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NPTEL ONLINE CERTIFICATION COURSE

Health, Safety & Environmental Management in Offshore and Petroleum engineering (HSE)

Module 1
Safety assurance and assessment
Lecture 3
Safety assurance

Welcome to the third lecture on health safety and environmental management in offshore and petroleum engineering shortly called as HSE under the braces of NPTEL IIT Madras. In the last two lectures we discussed about introduction to safety what are the lessons we generally learn from previous accidents that has occurred in oil and gas industries, what lessons are beneficial to us what are the different rules we can frame we can form so that safety becomes a part of education given to the personal working in oil and gas industries.

Now we are moving towards the module 1 which is on safety assurances and assessment I will now take you to third lecture that is safety assurance.

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When we talk about safety assurance.

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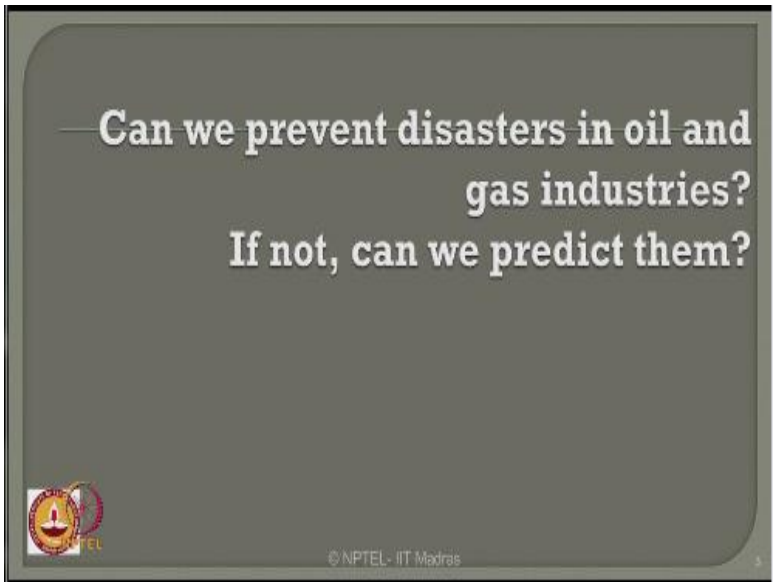

Let us ask a fundamental question can be really prevent disasters in oil and gas industries because these accidents which are catastrophic disasters not only result in human loss of life who are highly, technically qualified but also it incurs lot of financial lost to the plant. So the economic control is also very important therefore we must avoid these accidents can we really prevent these disasters in oil and gas industries, if not can we really predict them.

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Now here a question comes what is the importance of safety assurance which is involved, where a essential features of safety assurance program. A safety assurance should conform prevention of death or injury to any worker, working in the plant, it should also deal with prevention of death or injury the general public who are located nearby in the vicinity of the plant what we call societal damage, it should also ensure prevention of physical and financial damage to the plants that is very important.

Safety does not only address the physical loss of life it is also focused on the financial damage cost to the plan because this can result or such accidents can result in catastrophic economic in balance of the country as well for the specific organization whose plants are encountering serious catastrophic damages. It also focuses on prevention of damage to any third party property located nearby. So it is not only focused on your own property where you do exploration, processing, product and transportation.

But also it is your due reasonability to protect the damage cost to plants or any property located nearby. Therefore, ladies and gentleman it is very important that when I talk about risk assessment what is the spread of risk of your plant on the societal area is also important, that is

what we call as hazardous distances where any plant located nearby the vicinity of your production unit is also susceptible or viable for any such risks.

So safety assurance is not only focused on your plant, your personal, your property, but also it should focus on prevention of damage to any third party property located nearby the vicinity of your plant. Over and above most importantly you should have your goal which leads to prevention of damage to the environment because as we all understand oil and gas industries which focus on explanation of oil from deep sea shale gas etc, there are lot of cruet material which are explored which becomes waste after their processed.

Now these waste material has need to discharged, so one cannot discharge them along with the drilling fluid contents into the sea as it is because this can cause lot of environmental in balance to the aqua life or the marine life present in sea environment. Therefore, your safety assurance program is a broad in nature also focuses on prevention of damage to the environment.

So ladies and gentleman safety term related to oil and gas industry is not only injury to the worker, it is not only the personal safety, it is also the personal safety of the general public it is also the finical damage protection of the property it is also protection of the third party property located nearby your area and over and above by enlarge this is also prevention of damage to the environment in general.

So safety term related to oil and gas industry is a very large perspective, so looking at safety assurance, looking at safety development programs are by large interest that is why safety is a co-interest area in oil and gas industries.

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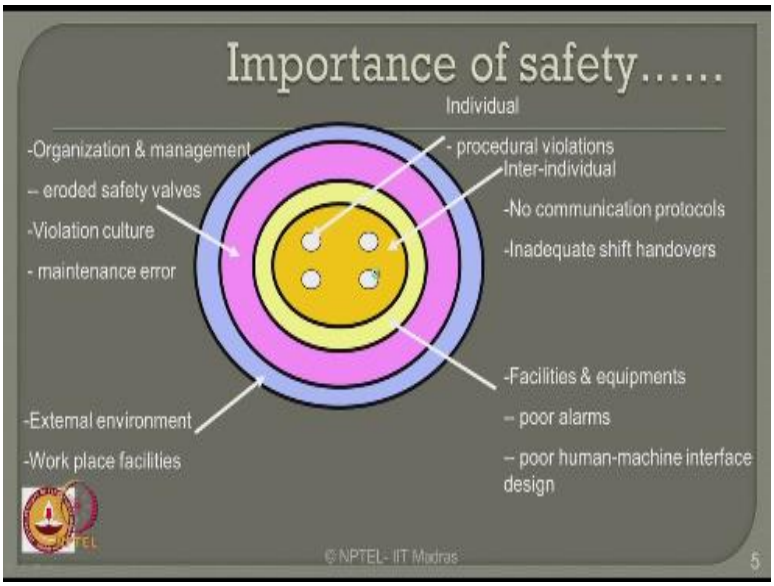

Yesterday we introduced what we mean by safety, let us now talk about important of safety. When we ask a question when a safety regulation is violated it is a very interesting in basic question. Generally, safety regulations are totally personal to start with. For example, any individual present in the plant working the sector or working on both if he encounters, if he encourages any procedural violation obviously they can be individually violating the regulations of safety in the plant.

So as long as they do individual violation it is only concentric towards them, but let us see how safety is challenge when this grows with a larger dimension. Now if we all understand that individual group of people are individual units of people working in the plant on different segments has a very poor intercommunication protocols, it means the protocol available for intercommunication between them is not enough.

So there is inadequacy in shift handovers, it means one person is working on one shift let us say A shift in the morning he has got handover the liabilities risk and responsibilities to a next person or next team coming on the shift B, if he does not communicate proper protocol of all the safety

implementations what he has been regulated during a shift to the person on the next shift this is also a procedural violation.

