Risk and Reliability of Offshore Structures
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Module – 03
Risk assessment and Reliability application
Lecture – 16
Risk and hazard assessment

Friends, welcome to the 16th lecture in module 3.

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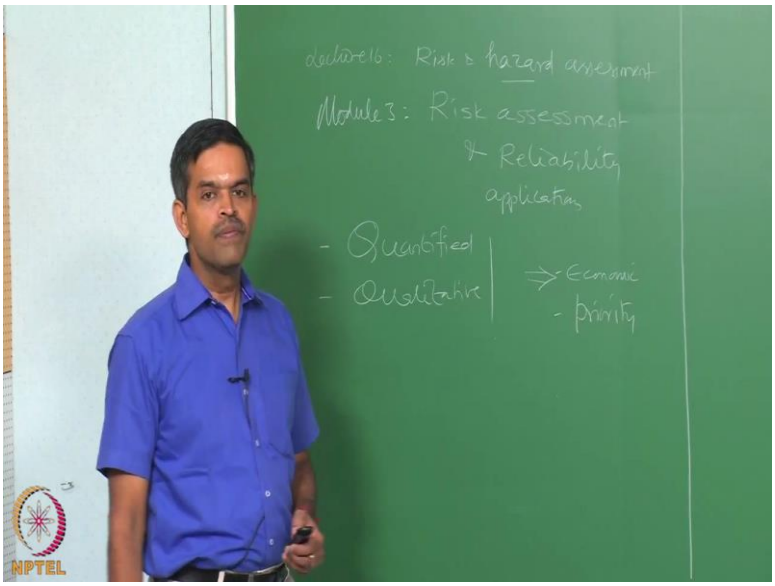

We will focus on risk and hazard assessment as a summary, this is actually the sixteenth lecture in module 3 where we are focusing on risk assessment and reliability application. We already said that risk assessment can be done in two ways; one is quantified manner another is in a qualitative manner. In both ways, risk should ultimately lead to an economic perspective; you should also interestingly tell me their priority of risk elements involved in the given system. On the whole, risk assessment actually is an extension of hazard because hazard is a scenario present in a given situation whereas, risk is realisation of a hazard.

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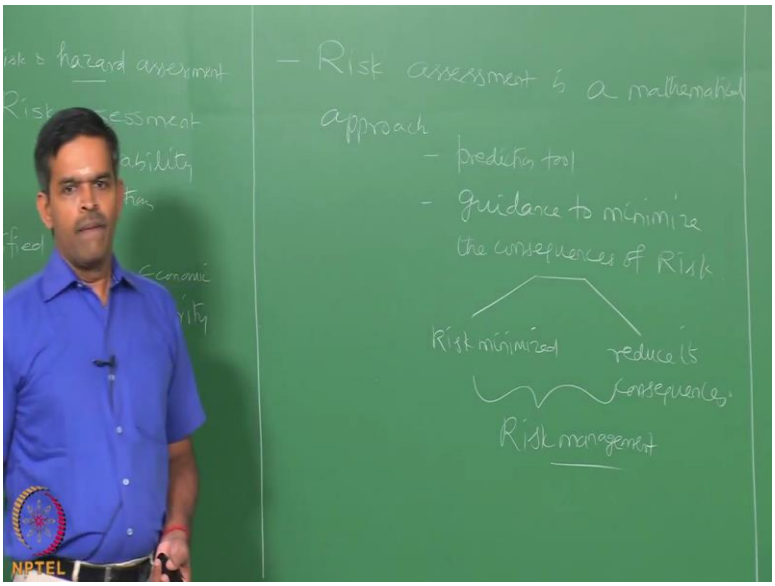

So, risk assessment is a mathematical approach which we saw which is generally practised by an engineers to predict the risk of accidents. So, risk assessment actually is one of the prediction tool it gives guidance on appropriate means of minimising the. So, this can also considered as guidance to minimize the consequences of risk. There are two ways my dear friends; one risk by itself can be minimised if you have a system where the risk presence is inevitable, unavoidable, and unintentional as in the case of so structure pride reduces the consequences. So, anyway both are risk management.

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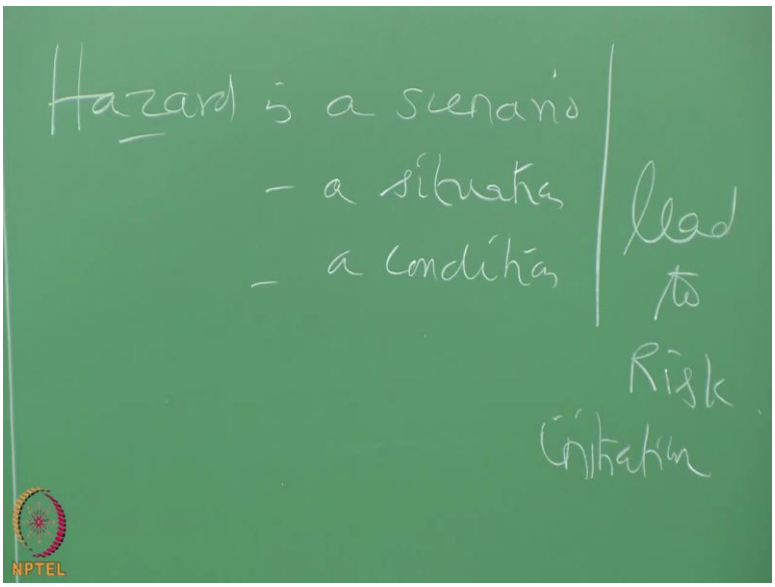

Risk assessment also uses scientific methods, logical techniques, logical tree, etcetera based on verifiable data. Whereas, hazard is actually a scenario is a situation is a condition which may lead torisk initiation. So, risk management hazard assessments are hazard identification, hazard evaluation, hazard management and control will all be steps

