Industrial Safety Engineering
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Lecture – 55
Safety Performance Indicators

Hello viewers. Last class we talked about, safety performance indicators, this class is continuation of what we have talk last time.

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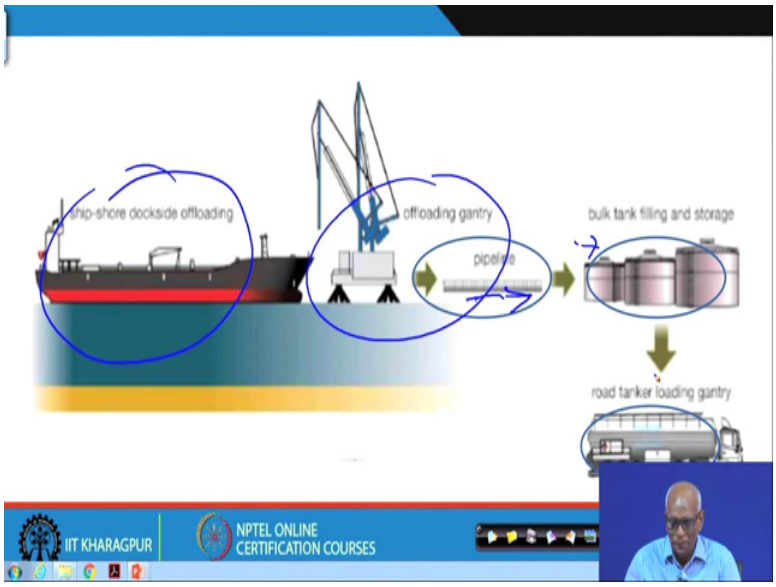

We were discussing the case study. Case study of offshore dockside, where the ships will bring the material, to the off loading gantry, from there it is offloaded through pipeline it will go to bulk tanks, from bulk tank it will go to road tanker. This is a scenario yesterday we have talked.

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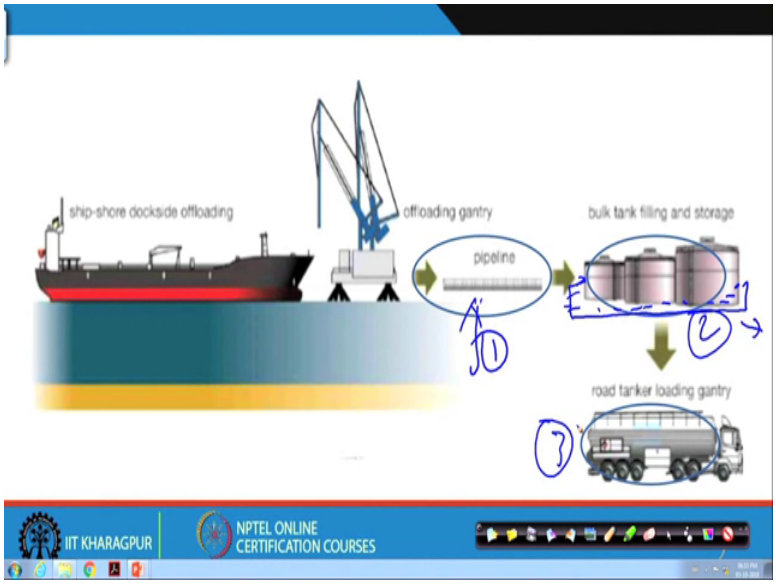

And in this we have identified three hazards scenarios. One is pipeline, other is bulk tankers, third is road tanker. We may select many more sceneries also, but for the case study purpose, we are selected these 3 as the major hazards. Hazards of the pipeline where the where the hazardous material is being carried, hazards in the bulk tank where the hazardous material is stored. These bulk tanks suppose if the any breakdown happens, if it comes out then we have a band.

So, that dissolve hazardous materials will not go to environment. So, that is one of the requirements when you are storing the hazardous materials. So, this band is also very important, if this also breaks, then if you will go to community.

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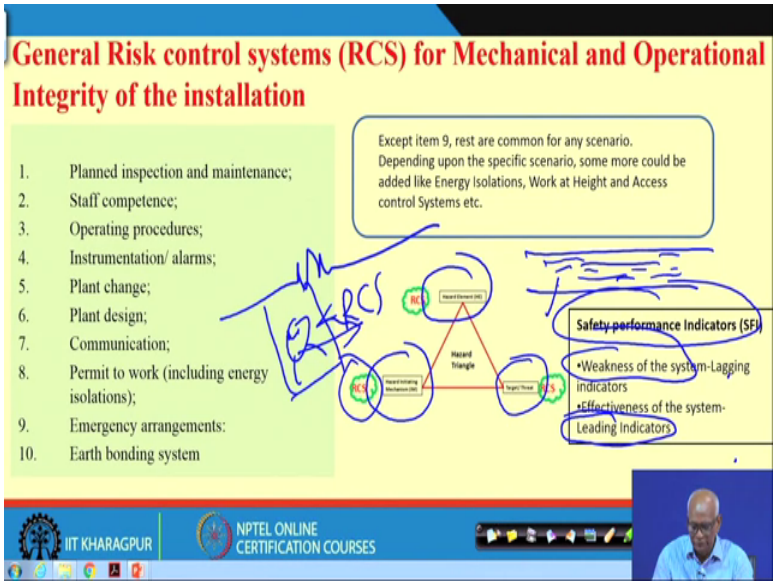

So, bulk tank associated with this band and the road tanker. Road tanker daily road tanker will come get it unloaded and take it. These 3 are the hazards. But understand hazard itself will not give you clarity. Every hazard is divided into 3 parts yesterday we are discussed, one is the hazards element other is the initiating mechanism third is the target. These three combined we call hazard.

