Industrial Safety Engineering
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Lecture - 54
Safety Performance Indicators – Part 1

Hello viewers in the last session we have talked about the occupational health and safety management system. How it is implemented in a valves class organization. Now after implementing how do you know whether we are done correctly or not? You have to measure something.

How do you measure occupational health safety and health management system? That is called safety performance indicators. One of the biggest problems in the industries is we do not know what to measure. And what we want to measure we do not have really we do not have data. So, we will talk here in this class, what are the safety performance indicators? How we measure?

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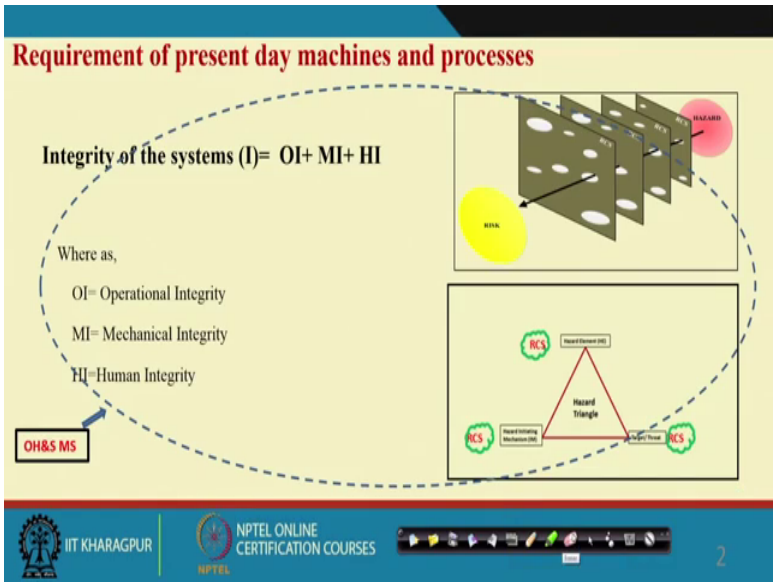

See in any organization what we have thought? We want our systems, our machines, or people the integrity should be very high we have talked this which is called operation integrity, mechanical integrity, human integrity should be very high should be as we require. What is integrity? Integrity is nothing, but behaving doing the way you design.

So, the machines the processes the people should behave the way we have design, then we call the integrity is very high. To have this integrity we have implemented occupational health safety management system. We understood the hazards very well, and how these hazards are coming out? So, hazard is divided into three parts one is hazard element, other is initiating mechanism, third is target.

So, hazard is divided into these things, so thoroughly we have to understand what is the hazard elements? What is the initiating mechanisms between hazard element and initiating mechanisms you should put risk control systems. So, these are the risk control systems and all these initiating mechanisms should be subjected to this risk control systems and we have to see whether they are performing very well or not. So, the safety manage this is what this is nothing, but the safety management system. How we are going to do find out the safety performance indicators we will talk now.

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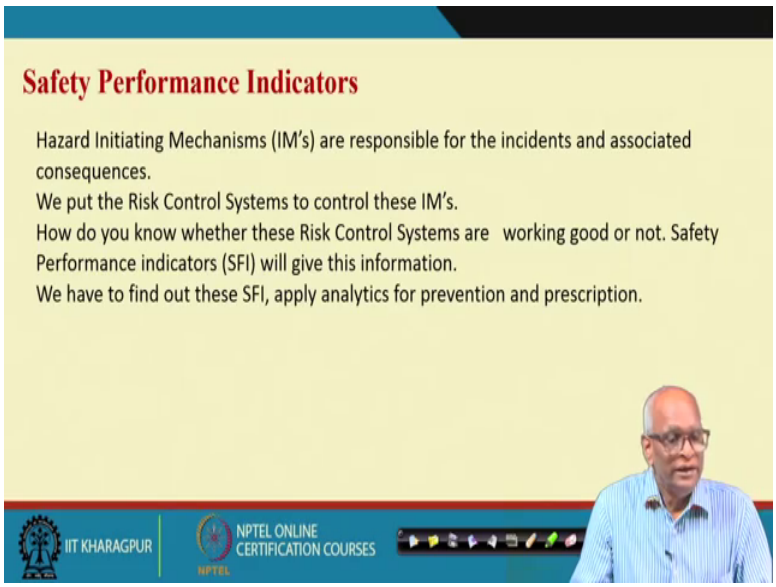

So, safety performance indicators: the hazard initiating mechanisms are responsible for the incidents and associated consequences. Hazard is there everywhere we has the technology increases, the initiating mechanism is the thing which will initiate the hazard. So, initiating mechanisms are responsible for the incidents and associated consequences. Hence, we put risk control systems to control this initiating mechanisms. How do you know whether the risk control systems are working good or not? That is safety performance indicators will give this information.

We have to find out the safety performance indicators. Once you find out safety performance indicators you apply analytics to get prescriptive, and prevention of these incidents. Now, we will go more detail on this now.

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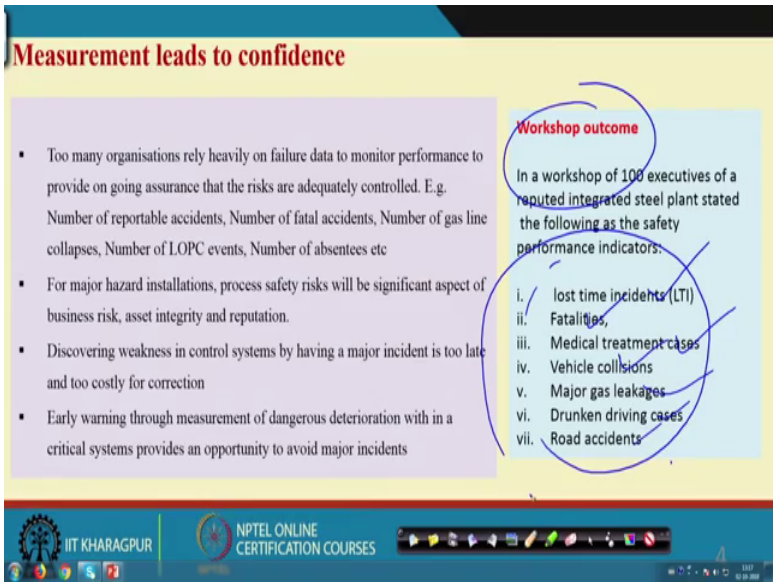

Why do we measure? Measurement leads to confidence anything you measure it will give your confidence. Too many organizations rely heavily on failure data to monitor performance. So, if you want to rely on the failure data some of the failures will happen once in long time and that time you cannot do anything. So, we have conducted one workshop in one of the organization where 100 executives of 2 years experience young executives, energetic executives they have participated. We have asked what you measure in your organization to know the safety performance?

