Chemical Process Safety
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Lecture 5
Problems related to Safety & Accident Loss Statistics

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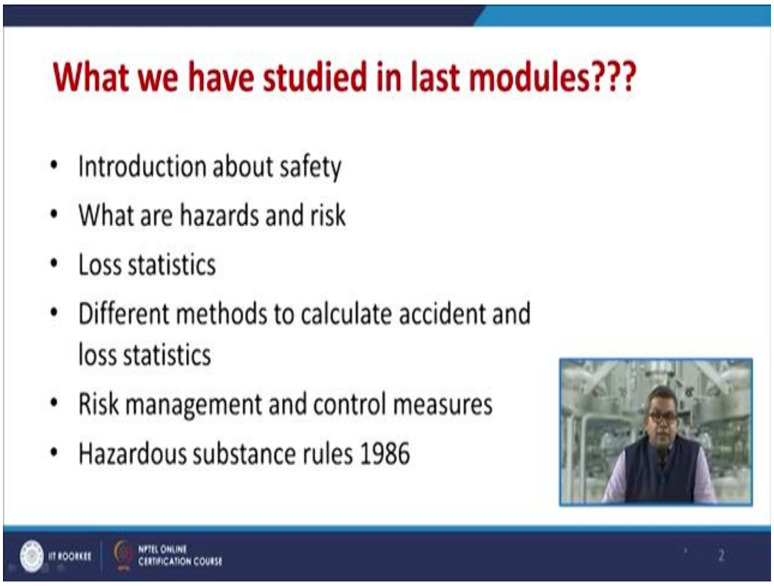

Welcome to the module related to the problem statements of loss statistics, so let us have a look about that what we had discussed in the previous modules. We have gone through about the introduction about safety, we have defined that what are the different hazards and risk, discussed about the loss statistics, we had gone through the different method to calculate the accident and different kind of loss statistics because these loss statistics plays a very vital role while designing any kind of safety operation within the plant or any kind of process, we have gone through the concept of risk management and different control methodologies, we had discussion about the hazardous substance rule in related to 1986.

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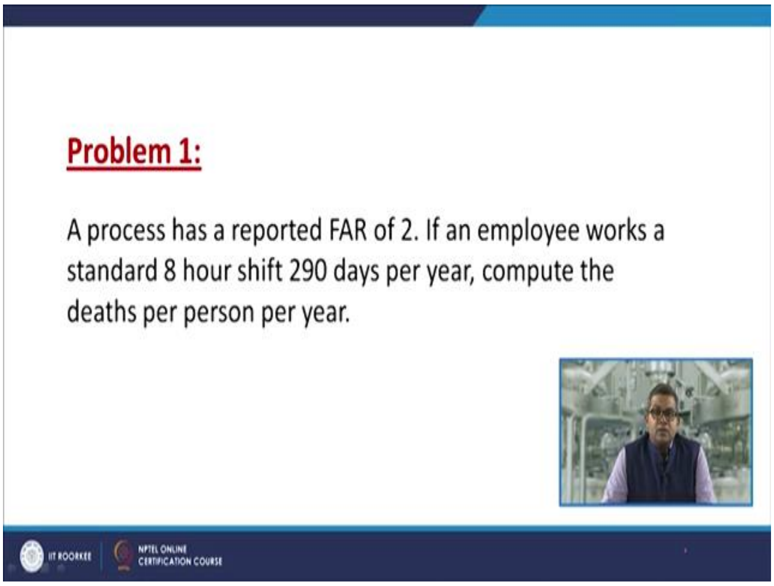

Now, in this particular module we are going to discuss the various problems related to the accidents and loss statistics and other topics related to the study which we have gone through so far. So let us have a look about the first problem. Now here in this particular problem this is related to the FAR (Fatality Accidental Rate) and a process has reported FAR of 2. So you need if an employee works standard 8 hour shift for 290 days per year, so you need to compute the death expected per person per year. So we are having the standard formula for this FAR.

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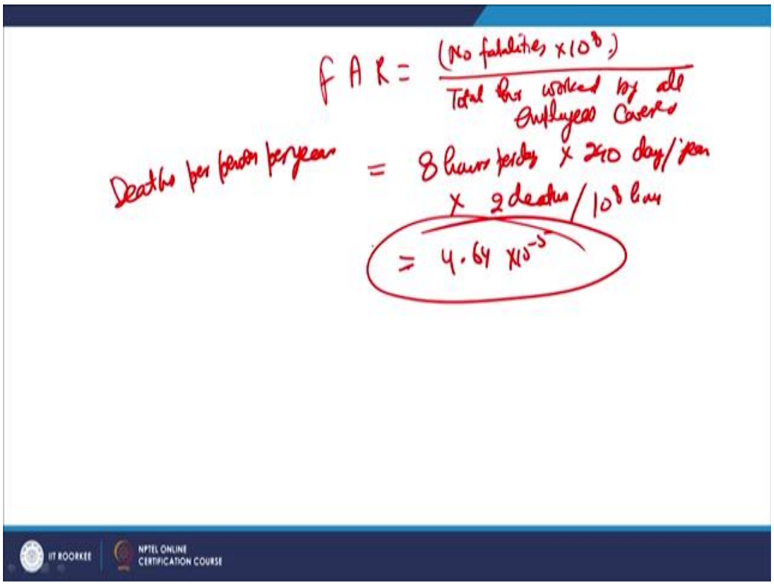

Now, this

FAR = (No. of fatalities × 10^8) / (Total hours worked by all employees covered)

So here you are having a shift of 8 hours per day, so,

Deaths per person per year = (8 hours per day) X (290 days/year) X (2 deaths/10^8 hours)

$= 4.64 \times 10^{-5}$

So the FAR is so the death per person this is the death sorry this is the deaths per person per year, so this is the death per person per year is coming out to be 4.64×10^{-5}

So, you can anticipate 4.64×10^{-5} death per person per year based on the statistical information given to you in this particular problem.