Now one can wonder that if a single unit or a single person in an unit violates individually a safety protocol what happens. If this person joints a unit and does not communicate between the groups in a proper form, then there is a second level growth of safety violation. Adding to this if the facilities equipments like for example, alarm systems signal development systems, human machine interface design is not effective in a given mechanism of production then this will further complication to safety violation.

Remember ladies and gentleman the safety violation started or safety irregularity started with a single individual person in a small unit when he is not communicating that violation within a group and there was a control violated within a group it grows well the environment or for example the mechanisms available in the plant also does not corporate there is a inadequate design in the alarm development systems, then the safety volition grows in the larger dimension. Adding to it if the organization and the management is also not caring about the safety updates.

For example, an individual in a group reported erosion of any specific valve he requested the replacement of a specific valve but the management or the organization did not take enough care to replace the valve within a stipulated time as recommended by the individual safety personal. So now in individual reporter or safety violation but the organization did not take care or attach importance to that specific violation.

So that is what we call as overruling of management in with respect to the safety violations. So safety valves or not replaced for example management in general has what we call as safety violation culture and management does not take the maintenance program very seriously. It is not periodically done inspections are not carried out, the post inspection reports are not distributed they are not consultant amongst the group. Now a small violation of an individual not being communicated to the group grown to the largest extent, mechanisms are not in proper place organization is not cooperative in terms of safety regulations putting all together.

When you have a compilation extend in environment for example, the work were facilities is not comfortable, the weather window is becoming very serious in such situation safety violations becomes very, very strong. Now one can ask a fundamental question if you look all of them, all these violations individually happening at a different time scale for example, the individual violation happens at a specific time, specific period whereas at the same time the violation or communication protocol does not happen, it means if there is no alignment of these mistakes together then the problem is less serious.

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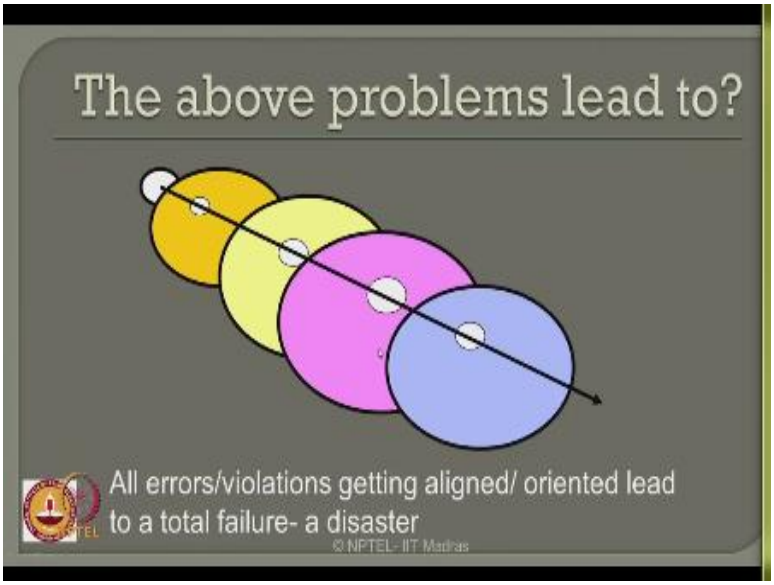

But if they get violated, if they all align completely on one go for example, starting with the individual together with environment all unfortunately get aligned at a same short then this is what we call as full disaster. Unfortunately in oil and gas industries wherever we encounter disasters reported in the previous case sheets in the last lectures you would always appreciate that all these violations starting from individual together with environment complication where get unfortunately aligned themselves.

That is why all these accidents resulted in a very serious protocol violation of safety therefore safety is not concerned only with the individual violation, while individual violates safety it can

become a catastrophic event if that violation gets aligned with all at different stages in a production of a plant.

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Let us quickly see what are the major trends involved in disasters of offshore plants. Essentially depending upon the survey conducted by various people report in the literature for your information ladies and gentleman there is a very detailed list of references available given in NPTEL website which contains lot of textbooks, reference material, journal papers, international conference proceedings I would urge.

All the listeners to collect a good database of all of them and go through them, try to have a parallel leading of all these support material along with my lecture if you really want to get the maximum benefit of my lecture. So based upon different literature review conducted by various researchers following was a major findings reporter in the journal papers they are focused on answering one question.

What is that is what are the trends in major disasters, what could be the reason major disasters happened in oil and gas industries. The foremost reason has been seen is that inadequate design,

the design protocol is not adequate to meet rough weather conditions. It means the adequate design is not compatible with that of the weather conditions when they become rough. So you have no control on the weather window but you certainly have a control on design procedures.

If your design procedures are not rugged, they are not robust so that they can meet at least survivability requirements even during the rough weather condition then major disasters in offshore plants could be avoided, so this is one of the foremost reasons why these disasters happened in off shore plants. The next in the list is the blow outs we all know blow outs really are accidents which are not controllable.

There are many factors which influences blow out activities we all understand as a practicing professional we do care for safety but blow outs are really uncontrollable incidences which happen in offshore production units. The third reason essentially is fire, now one can ask a very interesting question, what would be the fundamental reason for platform to set a blazed. Why important reason, why a platform gets a blazed is you have lot of inert material you have got lot of material available in invention stop on the plan which can catch fire.

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There is a separate module what we will discuss about fire resistant design of offshore structures where we talk about how this fire can be avoided by design in offshore platforms. Followed by fire of course is the explosion because all the chemical inventories involve oil and gas industry has got very high flammability requirements. Once they reach a temperature and pressure they get exploded once it become exploded there explosive they spread for a large duration are large circumferential area causing a thick smoke and a catastrophic damage that entire assert and disability of the plants.

The other reason which has been found has one of the critical reasons for major disasters is vessel collision, vessel collision can be one due to bad weather conditions, second due to improper and uncontrollable maneuverability requirements of the vessels.

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So therefore one good reason what we founded from the literature is the major disasters that occur due to weather conditions are declining, because the design has improved to cater to rough weather conditions as well. The design techniques, the design methods have been revised consistently and continuously and recommended by various international procedures encoded

provisions where these design methodologies enable a very robust design which can cater survivability challenges even during rough weather condition.

Therefore, the reason passed it has been noticed that the input design condition has resulted in reduction of major disasters caused only due to weather conditions. However, the design errors the update errors available which are resulting in blow outs, fire, explosion, and vessel collision, are still major challenges in avoiding catastrophic accidents in offshore and oil and gas industries.