They told lost time incidents, fatalities, medical treatment cases, vehicle collisions, major gas leakages, drunken driving cases, road accidents. These have these things they measure to know the safety performance indicator. Fatalities if the fatalities not happen what do you measure? Lost time incidents wait for the lost time incidents then only you measure if by chance lost time incident is not happening; that means, your safety performance is very good.

So, the organizations across the world normal organizations measure these things. But measurement of these things will not give you any improvement in the safety management system. For major hazard installations process safety this will be significant

aspect of business risk. One of the organization major process risk happened after 100 years. Mean while these people are thinking the processes are very very good, actually they are not very good. Discovering weakness in the control systems by having major incident is not good.

So, you are if you are free if you feel my system is weak only after major incident it is not good. Think of BP British Petroleum in one of the incident in US. People are telling even system is not good they said no I am not having major incident, but major incident happened. What you required is early morning through measurement of dangerous deteriorations; early warning we require early warning before major deteriorations that will help us.

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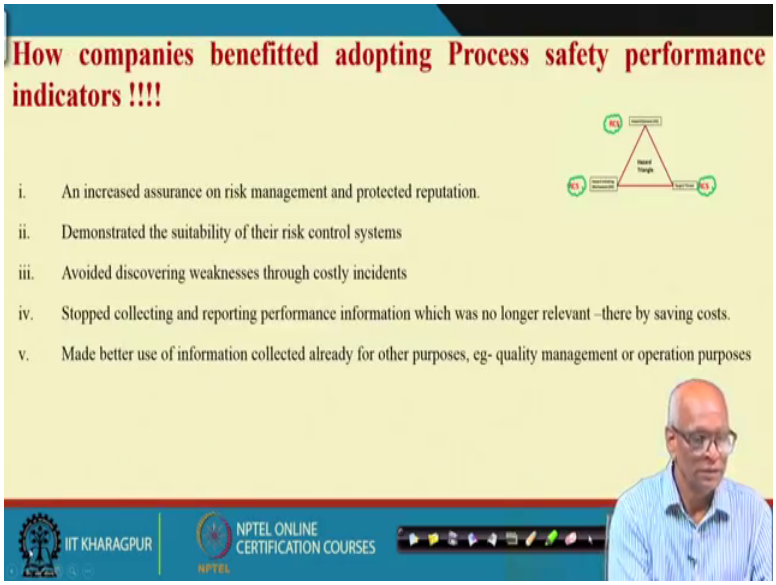

How the companies are benefited by the safety performance indicators? Increased assurance to the risk management system, it will give you more assurance that risk management system is working correctly, and or what improvements should be done. Demonstrated the suitability of the their risk control systems it will tell yes my risk control systems are doing very well doing good, or my risk control systems I have to make improvement.

You avoided discovering weakness through costly incidents by putting safety performance indicators in place you need not made for the costly incidents. Before any major incident happens itself you should be come to know so you can avoid major

incidents. Only these many organizations were put the safety performance indicators in place.

They have just stopped collecting performance regarding the regarding majoring states. They stopped collecting and reporting performance information which was no longer relevant unnecessary, un irrelevant information they stopped collecting, made better use of information collected already. So, the safety performance indicators will have plenty of data huge data. When you have huge data you can you can do very good analysis put the analytics and take the benefit of it.

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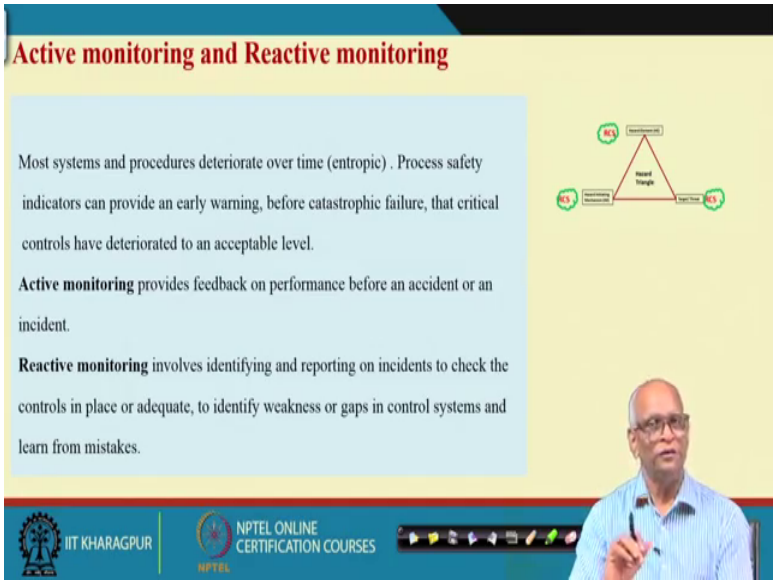

There are two types of monitoring one is active monitoring; other is reactive monitoring. What is active monitoring? The active monitoring provides feedback of the performance before an incident happens. Before any incident happens it will give you feedback that is called active monitoring.

Reactive monitoring it is identifying reporting on the incidents once the incident happened then you will get to know. So, reactive monitoring involves identifying and reporting on incident to check the control of the place adequacy, and all these things. So, there are active monitoring reactive monitoring the active monitoring will tell you beforehand, reactive monitoring will have will tell you after the incident happens.