If you have to address hazard you have to address all these 3 things. Hazardous element is which the one which is having potential to call the hazard. Some cases, here itself we can put the interventions like, if you are using a liquid for cleaning the tank very hazardous liquid, you may eliminate it by putting non hazardous liquid, but 95 percent 95 to 99 percent of the cases, you have to put the interventions that the initiating mechanisms. Very important, to know, what are the initiating mechanism and you have to put interventions to control those initiating mechanism, that is more important.

So, risk control systems we are going to put at the initiating mechanisms. Example, suppose a liquid is going in the pipe, this liquid hazardous liquid as long as it is in the pipe nothing will happen, the for the technology purpose you have to take the hazardous liquid, you cannot eliminate it. As long as it is in the pipe nothing is going to happen, what is initiating mechanism, if the pipe is weak by breaks then the hazardous liquid will come out.

We have to put intervention so that this pipe will not break, that is the intervention. If the pipe does not break as long as you control the pipe not breaking it, the hazardous liquid is within the boundary. Nothing it is not going to do anything like electricity. When it is in the line nothing is going to happen, it can be it can be 32 kb, 64 kb or 128 kb whatever it may be very high voltages as long as is within the line nothing going to happen. For our survival we require electricity, but if it comes out if you do not make proper connections. Or if you are working at the time power comes in then it will kill. So, you have to put risk control system there also.

So, hazards are there in our technology, it is required because of the because of our comfort, because of more power. Putting this control systems, these hazardous elements will become our slaves, we have to bring make the hazardous elements slaves as long as tiger is in the cage it is a slave. Cage is the risk control system, if you break the cage, if

you do not lock the cage, if you do not make the cage very effective tiger will come out. The slave will become real tiger. So, risk control systems are very very important ok.

We also talked the safety performance indicators, conventional traditional safety performance indicators, what you see outside in every organisation. We are shown the workshop results, people talk fatalities, people talk incidents, people talk accident, people talk leakages they are the safety performance indicators.

Friends those things are not going to help, improve the occupational health safety management system. The performance indicators which will help the OHMS system or you should know the weakness of the system; not the failure of the system. You have been hearing failure of the systems are the performance indicators, no they are not the real performance indicators. Weakness of the system, if you know the weakness of the system then you can take corrective actions, during the weakness of the system. So, that failures will not happen, they are called lagging indicators.

Similarly, the effectiveness of the system, whether the system how effectively it is working, that we call leading indicators by instituting a system of understanding, identifying, measuring, leading and lagging indicators. Using both and analysing them you will really achieve your safety performance, they are real the safety performance indicators.

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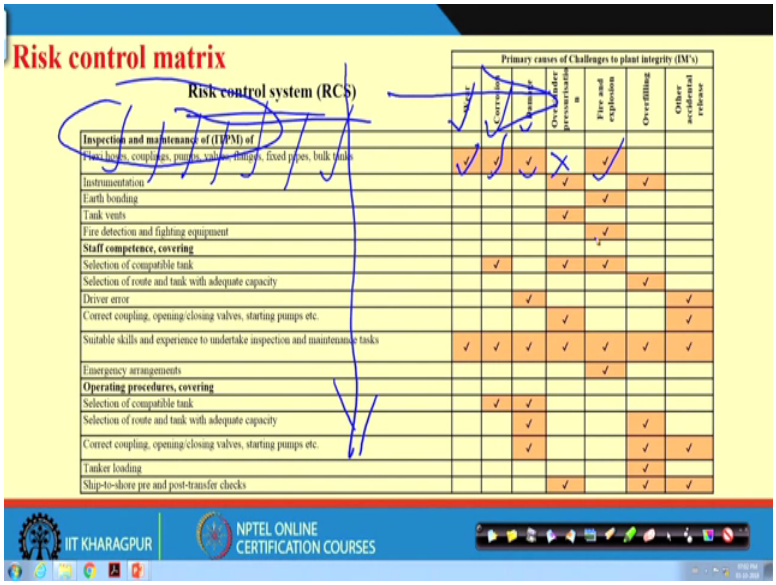

In the earlier session we have talked, the hazard hazardous elements, the pipelines, the tank storage tanks and carrying the transportation tanks they all finally lead to, the following major initiating mechanisms. One is wear, corrosion, wear of the pipelines, wear of the tanks, wear of the road tanks, corrosion of the pipeline, corrosion of the walls, corrosion of the pumps or damage of the lines, damage of the pumps, over filling, under filling, over pressurization, under pressurization, fire and explosion in the tank, in the pipe, in the road tanker.

And other accidental religious people not closing the valves, people not stopping the pumps all this things are the initiating mechanisms. For all these initiating mechanisms, we are going to put the risk control systems. I told you we have 9 common risk control systems, after lot of research people have come first you put this 9 risk control systems in place, over and above you can you can add some more thing.