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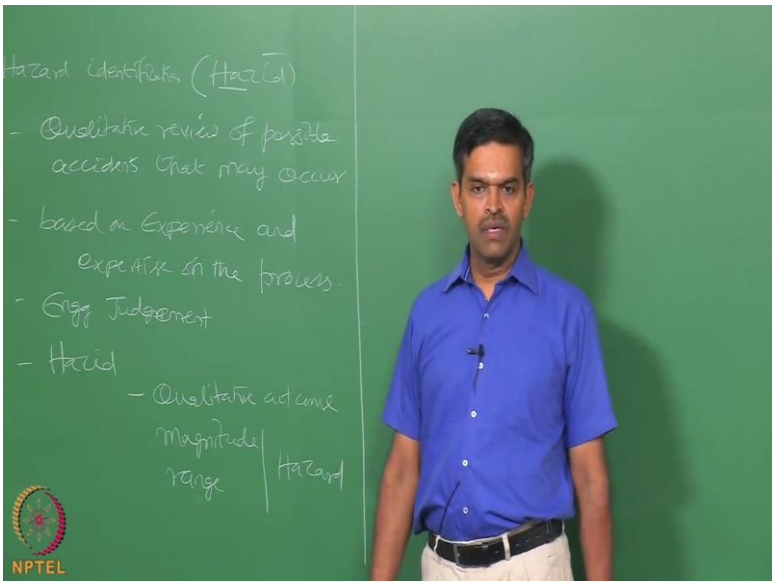

So, amongst all the foremost thing can be hazard identification. This kind of study is especially called as hazid hazard identification. Hazid studies it actually consists of qualitative review of possible accidents to occur that may occur. It is actually based on experience; it used engineering judgement wherever applicable there are several formats by which one can perform hazard or hazard identification. They are useful to give a qualitative appreciation of range and magnitude of hazards. So, hazid statement produces a qualitative outcome about the magnitude of the hazard and the range in a given system.

Once the system is qualitatively reviewed and one is able to identify the hazards present to the given system in terms of the range of the hazard as well as its magnitude.

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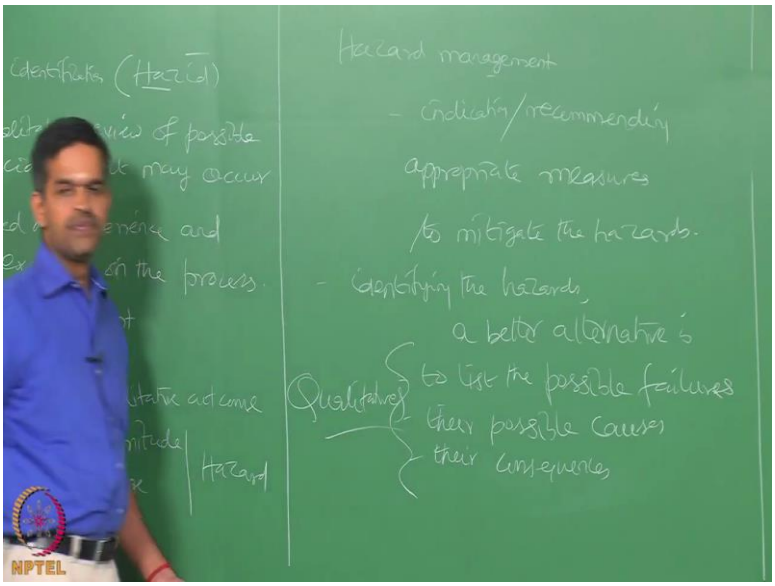

Then the next step come hazard management who has, now we need to manage these hazards management actually deals with indicating or recommending appropriate measures to mitigate the hazards. Therefore, hazard identification forms a very important step in hazard management, but the basic difficulty is the more precise purpose of selecting a list of possible failure cases or necessary for qualitative modelling. So, instead of identifying the hazard a better alternative could be to list the possible failures and their possible causes and their consequences may be all of them qualitative.

Interestingly, once the hazards are identified to manage the hazards one need to do one more study in addition to this parallel. Let us see what is that we already studied in risk assessment that consequents analysis is a very important step because it gives micro windows appreciation about the series of consequences that can arise from different modes of failure in a given system parallel to that to manage hazards in an effective manner, one also does what is called frequency analysis.

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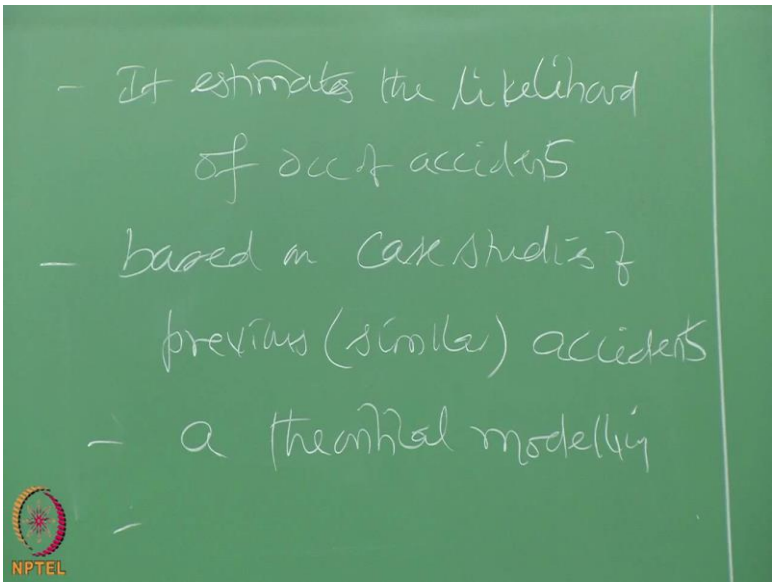

Frequency analysis actually estimates how likely the accidents occur. It estimates as a likelihood of occurrence of accidents it is usefully obtained from the analysis of previous accident experience. So, it is actually based on case studies of previous, let us say similar accidents. So, it is more or less your theoretical modelling consequence analysis is then followed parallel which we already saw in detail, but still form completion sake, let us write that.