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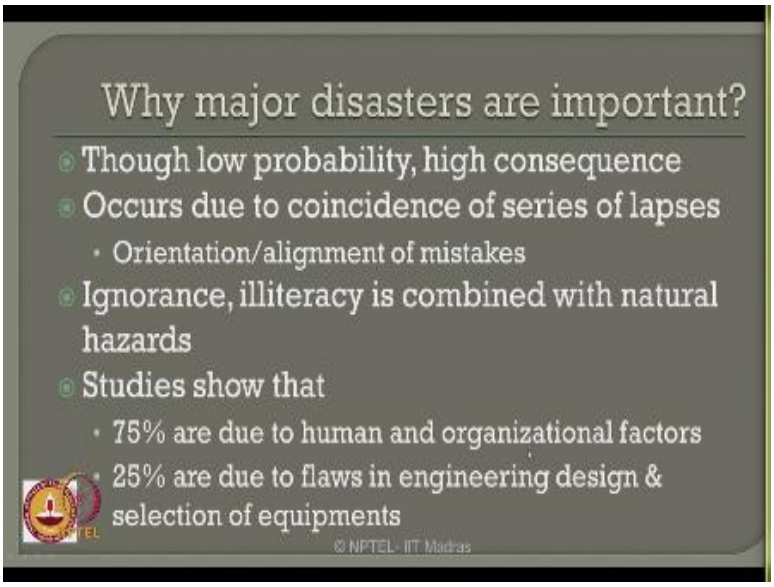

Now the question comes in our mind, why major disasters are important, what do we learn from them? We have seen a list of accident scenarios in the last lecture we realize these accidents resultant in loss of life who are highly technically qualified hiring such technical person is practically impossible because we are trained, professionals therefore, the loss of life of such professional really affects the production of the plant.

It really borders the image of the industry and therefore safety assurance is essentially challenged. Why major disasters are important? We can very really understand now though these

disasters have very low probability, but the consequences causes with this incidence are very, very and phenomenally high. Actually these accidents occur do you coincidence of series of lapses as we saw in the last slide it is orientation or alignment of mistakes committed by an individual which can result in a disaster.

Therefore, personal safety is foremost important in oil and gas industries. Ignorance, illiteracy when they combine together will result in what we call natural hazards. So you should be educated and at the same time you should always be known and updated about all mechanical, electrical, process safety regulations when you are put on boat before we are given a work permit to work on boat on oil and gas industry. Studies unfortunately or fortunately show that 75% of these disasters are essentially due to human and organizational factors.

That is very alarming picture here, when organization do not focus on training of safety assurance to the personal, when human do not take safety as one of the educative mode and practice safety in oil and gas production systems it will result catastrophically to about 75%. Of course, the remaining comes from flaws engineering design and selection of equipments, if you consider this as one of the techno economic requirements of saving oil and gas industries.

But I would put the first point as an important productive point from our goal that we can avoid at least close to 60% of formation of these accidents if we are educated and we can inculcate about work culture in the organization which essentially and predominantly and stringently focuses on safety first.

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When we talk about safety then ultimately the question comes in mind is, what is a consequence of safety violation, the essential consequence of safety violation is a great loss, it can be a human loss, it can be an economic loss. Now we will talk about what are the different loss control measures, can I control the loss? See I cannot avoid the loss because loss is a consequence which is very, very high in case of accidents happening in oil and gas industries. So loss cannot be completely avoided, can I control, can I minimize, can I mitigate the losses, it is possible? So what are the loss control measures?

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Loss control measures needs proper risk management, so one must first understand what is the risk involved in this kind of problems, how do you manage risk if the risk is encounter. It demands a detailed risk survey so one should know how to conduct a risk survey, you should be able to identify the risk and subsequently the consequences cost by that risk therefore, based on this you can establish risk level in all scenarios.

So you should be educated to identify different scenarios in a given plan, you should know how to identify the risk in a given plan, you should also know what are the consequences associated with that risk, therefore you can establish comfortably a risk level. We will do an example in the next lecture a problem will be solved to ascertain a risk level, therefore you will be having an hands on experience on ascertaining risk level as a safety executive.

Over and above it is very important to realize that good practice of upgrading the acceptability of risk level if very important, risk level is defined as acceptable levels in oil and gas industries. We all agree that risk cannot be made to 0 in oil production systems because the various factors which cannot be controlled by a human intervention. However, they can be minimized, they can

be mitigated, they can be predicted in advance, and therefore you can take some measures to minimize the loss, clearly understand now I am moving from safety to loss prevention.

The moment you address loss prevention I am addressing economic control of the plant therefore, even though accidents do occur, even though safety is violated by unfortunate incidences, but still the economic loss, the personals safety violation does not become serious therefore, the image of the production unit, image of the manufacturing concerns, image of the personal and safety assurance are maintained in order even though accidents cannot be completely avoided but we can always minimize them.

So good practice of upgrading the acceptability is very important so you must have a proper knowledge, proper education, and proper continuous updates of current safety standards practiced in oil and gas industries. Above all in organization level you should also be aware of different policy and planning upgrades which address periodic risk assessment.

And therefore recommend certain correction measures. So education of safety or risk assessment or risk management is not only concentrated with the personal working on boat right from the blue-caller list of people working in the industry to the brown-caller people working on boat safety is important to all of them.

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Safety should be practiced, updated by all of them by enlarge.

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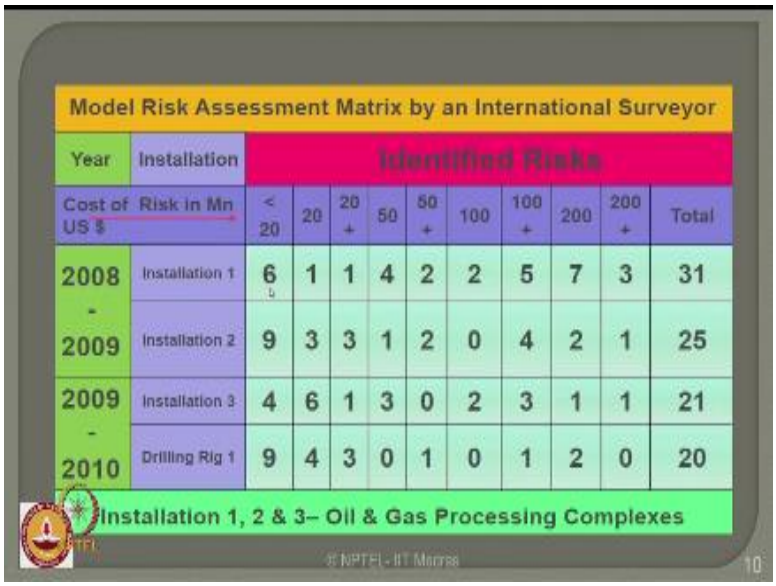

This slide actually shows the example which has been conducted a survey in two years 2008 and nine and nine and ten . So three installations and one drilling rig has been considered for the survey. The survey essentially brings an outcome on what to be then identified risk involve in different plants. As I said in the beginning the risk involved will be converted to the commercial or the financial loss. So I will convert them in terms of risk in million US dollars okay, so I have ascertain installation one and two.

