NPTEL

NPTEL ONLINE CERTIFICATION COURSE

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

Module 1
Safety assurance and assessment
Lecture 14: Summary 1st Module

Dear friends in this lecture 14 we are now going to summarize the studies what we conducted in the first module which focused on safety assurance and assessment in the course of health safety and environmental management in offshore in petroleum, engineering under the NPETL braces IIT-Madras.

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The first module of the course focused on safety assurance and assessment we will talk about summary and highlights of this particular module for closing this module 1 lectures at NPTL..

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Let us quickly see what are the topics we covered in the first module we spoke about introduction to safety we discussed safety assurance safety in design and operations we focused on organizing for safety we discussed problems associated to hazard identification classification assessment and evaluation we also discussed case study on Hazop reports we also understood how to conduct failure more effect analysis for 2 example problems.

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Dear friends oil gas industry makes continuous technological progress and this group as we all understand is highly rapid complexities at various stages like exploration stage transportation stage processing stage are entirely different they lead to constant change in manpower requirements and skill levels most important is to improve the conditions of work therefore ensure safety which becomes most important in the operational plant physical hazards and new unperfected technologies are being attempted indifferent segments in the world to compromise in safety. The complexities involved in deepwater oil exploration this of course leads to fear of compromise in safety

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Let us follow simple rules of safety assurance which has been discussed in the previous lectures and module 1 let us try to minimize and control hazardous incidents examples of different procedures followed in different countries like united sates, UK and Europe they have jointly developed different effective process safety programs and of course they proposed better and stringent regulations that need to be adopted by this industry overall the idea is to minimize and control the hazardous incidents which are occur in the reason past.

It is also important for us to know friends that one should perform HSC audit to understand the effectiveness of HSE management HSE management need to be it respectfully audited by a third party to see how efficiently this is being practiced in a specific industry and this is a mandate as far as oil and gas industries are concerned under the present regulations.

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We also have studied about international sustainability rating system which is called as is ISRS is an international practice to measure the effectiveness of HSE management of any company we have also seen what are the different segments which are participating in the ISRS program and we are understood how globally is ISRS can be conducted to ensure or to measure the effectiveness of HSE management in any process industry nevertheless as applied to iron gas industries also.

They have also discuss couple of interesting case studies from the case studies we infer that seventy percent of these are essentially due to human and organizational factors the remaining twenty-five percent arise from the flaws in engineering design and selection of equipments we have also seen in the recent past various developments and technology advancements made in the design updates have started declining the extent possibilities that arise from the faulty design.

Therefore if at all any accident as on today is foreseen at in this stage you can always believe that is going to be human machine interface or organizational factors which will become responsible to foresee such kind of extends in oil and gas industries so under the given task it become very

important for us to understand that safety training is very vital for all the personnel involved in oil gas industries.

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They are also seen in the lectures that how safety and risk can be compact we have understood that safety and risk or contemporary safety is a highly subjective term it cannot be measured it varies qualitatively from one personal to the other or once perspective with respect to the other however risk can easily be quantified hence quantitative risk assessment methods which we call abbreviated as QRA are very popular in HSE management.

We will also see that there are three systems which are commonly used to measure the accidents in offshore industry OSHA which is known as Occupational Safety and Health Administration by united states department of labor prescribes a method to measure accidents in offshore industry can also measure accidents by a technique called fatality accident rate which is called FAR or alternatively can measure accidents may fatality rate per person per year in the company.

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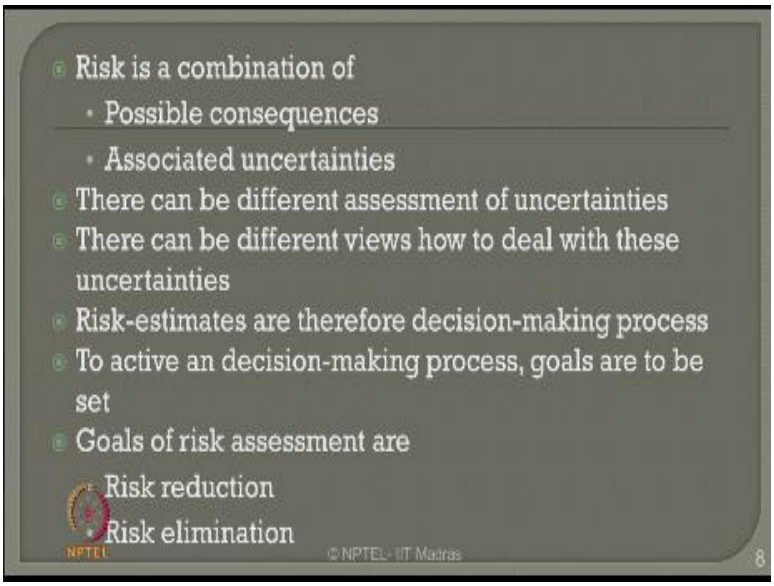

Let us try to understand that safety and risk becoming contemporary we cannot measure safety because being a subjective tool so we measure risk and try to identify safety indirectly through risk assessment and management once this is said and understood now we went along and try to find out that risk is now a combination of possible consequences and associated uncertainties there can be different assessments of uncertainties there can be different views how to deal with these uncertainties risk estimates are therefore friends the decision-making process.

To activate any decision-making process goals are to be set therefore we have got two distinct set of goals available in risk management in oil gas industries which we discussed in the previous lectures goals of risk assessment are therefore aiming at risk reduction and risk elimination.

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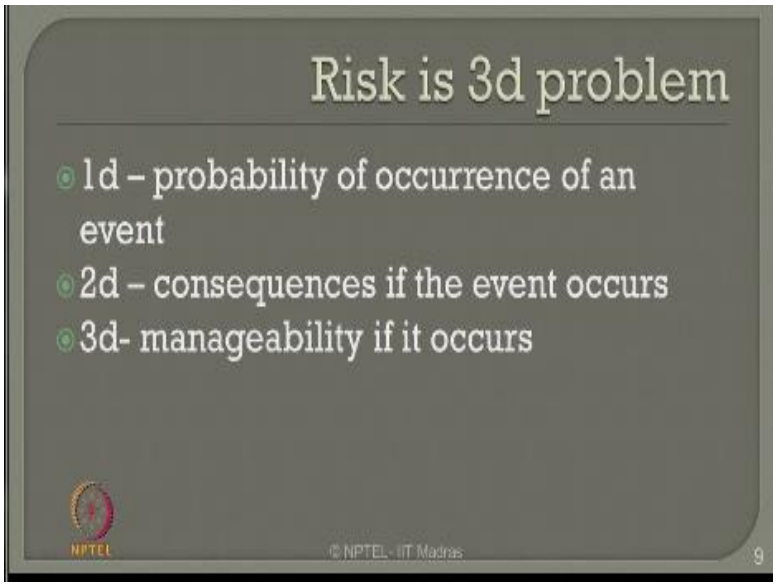

Dear friends we have clearly understood that risk is a three-dimensional problem the first dimension comes from the probability of occurrence of any event the second dimension is associated with the consequences if the event occurs of course the third dimension is manageability of the event if it occurs so the third one is clearly called risk management the first and second one are called risk assessment.

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Risk of course is acceptable to regulatory agency and also to the public which is predefined in the literature dear friends please understand offshore and oil and gas industry is not an industry where zero risk is involved the process is of a very high complex in nature therefore under operational temptation pressure there is always a probability that accidents do occur if accidents are available or they are going to be caused because of unforeseen incidents then you can always say risk cannot become zero in oil gas industries.

Therefore different regulatory agencies in the world have designated what is called acceptable level of risk which is acceptable to the company to the personal and also in form of societal risk to the public risk assessment unfortunately relies on inadequate scientific information or lack of data because the accidents are declining in the reason pass which is a good news but however learning lessons from accidents are not happening frequently because the data available based on which risk assessments are made or reversal or very few and we call them as inadequate scientific information.

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If this is understood clearly then we also have to understand and realize that there are certain limitations in safety assurance program the ageing assets the platforms becoming welder the material degradation the strength degradation the cause of various combination of environmental factors make them aged and that is one of the main worry which limits the safety assurance in offshore platforms the second major cause or the limitation is return on investment in safety practically related the financial perspective of investment on safety the return on this is phenomenally low or one can even say is practically next to 0.

Installations located in thickly populated areas cause lot of worries non adherence to standard operating procedures because many of them are attempting new technologies and complex machineries which are involved in oil gas production and processing the top 10 safety culture is one which is highly missing which is now improving that is a good news however this was found missing in many of the leading oil and gas industries as we all understand as there is a constant update in technological processes we foresee a very acute shortage of skilled manpower to operate these process plants of course there is lack of proper maintenance busy schedule which must have been done in these kind of industries and most importantly training and retaining of

manpower to assimilate that upcoming technology is a big black hole in many of the oil and gas industries dear friends please realize safety is not expensive it is priceless.