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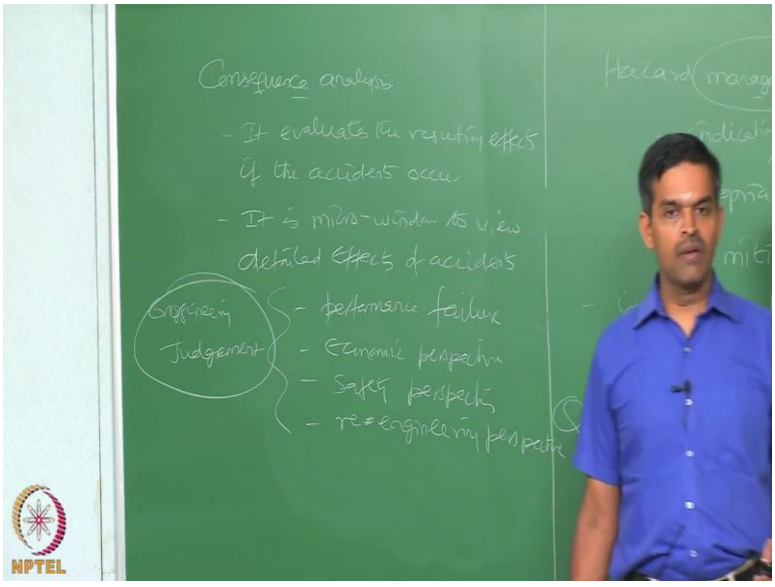

Consequence analysis is also an equally important step. It evaluates the resulting effects if the accidents occur it is a micro window. To view detailed effects of accidents in performance failure of the system in economic prospective, in safety prospective, in engineering prospective because it may sometimes lead to re design a component or an element or an process line or may be essentially based on engineering judgement . So, estimate of consequences of each possible event often requires some form of computer modelling, but may be essentially based on accident case study experiences or engineering judgements as far as their application is concerned in terms of understanding them for the consequences in the real problem.

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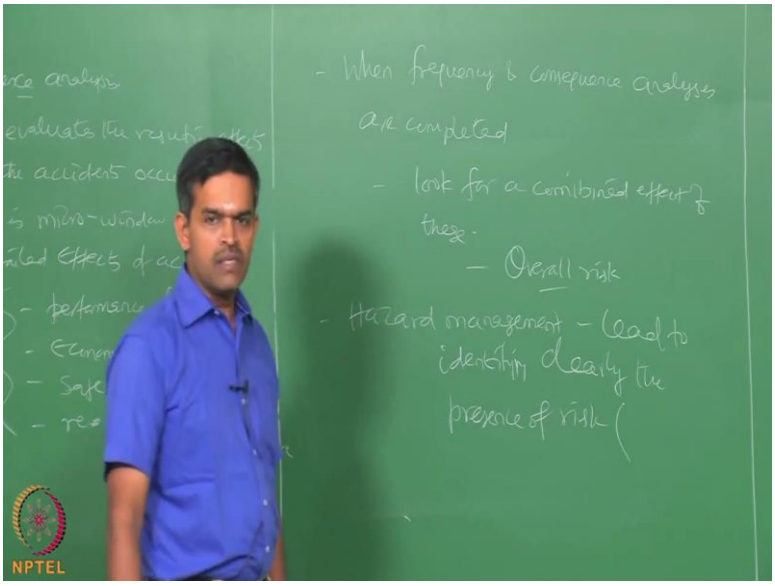

Now, when frequency analysis and consequence analysis are complete or completed, then one can look for combined effect of these which we call as overall risk now various forms of risk presentation may be used in analytical modelling to access risk in a given system risk to live is generally looked at most important consideration. Therefore, hazard management should lead to identifying clearly the presence of risk or to be very precise avoidance of this.

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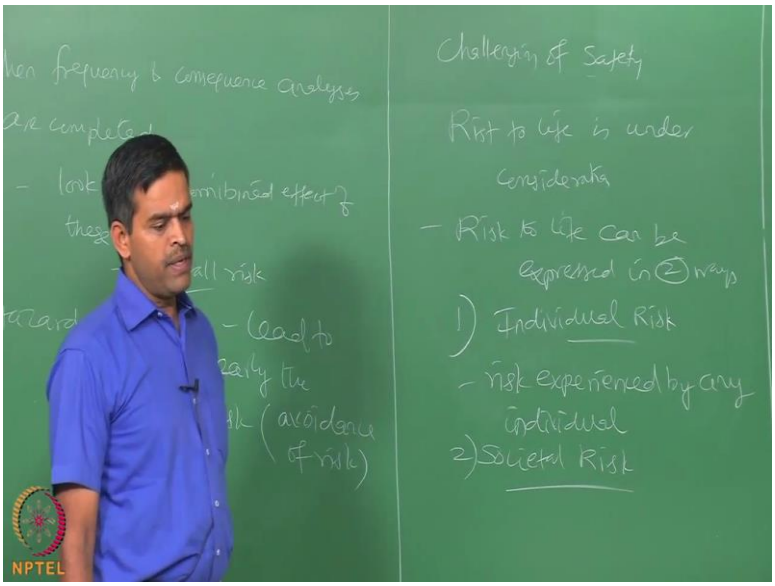

The moment I say the risk is present it may essentially come from challenging of safety. The moment I say challenging of safety then risk to life is under consideration apart from risk to the economic prospective of plans machineries, etcetera. The moment we talk about risk to life then it can be expressed in two complimentary ways. Risk to life can be expressed in two ways; one is what is called individual risk, it is risk experienced by any individual person working in the plant. The other alternative way issocietal risk this is the risk experienced by whole group of people exposed to the hazard.

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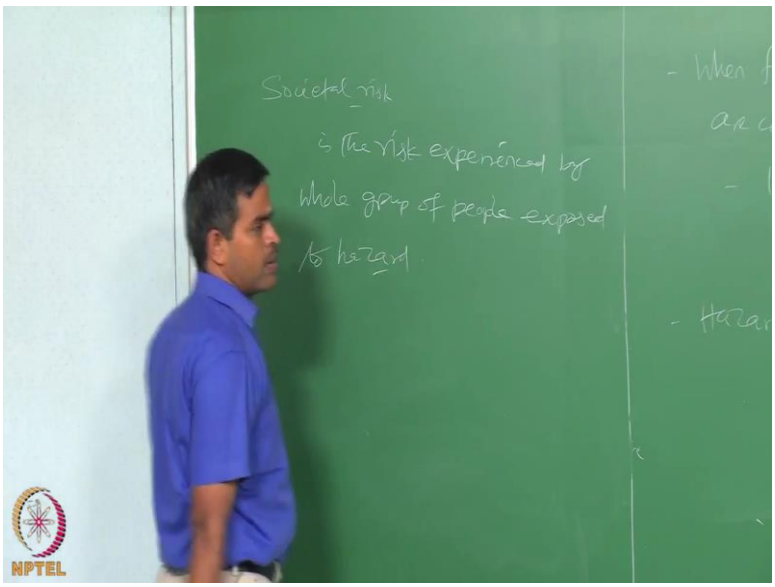

There are two forms by which risk can be expressed now; one is on individual prospective other is on societal prospective. So, friends let us now look at the interesting flow chart of QRA. Please pay attention to the flow chart shown on the screen now.