Installation three and drilling rig in the span of two years 2008, nine and nine and ten if you look at this table quickly there has been a constant risk involved and identified in all this installation ascertain for the past two years of eight, nine and nine and ten. However, the risk identified whose cost is crossing about 200 million US plus is minimized is reduced. In 2008 possibly one installation had specific loss of commercial loss of 2000 million yeah, 200 million US dollars exceeding about three in number.

Where this has been reduced practically to 0, so there has been methods, there has been safety practices implemented in different industries in oil and gas production systems where the safety is being addressed. Therefore, identified risks are reduced. However, if you look at the low level

risk assessments that are the cost of risk less than 20 million US dollars they are more or less consistent happening in the past two years. This is an indication that the cost implementation on low level risks or not focused to organization whereas cost involvement high economic loss had been focused by the organization.

But if you look at the overall assessment there has been no rescue of risk identified in the past two years, it various anywhere from 20 to as I ask 31, it means the risk cannot be completely avoided, risk is happening they are been identify and they all result in a commercial loss as close as, as high as 200 million dollars and the minimum loss which has been studied is above close to 20 million US dollars is also substantially a huge amount of money for a production unit.

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The next table shows ascertaining the risk in different installation units of 1 2 3 and drilling rig one in the two years period of 2008 nine and nine and ten which had shown the total risk of 20 to 31 variability what would be those acceptable risks and what will be those unacceptable level of risk measures. So unacceptable level is shown in red, acceptable is shown in yellow and adequate controls available in place is shown in green, fortunately those risk levels less than a rank of six are all acceptable.

Because there are adequate control measures available those acceptable level of risks up to 9 has been also indicated they are been consistently level lower than this. However, interestingly has safety practice has been stringently implemented in various oil and gas industries all over the world you will see that unacceptable risk the red band risks are practically 0. So there has been reduction in risk which are unacceptable must remember there has been accidents which are resulted in financial loss, so now there is a variation here.

Risks are unacceptable they are not reported but financial loss have been reported as high as 200 million US dollars. So there is a focus ladies and gentleman here risk also has a component of economy involved money one or to the part involved in discuss assessment. So can I de derive the risk discussions from safety of a person and equipment to safety of money investors that is economical safety which is also one of the important perspective of risk management.

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So therefore in safety division comes in mind, what are the safety divisions available personal safety, process safety, product and environmental safety, plant and equipment safety, well safety, fire detection and suppression safety, offshore logistics safety which includes helicopter safety

and marine safety, hydrogen sulphide safety, specifically security threats, corrosion check and control measures, crane safety, and monsoon preparations. There are various divisions of safety involved ladies and gentleman in oil and gas industries. Let us at least see one of them in detail slightly.

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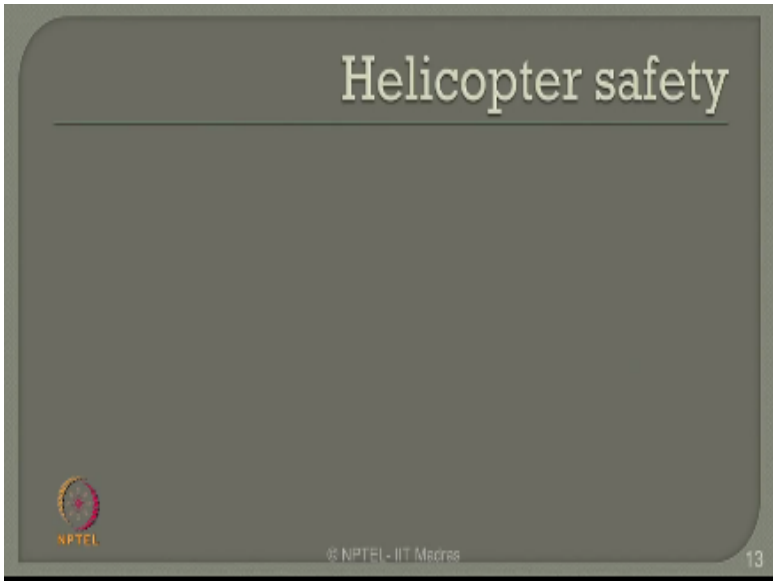

Let us talk about quickly the helicopter safety because remaining all I will cover them in the success in module separately I want to justly briefly introduce very summary of an helicopter safety.

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These are two pictures shown where the chopper has been completely ground it completely immersed this is a catastrophic accident and use to chopper completely.

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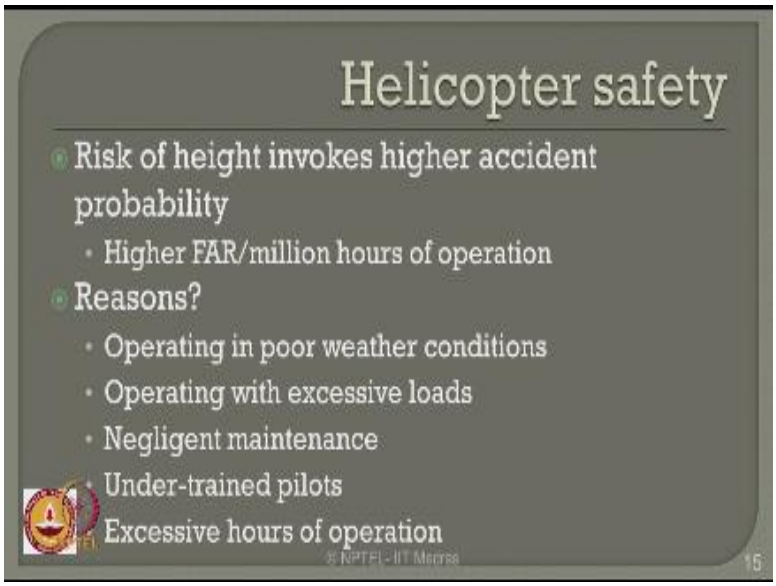

What are the standards available for helicopter safety, what are those factors which challenges helicopter safety. Essentially the risk of height invokes higher accident probability that they worked on greater heights it results and what is called higher fatality accident rate that is called FAR it is not full area ratio as you have seen in buildings here it is fatality accident rate, it is higher as you work on higher heights, or on the other hand the FAR increases with increase in millions hours of operation.

So if you keep on increasing the period of operation of an helicopter working at greater heights the FAR will keep on increasing. There are many reasons for this, some of them identified as a study conducted by my colleagues and different research purpose one is operating in poor weather conditions, other is operating with excessive loads negligent maintenance done for the helicopters under trained pilots have been deployed, essentially it has been found that excessive hours of operation has formed a major reason for helicopter accidents.

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There are different industrial standards where helicopter safety actually is being deliberated for information of the user, let us list the standards CAP 437, standards for offshore helicopter landing areas. ICAO international standards which is governed by international civil aviation organization. Health and usage monitoring systems which we called briefly has HUMS. UKOOA which is offshore operators association guidelines.

Crew resource management which is called as CRM, and the helicopter operating and maintenance program which we call as HOMP. These are some of the list of standards which focus on how helicopter safety can be ascertain can be assured when your operate the choppers for oil and gas industry production systems.