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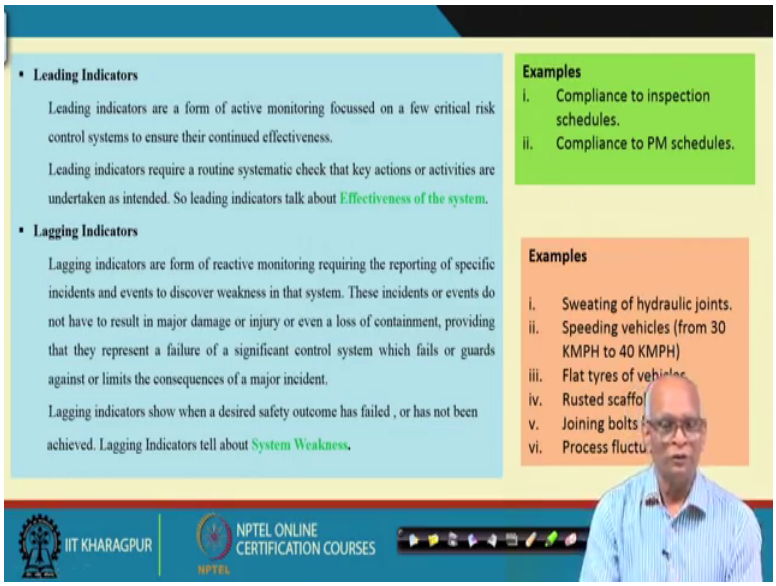

Now, let us talk about what is the leading indicators? What is the lagging indicators? This is the topic which we will be discussing in more detail.

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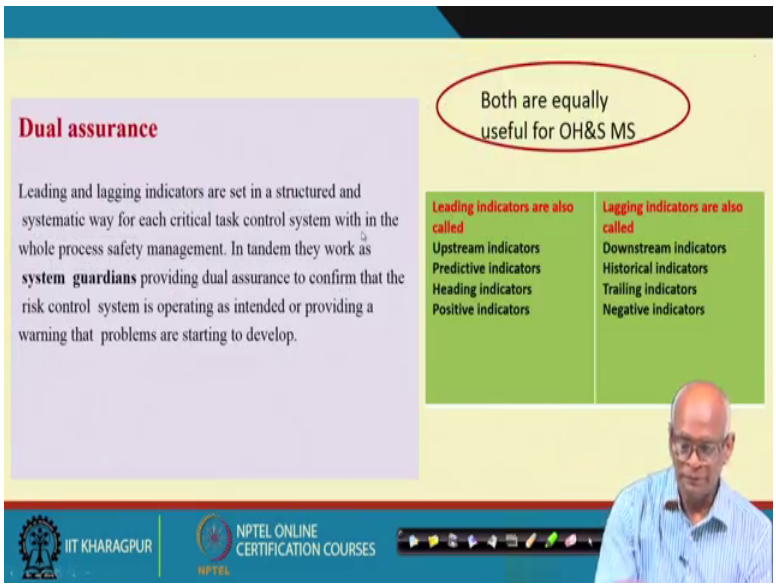

Leading indicators will give you effectiveness of the system whether the system is effective or not? Leading indicators will give you the effectiveness of the systems, they are the part of the reactive monitoring. What is the example? How do you know? How do you know the effectiveness of the system? So, compliance to inspections schedules if at you if you want to know any deterioration happening you have to inspect it unless you

inspect you will not come to know. So, compliance to inspections schedules is the leading indicator.

Compliance to the plan maintenance schedules, preventive maintenance schedules, compliance. How PM is happening? I am not talking about that, but compliance to those schedules, compliant your programs, compliance to your observations. So, it will tell the effectiveness of the systems. The lagging indicator talks about the weakness of the system. So, lagging indicators are a form of reactive monitoring requiring reporting of specific incidents. Lagging indicators show whether the desired safety outcome is happening or failed?

Lagging indicators will tell the desired outcomes have failed or not it is lagging indicators need not tell after the total failure. These lagging indicators will tell the safety outcome is getting achieved or not. What are the examples? Hydraulic joint total failure of hydraulic joint is the deterioration, the sweating of the hydraulic joint, small leakage is a lagging indicator. If the speed limit is 30 to 40 kilo meters if somebody is going 41 it is a lagging indicator. To know the condition of the condition of the vehicle flat tyre is a lagging indicator, it has happened but flat tyre is a lagging indicator.

Rusted scaffoldings rusting and the scaffoldings will lead to the failure, but rusting itself it is a lagging indicator. Once you understand if see the resting then if you if you take action scaffolding will not fail. Some of the bolts are become little loose nothing as failed, the joint has not failed. But, it has become loose, it is a lagging indicator because if you do not address the looseness then it will fail, so lagging indicator start from looseness. So what in the processes? Processes has not failed but there are fluctuations, they are lagging indicators.

So, lagging indicators leading indicators both are important to the organization. We should not feel lagging indicators is something bad, see the lagging indicators are called downstream indicators, historical indicators, or trailing indicators, or negative indicators also. Some people call the leading indicators are upstream indicators, predictive indicators, heading in people call by these names also.

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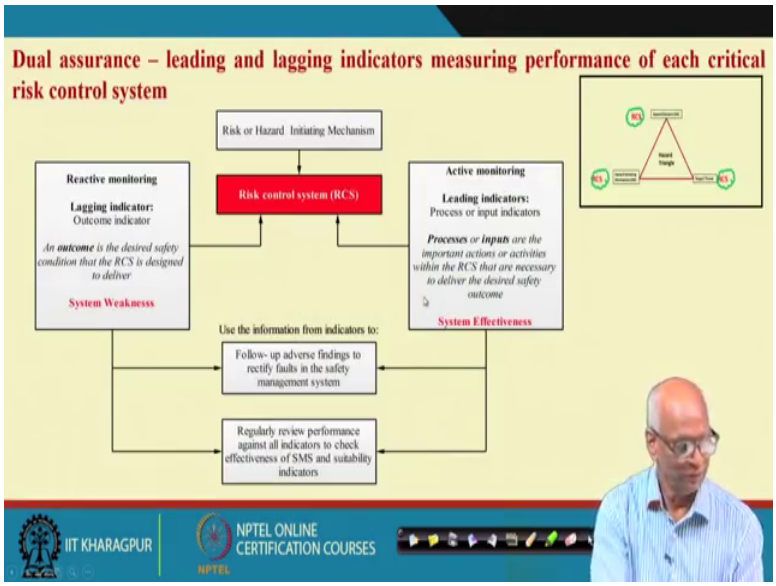

We have to have both lagging leading indicators and lagging indicators both are helpful. Please mind the lagging indicators what we are talking is not the total failure. Symptoms are failure, small failures, weakness of the system, failure of the system we are not talking, weakness of the system we are talking. So, the weakness of the system you should take, the effectiveness of the system you should take, and you should you should monitor your whole system, your management system you should decide.