So, suppose we have put inspection and maintenance which is call ITPM very important this is one of the risk control system. What are the things which we will do here? Inspection and maintenance of flexible hoses, couplings, pumps, walls, flanges, fixed pipes, bulk tanks all these things will do inspection. It is applicable to which of the initiating mechanism. The inspection of the hoses, couplings it will address to wear it is accepted to corrosion if you want to control wear initiative mechanism. You have to do the inspection and maintenance of the following things and damaged you can inspect and more filling pressurization, the inspection of flexible hoses will not come hence, we have not shown here.

Similarly, if you see instrumentation, what inspection we will do? Instrumentation will tell about the wear oh ok. Nowadays in the very complicated pipelines in the steel plants if you go, we have instrumentation there. But here we do not have instrumentation. So, we use instrumentation for over filling over and under pressurization. Similarly, tank vents, tank vent is important for what? Fire, if the tank is venting. Where what is the initiated mechanism it will control? Fire and explosion hence will do it here.

Coming to staff competence, that is one more the risk control system, out of 9 risk control systems, staff competence. Staff competence should cover what? Selection of compatible tank, people should have competencies to select the right tank if you put this

risk control system, this is applicable to which initiating mechanism? This is if you put right tank then corrosion will not happen.

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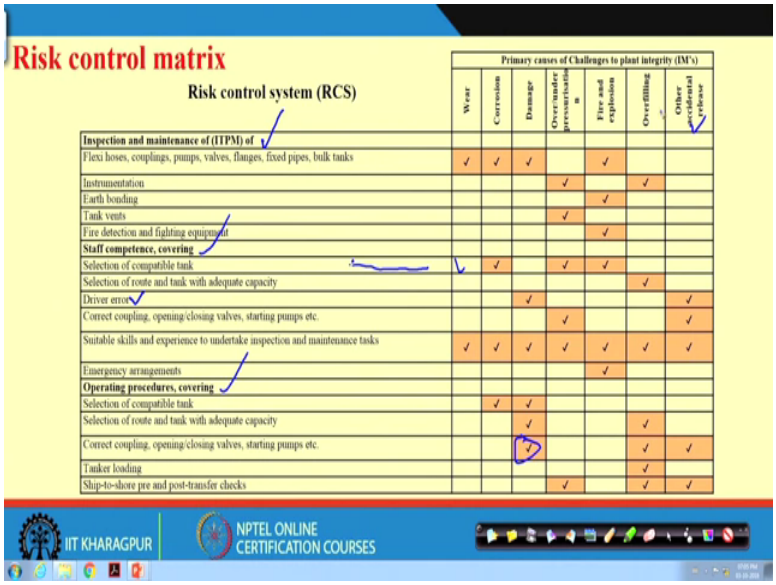

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Or wear will not happen or overfilling will not happen or fire and explosion will not happen. Suppose if you said driver error; driver error is one of the things under the staff competence you have to use driver error, for if initiating mechanism means the damage, how will it be damaged? Drivers heating the pipes, That is why we have taken driver error. As the staff competence it will be applied to damage.

So, like this for all the risk control systems like operating procedures. So, correct coupling opening closing valves starting pumps. Operating procedures, people should put correct coupling. People should close correct valves, people should have right start up pumps. This is applicable to which initiative mechanism. If you do this correctly damages will not happen. Hence, by applying this you can control the damage; by applying this risk control system you can control the damage. You can control over overfilling, you can control accidental religious by doing the correct if you do not do coupling properly hose pipe, then something leak will happen; that is other accidental release.

So, if you want to control this is the risk control system which you have to use. So, for wear what are the various risk control system. All 9 10 risk control systems may not be applicable for all the initiative mechanisms by doing this we are trying to select, which are the risk control systems we have to use for initiating mechanisms ok.

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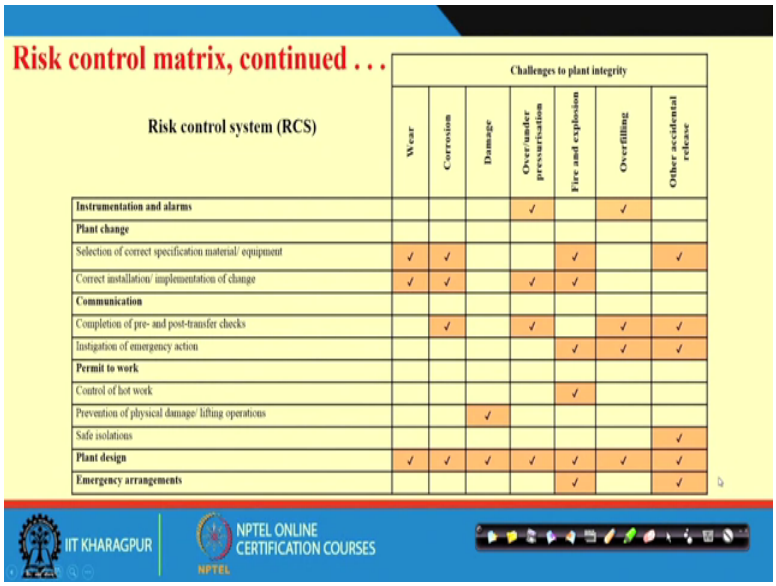

Similarly, plant change, communication, permit to work, permit to work permit to work we have added actually isolate isolating mechanisms. The isolating mechanism will be more useful for overfilling the, overfilling up the tanks or damaged many places isolating mechanism will be applicable everywhere. Emergency arrangement, where the emergency arrangements will be applicable to which of the initiative mechanism. Fire and explosion; fire if you want to control, if you want not fire and explosion to happen you should have emergency arrangements ok.