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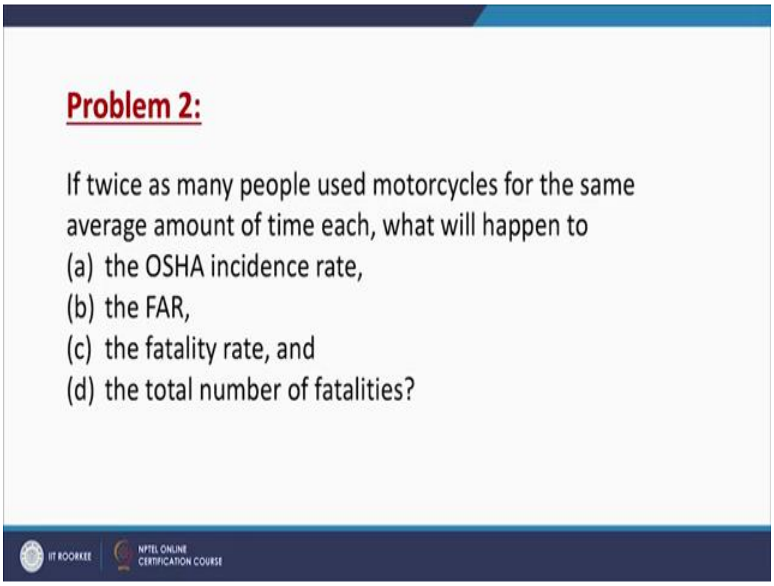

Now, let us have another problem, this problem says that if twice as many people used motorcycles for the same average amount of time each, what will happen to the OSHA incidence rate, number 2 the FAR, number 3 the fatality rate, number 4 is the total number of fatalities? So in this particular problem the OSHA incidence rate will remain same because the number of injuries and death will double but the total number of hours exposed will double as well.

Now, the second problem says that you need to calculate the FAR, now here the FAR remain unchanged for the same reason which we have discussed in part number A that is related to the OIR. Now the third problem says that what would be the fatality rate? Now the fatality rate or death per person per year will double, the fatality rate does not depend on the number of hours exposed. And the last part covers that the total number of fatalities, so based on the information because twice many people use the motorcycle the total number of fatalities will be doubled in this particular case.

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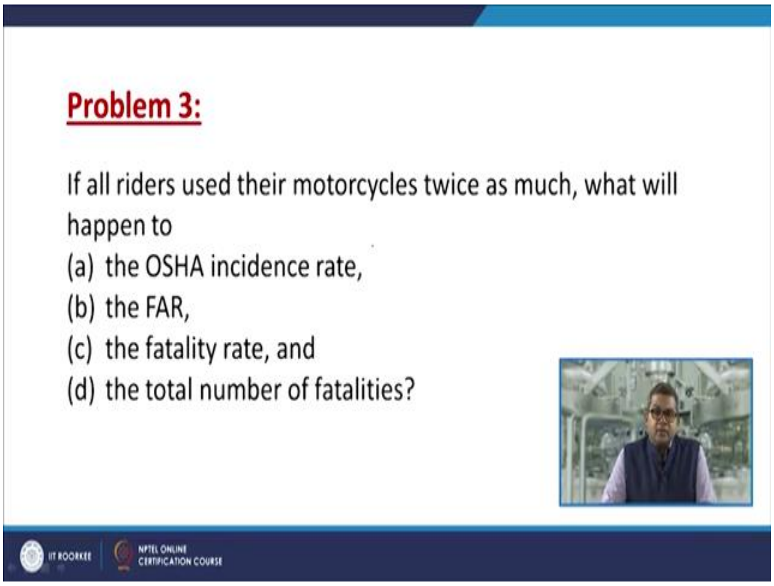

Now, let us have problem number 3. This problem says that if all riders used their motorcycle twice as much what will happen to the OIR? Now let us come to the problem number 3, now here the problem is a bit similar to previous one. Here the slide change that if all riders they use their motorcycle twice as much what will happen to the OIR and FAR the fatality rate and the total number of fatalities. So the OSHA incidence rate will remain the same and the number of injuries and death that will be doubled, but the total number of hours exposed will double as well.

As far as FAR is concerned the FAR will remain unchanged for the same reason which we have discussed for the OSHA incidence rate, regarding the fatality rate, the fatality rate will double because the riders they are using motorcycle twice. So the twice as many as fatalities will occur within this particular group.

The last part of the problem says that what would be the total number of fatalities? So in that particular case because they are the riders they are using the motorcycle twice as much so the number of fatalities would be double in this particular case.

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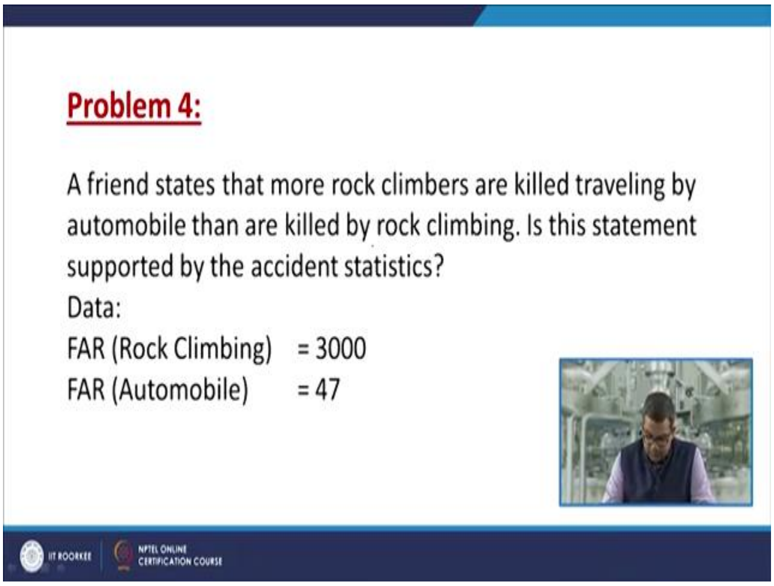

Now, let us have another problem that is problem number 4. Here a friend states that more rock climbers are killed travelling by automobile than are killed by rock climbing, is this statement supported by the accident statistics? So for this particular aspect we require couple of data and these data are always available in the reference book. So FAR for rock climbing it is given that 3000 and FAR for automobile it is given that the 47. So as per the data, it shows that the travelling by automobile which is having the FAR of 47 is safer than the rock climbing.