So, taking both weakness of the system and effectiveness of the system is called dual assurance. So, by taking these two people work for people take these two leading and lagging indicators their system guardians who is guardian? Guardian will help you guardian will guide you so this lagging indicators leading indicators are taken as the system guardians.

The combination of these two we will make our intervention program how to do it? All the intervention programs even the strategies we will do based on these things. So, this is dual assurance system. So, what is dual assurance? You have the initiating mechanism. For the initiating mechanism you put the risk control systems, always the initiating mechanism if you do not control then it will result into the target or consequence.

So, the initiating mechanism at the initiating mechanism you should not allow the risk hazard initiating mechanism to function you have to put the intervention there between the hazard element and hazard initiating mechanism you will put. So, you put the you

have initiating mechanism you have put the risk control system. Now the risk control system how effectively it is working? Then what is the outcome of the risk control system? What do you expect? An outcome is the desired safety condition is it happening? If you say if you say that joint should not fail is the outcome. So, lagging indicator is the looseness of the joint, the vibration in the joint, that is the lagging indicator.

So, by measuring those things finally, you will see this outcome will be achieved. Similarly the leading indicators are the process are input indicators. So, by putting these risk control system you see whether the system effectiveness is working or not? The process are inputs are the important actions are activities within the RCS that has necessary to delivery desired safety outcome.

So, these risk control system whether it is happening or not? We see the process processes and inputs, beforehand we will come to know system effectiveness. So, here we are seeing the weakness by the deterioration. Here we are seeing the effectiveness by whether the processes are happening or not? The processes are happening or not we will see by leading indicators. We will get the results of this results of this both we will get it, we will get it here. We will analyze and we will do our performance and review all those things.

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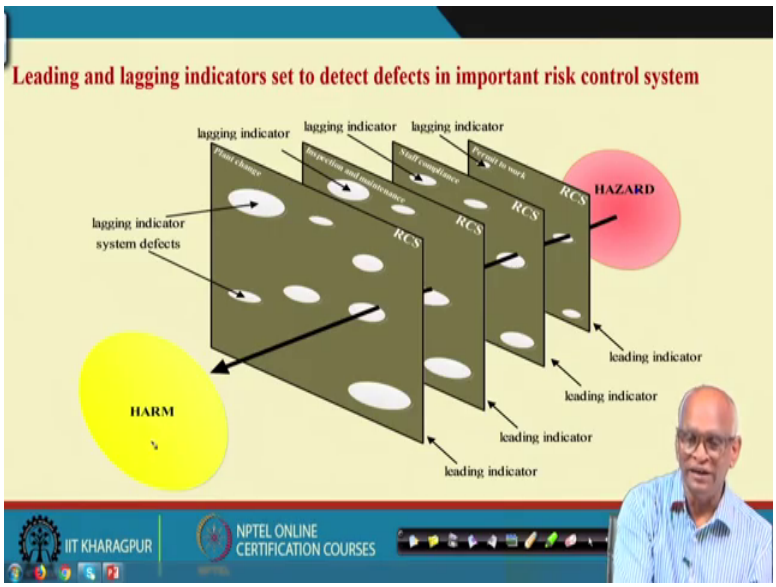

So, what are the what are these indicators in list? What we have discussed is you have hazard, you have harm is rent, the hazard not to become incident you put the risk control

systems ok. The risk control system the health of the risk control system, condition of the risk control system, is the lagging indicator. The effectiveness of the risk control system is the leading indicator. Risk control system is the lifeline, hazard not to become harm. If the risk control systems health effectiveness is very important that is what we are talking. These are the leading indicators will tell the what is the health? Lagging indicators will you what are the weaknesses? What are the weaknesses? So, measuring both will health that is the safety performance indicators.

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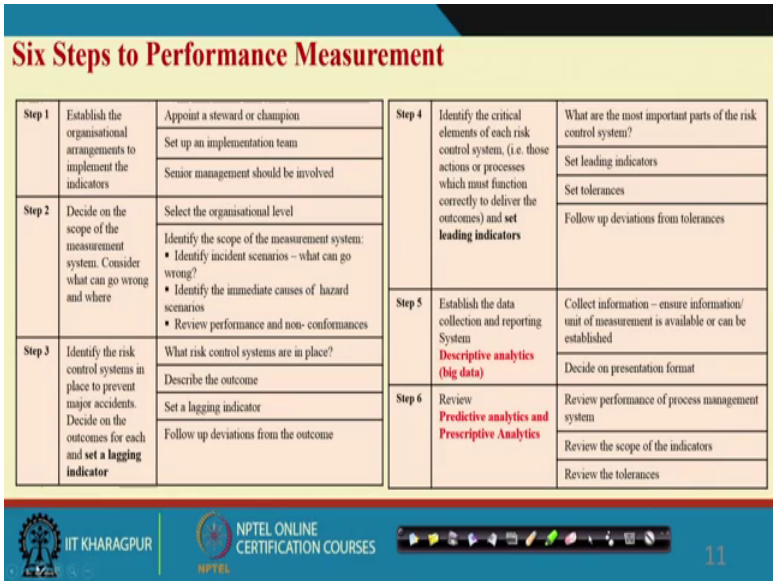

These are the six step process made by HSC which is which is pretty good for finding the safety performance measurement. That is one first step is establish organization arrangements wherever you are going to do right to work right initiative you require a champion, you require a team to implement that is the first step. Second step is scope what is that you want to do? You need not have leading and lagging indicators for everything, for already the hazard the risk is ALARP level you need not measure those things. So, you will define the scope at the organization level.

What is that we are going to do? Because every data collection every it all cause money. Third is so identify, so in the based on the initiating mechanisms by putting through the risk control systems you have to identify set the lagging indicators, you have to find out the lagging indicators. So, for finding the lagging indicator for when you pass the risk in to risk control system we will see what is the outcome. From the outcome will decide

what is the lagging indicator. Then we will do the leading indicator. Leading indicators identify critical elements of each risk control system, those actions processes which must function correctly.

What are those things? Percentage of inspections, percentage of compliances all those things, if those are not happening. If it is performing at 70 percent you should think whether it is this is acceptable or not? So, all those all those leading things leading indicators will perform. So, we will we will find out the leading indicators. So, every leading indicator you should you need not the get ALARP. So, at what at what tolerance at what level at what level if suppose if the percent of percentage of inspections is say 95 percent, 5 percent is less.