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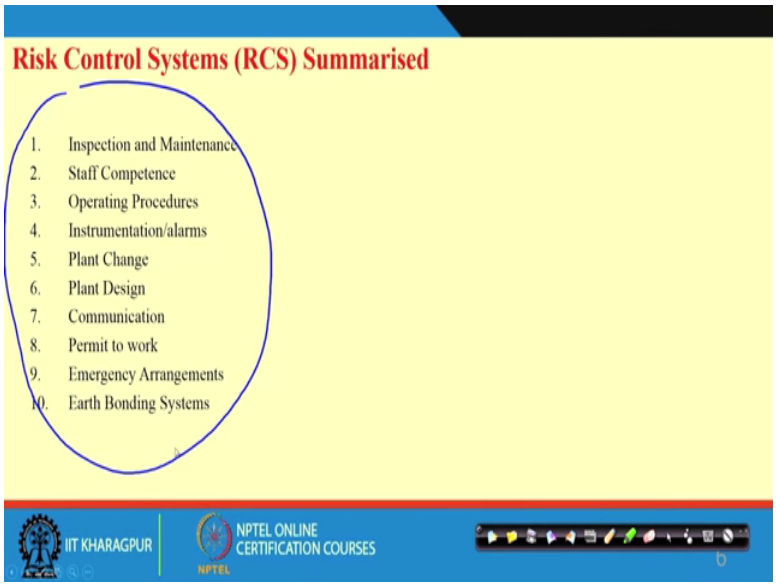

So, these are the risk control systems and summarising

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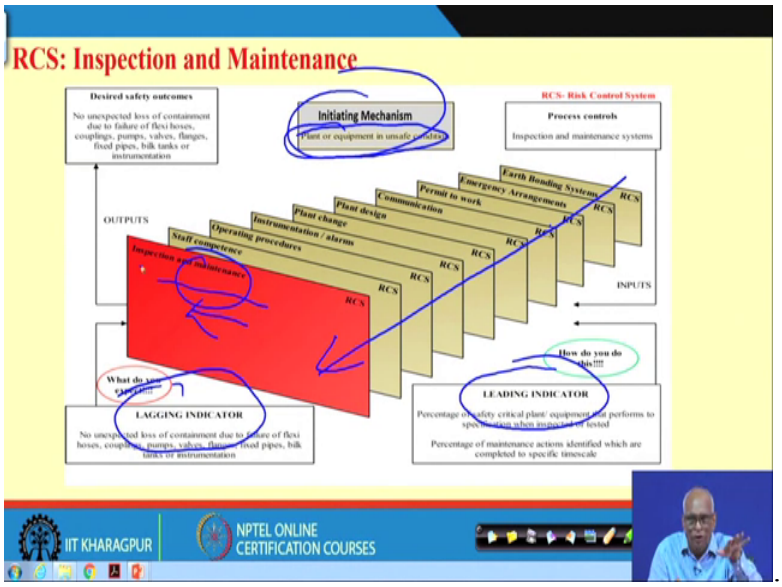

These are, the risk control systems, see 10 risk control systems. What we have discussed, the initiating mechanism you have to put against initiative mechanism risk control systems. How, what sort of initiating mechanism you have for that how many risk control systems are required we have decided earlier. Suppose, initiating mechanism means plant are equipment in unsafe condition. That is one of the initiate, if the plant is unsafe condition then the hazards will open out. So, itpm suppose, itpm is one of the risk

control system from the initiating mechanism we have to find out lagging indicators and leading indicators. Lagging indicators will tell the weakness of the system; leading indicators will tell the effectiveness.

So, for every initiative mechanism if you want to apply risk control system you have put the risk control system. Whether the risk control system is working effectively or not, for that you have to find out the lagging indicator you have to find out the leading indicator. For plant or equipment in unsafe condition if this is the initiating mechanism. If itps inspection and maintenance inspection testing and maintenance is the risk control system.

What is outcome? What is the outcome you expect, by putting this inspection and maintenance if plant and equipment unsafe condition. What outcome you look for? The outcome you look for is desired outcomes no unexpected loss of containment due to failure flexible hoses. By inspection and maintenance what is the outcome you look for? No unexpected loss of containment due to failure of flexible hoses that is what you required that is why you do you put this itpm as the risk control system. Or no unexpected loss containment from couplings, pumps, valves, flanges, fixed pipes, bulk tanks are instrumentation no loss of no losses should happen; unexpected losses for that you do inspection and maintenance this is the outcome.

