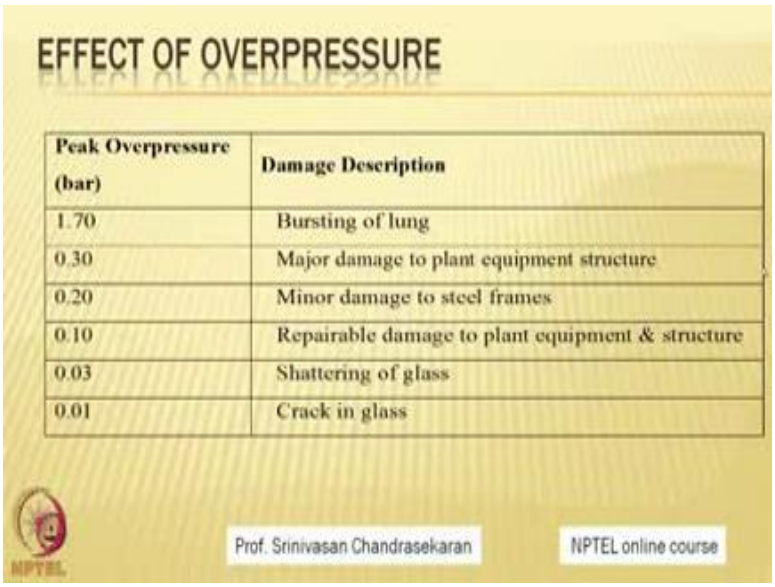

Please pay attention to table shown in the screen now. Talking about the peak over pressure and the damage description as we also saw in the case of the radiation effects. For a peak over pressure, in terms of bar if it is 1.7 it result in as high as bursting of lungs of human; if it very low to 0.01 bar, it may even crack a glasses or infrastructure. So, therefore, the peak over pressure variation from about 1 percent to let say about 1.70 bars can cause serious damage, but not only to human being, but also to plants and equipments as you can see from here.

And the damage assessed based on the consequences can be two; one is the direct effect on the human organ which we saw already; the second could be damage cause to human because of debris which formed by the way of damaging the structural components in a given system because of the over pressure.

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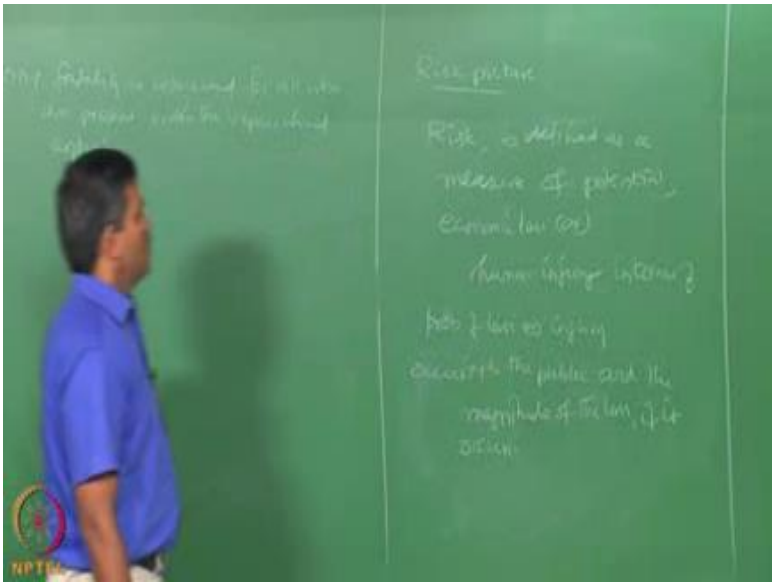

So, this discussion should lead to ultimately what we call as risk picture. So, let us see how these discussions of the type of damage scenario lead to what we call risk picture. Let us say risk is defined as a measure of potential or economic loss. So, how do you define risk in general you known this let us revisit this definition again? Risk is defined as the measure of potential, economic loss or human injury in terms of probability of loss or injury, how do we measure is probability of loss or injury that is how you measure this

engine occurring to the public and the magnitude of the loss if it occurs. One is what probability of occurrence is; others is if it occurs, what is the magnitude. It is measures always in terms of loss; it may be economic or fatal.