Are you supposed to become ALARP? You have to understand if it is come in to 70 percent probably there you have to become ALARP. So, you have to for different processes you can put the leading indicators, set the set the tolerances. By setting these tolerances you will reduce the efforts, otherwise for every small deviation you need not become ALARP, it is something like tolerances. While manufacturing a component if you put the very tight tolerances then the cost will be very high.

Similarly, here also if the leading indicators if you put very tight tolerances. Then the efforts will be very high the leading and lagging indicators shows data you will get the data collection process is called the descriptive analysis. You have to collect this data we are not collecting fatal accidents or injuries are failed components. We are collecting lagging indicators that the health of the equipment the effectiveness of taking the weakness of the system, the effectiveness of the system we are collecting it. Those data which will be very high it is a big data you can use in the in the present trend is using data analytics.

You can use this data this put in the data analytics all the techniques of the data analytics. You can you can get the predictions we have seen the IIT Kharagpur has done the data analytics for one of the organization, very good organization. But the data is not at all good data, right data.

It is all rubbish data for the data analytics point of view. So, the performance indicators good lagging and leading indicators data will give you very good data for the prediction

and prescription that is one of the very good advantage of the putting the safety performance indicators.

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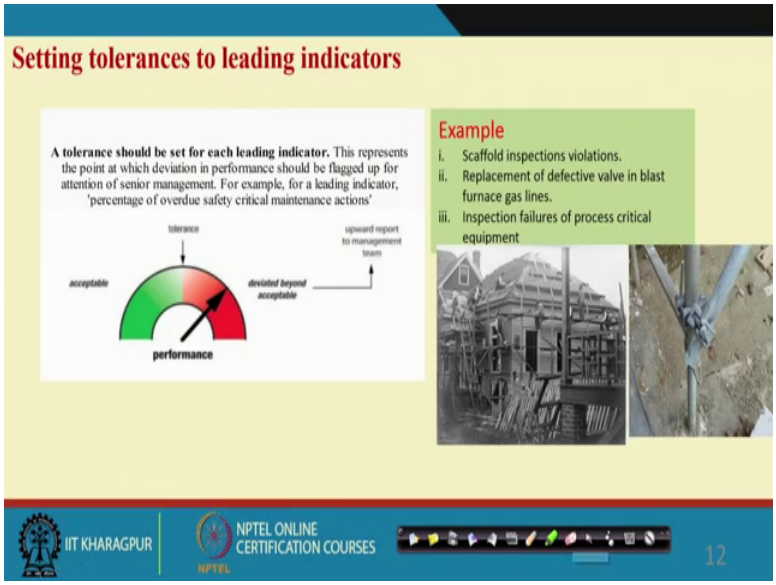

So, this is tolerance. At what level people should get the tolerances you give it to the leading indicators? At what level the organization should be worried? So, let us see these are the scaffoldings, these are the scaffoldings. So, scaffold inspection violations.

So, scaffolding inspection violations how many scaffolding inspections you will be doing? So, if you do not do scaffolding inspection 100 percent then it is very very deterioration for the effectiveness. Scaffoldings whenever we put you have to have 100 percent inspection where the deviation is 0, replacement of defective valve in blast furnace gas lines. Suppose if the valve is defect defective.

So, if it is small detection you did not replace immediately there is time. Inspection failures of process critical equipment if the process normal equipment inspections are not happening you may have tolerance. But it is the process critical equipments you should have 100 percent inspections you need not tolerance.

So, there acceptable limit is very less for the normal equipments your acceptable tolerance is more. So, you will be putting the tolerances depending upon the critical equipment, tipping depending upon the critical activities on the leading indicators. Let us go for a say case study. Case study will bring you more clarity.

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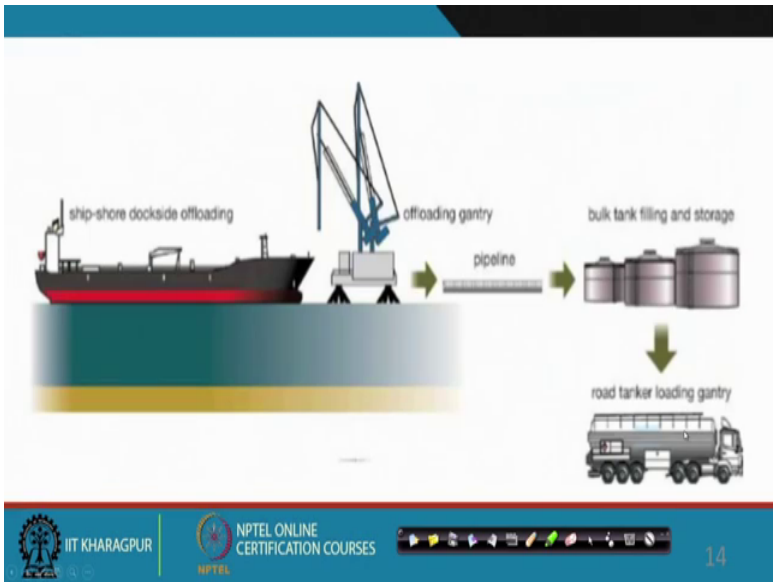

This is this is the offshore a ship coming and unloading the various materials into the offloading gantry through the offloading gantry, through the pipeline to the bulk tank filling and storages. From there it will be loaded into road tankers, it will be dispatched to the customers. This is the case study we are taking.