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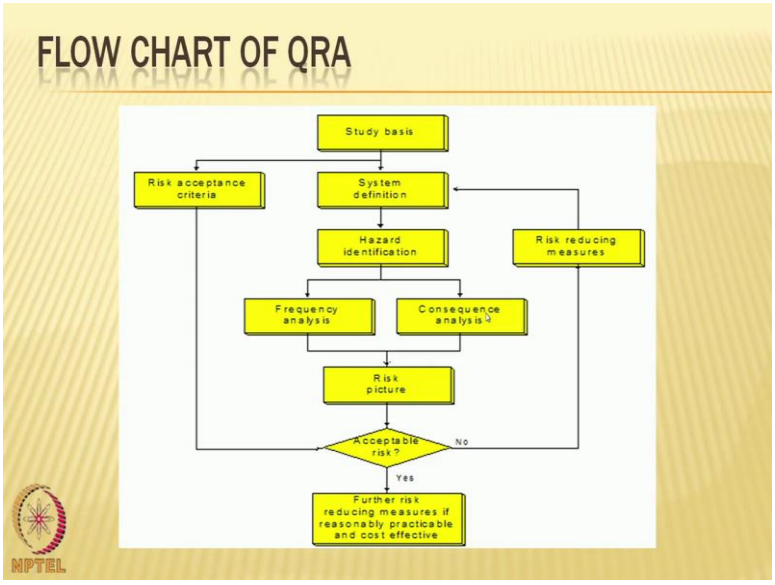

Let us decide, what is the study basis we are looking at? For any study basis for a system we have to identify, define the system first. Before defining the system, please understand an important step, one should always define the risk acceptance criteria. So, risk acceptance criteria do not depend on the system definition at all, it is a prior to the study basis. So, depending upon the study basis one first decides what is the acceptance criteria of risk. So, parallelly you identify the system for a given system conduct, hazid studies that are hazard identification and identify the studies in parallel do also frequency analysis and consequence analysis. As just now we discussed combine together, we will get what is called as the risk picture.

Once we get the risk picture, let us try to see whether there is obtained from a given system is acceptable because you will compare this with acceptable level, what is been predefined even much before the start of the problem. If the risk is acceptable then you proceed and do for further risk reducing measures. If they are practical as we saw in our last lecture, if the receptacle is not within the threshold value of the acceptable criteria then up employee risk reducing measures go back to the new system definition and

proceed the same chart back again. So, it is very important in a given system the QRA focus essentially on risk reduction or limiting risk within tolerable reasonable limits.

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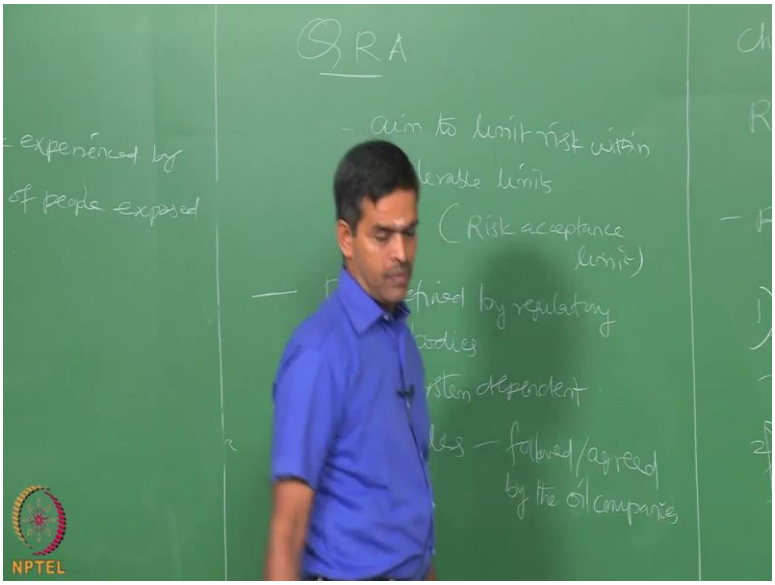

So, any qualitative or quantitative risk assessment tools should aim to limit risk within the tolerable limits, to be very precise within risk acceptance limits. Please understand risk acceptance limits are predefined by regulatory bodies, they are not system dependent. They are governed by environmental protection authority rules which should be followed and agreed upon by oil companies.

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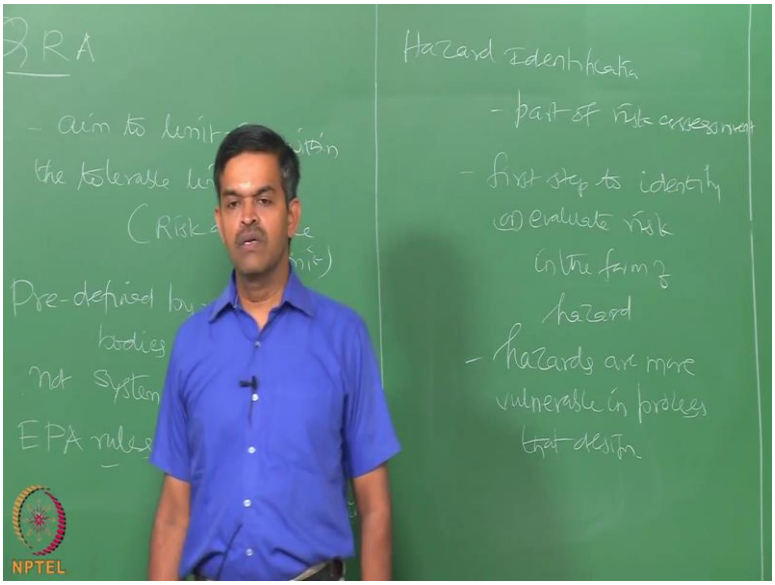

So, if we look more in detail about the hazard identification, interestingly friends' hazard identification becomes also a part of risk assessment because ultimately hazard identified will be analysed for frequency and consequences of those hazards and which will lead to a combined picture of risk. Therefore, hazard identification is a formal part of risk assessment, basically it is a first step to identify or evaluate risk in the form of hazard. It is important to identify the hazards that are inherent in the process. So, hazards are more vulnerable in process than design.