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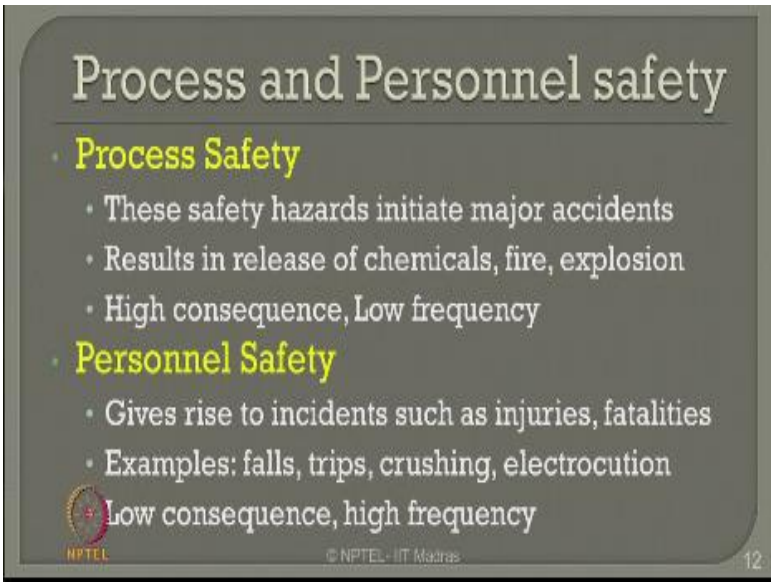

The moment we have safety in our mind then we can quickly compared two interesting domains of safety one is the process safety other is the personal safety process safety is actually addressing the hazards which are initiated from major accidents the result of millions of chemicals cause fire explosion etc… these incidents or accidents are essentially high consequence low frequency phenomena on the other hand if you look at personal safety it gives rise to incidents such as injuries fatalities etc…

A few examples of this order which is commonly seen in oil gas industries are the false tips crushing electrocution etc… if you look at the whole phenomena in general and compare it with process safety one can realize that personal safety phenomena or accidents and incidents or low consequence high frequency as we all now realize risk is a product of these two however risk in terms of process management and personal management both are important therefore HSE covers both by enlarge.

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Then one can ask a question how can we improvise safety in drilling operation which is one of the major source of many accidents that has happened in the recent past we discussed in one of the lectures that systems design concept can certainly improve safety in drilling operations the best way to minimize injuries illness and fatalities is to design the plant with minimum hazards and risk though the statement is highly conceptual but still this can be implemented with lot of engineering methodologies in the design stage itself by designing properly one can certainly eliminate hazards and control risk to a very greater extent can bring the risk to an acceptable level even at the source itself.

Controlling risk is a good idea so good habit make it as early as possible in the life cycle of the items in the workplace one can do redesign of the process one can retrofit existing workplaces the facilities the equipment's tools and plants and machinery and the whole working scheme so that you can bring down or control the risk as early as possible in the design stage itself.

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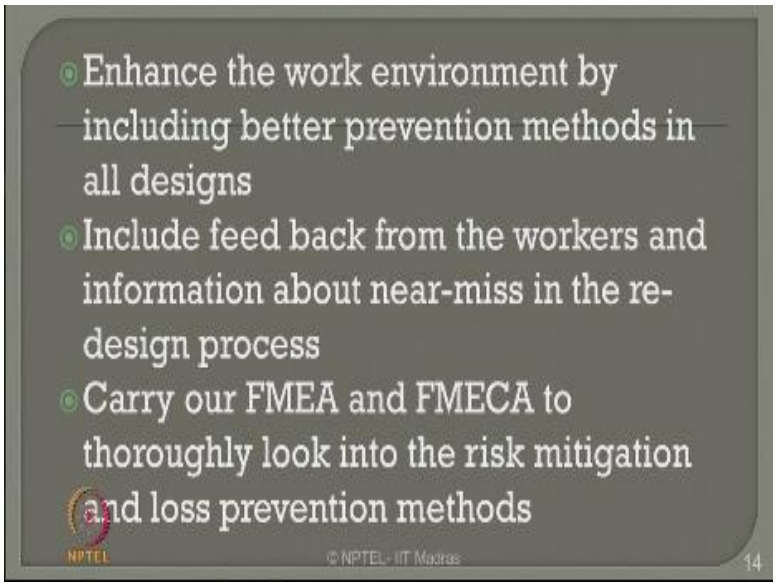

Enhance the work environment by including better prevention methods in all the design processes certainly include feedback from the workers an information about the near miss events in the redesigning the process of a plant carry out FMEA and FMECA to thoroughly look into the risk mitigation and loss prevention methods which are discussed in few lectures earlier.

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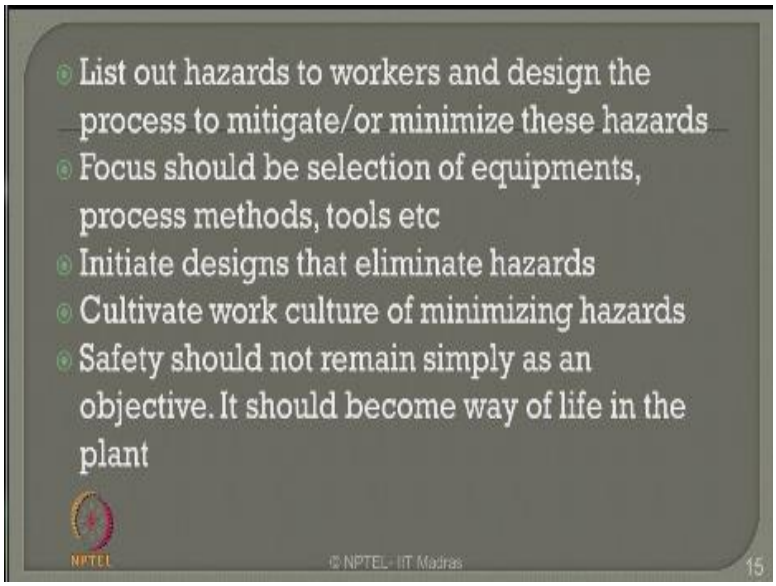

Kindly list out the hazards to the workers a redesigned the process to mitigate or to minimize these as hazards focus should be essentially and selection of equipments process method tools etc… initiate design schemes that can eliminate hazards in the fundamental stage itself FMEA is one interesting study which can help you to do this dear friends cultivate well culture of minimizing hazards in your plant area safety should not remain simply as an objective it should become way of life in the plant.

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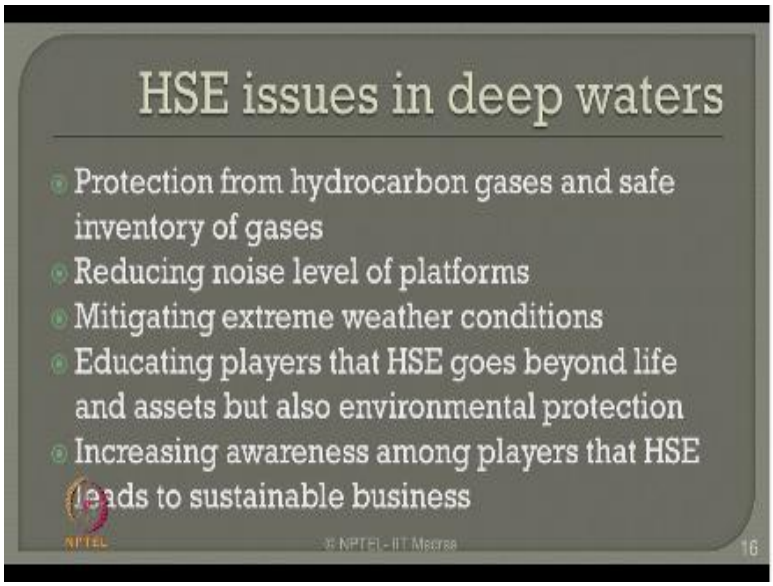

Once we said this let us quickly see why safety norms are always challenged in deep water oil explorations that is what are the HSE issues in deep waters Protection from hydrocarbon gases and safe inventive gases is one of the main and critical issue when you talk about deep water oil explain production reduces noise level of platforms which can cause fatigue to the operators on both should also be very interesting idea.

So that the noise level of the platform should be brought down between with an acceptable standard levels you must know how the design can adapt to the extreme weather conditions are you must have schemes which can mitigate the extreme weather conditions on your plant, you should educate players participate in HSE which goes beyond life and assets but also Environmental Protection should be a basic policy, increasing awareness among players that HSE leads to sustainable business is a very important objective which can promote safety culture in the entire production unit.

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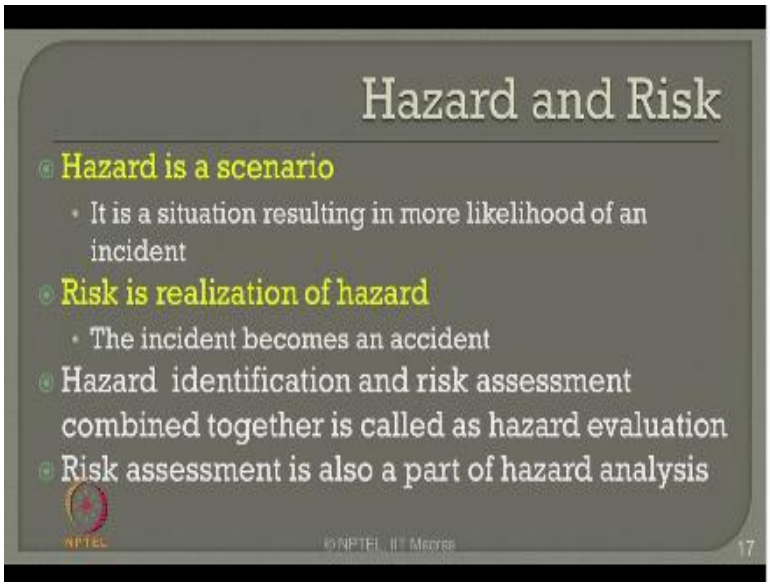

Having said this we started moving our lectures from risk towards hazard management, let us quickly see the comparison between hazard and a risk, hazard is a scenario where risk is the realization of the scenario, hazard is a situation resulting in more likelihood of an incident where as when the incident becomes an accident this is called risk. Hazard identification and risk assessment combined together is called Hazard evaluation. Risk assessment is also a part of hazard analysis which we did in few lectures.