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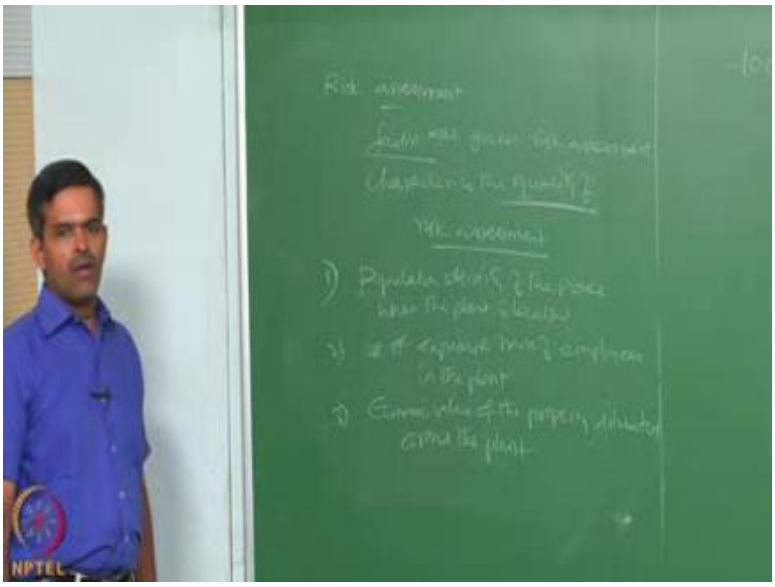

Therefore, depends on many factors so these factors that govern risk assessment; characterizes the quality of risk assessment that is very, very important. How accurate is the risk assessment depends on what are the factors you have considered for assessing the risk. So, what are the factors that make better risk assessment? One you must consider the population density of the place where the plant is located. You must consider number of exposure hours of the employee in the plant. You must consider also economic value of the property situated around the plant.

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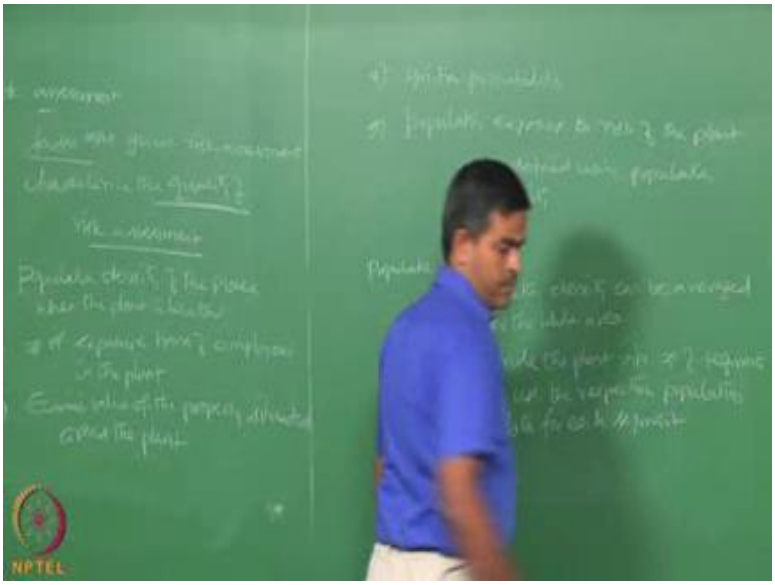

One must also consider ignition probabilities. It is also necessary to known population exposure, because it is necessary to estimate consequence and the risk resulting from incident. The exposed population is often defined using the population density is defined by using the population density. Population densities are an important part of risk assessment because of various reasons. The most notable is that the density is typically used to determine number of people affected by a given accident in specific hazard area. Sometimes population data are available in sketchy forms also. So, populations data is available in different formats. Population density can be average over the whole area; two - the area can be subdivided into number of segments and you can use separate population data for each segment; divide the plant into number of segments and use the respective population data for each segment.