In fact, in production than design because hazards are scenarios which can become vulnerable when the operational temperature and pressure, and the operational conditions keep on varying which can challenge the safety of a given person in a given situation. Therefore, evaluation of hazards is closely related to the process conditions or the production conditions prevailing in the plant all through. So, based on detail investigation and hazard identification, event list is generated.

We already know what are the different kinds of events initiating, triggering event, etcetera. They are generated which considers various potential sources of accidents, for example, it can be leaks, cracks, structural failure, realise of chemicals, large inventory, electrical short circuiting, I mean you can have a long list of examples, where you can generate an event list based on the hazards identified in the given plant when the plant is in the production of process line.

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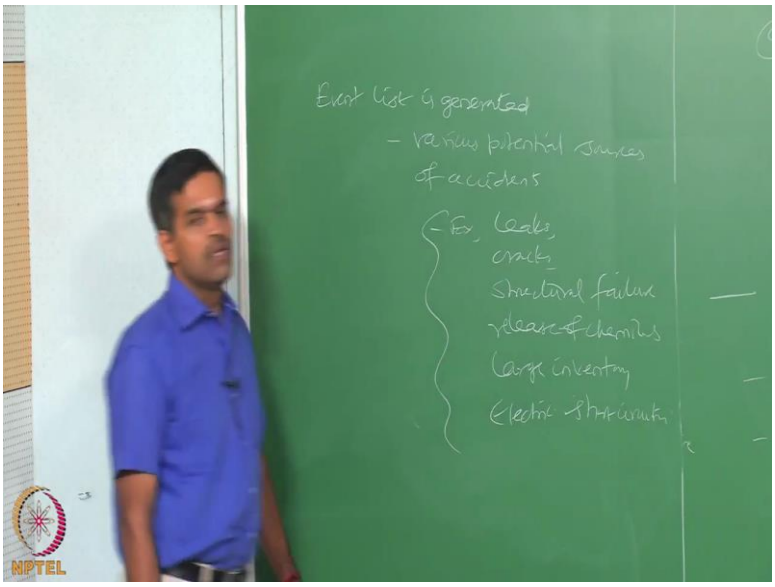

The compile list can include the pipeline works, the vessels and direct communication with the process because they share lot of signified inventory details which cannot be isolated in the event of emergency that is very important. Now, following data may be necessary to envisage various failure scenarios.

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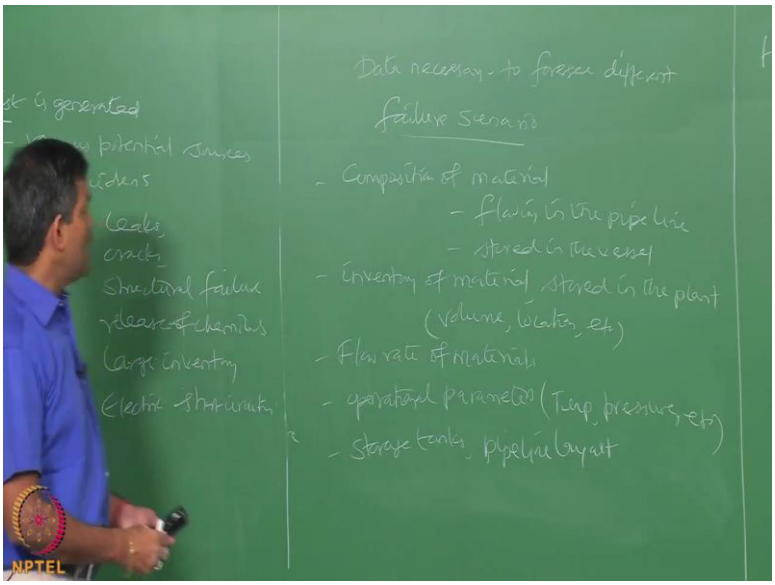

Let us say, I want to know what are the data necessary to foresee different failure scenario? One can say composition of material which is essentially flowing in the pipeline may be stored in the vessel, etcetera. Also inventory of material which is stored in the plant inventory in the terms of its volume, location, etcetera. Then flow rate of material passing through the pipelines then operational parameters like temperature, pressure, etcetera. Then also storage tanks, pipelines layout, etcetera all should be studied in detail. So, that failure scenario can be identified and detailed event list can be prepared for the logical risk analysis.

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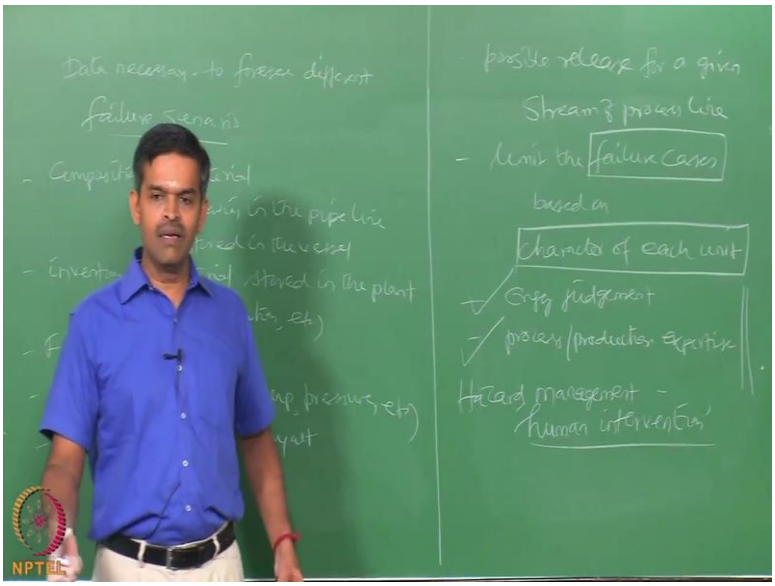

In addition to this, one should also look at possible release scenarios for a given stream of process it can start from a pin hole leak up to a catastrophic failure rupture of the vessel or a full boar rupture of a given pipeline. Interestingly, identifying these kind of lists qualitatively and quantifying them and then doing a frequency and consequence analysis is highly time consuming. Therefore, what generally one does is limit the failure cases based on character of each unit. So, this comes from more or less engineering judgement and process or product or production expertise

So, based on this you do not have to prepare an exhaustive list of all possible failure scenarios, only pick and choose those failure cases which are seriously limited to that kind of character of the plant or a segment of the plant, which you already know based on your experience and production judgement or your engineering judgement. So, use this as the tool. So, that in hazard management which is the primary step in risk assessment human intervention plays a very important role in terms of modifying or mitigating or actuating the risk presents in a given plant.