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Now to summarize the lectures in first module I have got certain excise problems which I will try to solve now for you, I have also given certain self assignment problems for you to answer so that you try to answer them and let me know the difficulties.

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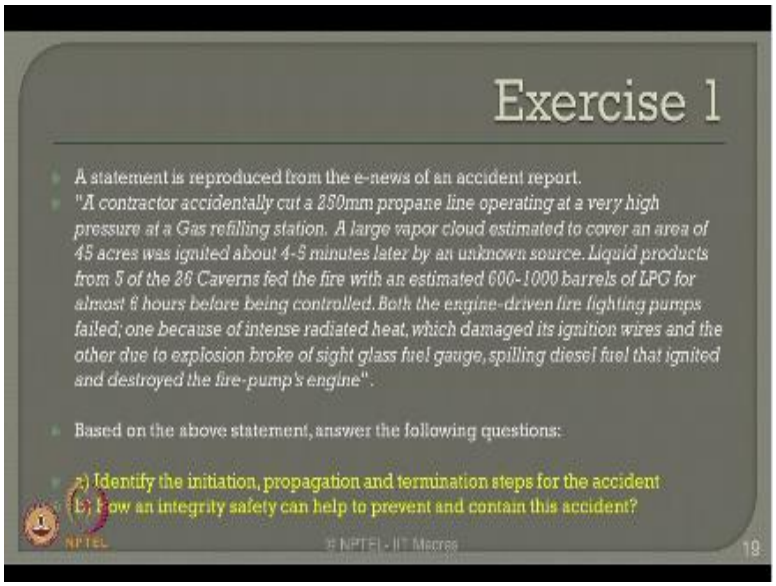

Let us quickly see problem number one, your statement is reproduced from the unions of an accident report please read the statement carefully, your contractor accidentally cut a 250 millimeter propane line operating at a very high pressure at a gas refilling station, a large vapor cloud estimated to cover an area of 45 year plus was ignited about four to five minutes later by an unknown source.

So these two events occurred parallel, liquid products from five of the 26 cabins fed the fire with an estimated 600,000 barrels of LPG for almost six hours before being controlled, both the engine driven firefighting pumps failed, one because of intense radiated heat which damaged its ignition wires and the other failed due to explosion, broke of sight, glass fuel gauge which resulted in spilling of diesel fuel that ignited in discard the fire pumps engine completely.

These are very interesting accident statement which is reproduced from a news report. Now the questions are the following, based on the above statement answer the following questions, identify the initiation, the propagation and termination steps for the above Illustrated accident, the second question is how an integrity safety can help to prevent and contain this accident, of course I will solve this and give you the answer in the next slide.

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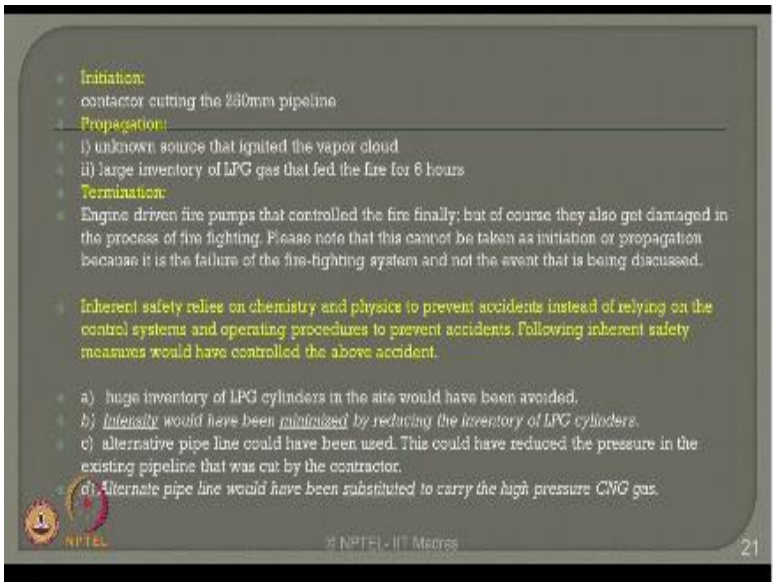

Initiation may be essentially from the activity carried out by the contractor where's contactor started cutting the 250 mm pipeline, propagation initiated from an unknown source that ignited the vapor clouds, so be careful about the inventory of the stock of inventory which are hazardous chemicals near a plant, the second source of propagation can be the large invent of LPG gas itself which fed the fire for about six hours.

Now the question is how this can be terminated, termination must have come from the fire pumps, the engine driven fire pumps that control the fire finally but of course they also get damaged in the process of firefighting, please note that this cannot be taken as an initiation of propagation because it is a failure of a firefighting system and not the event that is being discussed.

The second question is about, how one can improvise inherent safety to control the spread of such accidents, inherent safety relies on chemistry and physics to prevent such accidents instead of relying on the control systems and operating procedures to prevent such accidents, following inherent safety measures would have controlled the above accident very carefully, huge inventory of LPG cylinders in the site would have been avoided.

Intensity would have been minimized by reducing inventive LPG cylinders, alternate pipeline could have been used, this could have reduced the pressure of the existing pipeline which was ultimately cut by the contractor even after a proper work permit was issued to the fellow, therefore alternate pipeline would have been substituted to carry the high pressure CNG gas.

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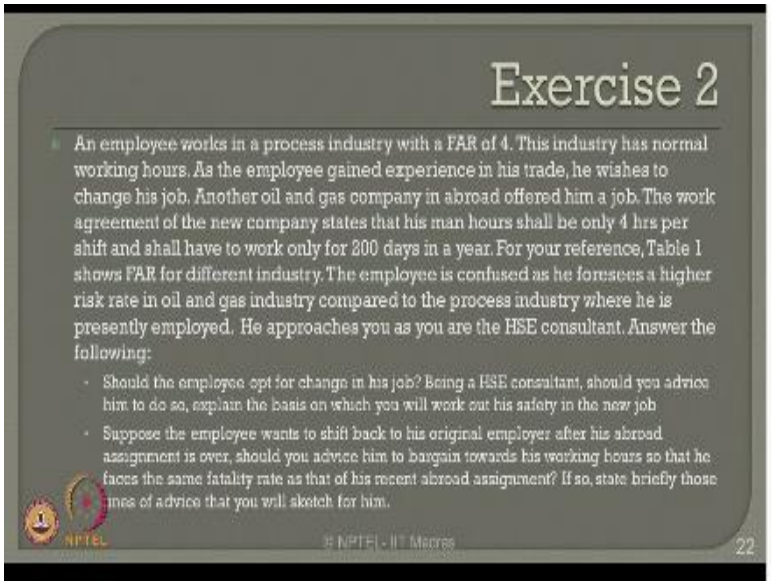

The second question is on risk assessment, let us read this question carefully it is a very interesting question which most of HSE executives need to answer and employ works in a process industry with fatality accident weight of value for, this industry has normal working hours as the employee gained experience in this tree he wishes to change his job, another oil and gas company in abroad offered him a job.

The work agreement of the new company states that his manners shall be only four hours per shift and have to work only 200 days in a year, for a reference table 1 shows the fidelity extended for different industries which I will show you subsequently, the employer is confused after looking at this table because he foresees a higher risk rate in oil and gas industry compared to the process industry where he is presently employed.

Now he approaches you as you are the HSE consultant and said the following questions to him, should the employing off for the change in his job, being a HSE consultant should be advising to do so please explain the basis on which you will work out a safety in the new job because he has shown is concerned because the new job oil and gas industry has got a very high FAR compared to the present industry where he is working.

The second question is more interesting, suppose employee once shift back to his original employer after his abroad assignment is over, should be advising to bargain towards working hours so that his he faces the same fertility rate as that of his reason abroad assignment, if so straight briefly those lines of advice what you will give in to take the next job.

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The table 1 shows here is the fatality excellent rate for various industries, if you looked at this table carefully the industry what the present person is working is a process industry whose FAR - is closely around two, whereas the one which is want to shift is an FAR with 62, so the fatality extend rate of a very high number borders the person to decide whether should we shift from the present industry to the new industry.

Whose fatality extent rate is phenomenally high therefore your approaches you as a consultant and you should advise him.

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Let us see the solution for the specific problem question the question.

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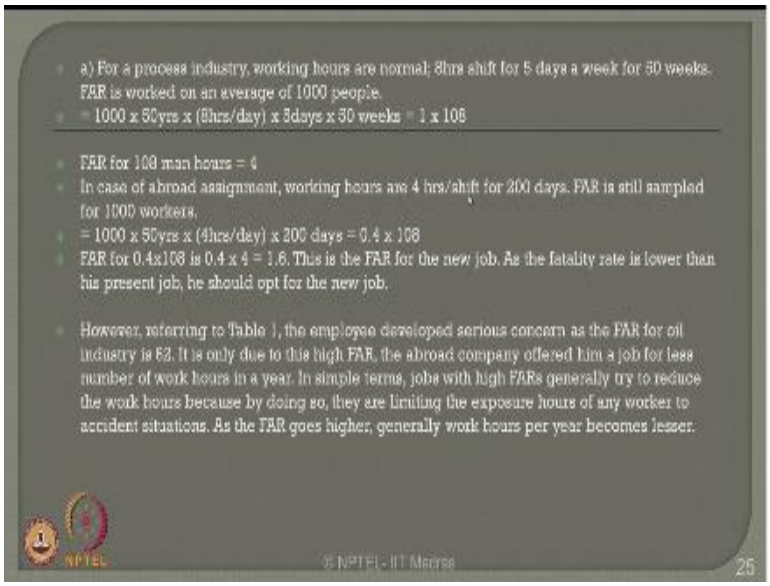

Let us take the first question A, for a process industry as stated in the example the working hours are normal that is A toss a shift for 5 days will be for 50 weeks, FAR is actually worked out on an average of thousand people that is the standard norms. So 1000 x 50 weeks of his work and 8 hours a day and five days a week for 50 gives him a value of so much, so FAR for 108 manners is four as you see from the table.