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Parallel to this is marine logistics is also important because one is in air, one is in water. So marine logistics focus on what could be the platform support vessels which be kept emergency, what should be the offshore supply vessel configurations, how much should be the stand by a number, what should be the inter-field transfer configurations, what should be the supply vessel configuration for regular food water supply etc.

What should be the configuration or the multipurpose supply vessels which the offshore production systems depend on what should the configurations that crew tankers or tankers for crew transport to the offshore locations, patrolling vessels for security purposes, speed boats for transporting the crew to un-manned platforms because un-manned platforms on emergency can should be attended in case of any requirement and so on so forth.

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Let us now move towards what are the terminologies involved in risk assessment. One can ask a question how risk assessment becomes whiter, we have seen in the previous slides that risk management, risk preparedness, risk mitigation, and risk assessment or essential heart beat of implement of safety program by any organization or by any safety individual personal. There are different terminologies which are very important which are commonly used in literature regarding risk assessment.

What is an accident, and accident is an occurrence of single or sequence of events that produce unintended loss. The accident generally refers to the occurrence of events, it does not refer to the magnitude of the event please understand it is only the occurrence not the magnitude, safety or loss prevention is defined as the prevention of hazard occurrences there is accidents through proper hazard identification, assessment and elimination.

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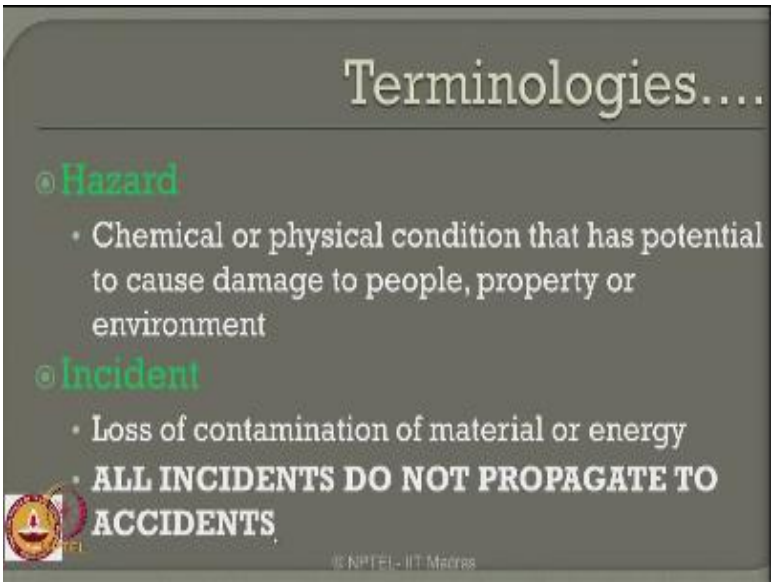

What is a hazard, hazard is chemical or a physical conditions a scenario which has a potential to cause damage to people, property or environment all are coming under the single base call hazard. What is an incident, incident is a loss of contamination of material or energy, all incidents do not propagate accident remember that, there are two different terms accident and incident are different. Incident is a loss of contamination or of material or energy all incidents do not propagate to form or to become an accident.

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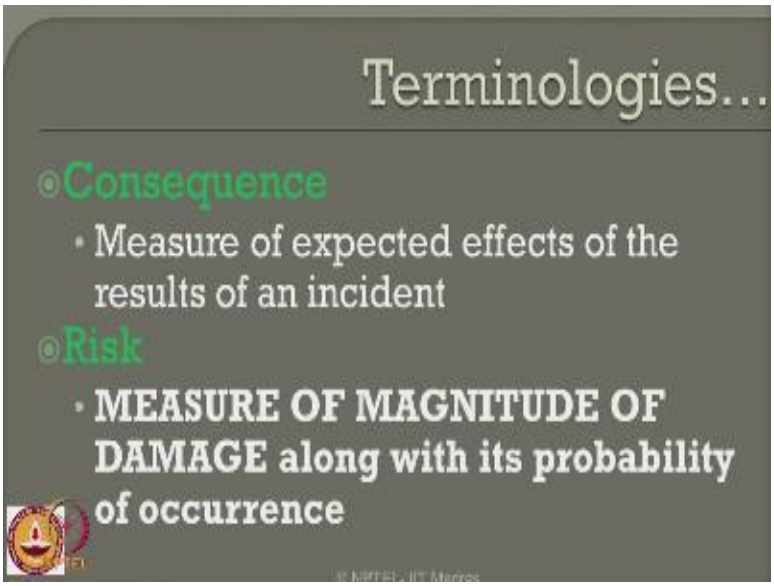

What is a consequence? Consequence is a measure of expected effects of result of an accident, it is not unexpected. Consequence is a measure of expected effects, therefore it access risk you must know what is the effect of the violation of safety or risk in terms of expected effects cause by these violations. Therefore, risk is a measure of both magnitude of damage along with its probability of occurrence. So we said in the last lecture risk is a product of magnitude and occurrence or probability of occurrence or frequency.

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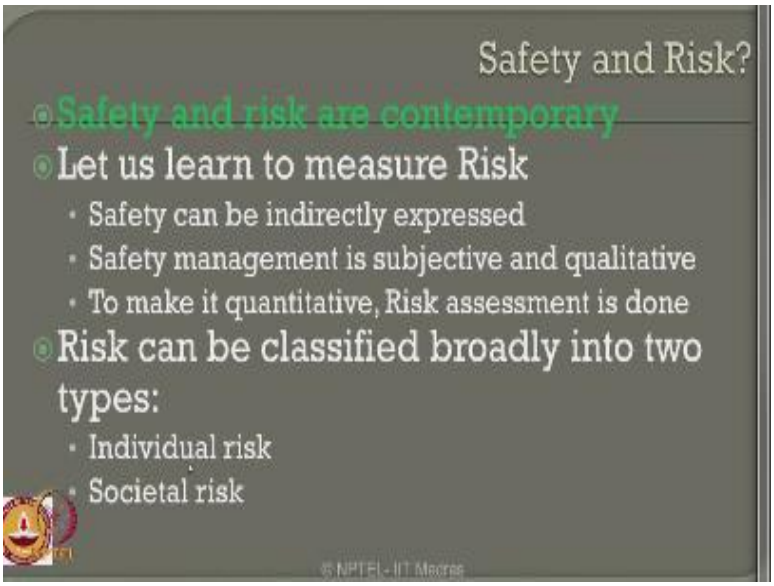

One can compare now what is the difference between safety and risk. Safety and risk are essentially contemporary; let us learn to measure risk because safety cannot be measure as a subjective term. Safety can be indirectly expressed, safety management is highly subjective and qualitative to make it quantitative risk assessment is actually carried out. So risk can be classified into two types, one is called individual risk other is called societal risk.