So, what is the weakness in the system? The weakness of the system is unexpect number of unexpected loss of containments. This is what, you want outcome should be like this you are finding out the weakness of the system. Weakness of the system is how many times unexpected loss of containments small not big, due to failure of flexible hoses, failure of couplings, failure of pumps, failure of valves, failure of flanges happen. Not total failure of the valves, only the number of unexpected loss of containment, leakages sweating small, the plant has not stopped because of that, but it is showing the weakness. All these things you should measure suppose, if you have 10 pipeline, all the 10 pipelines you have to find out this. Each pipeline has got 5 valves 10 pipelines has got 50 valves, all 50 valves you have to find out unexpected loss. So, you should have a system to find out unexpected loss from all these thing how much big data it is, similarly leading indicator. What is leading indicator? The process controls if you for this plant and equipment unsafe condition if we put it through inspection and maintenance, what will be the leading indicators? Percentage of safety critical equipment that performs to

specification, you have safety critical equipments how many percentage of thing percent of the equipments. When you are seen, are performing the way they should perform, nothing as happened but 100 percent performance. How many percentage of maintenance action identified which are completed we have identified itpm is maintenance also there.

So, you have identified say 100 maintenance activities for some problems on small problems. How many them are completed? What percentage is completed? If it is 100 percent completed what you call the system is effective. If it is 70 percent completed will you call system is effective? It depends, if it the critical equipment 100 percent complaints, if it is non ciritical equipment 100 percent need not be there ok.

So, they are not failures, failed complains to your actions; complains to your actions to keep the system effective if the leading indicator. Small failures, if the lagging indicator not big failures total failures this is not the total failures.

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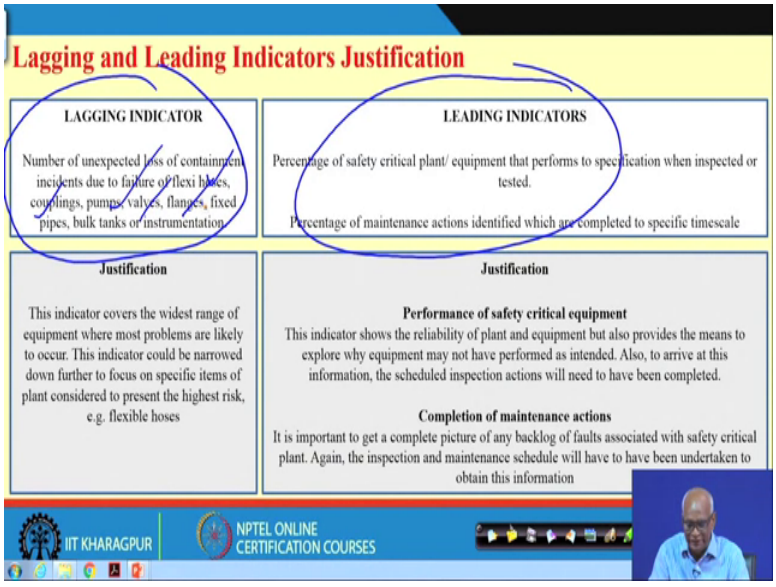

So, lagging indicators, these are the lagging indicators these are the leading indicators, for 1 initiating mechanism it is showing 1 line, but the total data is numerous from here. You should have lagging indicator of data of flexible hoses, couplings, pumps, valves, flanges all these things. It becomes big data.

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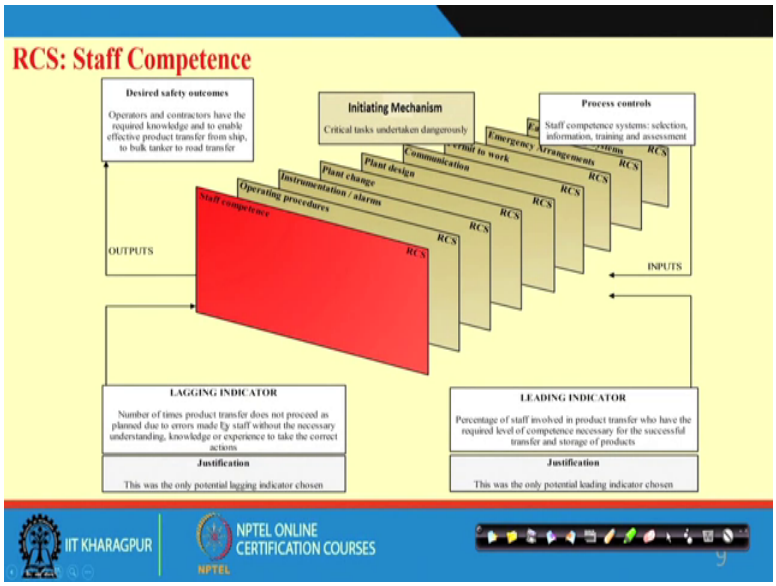

Similarly, you take critical task undertaken dangerously as the initiative mechanism. Now, you put it through staff competence. For example, I taken staff competence, earlier I taken itpm. So, for this what is the outcome you expect operators and contractors have that required knowledge enable effect and to enable effective to product transfer from ship. So, product for transferring the from ship to pipelines, pipelines to tanker, tanker to all these things. People should have enough knowledge. That is what you expect, what is the lagging indicator? Number of times product transferred does not proceed as planned due to errors made by the staff. How many is nothing great loss has happened, but how many times the transfer did not happen because of the competency of the people.