So, rock climbing produces many more fatalities per exposed hour than the travelling by automobile. However, the rock (climbing) rock climbers probably spend more time travelling by automobile than the rock climbing. So as a result the statement is very ambiguous that a statement might be correct but we may require some more data because it does not reflect any kind of uses of either rock climbing or the travelling by the automobile, so sometimes you may say that some more data or some more statistical information is required to solve this particular problem.

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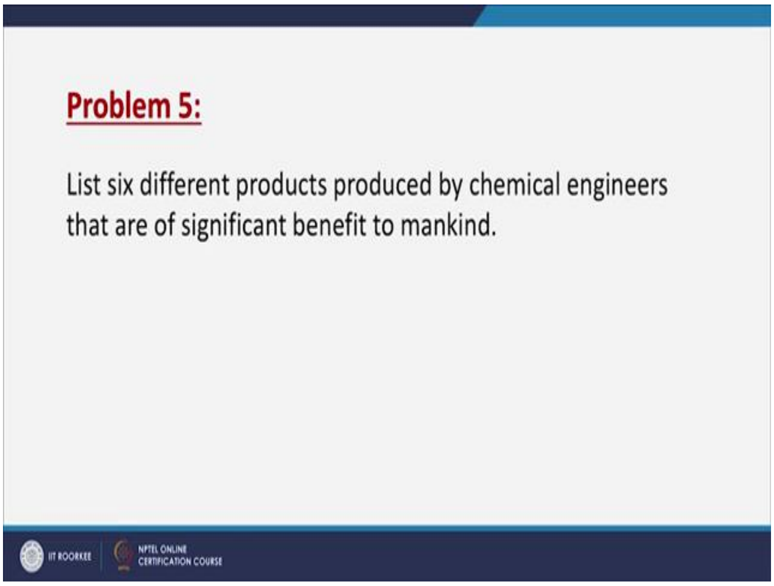

There are you may in this particular problem you may list to six different products produced by any chemical engineer that are significant benefit of the mankind, it is a very interesting question. So there are may be like you can say the penicillin, gasoline, synthetic rubber, paper, plastic, sometimes concrete and you can say the all kind of food items, etc.

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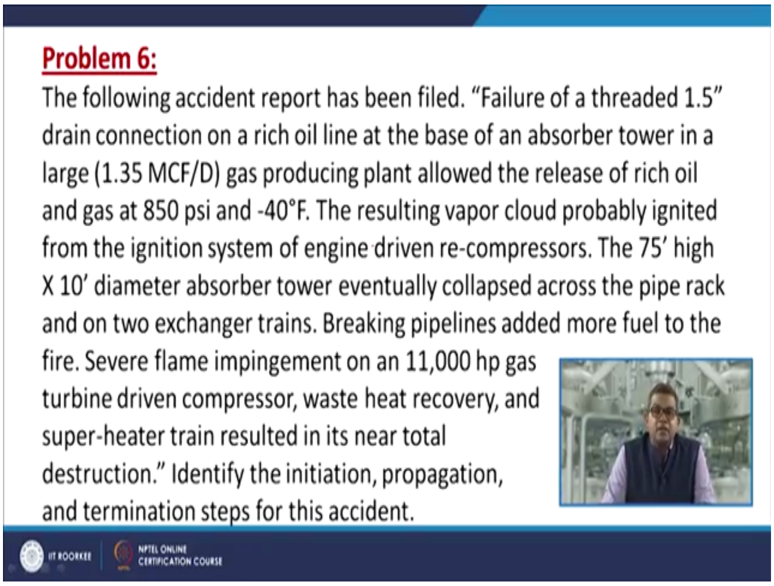

Our other problem says it is a bit long problem you can say that the following accident report has been filed, that "the failure of threaded 1.5 inch drain connection on a rich oil line at the base of an absorber tower in a large that is having the 1.35 MCF per day the gas producing plant allowed the release of rich oil and the gas at 850 psi and -40 degree Fahrenheit. So the resulting vapour cloud probably ignited from the ignition system of an engine driven re-compressor and a 75 feet high and 10 feet diameter absorber tower eventually collapsed across the pipe rack and on two exchanger trains.

So, the breaking pipeline added more fuel to the fire and severe flame impingement on the on an 11,000 horsepower gas turbine driven compression, waste heat recovery, and the super-heater train resulted in its total destruction. Now here you need to identify the initiation, propagation and termination step for this particular accident. Remember whenever we discussed about the initiation, propagation, and termination it all depends about the perception to persuasion of a human being, sometimes engineering perspective maybe different than a common people perspective.

So, let us talk about the engineering perspective, so initiation maybe referred as a failure of threaded drain connection, propagation because once initiation start let us discuss about the propagation so the release of rich oil and the gas and the formation of a vapour cloud, ignition of that vapour cloud by the re-compressor and the collapse of absorber tower across pipe rack, so this is the propagation.

And of course the termination is the consumption of all kind of combustible material present within the plant periphery. So by this particular problem you can have a look about different aspect of initiation and propagation.