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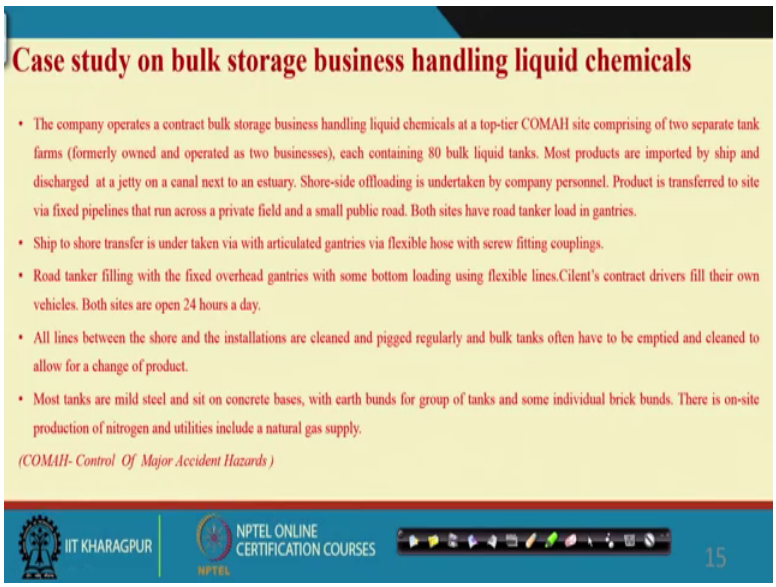

So, case study shows the company operates constant bulk storage business handling, chemicals. So, there is an offshore at the offshore there are a tankers provided it is they are called bulk tanks. They are all loaded into the bulk tanks through the pipelines it

works and the road tanker will come and take from the bulk tanker and supply to the equipment to the customers. This is the whole of the case study. So, this is the ship, this is the bulk tankers, it is unloaded in the bulk tanks from there it will go to the road tanker. This is the pipeline ok.

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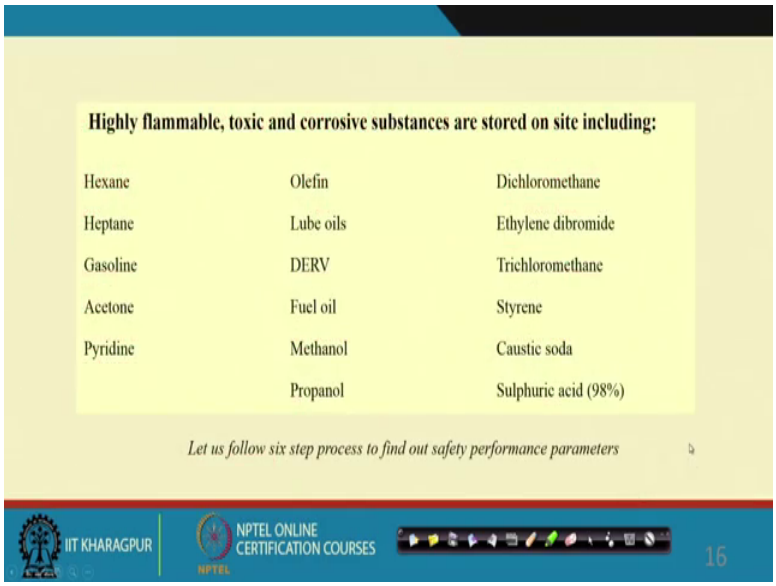

What are the materials they are handling? They are handling very hazardous material, hexane, heptanes, gasoline all these things. They are very hazardous materials.

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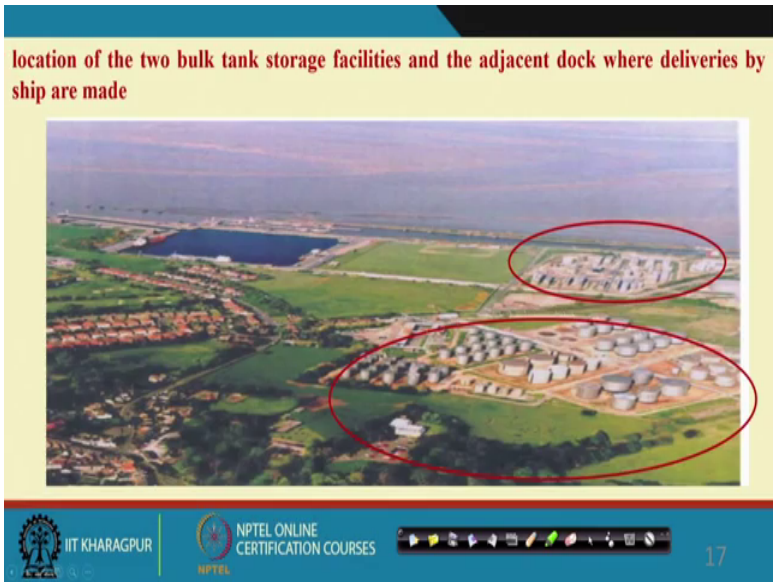

So, these are the bulk tankers these are the bulk tankers. There are two sites this is one site, this is other site the ship will come here. From here the pipes will take it to the bulk tankers.

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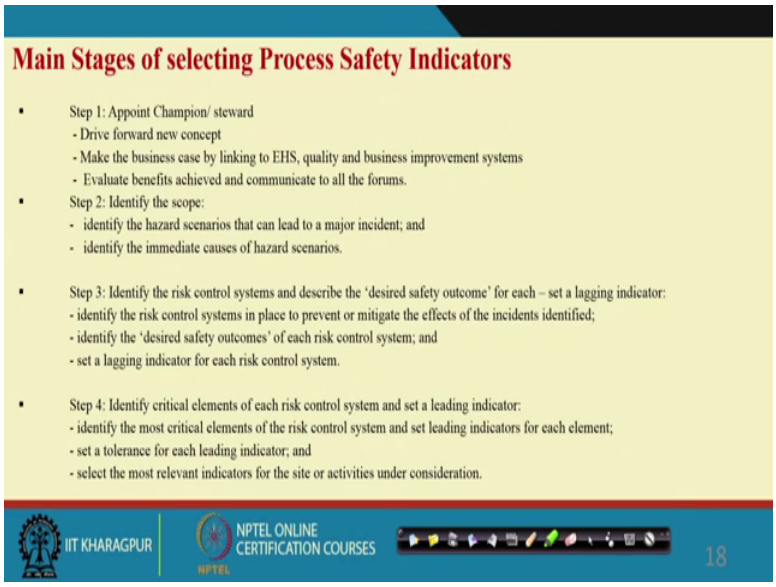

So, what are the main stages of the process safety indications which we have discussed? So, appointing the champion we will drive the whole initiative then we have to identify the scope, then we have to get the lagging indicators. Then we have to find out safety outcomes and the lagging indicators. Then we have to find out the leading indicators, then we have to rest is the analysis part.