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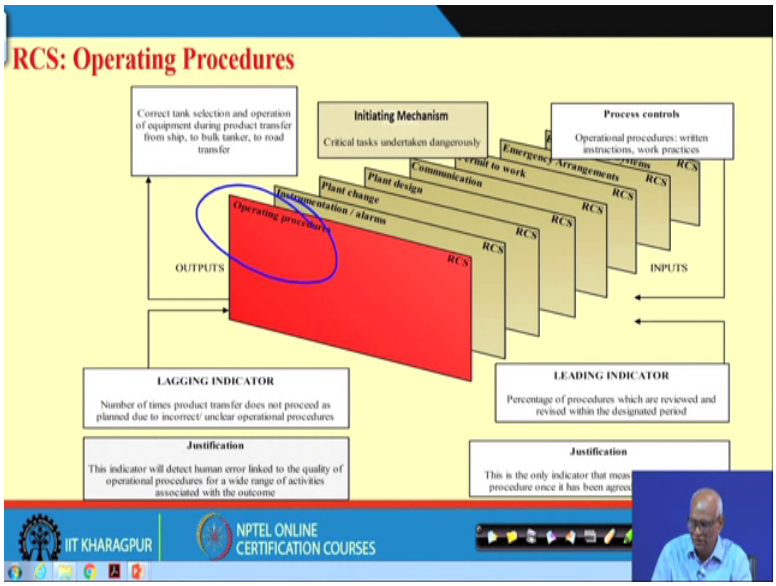

Because of the competency of the people, how many times it happened, how many pipeline transferred has not happened, how many times the tanker transfer not happened how many people not do. So, it is failures, small failures. If it is happening more times you have to take corrective action. If it happened once, probably may not take, but you are seeing the weakness of the system.

Similarly when you come to leading indicator, the inputs for the leading indicators is operational procedures, written instructions, working work practices all this thing should be there. Now leading indicator is percentage of procedures which are reviewed. The procedures for doing all these things it should be live, it should be reviewed and revised which in the designated period. If a procedure is to be reviewed within this much period has it been reviewed.

So, percentage are reviewed, if there if it is coming to very less; that means, your system effectiveness can be why do you want to review? Review people do if any changes ask you made it they will make, if any redundancy is there that they will see the redundancy.

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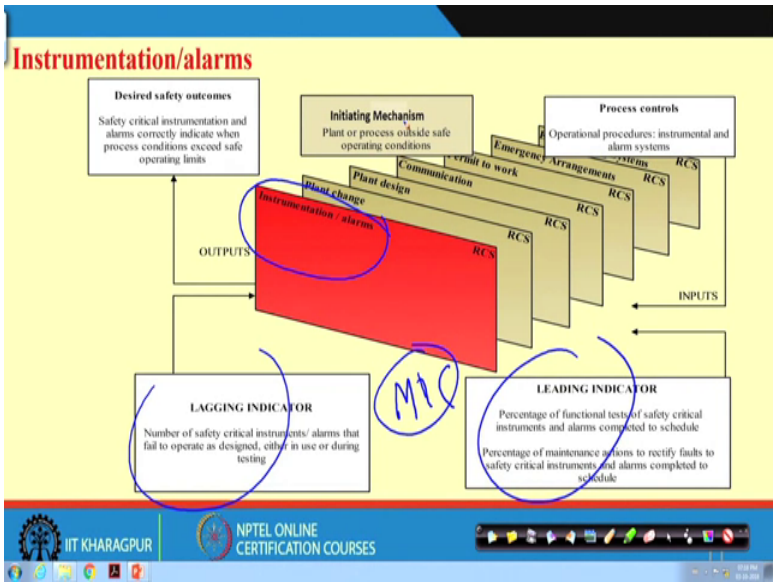

Similarly, plant and process outside safe operating conditions, outside safe operating conditions so instrumentation alarms is the risk control system. Bhopal disaster has happened when there is a leak, MIC leak, methyl isocyanide leak happening people are not able to ascertain from the control room. They are not, the people who are they are not able to read something wrong is happening, instrumentation alarms.

So, major thing happen; if you have the deserved outcomes safety critical instrumentation and alarms correctly indicate when process conditions exceeds safe operating limits. That is outcome it has not shown here with Bhopal. This thing to happen what is that you have to measure number of safety critical instruments alarms that fail to operate as designed. It has not failed totally something it is showing more, something it is showing less maybe calibration not done what are the number of small things which are happened to effect the deserved outcome. That we have to they are the lagging indicators.

So, for the leading indicators what is the input operational procedures instrumental and alarm systems they are the things which we have to do it. what are the leading indicators? Percentage of functional tests of safety critical instruments and alarms completed schedule. All these for the critical equipments you should you should test whether they are working or not. How many what percentage of the instruments alarms you have completed, done? That will show the effectiveness of the system percentage of

maintenance actions rectify parts of the safety critical equipment. The safety critical equipment some defects are shown, how many you have completed that is the leading indicator. So, this is for the effectiveness. This is for the system weakness.