So, it becomes very important friends that individual person need to be trained, need to be educated about all the history of accidents and risk assessments in detail. So, that he gains knowledge, he gains experience in the given production system, both in design and process layout. Therefore, at any given point of time he should be equipped to identify

the list of events which are very serious enough to cause potential loss or become potential sources of various accidents which can result from different failure scenarios.

So, on the whole you know to really do a risk assessment effectively, one need to have an excellent capacity building, one should understand basically their design and character of each unit in a given plant, and each should have a good experience in process and production line present in the particular plant. You should also be a successful and good designer who also understands the consequence of a wrong design or choose of wrong material or choice of a wrong specification etcetera and their consequences on the overall performance of the system which we call as essential reliability.

Therefore, it is important that risk assessment are hazard management in general in a broader braise looks up on a very strong dependency to capacity building of individual personal because human intervention is a very important logical algorithm present inherently in hazard management. If I talk about selection and failure scenarios, it is very important that one should generate the list of events, one should also look at selecting the initiating events.

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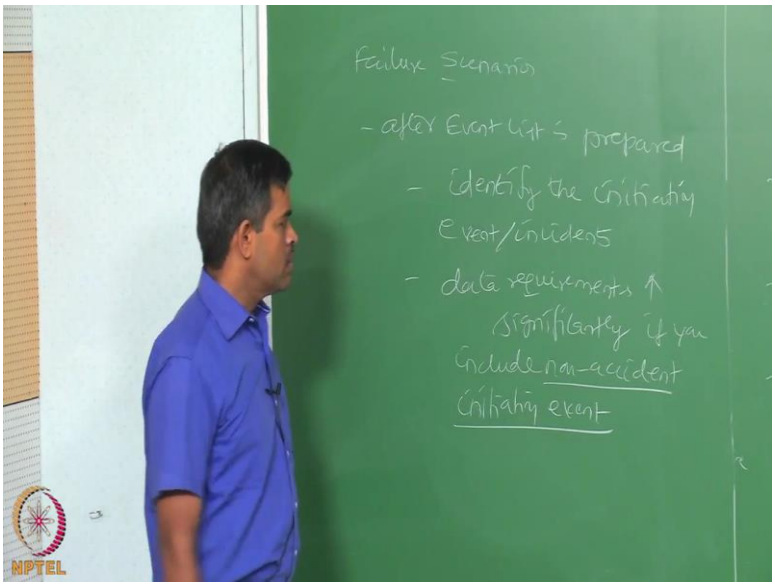

So, in listing the failure scenarios after, let us say event list is prepared one should be able to identify the initiating event or incidents. The data requirement to identify this, the data requirements to identify the initiating events increases significantly with the

inclusion of non accident initiating events, if you include non accident initiating event. So, it is important that one must isolate from the event list what are the possible events which can trigger accidents? What are the possible events which will not trigger? What we call non accident initiating events because if we include all of the data requirement to characterize the initiating event becomes highly complicated, while the potential range of release of size is tremendous grouping are possible and one of the best solution.

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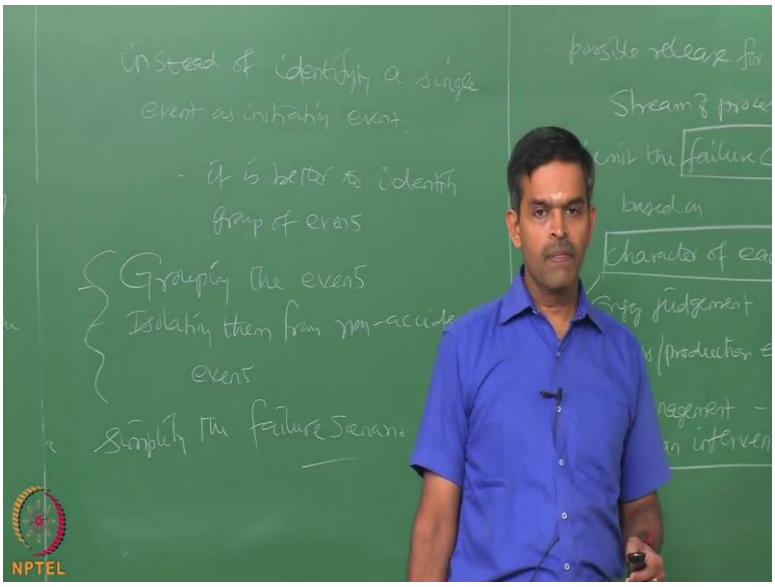

Therefore instead of identifying a single event as initiating event it is better to identify group of events. So, the technique is grouping the events, isolating them from non accident events, will actually simplify the failure scenario because failure scenario identification is one of the important step in hazard management.

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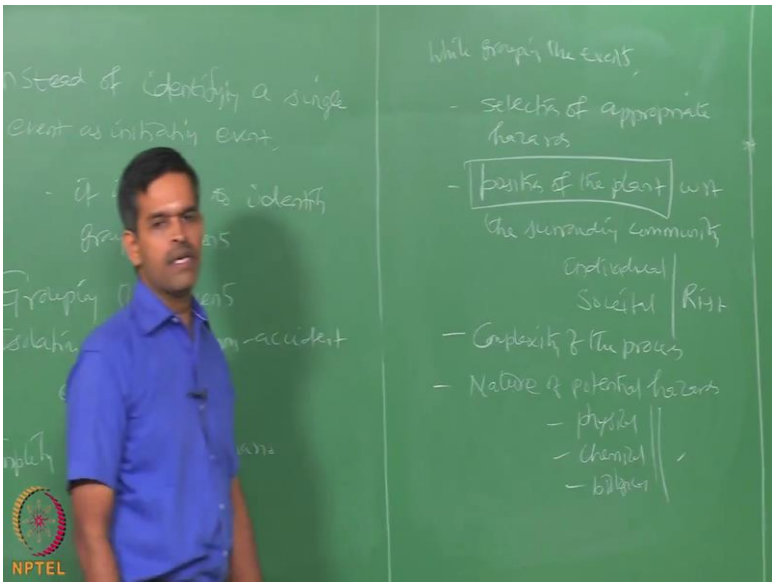

In further detail, while grouping the events for identifying the failure scenario it is important that selection of appropriate hazards need to be considered, position of the plant in relationship to the surrounding community with respect to the surrounding community is important because we are looking for both the individual risk and societal risk. So, where is the position of the plant geographically and what is the density of population around the plant is very important.