In the case of an abroad assignment where the person is employed or offer an employment in oil and gas industry, the working hours clearly show so only four hours a shift for 200 days, Far a still sample 4,000 workers, so 1000 or 50, 4 hours a day of 200 days give only 40% of the existing risk. So FAR for 0.4x 108 will be obviously 0.4 x 4 which will be 1.6, in this mind of comparison.

This is the FAR for the new job, as a fatality rate is much lower than his present job you should opt for the new job, one can ask me a question how this FAR is being reduced, because the working hours are reduced. Friends please understand fatality exchange rate is not a simple number it depends on how many hours you are exposed for that risk.

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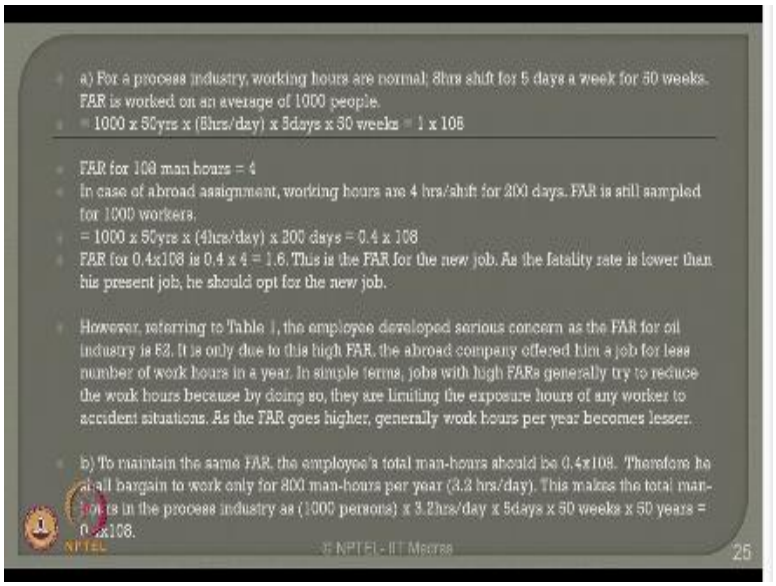

However referring the table 1 the employer developed a serious concerned as a FAR for oil and gas industry is 62, it is essentially due to this FAR the abroad company offer him a job for less number of working hours in a year, in simple terms jobs with higher FAR's generally try should reduce the working hours because by doing so they are limiting the expose of hours of any work path to accident situations.

As the FAR's go higher and higher generally working hours per year becomes lower and lower. Now the second question the person wants to shift from the oil and gas industry back to his principal employer which is a process industry now he wants to meet on the same FAR, the employers total manners should be 0.4 x 108 that is what we have seen in the calculation here, therefore he is now bargain to his present employer that only for 800 manners per year that is 3.2 hours per day he will work.

This makes the total manners in the process industry for 1000 persons as 0.4, 108 so the person will have the same FAR as he is presently working in the oil and gas industry.

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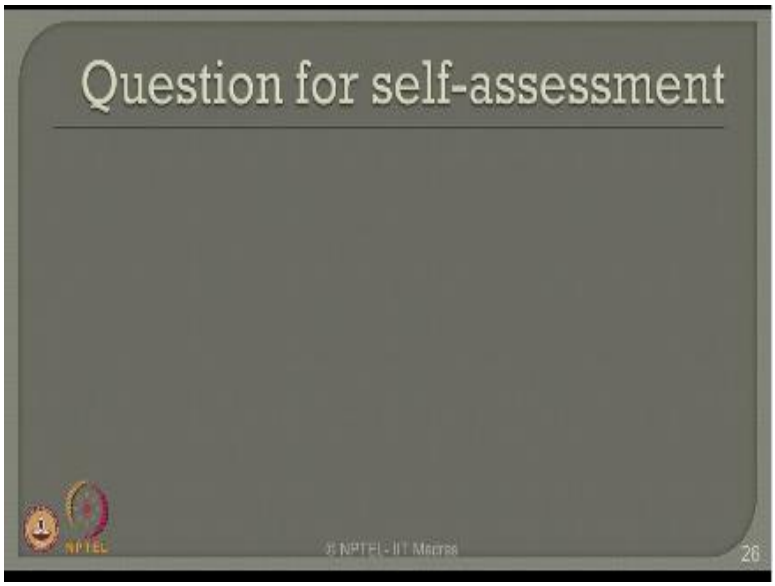

I have certain questions for the safe assessment, these questions are very important to assume a straight to answer them based on the knowledge whatever time from the lectures and from the reference material suggested to you in the NPTEL website.

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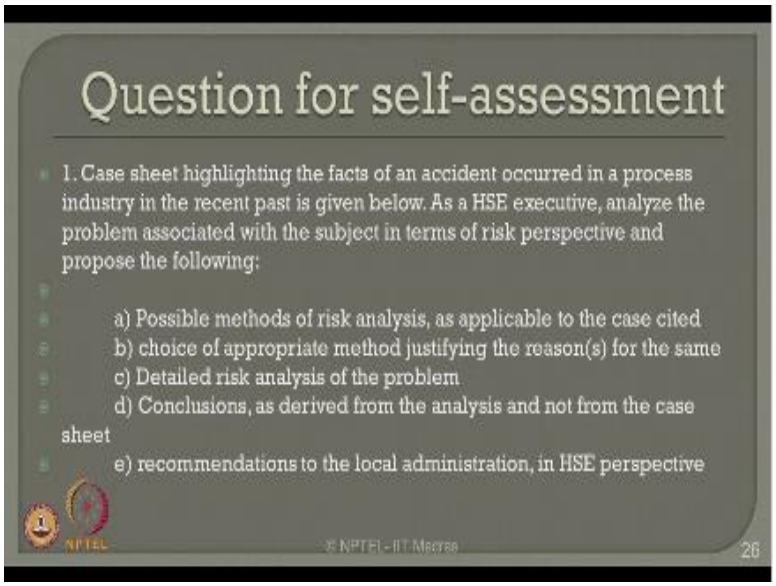

K sheet highlighting the facts of an accident occur in a process industry in the recent past is given below, as HSE executive analyze the problem associated with a subject in terms of this perspective and propose the following, what are the possible methods of risk analysis as applicable to the case cited, what are the choice of appropriate method justifying the reasons for the same, can you be a detailed risk analysis of the problem.

Can you draw conclusions as derived from the analysis and not from the k sheet, also can you give a recommendations to the local administration in HSE perspective.

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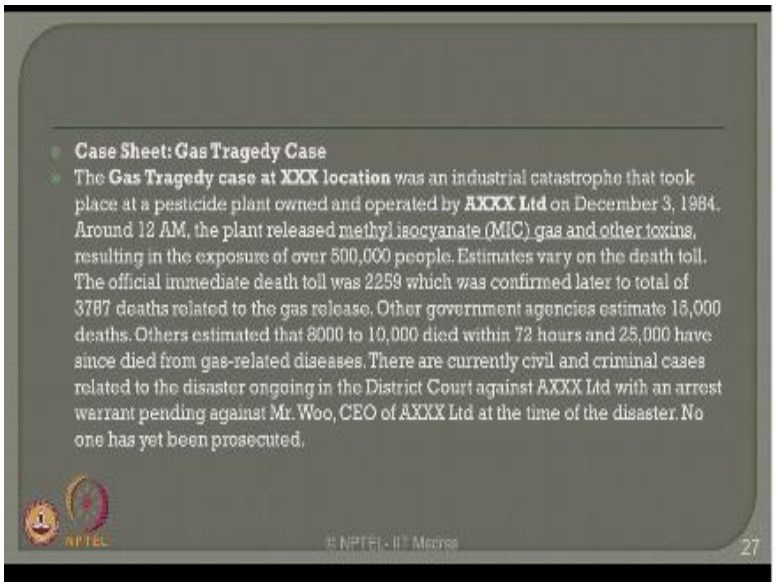

Let us see what is a K sheet, k sheet is about a gas tragedy case, the gas tragedy at XXX location was an industrial catastrophe that took place at the estate plant owned and operated by eight the + limited on December 3, 1984 around 12 am the plant released methyl iso-cyanate gas another toxins resulting in the exposure of about 500,000people, estimates very death toll the official immediate death toll was about 2259 which was confirmed later the total of 378 deaths related to the gas release.

Other government agencies estimated 15,000 deaths others estimated 8000 to 10, 0000 thousand died within 70 cats whereas 25,000 died since the gas related problem diseases as occurred, there are currently civil and criminal cases related adjust are going on in the district court against he had to plus limited within arrest warrant pending against the CEO of the company, no one has been yet prosecuted so far.