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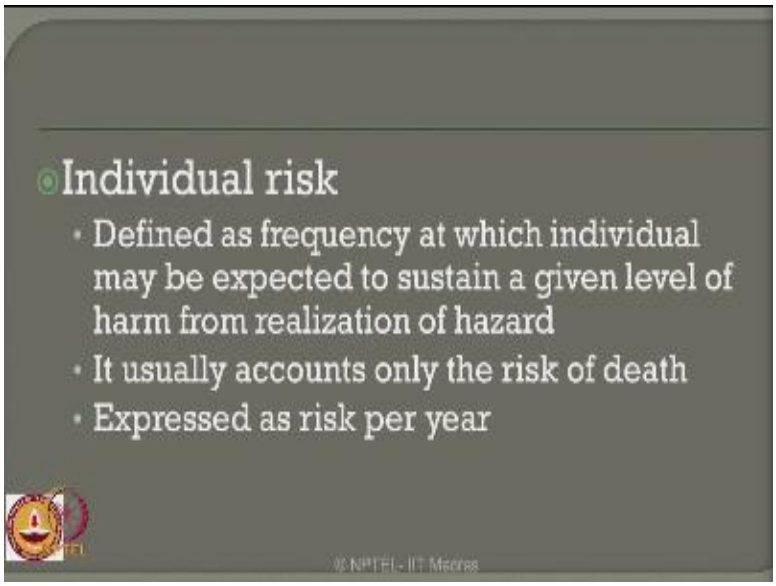

Let us defined what is individual risk, individual risk is defined as a frequency at which individual may be expected to sustain a given level of harm ness from realization of an hazard. It usually accounts only the risk of death it expressed as risk per year.

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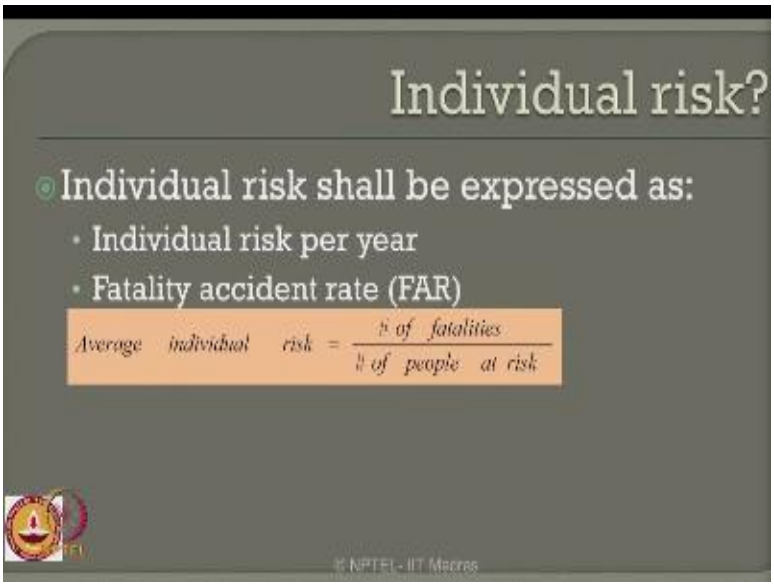

Individual risk can be expressed in two forms it can be expressed as individual risk per year or fatality accident rate abbreviated as FAR. Average individual risk is given by a simple expression it is number of fatalities over the number of people at risk.

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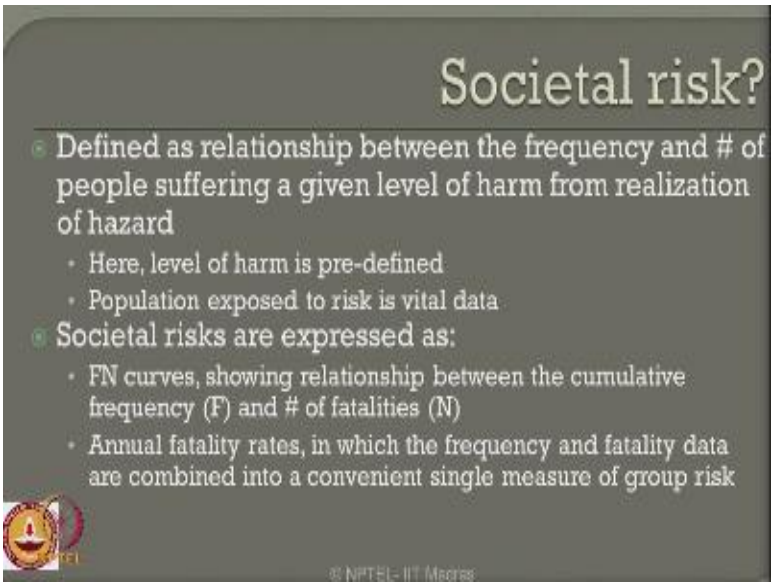

Societal risk is also an important dimension it is defined as relationship between the frequency and the number of people suffering a given level of harm ness from realization of hazard, here the level of harm ness is pre-defined remember that is very important catch here. Population exposed to risk is one of the vital data. For example, if the population is minimized whose expose to risk obviously the risk level in societal damage will be lower.

Alternatively if the level of harm is pre-defined then also the estimate of societal risk will be lower. Societal risk is expressed in two forms it can be based on the FN curves, showing relationship between the cumulative frequency which is not thus F and the number of fatality is which is not thus N in the FN curve can also be expressed as annual fatality rates in which the frequency of fatality data are combined together in a convenient single measure of what we called group risk.

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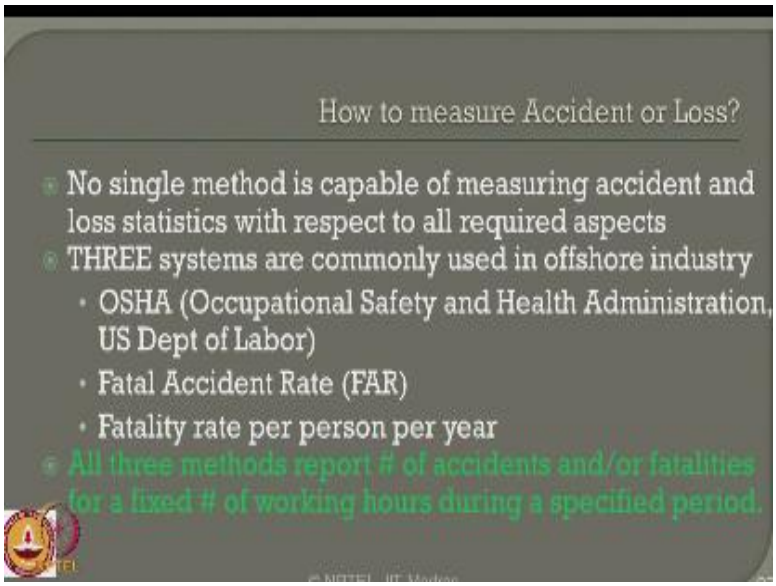

Now the question is how to measure accident or a loss because it appears to be as a de-subjective, but we can still measure a loss let us see how. Of course there is no single method which is capable of measuring accident or loss statistics with respect to all the require aspects involved in an accident. There are three systems which are commonly recommended by the industry to measure accident or loss.