One should also consider the complexity of the process while grouping the events. One should also consider the nature of potential hazards, are they going to cause physical hazards? Are they going to cause chemical hazards? Are they going to cause biological hazards? So, one should look at the nature of the potential hazard then one has got to group the events which can form initiating triggering preceding non successful non accidental events in a given system.

So, friends we have an idea that failure scenario or preparing a list of events which can be included in a failure scenario becomes actually very complicated because order of failure scenario or the number of failure scenario given in a system becomes very enlarge.

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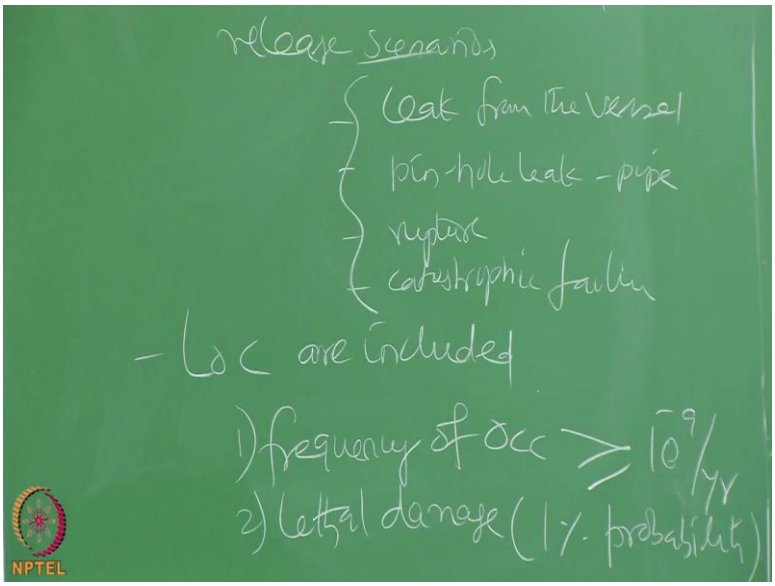

Therefore one can limit this failure scenario, one can limit the failure scenario by a very intelligent tool what we call LOC; loss of containment basically release scenario in sense it can be leak from the vessel, it can be a pin hole leak of a pipeline, it can be ruptured, it can be catastrophic failure of the vessel. So, there can be many release scenarios.

So, losses of containment events are essentially the release scenarios contributing to the individual or societal risk directly. So, LOC's are included when you are talking about two types of failures; one if the frequency of occurrence of that scenario or the failure is greater than or equal to 10 power minus 9 per year or the lethal damage which can be caused by the scenario will be equal to one person probability.

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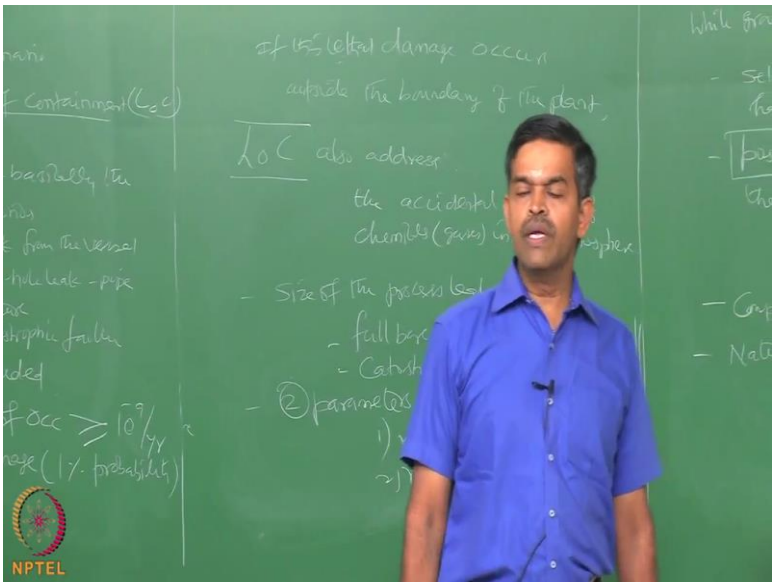

If this lethal damage occurs outside the boundary of the plant, then the issue is more serious than under these situations the loss of containment events should be included definitely in the failure scenario. Failure cases in the facilities are defined in terms of loss of contaminants scenarios to be more precise. They actually address the accidental release of flammable fluids into the atmosphere. So, loss of containment also addresses the accidental release of chemicals or gases into atmosphere. So, loss of containment events are may be the primary and vital events in the given risk assessment and tool.

What are those events which can include the loss of containment in terms of released scenarios, it can besize of the process leak whether it is a full bore rupture, whether it is a catastrophic rupture of the failure of the vessel, etcetera, for each failure case one should look at the release rate and release duration two parameters are important one, what is the release rate and what is the release duration based on this two? One can do a mathematical modelling of the dispersion releases.