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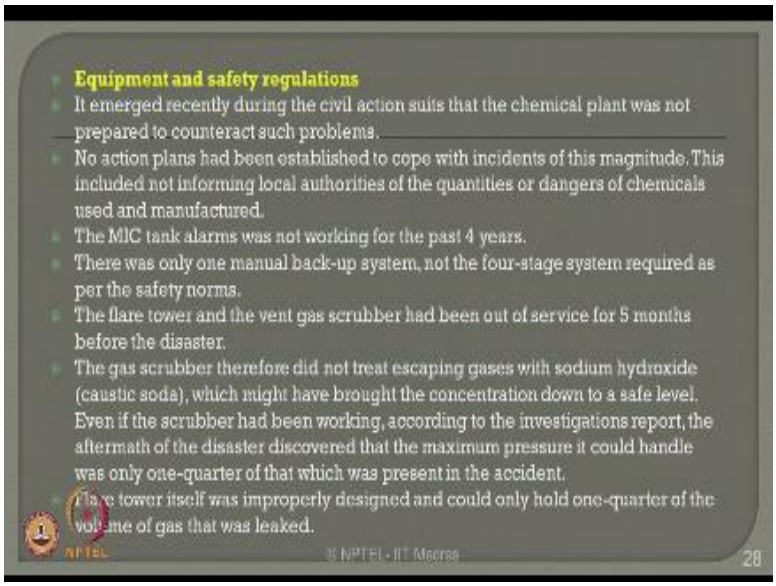

Let us speak to see what are the equipment and safety regulations which must have been follow and violated, it emerge recently during the civil action that the chemical plant was not prepared to counteract such problems, no action plan had been established to cope with the incidence of this magnitude this included not informing local authorities of the quantities or dangerous of chemicals used and manufactured.

The methyl isocyanate tank alarms was not working for the past four hours since accidents occur, there was only one manual backup system not the four stage system has required in the original design as per the safety norms, the flat tower and the wind gas scrubber had not been in service for five months since the accident occur before the disaster, the gas scrubber therefore did not treat the escaping gases that sodium hydroxide which is caustic soda.

Which might have brought the concentration down to a safe level even if the scrubber have been working according to the investigation reports the aftermath of disaster discovered that maximum pressure it could handle was only one quarter of that which has been present in the accident, flat tower itself was improperly designed and could hold only one quarter of the volume of gas that was leaked.

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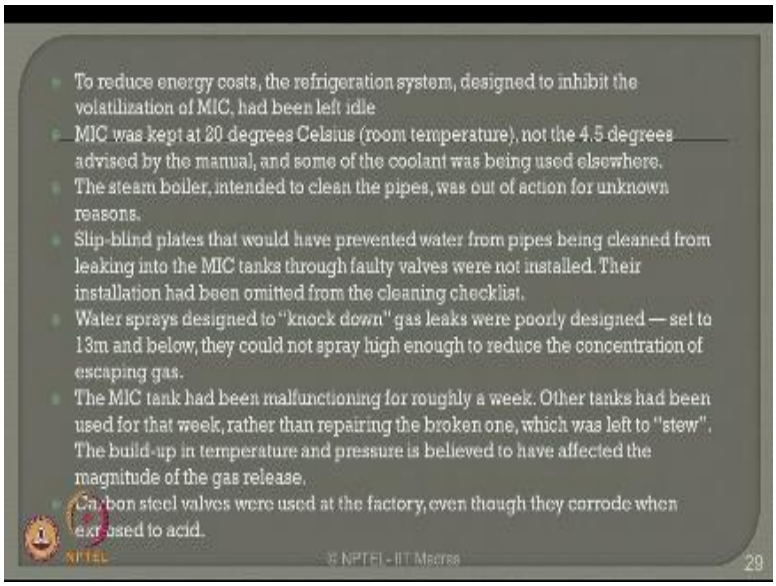

To reduce the energy costs the refrigerant system designed to inhibit the variation of M.A.C had been left idle, the methyl isocyanate was kept at 20 degree Celsius not at 4.5 which was supposed to be as per the safety norms, the steam boiler intended to clean the pipes was out of action for unknown reasons, slip blind plates there will be prevented waterfront pipes being cleaned from leaking into MIC tanks through a faulty walls were not insolved.

Their installation had been omitted from the cleaning checklist, water space designed to knock down gas leaks where poorly designed set to 13 meter in below they could not spray high enough to reduce the concentration of the escaping gas in the atmosphere, the methyl isocyanate tank had been malfunctioning for roughly a week other tanks had been used for the week rather than repairing the broken one which are left to this tube.

The buildup in temperature and pressure is believed to have happened which affected the magnitude of the gas release; carbon steel valves were used at the factory even though they covered when exposed to acid which was a known fact.

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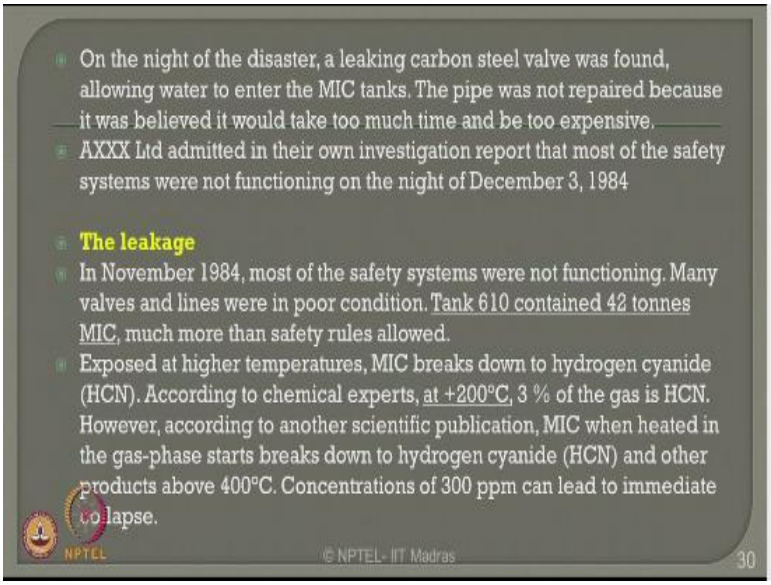

On the night of the disaster, a leaking carbon steel valve was found allowing water to enter MIC tanks. The pipe was not repaired because it is believed you have taken too much time and be too expensive. AXXX limited admitted in their own investigation report that most of the safety systems were not functioning on the night of December, 3 1984. November 1984, most of the safety systems were not functioning many valves and lines were in poor condition. Tank 610 which contains 42 tones of MIC much more than safety rules was allowed in operation.

The exposed at higher temperature MIC breaks down to hydrogen cyanide according to chemical experts at 200˚C 3% of gas is hydrogen cyanide. However, according to another scientific publication the methyl isocyanides been heated in gas phase starts breakdown to hydrogen cyanide and other products above only 400˚C. Concentrations are higher as 300ppm which was exit can lead to immediate collapse of the whole system.

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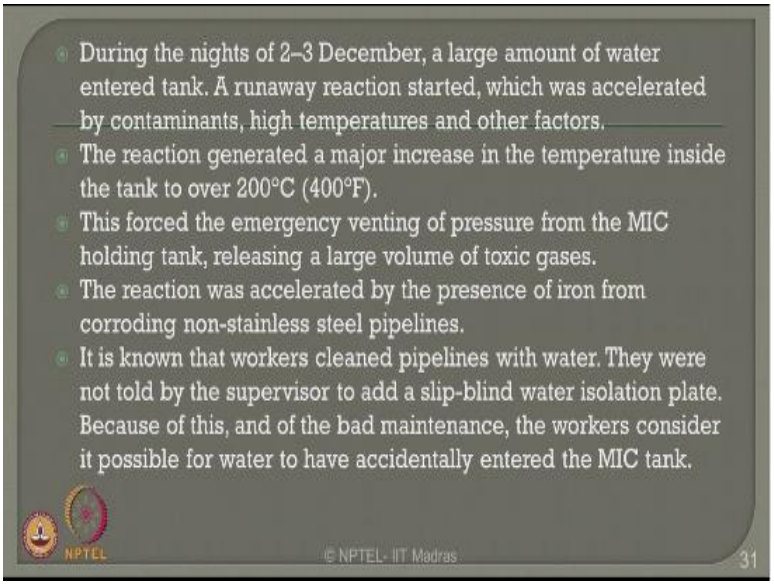

During the nights of second and third December a large amount of water entered the tank here runaway reaction started which accelerated by contaminants, high temperature and other factors. The reaction generated a major increase in temperature inside the tank which roast about 200˚C this force emergency venting a pressure from MIC holding tank, releasing a large number of toxic gases. The reaction was accelerated by the presence of iron from corroding non stainless steel pipe lines. It is known that workers cleaned pipelines with water, they were not told by the supervisor to add slip blind water isolation plates.

Because of this and of the bad maintenance, the workers consider it is possible for water to have accidentally entered the methyl isocyanate tank.