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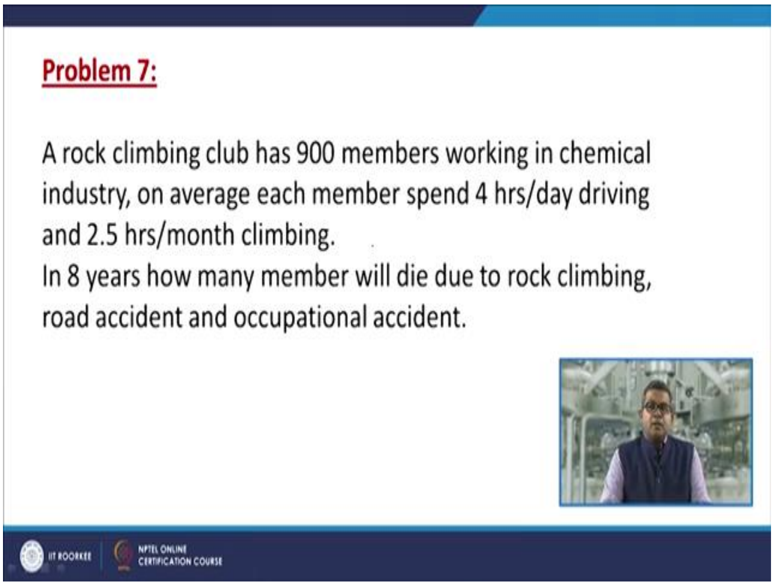

Now, let us have a look about the problem number 7. Here a rock climbing club has 900 members working in a chemical industry, on average each member spend 4 hours per day in driving and 2.5 hours per month in climbing. So in 8 years how many members will die due to this rock climbing aspect, road accident and occupational statistics?

So for this particular aspect you may require certain data related to the fatality accidental rate which we will utilize while solving this particular problem.

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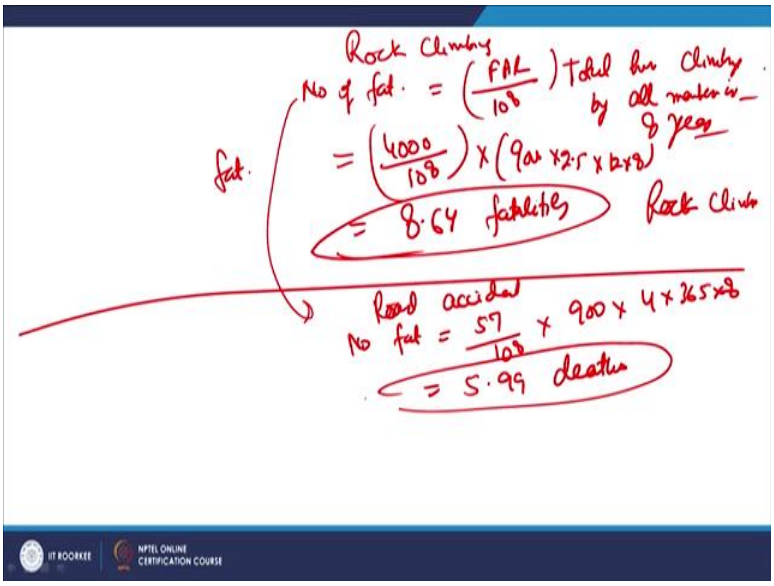

So here, let us take the first example of rock climbing. So,

Number of fatalities = (FAR/10^8) total hrs climbing by all member in 8 years.

So this fatality is comes out to be,

Number of fatalities = (4000/10^8) X (900X2.5X12X8)

So it is comes out to be 8.64 fatalities, so this is attributed to the rock climbing.

Now, let us have a look about the road accident. So number of fatalities is again we are having the same formula, so here we are having:

Number of fatalities = (57/ 10^8) X (900X4X365X8)

= 5.99 deaths.

So here you may expect 5.99 deaths in respect to the fatality.

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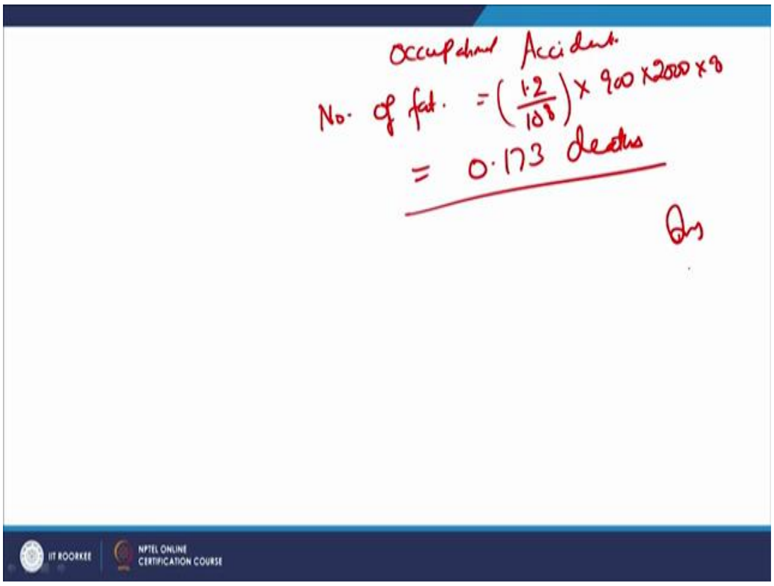

Now, in the next aspect we are having the occupational accident. So again we will utilize the same formula which we have discussed in the previous slide. So,

Number of fatalities = ($1.2/ 10^8$) X (900X2000X8)

= 0.173 deaths.

So these are the answers for this problem number 7.