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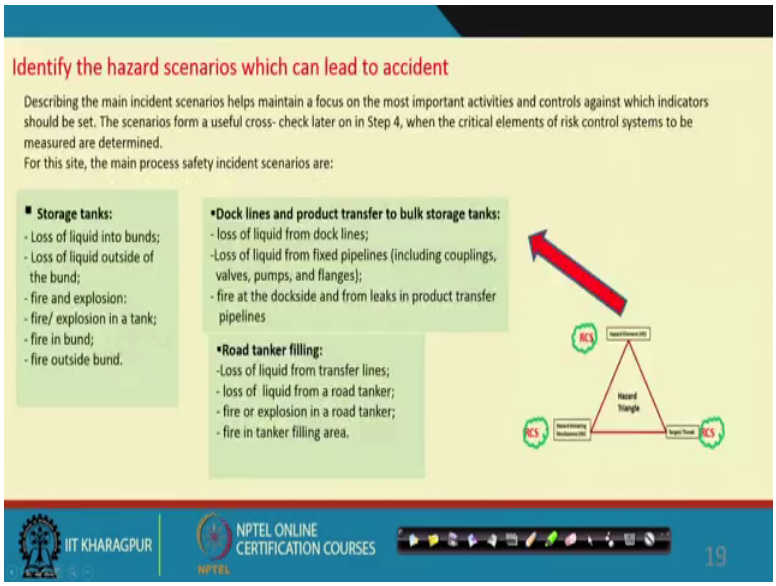

What are the hazardous scenarios here? Hazardous scenarios means in our in our safety triangle we called hazardous elements. In the whole process which we are discuss storage tanks is one of the hazardous element. So, what will what will happen in the storage tanks? Loss of liquids loss of liquids in the bunds, the liquid the tanks will have bund. Bund is if any case if the any leakage happens the bunds will hold the liquid it will not go to outside.

So, loss into the liquid from the tanks loss of liquid outside of the bund fails it will go to outside. Fire and explosions: fire and explosion in the tank fire and explosions in the bund and fire outside. These are all hazardous elements for the storage tanks. For dock lines loss dock lines means the product transfer lines pipe lines all those pipe lines loss of liquid, loss of liquid from fixed pipelines like coupling, valves. Fire at the dock road tanker road tankers are they will take the material outside.

So, while filling road tanker while filling loss of liquid from the transfer lines if the liquid goes here and there, loss of liquid from the road tanker fire and explosion. So, these three storage tanks, dock lines, road tankers they are the hazardous elements. Now these hazardous elements we have to see the initiating method, what are the initiating mechanism for this?

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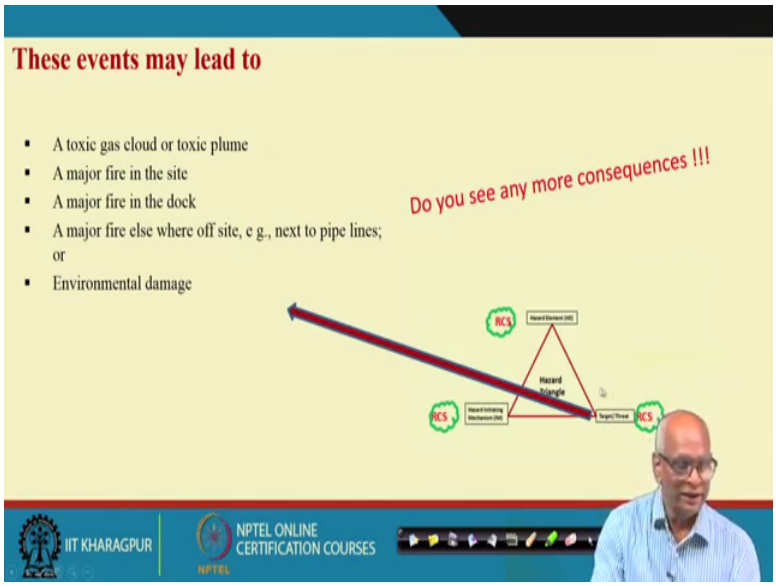

The target is so if the initiating mechanism fails, we will have toxic gas cloud, major fire at the site, major fire at the dock, major fire. All are very very hazardous, very dangerous for the organizations. You may say something more also we have put some of the outcome I have put in the safety triangle this is the outcome. Now we will go for the initiating mechanisms.

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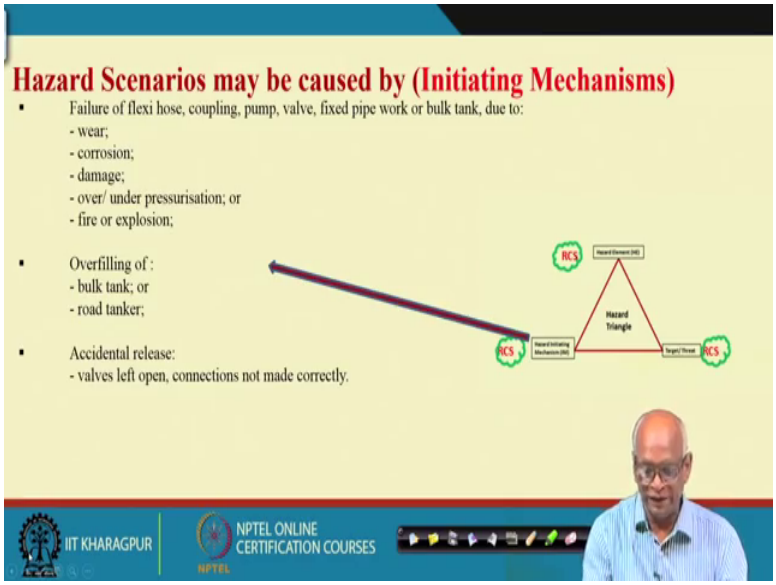

What are the initiating mechanisms? Failure of flexible hoses, couplings, pumps. The failure of flexible hose pumps valve fixed pipe, why do they fail? Because of the because

of the wear, corrosion, damage over under pressurization fire explosion these are all the hazard initiating mechanism or over filling of bulk tank. If you fill more it will spill out.

Overfilling of road tanker if you fill more it is initiating mechanism. So, accidental release valves not closed valves are open, connections not connections are not made correctly there the initiating mechanisms.