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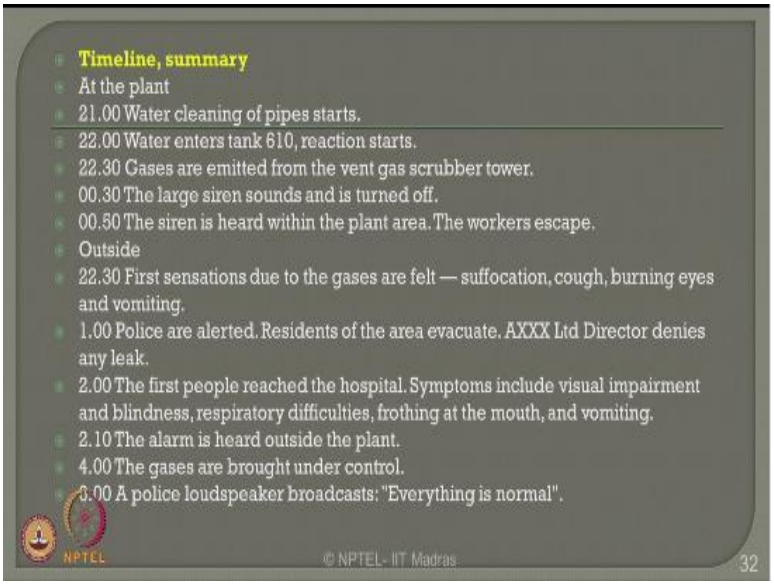

For looked at the timeline of a summary, at the plant at 21 hours water cleaning of pipe started 22 hours water enters the tank, 23.30 emitted from the vent gas scrubber tower. At midnight the largest siren sounds and turned off at midnight again the siren is heard within the plant area the workers escaped. In the outside at 23.30first sensation due to gases were filled with the public it cause suffocation, cough, burning eyes and vomiting.

At one o’clock in the midnight police were alerted, residents of a cover area evacuated. AXXX Director denies any leak in an official press release. At two o'clock in the early morning the first people reach the hospital symptoms include visual impairment, blindness, respiratory difficulties, frothing at the mouth and vomiting. At 2.10 the alarm is heard outside the plant. At four o’clock gases brought under control, at six o'clock a police spokesman said in the loudspeaker everything is normal.

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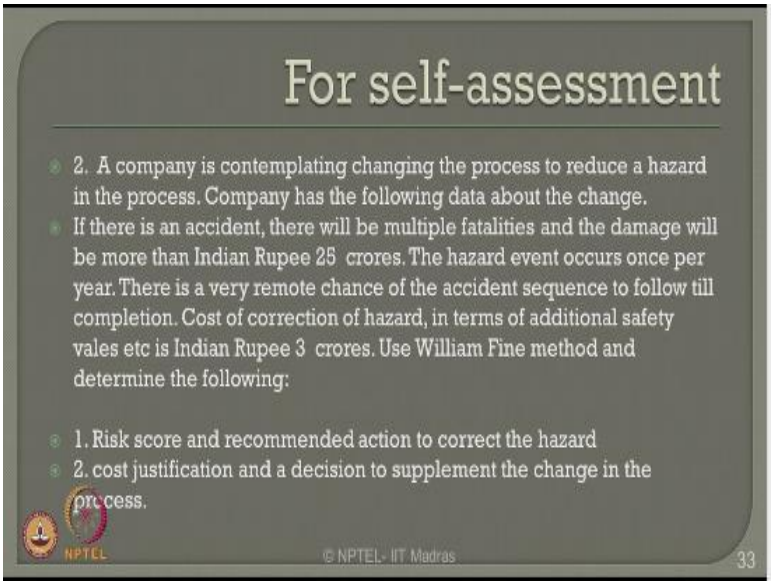

Let us look at next question for self-assessment, a company is contemplating changes to the process in order to reduce hazard in a given process system. Company as the following data about to change. If there is an accident there will be multiple fatalities and the damage will be more than Indian rupee of 25 crores. The hazard event occurs once per year and there is a very remote chance of the accident sequence to follow till completion. The cost of correction of hazard in terms of additional safety results is about Indian rupee 3 crores.

Use William fine method and determine the following. Risk a score recommended action to correct the hazard. Cost justification and a decision to supplement the change in the process.

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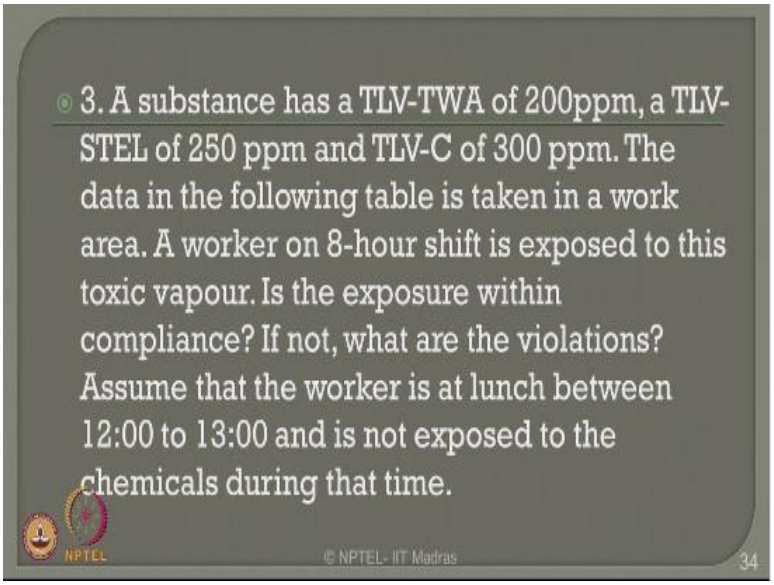

Question number 3, a substance has got TLV-TWA time weighted average of about 200 parts per million, a TLV STEL that is short-term exposure limit of 250 ppm and of 300 ppm, these are characteristics in terms of parts per million of specific substance or a chemical. Now the data the following table is taken in a work area, a worker on an eight hour shift is exposed to this toxic vapor. Now the question is, is the exposure within compliance limits, if not what are the violations?

Assume that the worker is at lunch between 12 to 13 hours and is not exposed to these chemicals during the time. Now one may require a table of how the exposure is attacking the working personal in an eight hour shift.

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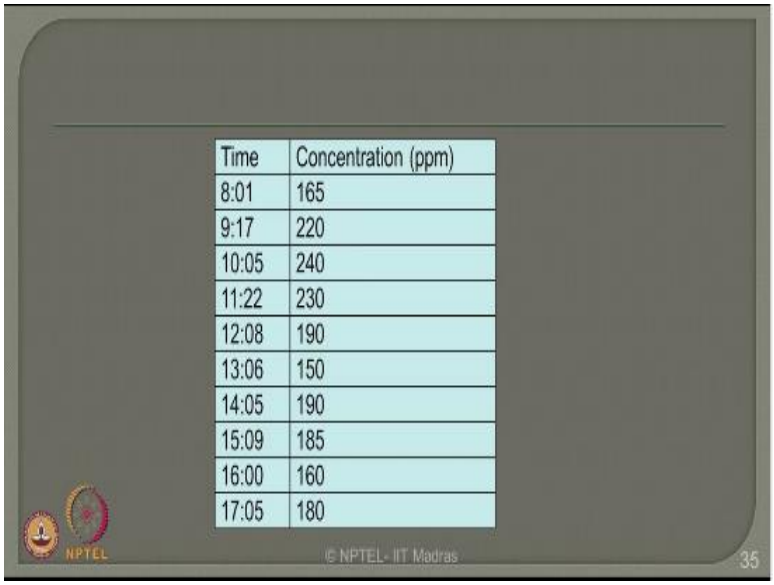

So the table gives you the detail starting at eight o'clock in the morning till five o'clock in the evening leaving the lunch hours that is between 13 and 14 the data has been taken in terms of concentration of ppm what the person is exposed. With this data kindly answer those two questions which I asked you in the last slide.

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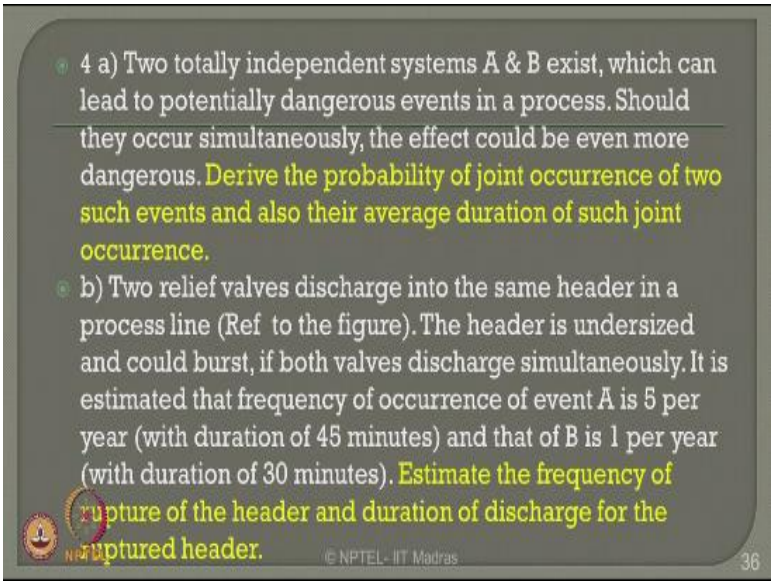

Example question four for self-assessment, there are two totally independent systems naming A and B exist in a plant which can lead to potentially dangerous events in a given process. Now the question asked is, if these systems operate simultaneously the effect could be even more than dangerous. Derive the probability of joint occurrence of two such events and also their average duration of such joint occurrence. Two relief valves discharge in the same header in the process line I show a figure the next slide.

The header is under sized and could burst if both valves discharge simultaneously. It is estimated that the frequency of occurrence of event A is five per year with the duration of 45 minutes each time and that of B is one per year with the duration of 30 minutes each time. Estimate the frequency of rupture of the header and duration of discharge for the ruptured header.