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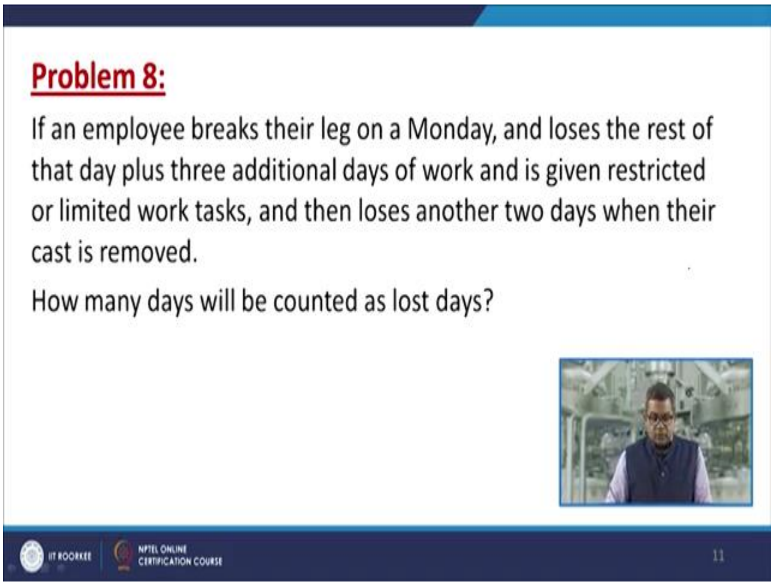

Now, let us have a look about the next problem. Here if an employee breaks their leg on a Monday and loses the rest of that day plus 3 additional day of work and has given restricted or we can say the limited work task and then loses another 2 days when their (its his) cast is removed, so here you have to calculate that how many days will be counted on lost day? So here if an employee breaks their leg on Monday and loses the rest of day the three additional day of work that is the employee comes back on the Friday and then loses another 2 days when his cast was removed, so as the day of injury or illness occurred is not counted as a lost work day because he was present on that very day, the total number of lost day would be 5.

So, you may take a note that for a incident that have lost time occurring over longer period of time weekend are counted as a working day and the number of lost day is kept at 180 days. So this is the aspect of this particular problem.

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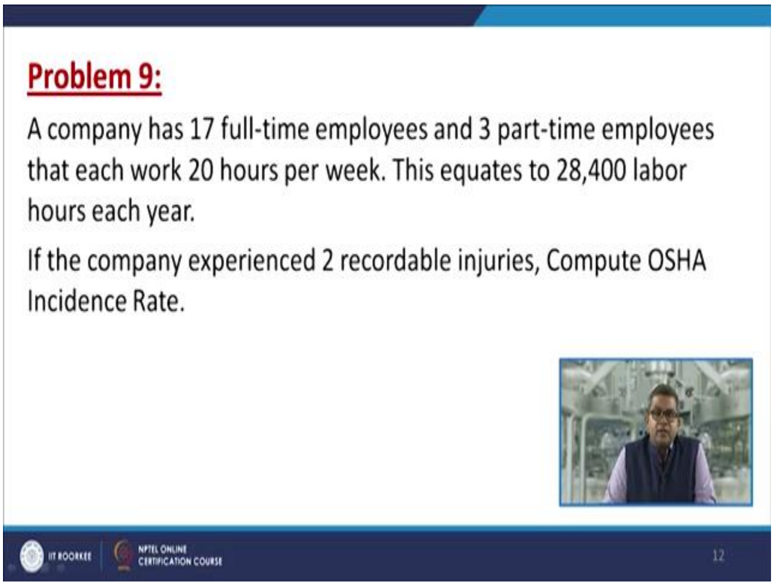

Now, let us have a look about the next problem that a company has 17 full-time employees and 3 part-time employees that each worker 20 hours per week. So this equates that 28,400 labor hours each year. Now if company experienced 2 recordable injuries, then you need to calculate the OIR or OSHA incidence rate for this particular aspect.

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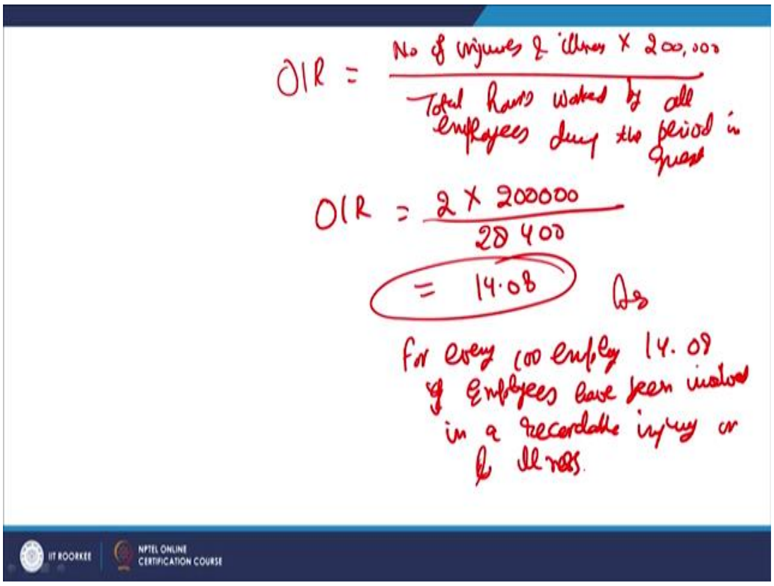

So here, let us have a look about that what OIR says,

OIR = (No. of injuries & illness × 200,000) / (Total hours worked by all employees during period covered)

OIR = (2 × 200,000) / 28400

= 14.08

so this is the answer. So for every 100 employee 14.08 employees have been involved in a recordable injury or illness. So this is the problem related to the OIR.