So, by this time you may saw understood, how initiate mechanism, put through these control systems, lead to lagging indicators when it is to see that it is working of the desired outcome or not or how the leading indicators are coming. So, for every if you have 100 initiating mechanisms and each initiating mechanism as got say 10 5 risk control systems that much lagging indicators will come. Choose data, nothing has failed please understand, but you have the data to understand the system failure, system weakness and system effectiveness.

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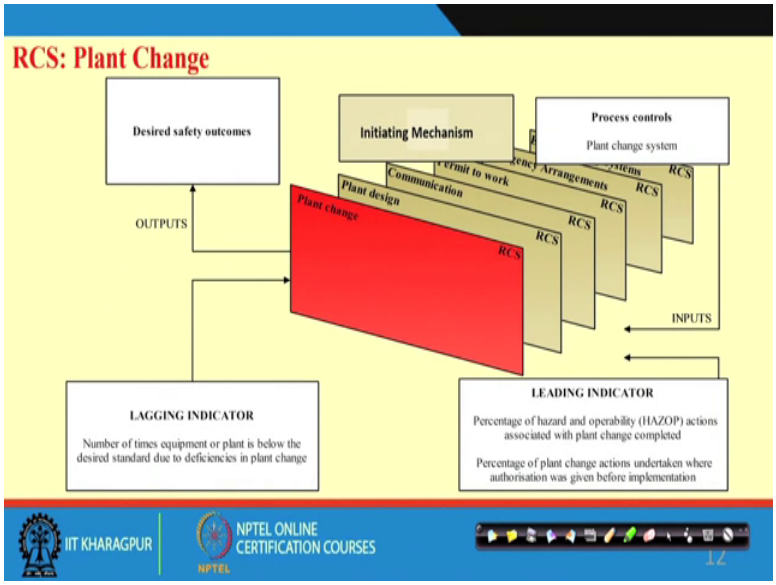

Similarly plant change, same explanations you can do; plant design, communication.

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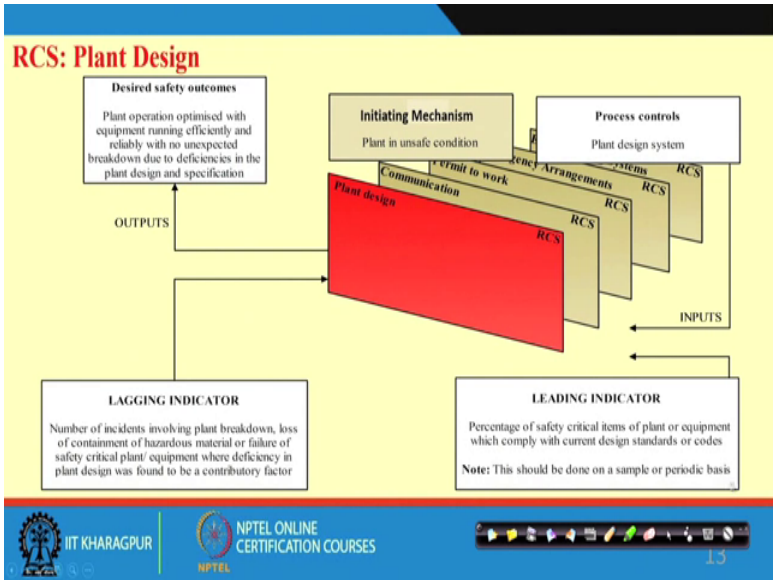

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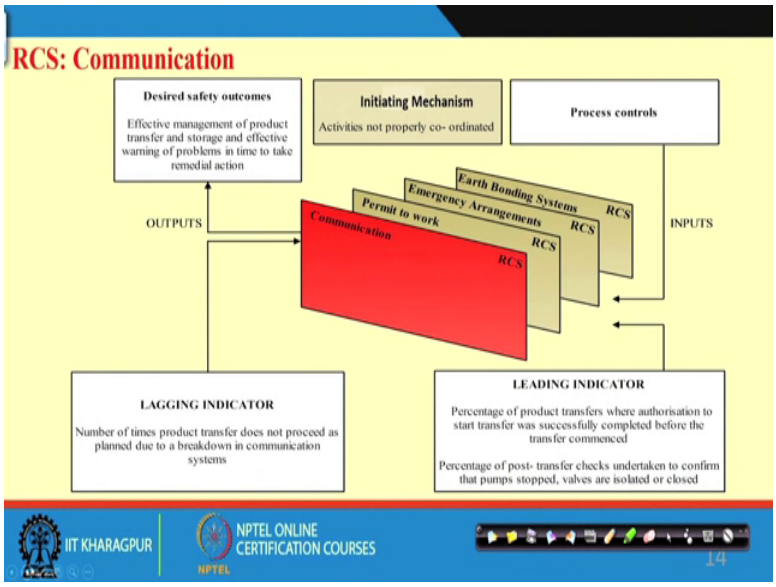

So, communication, whether the see, the activities not properly coordinated, proper communication has to be done. If communication is the risk control system, what do you expect, what is outcome you expect from this? Effective management of product transfer storage effective warning problems in time to take remedial action. If anything is wrong happening, it should be in time it is to be communicated. So, that they will understand, that is the communication. So, many times it is not happen.

So, percentage of product transfer where authorisation to the transfer lines successfully completed before the transfer is completed, here mostly you will you will see in terms of

percentages, what you plan? How much percentage you have completed, here you see the small failures.