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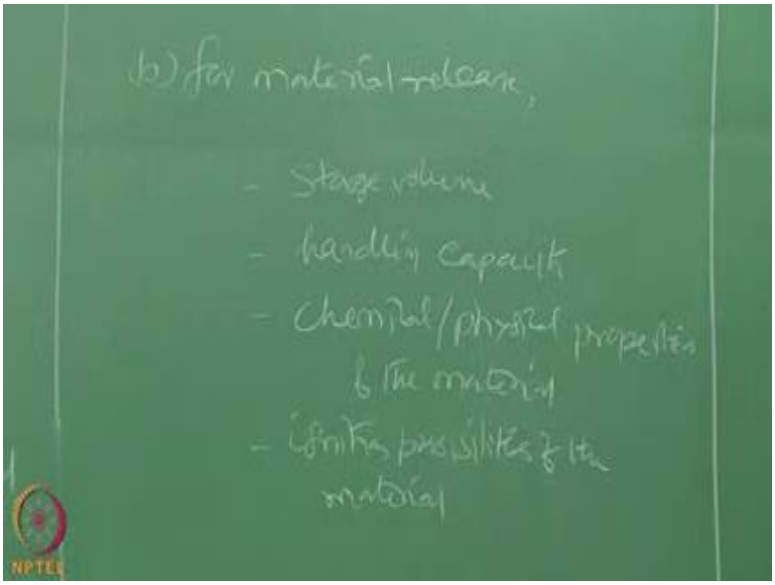

Interestingly for material release, so we need to have a data about material inventory as well. One should know the storage volume, handling capacity, chemical and physical properties of the material, ignition probability or possibility of a material x and y. So a is about the population; b is about the material. Based on these some can calculate risk or societal risk.

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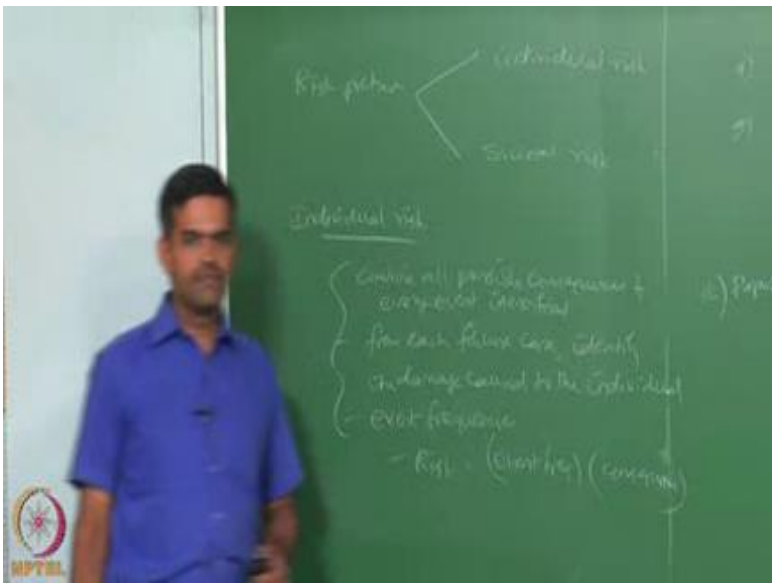

Now the risk picture is essentially divided into two segments; one is individual risk as a risk; societal risk. If I talk about individual risk, risk assessment is carried out by combining the consequences of every possible event, so the steps could be combined all possible consequences of every event identified. From each failure case, failure case or damage scenario, identify the damage cost to the individual; also obtain the event frequencies, how frequently such failures can happen to obtain essentially the individual risk because it is risk actually the product of event frequency and the consequence.

So, risk picture is essentially an interesting data by which it should converges to quantifying the risk on individual as well as societal. So, obtain this picture one need to actually have many data as an input supply to the system; one could be important is that population data, other could be material release or the source of the material. So we already said risk ultimately should convert to type of loss, it can be property loss or damage to the property or may be loss or damage to life etcetera, so risk should be quantifying not only the economic terms but also loss in terms of loss of human life what we then count as individual or societal risk.

So, friends, in this lecture, we learnt how to actually identify different parameters which can contribute what are the importance of these parameter, what would be the consequence of the parameters chosen to identify the risk picture in this lecture. We will continue the next lecture to identify what would be the societal risk and elaborate on the risk picture in detail, with which we will close this complete course with the last lecture in the next class.

Thank you very much.