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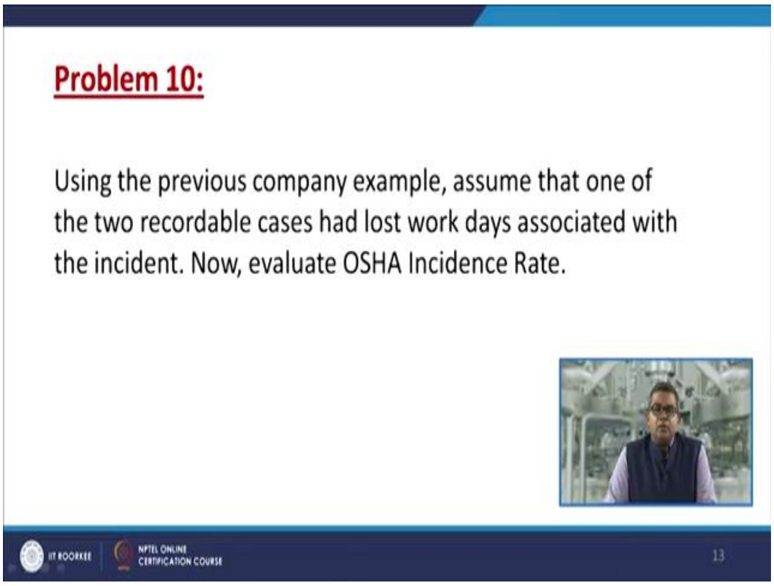

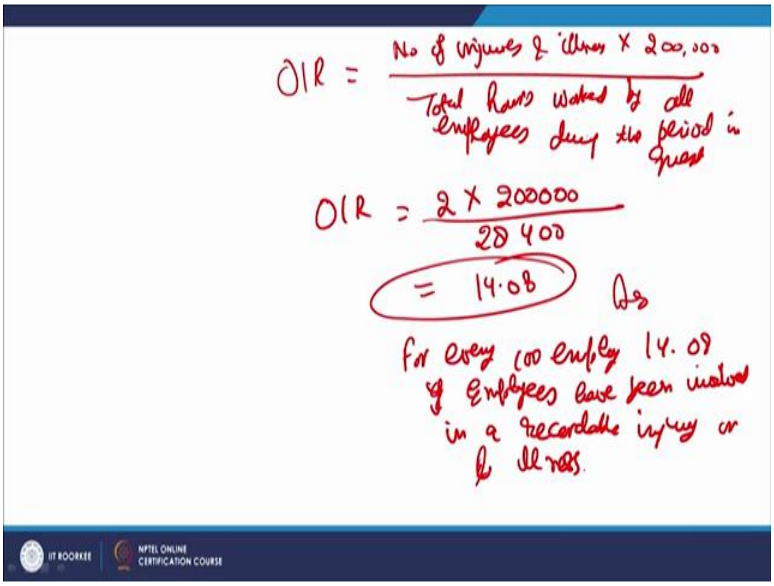

Now, let us have a look about the next problem that is problem number 10 that is using the previous example which we have discussed that is problem number 9. Assume that one of the two recordable cases had lost work days associated with the incident. So now you again need to evaluate the OIR based on this particular statement.

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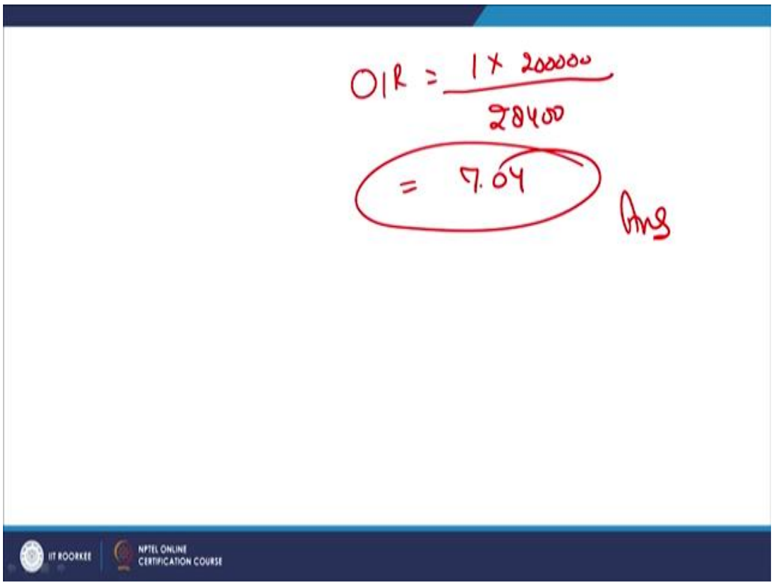

So, again refer back to the original one which we had discussed in the previous problem

$$\textbf{OIR} = (1 \times 200{,}000) / 28400$$

$$= 7.04$$

So for every 100 employee 7.04 employees have suffered lost time because of the work related injury or illness.

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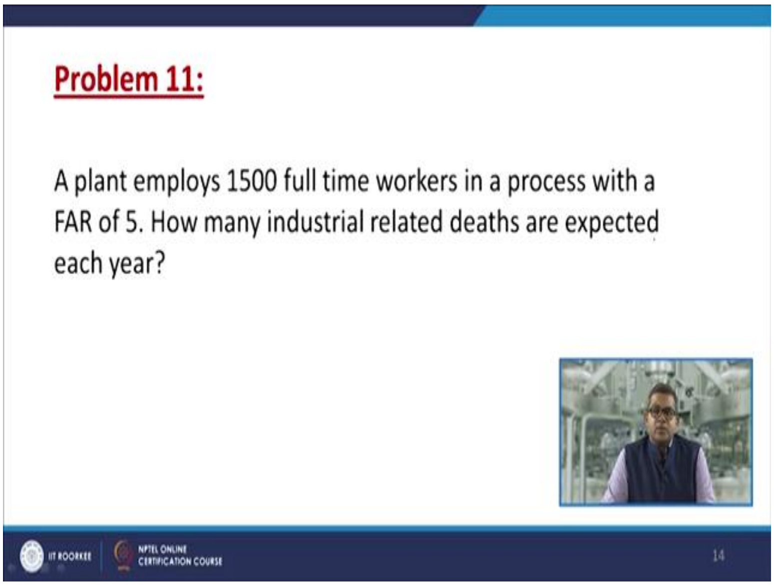

Let us see the other problem that is problem number 11. So a plant employs a plant employs a 1500 full time workers in a process with a having the FAR of 5. So how many industrial related deaths are expected each year?