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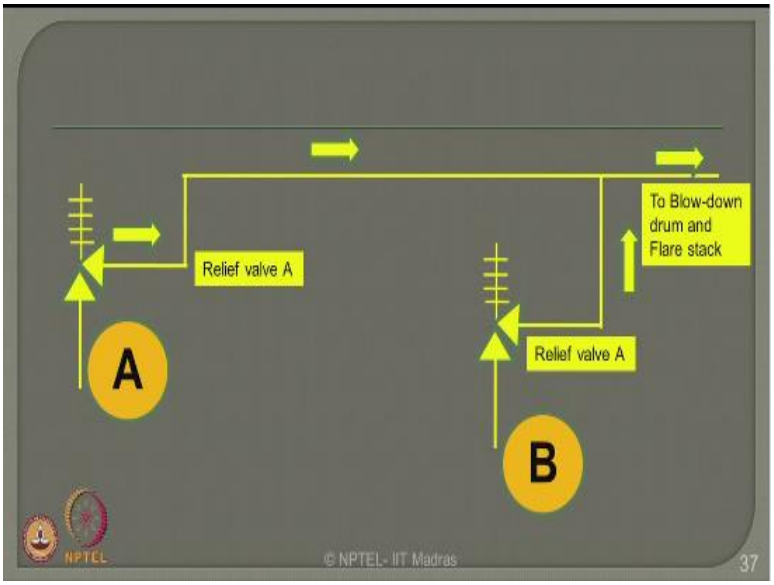

These are the two events A and B valves which are operating on the common header which will lead to the blow down drum and the flare stack. The question is positive in the previous slide, please understand the question and give me the answers for both the questions asked in the slide.

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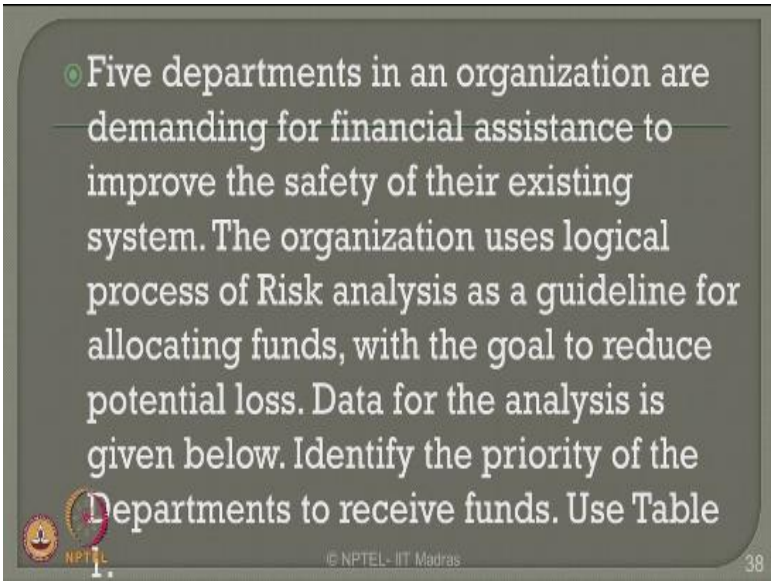

The next example is very interesting, five departments in an oil gas industry are demanding for financial assistance to improve the safety of their existing system. The organization uses logical process of risk analysis as a guideline for allocating funds with the goal to reduce the potential loss. Data for the analysis require is given below in the next slide, please identify the priority of the departments receive funds. Use table 1 given the next slide.

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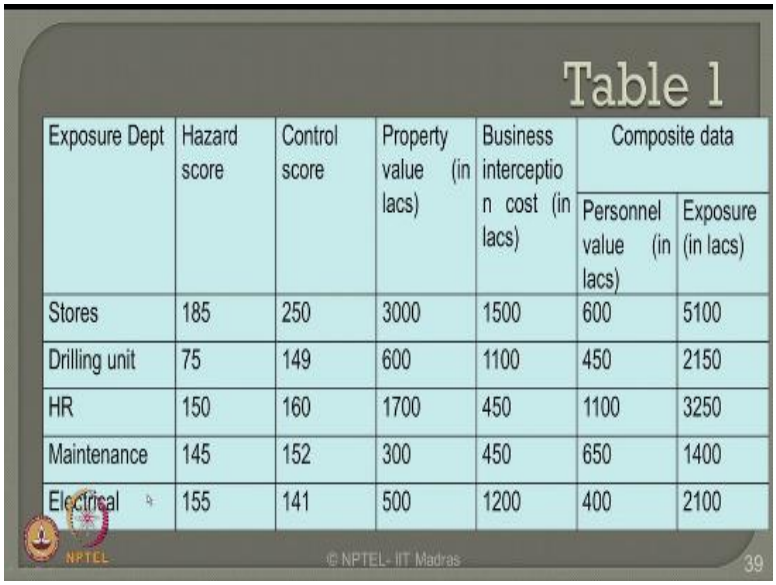

For the problem, the table 1 shows there are about five departments in a given unit, there hazard scores, control score are given the property value in terms of lakhs and business interception cost in terms of lakhs are given the composite data in terms of personal value and exposure in lakhs or available to you. Kindly do the risk ranking and then try to advise as an just executive which department amongst this five who receive the maximum funding in terms of risk mitigation and solution for the existing risk problems.

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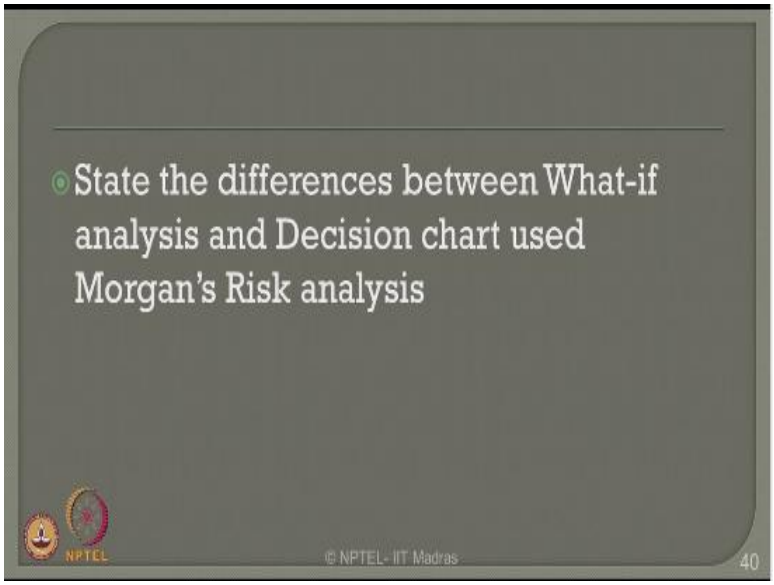

Next question is as follows state the differences between the what-if analysis and the decision chart that is used in Morgan's risk analysis.

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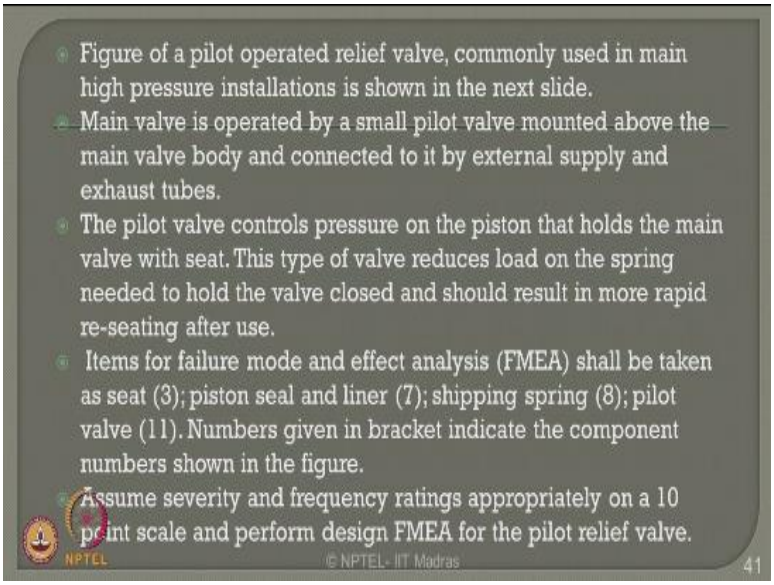

The next question is very interesting, there is a figure of a pilot operated relief valve which I will show you in the next slide which is commonly used in the main high-pressure installation which is shown. The main valve is operated by a small pilot valve mounted above the main valve body and is connected to the main valve by an external supply and the exhaust tubes. The pilot valve controls pressure on the piston that holds the main valve with the seat. This type of valve reduces load on the spring that is needed to hold the valve closed and therefore result in more rapid reseating after use.

The items have failure mode and effective analysis are identified as follows, the seat which is indicated as 3 number in the figure. The piston seal and liner indicated as number 7 in the figure, the shipping spring as number 8, the pilot valve as indicated as number 11. The numbers given in the bracket indicate the component number in the figure which is now shown to you. Assume the severity and frequency rating appropriately in a scale of 10 point and perform a detail FMEA for the pilot relief valve shown in the figure.