One is suggested by OSHA which is occupational safety and health administration US department of labor, other can be the fatality accident rate as an equation suggested in a earlier slide. The next method can be fatality rate per person per year, now interestingly all these three methods are measuring accident as a commonness between them, let us see what is there commonness?

The commonness in all the three method is the fixed number of working hours during a specific period of time all these three associate only a fixed number of working hours, therefore the population expose to risk in terms of working hours is always limited, is always considered as an important vital data in assessing risk.

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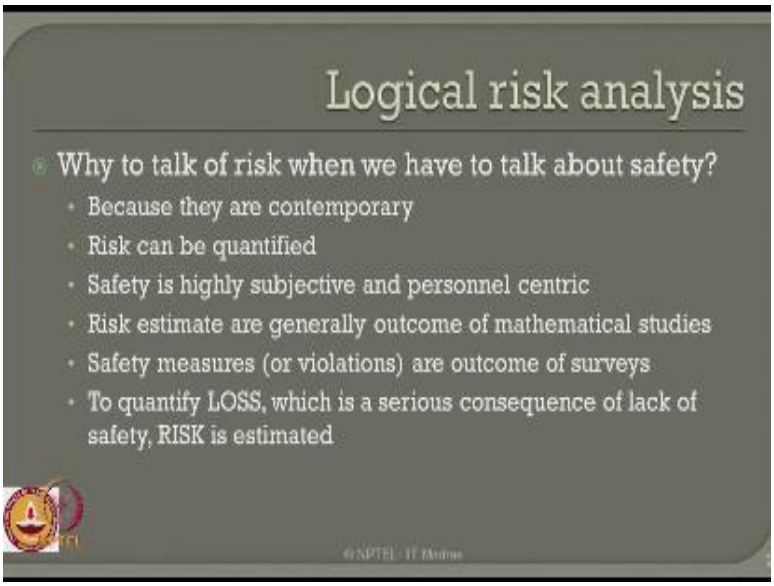

Let us talk about what is the logical risk analysis can I make risk analysis logical. The question comes in mind why to talk of risk, when we talk about safety, answers are very simple risk and safety are contemporary, risk can be quantified, safety cannot be because it is qualitative statement it is highly subjected, risk estimates are generally outcome of mathematical studies, safety measures are outcome of surveys so there is a difference between this.

Therefore, the quantify loss which is one the serious consequence of lack of safety risk is estimated. So safety is indirectly addressed, computed, calculated, and visualized as risk assessment and management in oil and gas industries.

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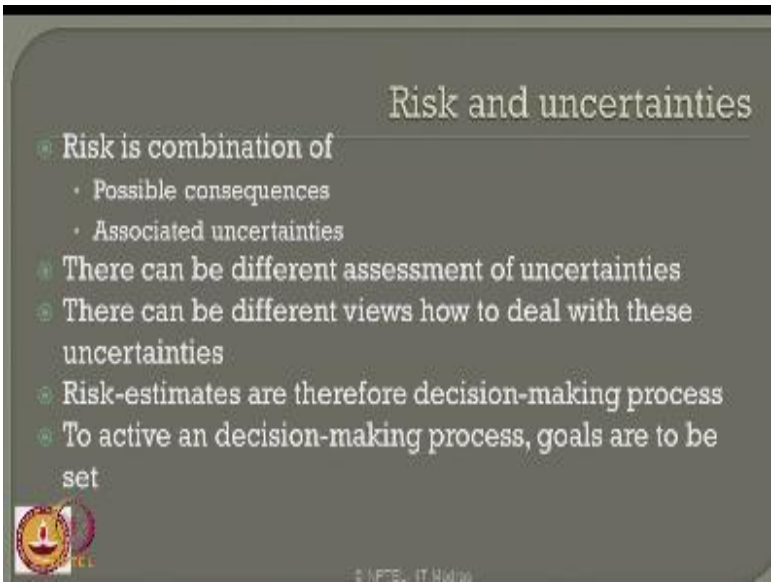

Now let us talk about what are the uncertainties associated with risk, risk is combination of consequence and uncertainties associated with the consequence there can be different assessment of uncertainties, there can be different views how to deal with these uncertainties, risk estimates are therefore an important decision making process. To active an decision-making process or to make it activated there are goals to be set.

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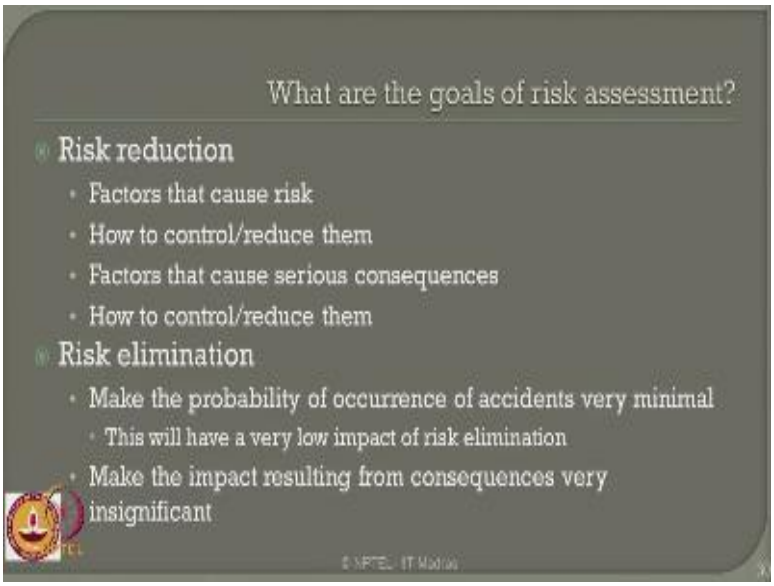

Therefore what are these goals for risk assessment, risk reduction is one of the goal which depends on factors that cause risk how to control or reduce them, factors that cause serious consequence, how to control or reduce them, risk elimination depends on making the probability of occurrence of accidents very minimal this will have very low impact on risk elimination make the impact resulting from consequences very insignificant.