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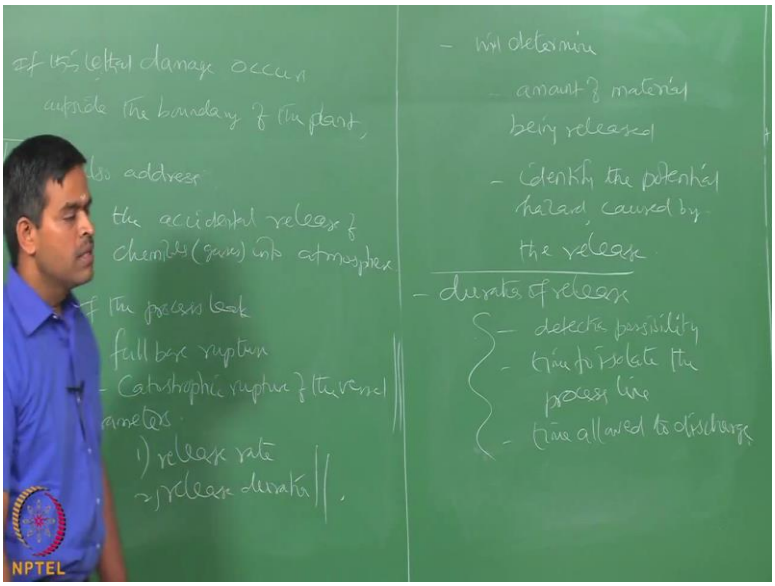

We will determine these two parameters, will determine the amount of material being discharged or released in atmosphere, the amount of material being released and this will lead to identifying. This will help us to identify the potential hazard cost by the release. Now, duration of release is dependent on the time to detect the released fluids because you really do not know will we able to detect the release instantaneously the moment release occurs that is the best way to do hazard management or risk mitigation, but there may be delay cost in identifying the release and it can always happen after release occurs.

So, the duration of release is what very different parameters which are inherently or implicitly affecting these ones. This parameter could be their detection possibility it means how delay you inspected and detected it. Then how much time you take to isolate the process line because you know one of the process segment of the line is leaking you would not isolate the line you want to shut down the specific branch of the line. So, how much time you will take to isolate the process line and how much time you will allow the discharge because these three parameters will govern the duration of the release, which becomes a very important parameter in all LOC events.

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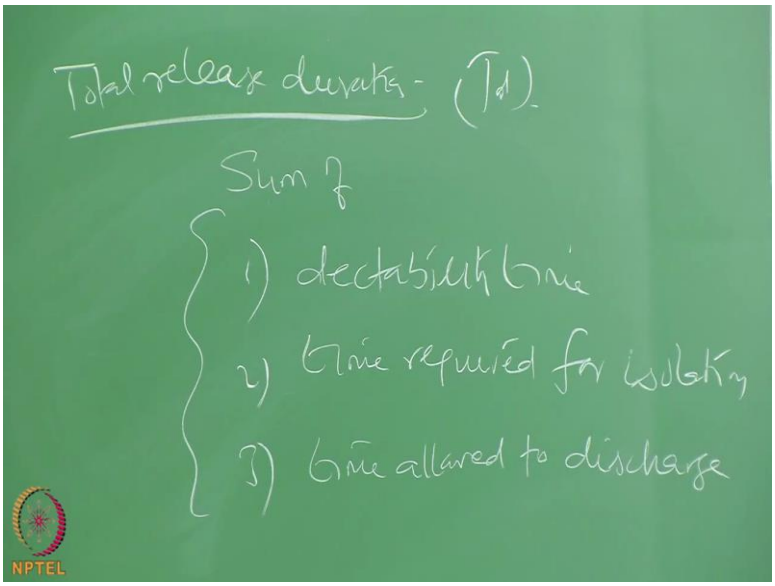

Therefore, the total released duration can be a sum of these three; the total release duration can be the sum of the dectability time, time for isolation and time allowed to discharge. So, it can be the sum of these three, which will give me TD, which is duration time. Now, if you look at the time dectability it depends upon couple of factors.

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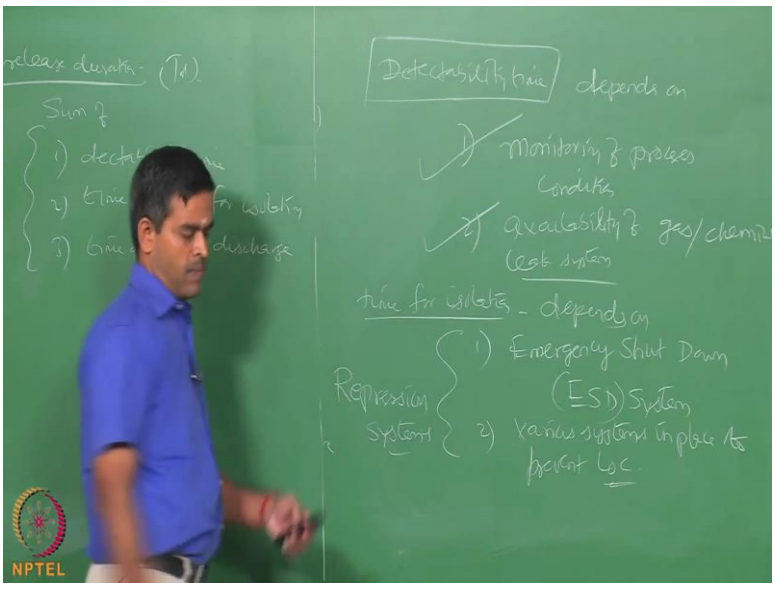

Then detectability time depends on couple of factors, depends on the monitoring of the process, condition two; the availability of gas chemical leak system. So, you may have a sensor, you may have a detector system, you may have a leak detection system in a given

pipeline. So, what is an availability and what is the monitoring of the process condition you are adopting in a given system that will control the detectability time of your any leak process surveillance of the process area, either be the operator by a routine patrol or by a remote surveillance system is always generally used in all gas industries and process sector.

While the time to isolate depends on let us say, the time for isolating this depends on the emergency shut down or to call ESD system. It also depends on various measures and systems that are put in place to prevent the loss of containment. So, what are the various systems in place to prevent the loss of containment it all depends upon, how will you know the time for isolation in the given system? Such systems are called in literature repression systems.

So, interestingly friends in this lecture we discussed about the bridging between hazard management and risk assessment. We also said what are those important tools and interesting flow chart to look at the hazard management where consequence and frequency analysis becomes an important to both qualitative and quantitative risk assessment, which tells me actually the adoption of the policies by the company to limit the risk within the acceptable criteria. In the last lecture, we discussed about the uncertainties and ambiguities in risk acceptance criteria. We also said what are those factors which will actually identify help identify the loss of containment event which becomes a very prominent initiating event in any given system based on which a logical tree can be established for risk assessment.

I hope we are now concluding towards risk assessment tools which are generally used for offshore structures especially for pros industries like gas production systems. In couple of lectures, we will try to wind up the whole course in third module as well and tutorials and assignments are posted. Interestingly exercises are given in various modules of this particular course reference are listed, please go through the main parallel whatever questions you have please post them in the discussion forum, I will be glad to answer them parallely.

Thank you very much.