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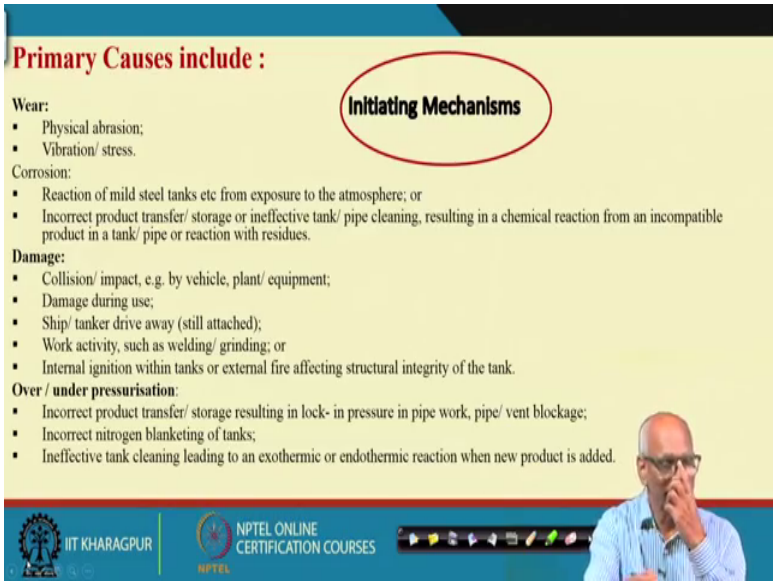

Some more initiating mechanisms physical abrasions, vibration corrosion; so, corrosion by the corrosion will happen, corrosion will happen because of the reaction of the milds with the mild steel.

Incorrect correct product transfer, the product which is supposed to be transferred something more is something differently out transferred. Damage collision impact by vehicles, damage during use, work activity, welding grinding which are not supposed to done if you have done it may damage the whole situation, over an under pressurization.

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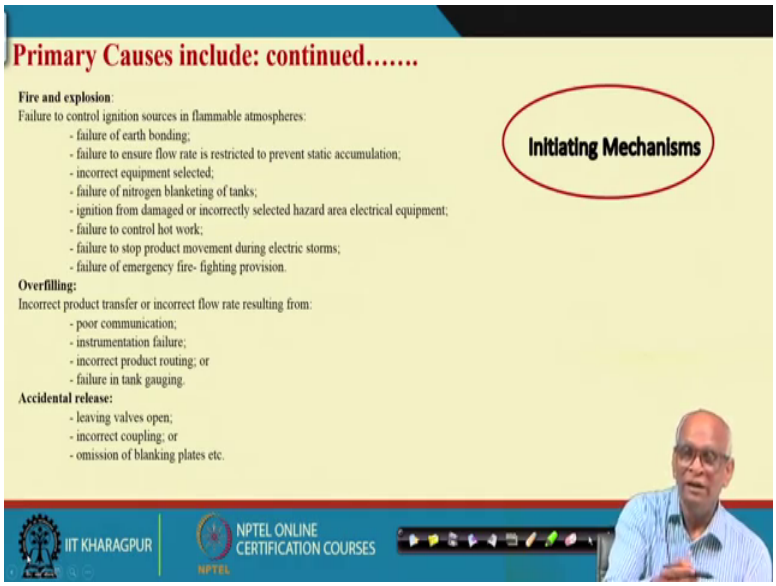

What are the initiating mechanism for fire and fire and explosion? Failure of earth bonding, failure to ensure flow rate, incorrect equipment selection, failure of nitrogen blanketing of tanks, or failure of control hot work you are not controlled properly. Hot work hot work means welding and all these things. So, a spark as come and has fallen a some cloud. So, whatever initiating mechanism for overfilling poor communication people are not communicated, so overfilling.

Instrumentations of a the instrumentation failures in Bhopal gas disaster people thought instrumentation is failed when the pressure is increasing actually did not failed. So, many times instrumentation fail so you think everything is good, but instrumentation is showing wrong.

Failure to tank gauging the gauges in the tanks they are not doing very well. So, accidental release, so what are the initial initiating mechanism for accidental release? Leaving valves open, valve is not open, incorrect coupling. When you have to couple you are not couple properly, omission of blank blanking plates.

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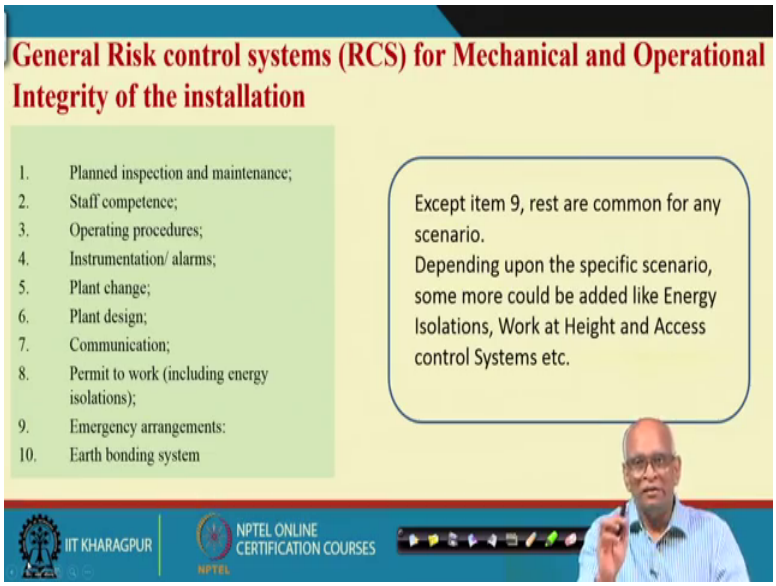

So, by putting the risk control systems the HSC has worked very hard in this. So, they said you need not find out what should be the risk control system. Out of this 10 risk control systems, 9 are normally common to everything every scenario. Like planned inspection and maintenance if you put planned inspection and maintenance many things will be arrested, or staff competence. If you have good staff competence mistakes will not be done.

So, planned inspection maintenance, staff competence, operating procedures, instrumentation, the changes in the plant, changes in the design, communication, permit to work, permit to work especially it is seen across the world 80 percent of the major accidents happen because the energy isolations are not done. So, you can put energy isolation, energy isolation is one of the risk control system. Emergency arrangements, if anything happens the risk should be controlled they are called emergency arrangements. So these 9 are almost common but, depending upon the site you can have much more.

For this site we have added earth bonding system, earth bonding system will not be there for every site, or if you particular site working at height is very important you can put working at height. So, the 9 risk control systems are common for all these things. So, 1 or 2, 3 you may add as per your site, so we will stop here. Next session we will take this forward the case study, we will take it forward in the next session.

Thank you.