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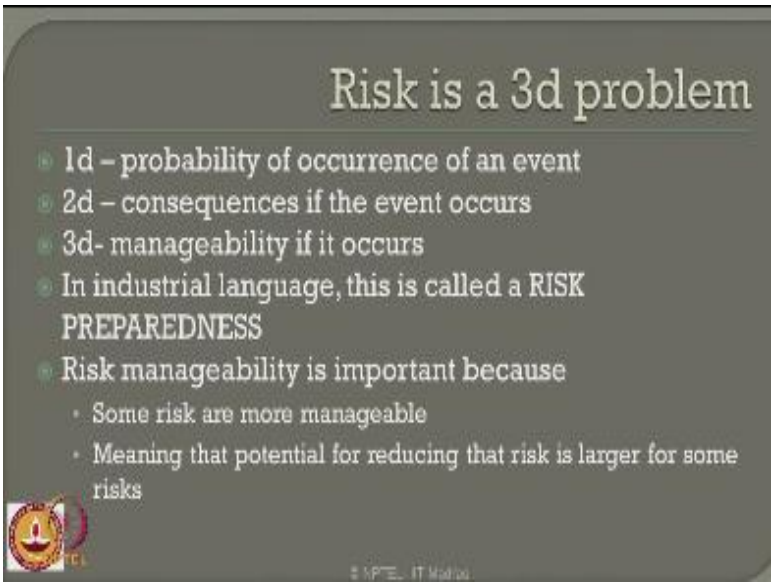

Therefore, risk is a three dimensional problem, the first dimension is probability of occurrence of an event, the second could be consequences, the third dimension is manageability if the risk occurs. So risk management is what we call as risk preparedness in oil and gas industries. Risk manageability is very important because some risk are more manageable meaning that potential for reducing that risk is larger incase of certain risk management problems.

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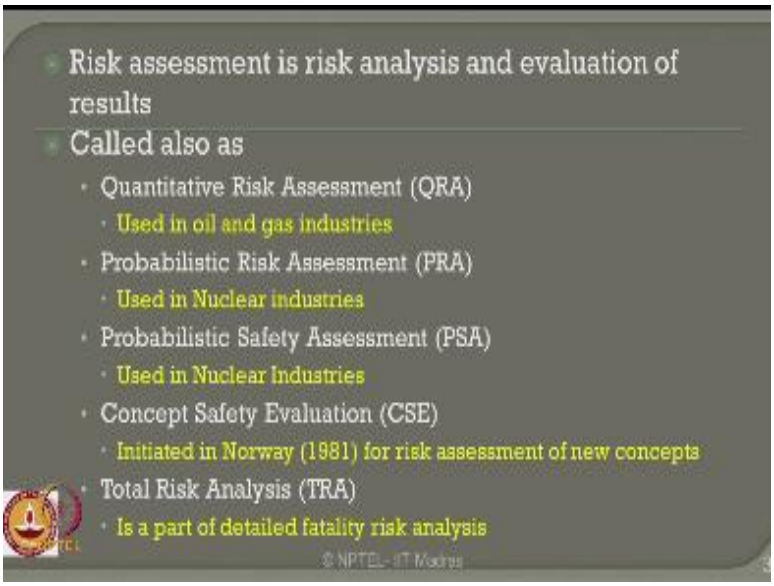

Risk assessment is therefore risk analysis and evaluation of results. It is also called as QRA which is quantitative risk assessment when they are applied to oil gas industries is called as PRA which is probabilistic assessment when they are applied in nuclear industries is call as PSA when used as nuclear industries it is call a CSE, when it is initiated in Norway studies, it is called as total risk analysis which becomes a part of detailed fatality risk analysis.

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Therefore if you fail to plan you plan to fail.

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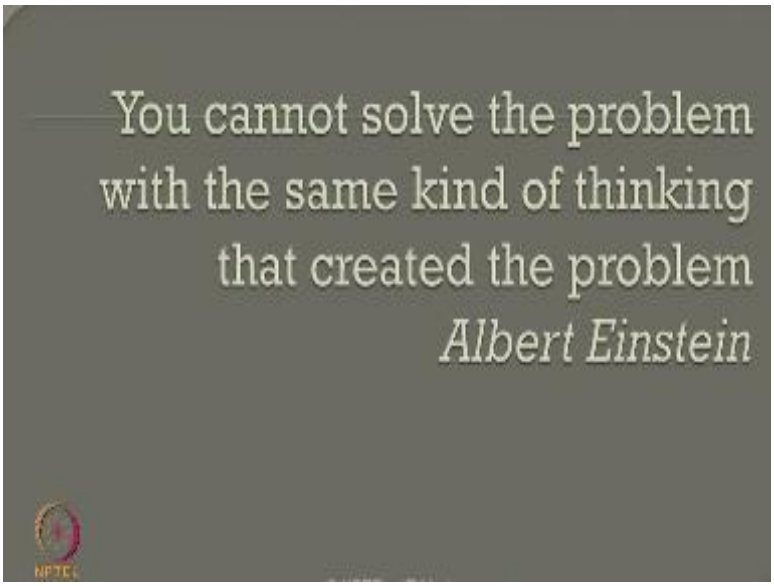

You cannot solve the problem with the same kind of thinking that created the problem has said by his excellence Albert Einstein.

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Safety has got two facets one is a lion is called occupational safety, it happens in groups, it is a killer, it is often visible, it can never be fully tamed, it can never be fully left un-guarded, it requires a constant vigilance.

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The other one is process safety which is like a Tiger it kills alone, it is hard to deduct, it is not commonly seen, it is a killer, it can never be fully tamed, it can never be left un-guarded, and at the same time it requires a constant vigilance.

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Safety matters ladies and gentle men if safety is challenged you are in serious trouble.

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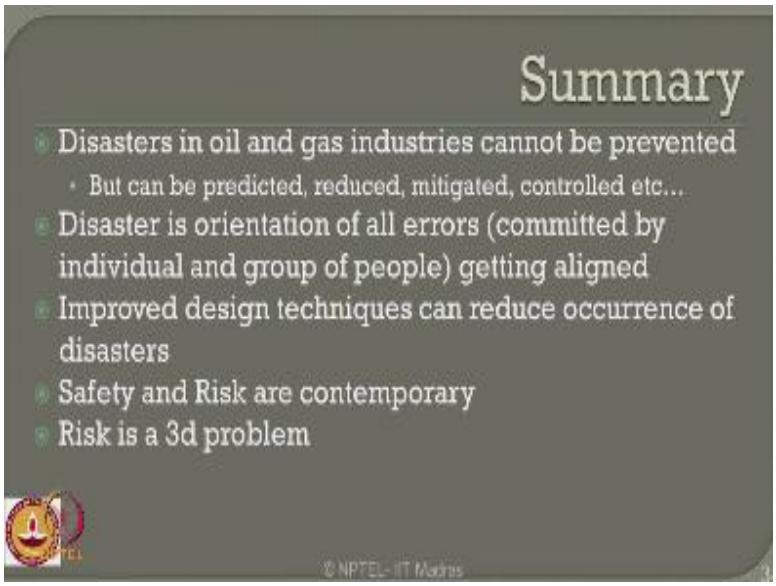

Let us see the summary of this lecture disasters in oil and gas industries cannot be prevented they can be predicted, reduced, mitigated, and controlled. Disaster is an orientation of all errors committed by an individual, cost by group of people getting aligned. Improved design techniques can reduce occurrence of disasters, safety and risk are contemporary, safety cannot be measured as it is qualitative, risk can be measure because it is mathematically modeled, risk is a three dimensional problem the third dimension is risk preparedness.

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Thank you very much for listening this lecture.

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