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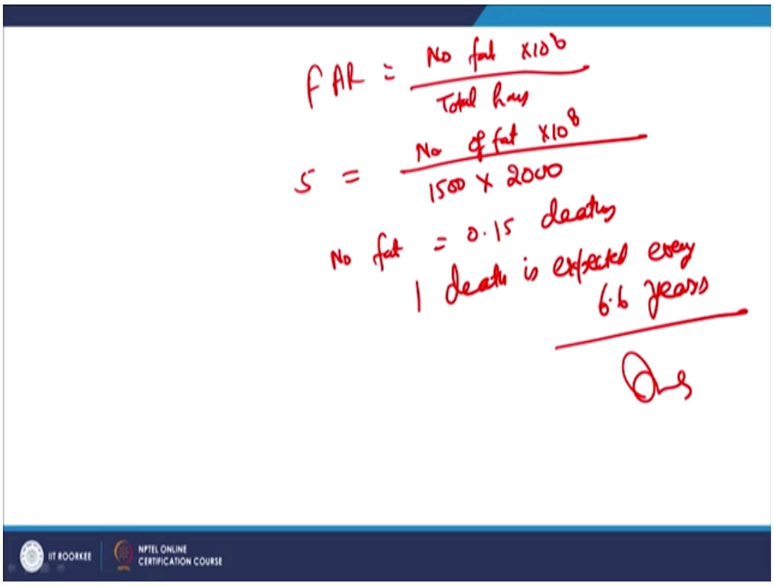

It is quite simple problem because we are having the FAR of this general formula:

FAR = (No. of fatalities × 10^8) / (Total hours worked by all employees covered)

So it is given that FAR is given 5,

$5 = (\text{No. of fatalities} \times 10^8) / (1500 \times 2000)$

No. of Fatalities = 0.15 deaths

So that is in other words you can say that one death is expected in every 6.6 years that is the answer. So here we have calculated this one.

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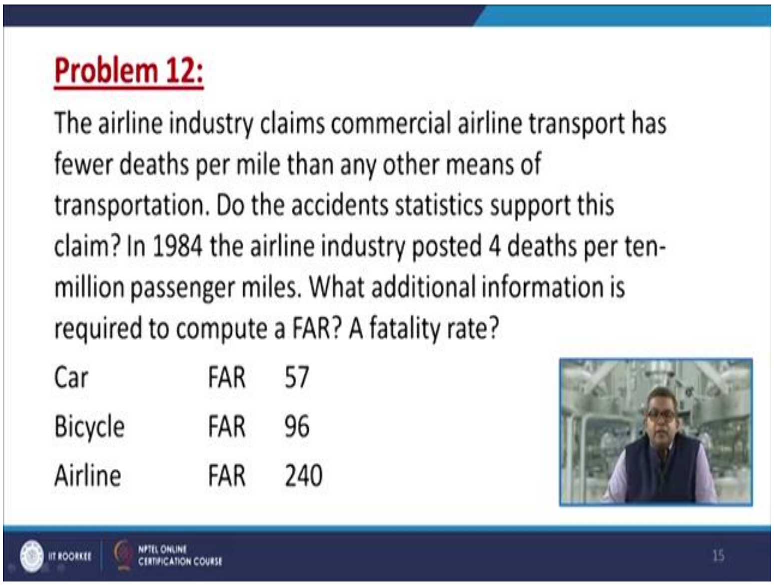

Now, let us take the problem number 12. Here an airline industry claims that commercial airline transport has fewer deaths per mile than any other means of transportation. Now do the accident statistics support this claim? First thing. In 1984 the airline industry posted 4 deaths per 10 million passenger miles. So what additional information is required to compute FAR? A fatality rate, etc.

So, here you are having the FAR for Car riding 57, FAR for Bicycle riding 96 and FAR for Airline it is given 240.

Now here, let us solve this particular problem that due to the high speed of aircraft more miles are accumulated, so on a peak hour basis they are travelling by plane is approximately 4 times more dangerous than by travel.

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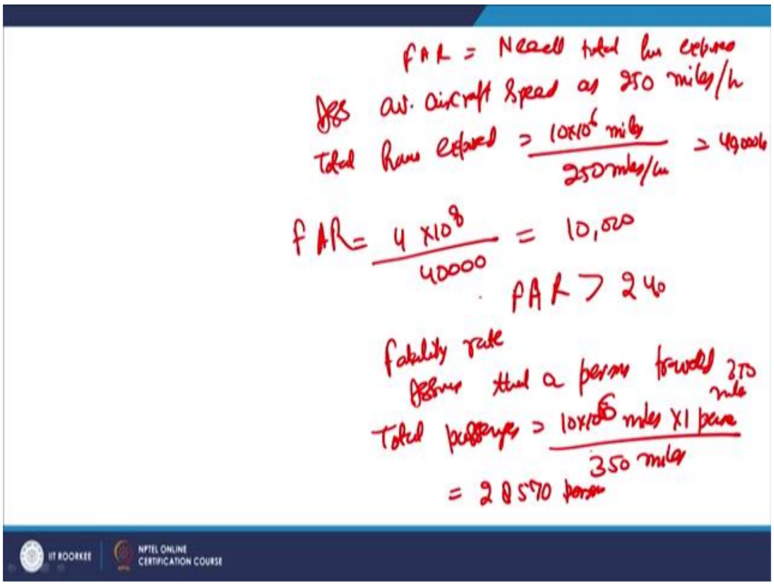

So, FAR: this need total hours exposed. So let us assume that average air craft speed is 250 miles per hour,

Total hours exposed = ($10X10^6$ miles)/ (250miles/hour) = 40,000 h

FAR = (4 deaths X 10^8) / (40000 hours) = 10,000

This FAR is greater than 240. So you can see that the problem is bit severe.