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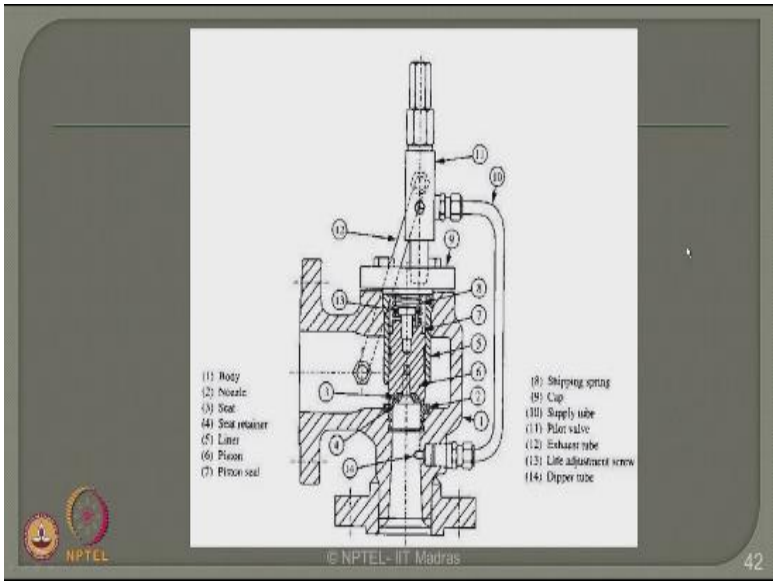

Now you can see here the component 1one is the entire body of the valve, the component 2 is a nozzle, the component 3 is a seal, the component 6 is the piston which is being shown in the valve here, component 8 is the shipping spring which is actually used to activate the recent ring of the valve for the closer and 14 point is the dipper valve which contains the pressure on the internal line. Try to understand the mechanical working of this valve with the help of the slide shown in the previous one and prepare a detail FMEA for this particular problem.

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The next question is interestingly a case sheet where you have got to prepare the hazard and operability study on LPG bottling plant located in India at location YYY. The LPG bottling plant is operated by an XXX company which has got an LPG bulk storage capacity of our 900 metric ton. It is being stored in six bullets of capacity each of 150 metric ton the bottling plant is under operation to refill this bulk store LPG into cylinders both for domestic and commercial use.

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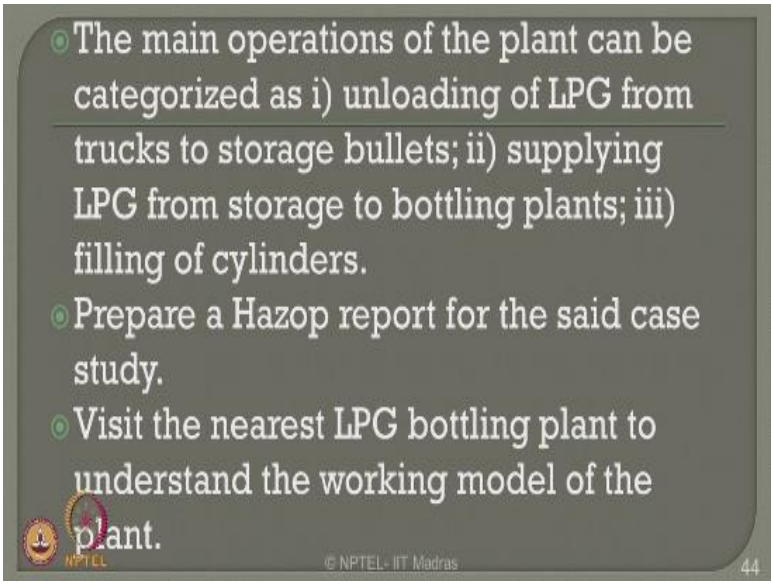

The main operation of the plant can be categorized as unloading of LPG from trucks to the storage bullets, supplying LPG from the storage bullets to the bottling plants, the third area can be refilling of cylinders. Prepare a Hazop report for the said case study. Visit the nearest LPG bottling plant by your area to understand the working model of this plant.

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The next question is on preparation of FMEA report for a big system assembly impart in a passenger car which I will show you a video at the end of this lecture.

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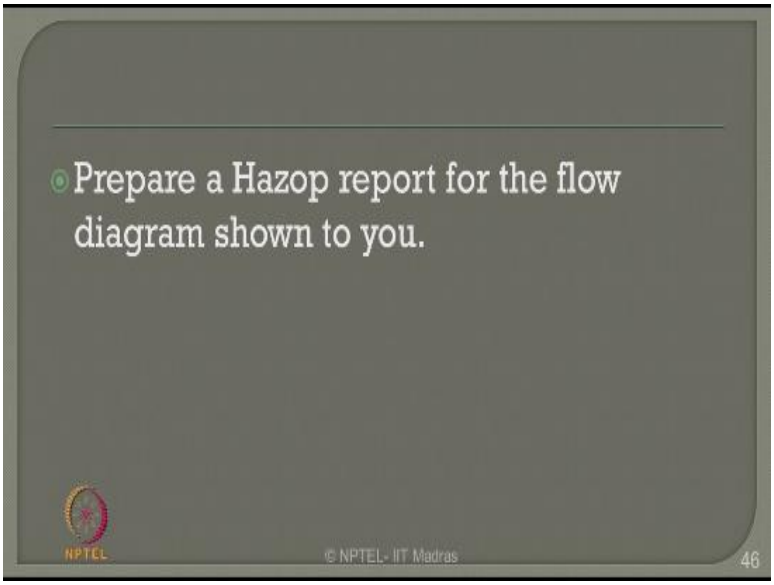

Following by which another question is a Hazop report for a flow diagram which I will also show you as a video now.

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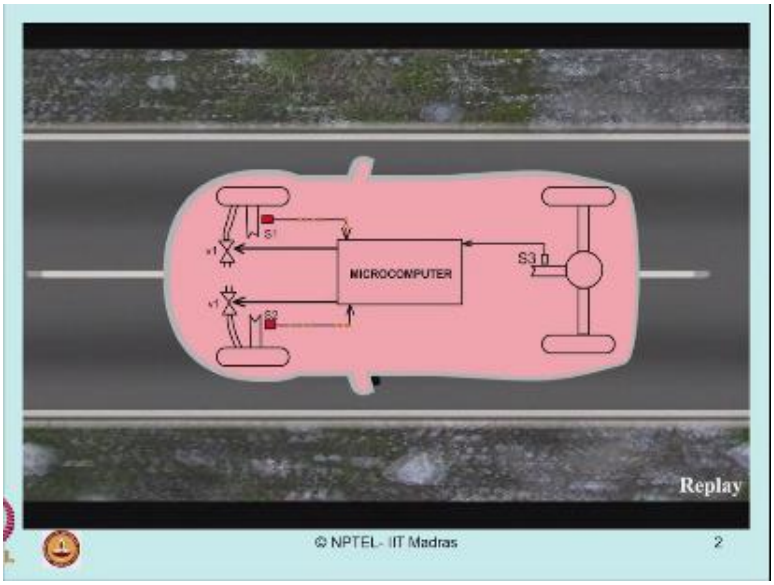

Watch this video this video has got two valves of a passenger car which will be used to control the speed of the car in case of any unforced in emergency. To watch law sensors s1, s2 connector the microcomputer they should open or close the valve as they are required. Sometimes the microcomputer may not receive the signal properly there can be elapse of communication between the sensors to that of the valves and in that case since s3 will operate the brake system effectively. So you have to do an FMEA for this kind of brake assembly system in a mechanical device in a passenger car system. Identify the components and try to find out the ranking of criticality of these components in terms of effective working of the passenger car.

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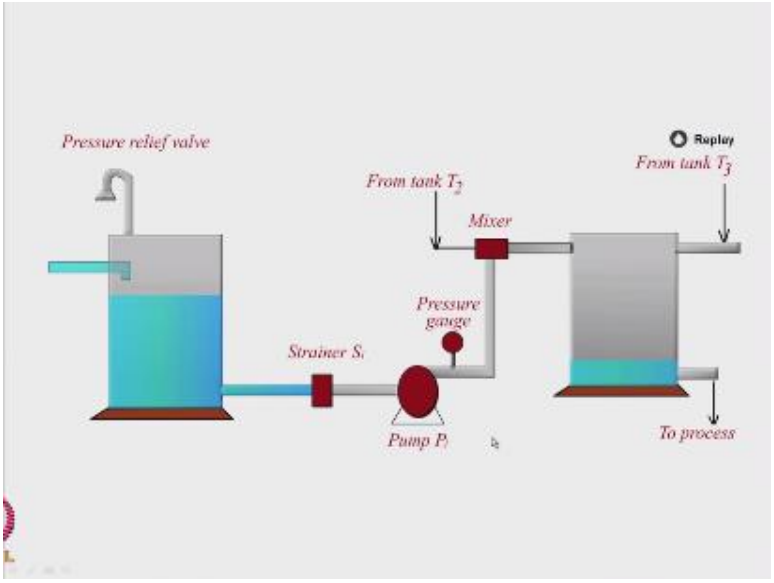

The figure what you see here is combination of three tankers tanker t1, tanker t2 which is supply line and tanker 33 there is a pressure relief valve located in tanker t1 and of course there is a process happening in tank at 3, the tank that 3 you he is chemical from t1and t2 which is passed through a mixture and the strainer respectively. Now in case if the chemical from the tanker t1 passes through the strainer which is pumped out and a pressure gauge is maintained here to see the pressure if they basically blocked in the line because of the strainer, because attack the t1 may receive chemicals with floated and suspended particles.

If a strainer blocks them then in that case this area of the supply pipeline becomes empty which resists the valves in failure of the pump p1. Therefore, more chemical from tank t1 will be no pumped to tank 33 however chemical from tank t2 alone comes to time t3. A very simple process which make is to understand how to write down Hazop report for this kind of study.

So preparing a Hazop report for this identifying the segment and see what are the design intends and the deviations of the given problem. Ladies and gentle men this was the summary lecture of module 1 safety assurance in HSE management NPTEL IIT-Madras I have given you certain questions for answering you can answer them any doubts related to this can be pleased posted to NPTEL IIT Madras, thank you very much and bye you.

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