Now, let us see that the fatality rate so assume that a person travelled 350 miles, so,

Total passengers = $10X10^6$ miles X 1 person/ 350 miles

= 28,570 persons

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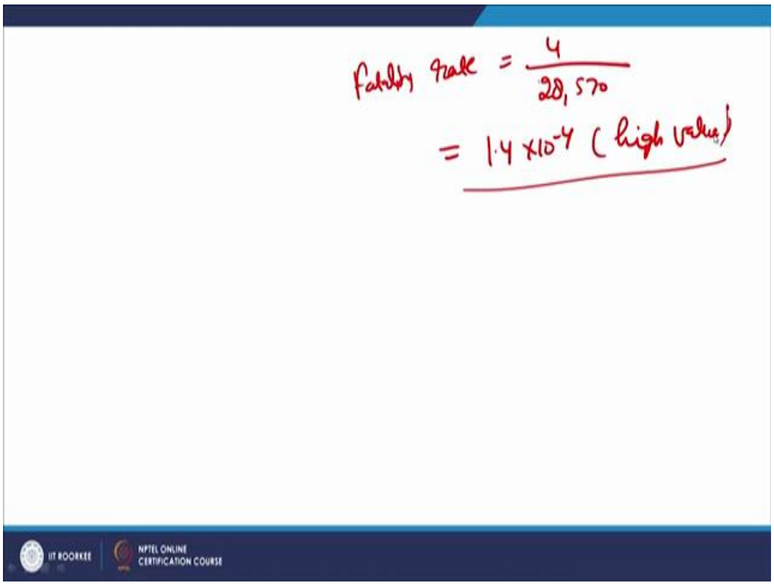

So, the fatality rate,

Fatality Rate = 4/28,570

= 1.4 X 10^{-4} (high value)

This is relatively very high value. So this is I mean you can say that we have calculated this fatality rate and it is more than expected one.

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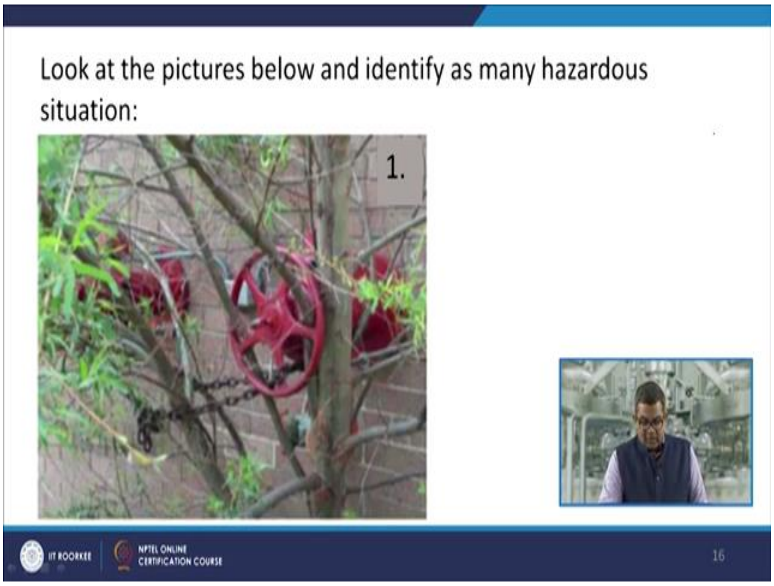

Now, let us take another problem, here you need to look at there is a picture below and you may need to identify as many as hazardous situations. So here they are 2, 3 figures are given to you. So let us find out that hazardous situation. Now this is a fire water valve and cannot be operated because of the branch growing all around which you can see in the photograph and this restricted the operational ability of this particular valve.

And valve is locked in a position with the branches of the tree, so the general housekeeping of the trees has deteriorated and trees are left to grow to the extent that they prevent the access to the critical piece of equipment, so this is extremely hazardous scenario for this one. So once if it is required to use this particular valve then probably it may not be in a position to operate.

Let us have a look about another problem, again you need to look at the figure below or picture below and identify the hazardous situation. So here the flexible hoses are used to connect the piping which do not fit together properly remember. So also the flanges on the right they appears to be missing at least one bolt we can see and the phases of the flanges do not align properly, so the hose behind it would appear to be home made by attaching a flexible hose to a pipe using a cable tie.

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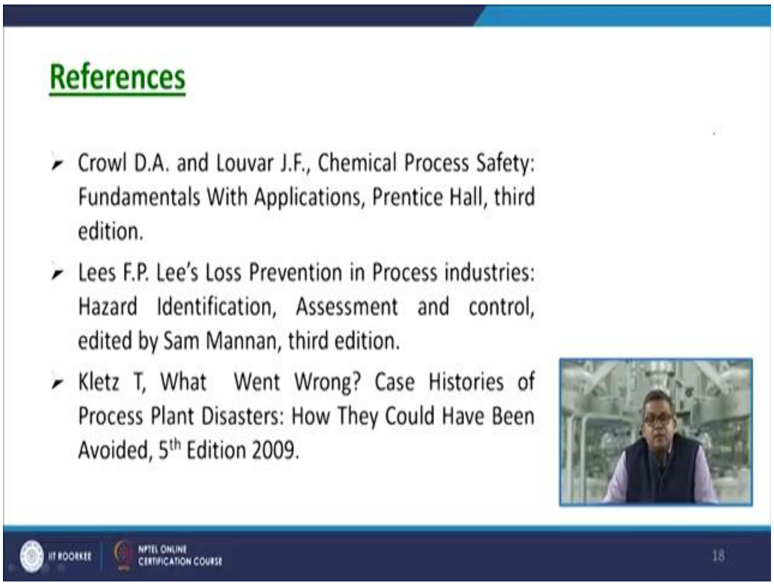

So, this is again a very dangerous situation and sometimes this kind of makeshift or rough arrangement will not solve its purpose. So in this particular module we had discussed various problems, some psychological problems, some numerical problems related to the lost statistics and again you can have a look of the first reference where you may find several other unsolved problems and you may try those problems for your further reading. Apart from this we have listed couple of more references to help you out to solve this type of problems, thank you very much.