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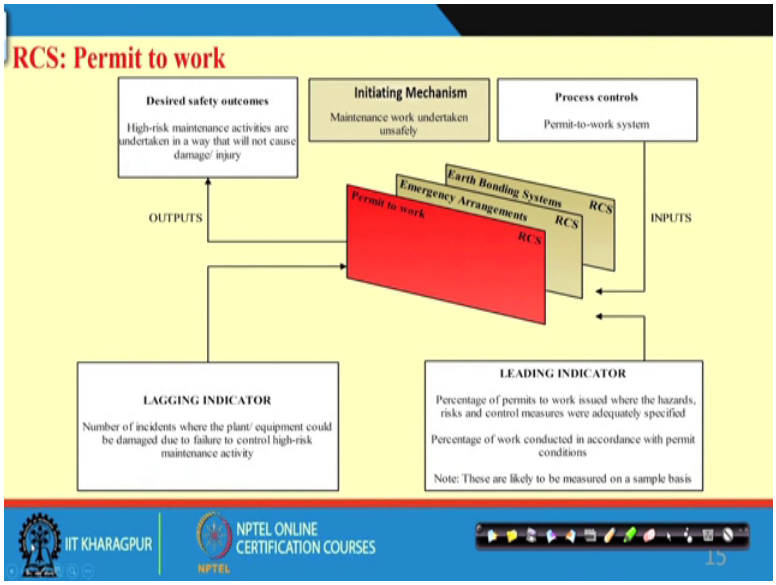

Similarly, permit to work very very important. Permit to work, especially the energy isolations part of part of permit to work. It will if you do permit to work energy isolations properly during the maintenance, during the operation people will not get hurt; believe me out of the fatalities, major incidents which are happening 80 percent attribute to only energy isolations. That is why I decided to take one class for you on energy isolations. People do not have proper concept of energy isolations. That is why; the ohs management system, people are not able to effectively control. So, next class will be on energy isolations. So, permit to work; energy isolations is part of permit to work.

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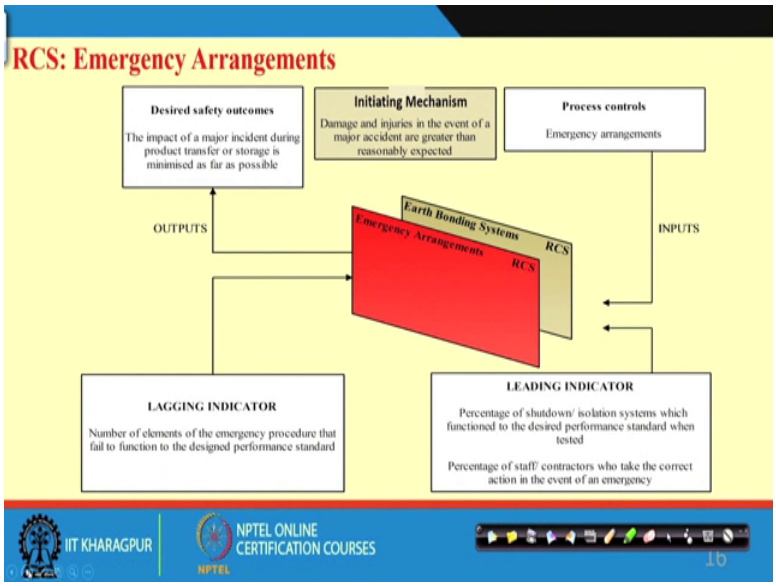

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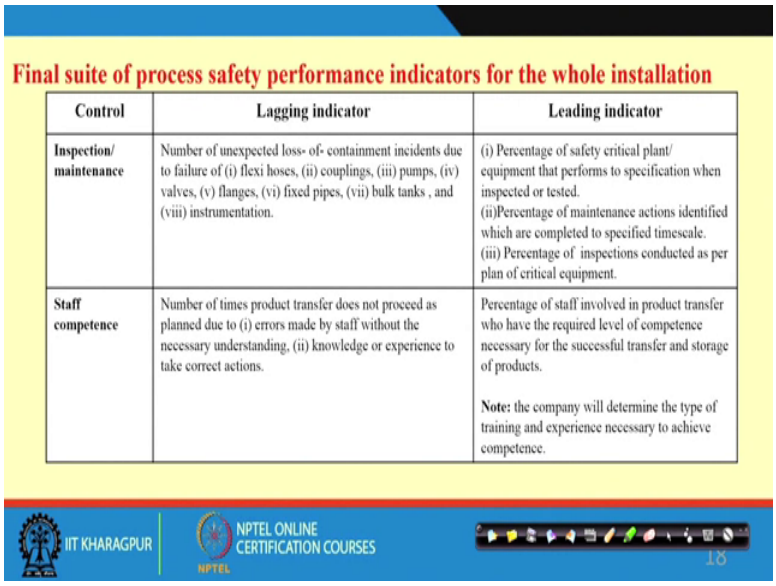

Emergency arrangement; so, like that; we have seen, for all the initiating mechanisms, how to apply risk control systems, from risk control system how will you bring out lagging indicators, leading indicators. Now I am putting everything in one place. So, for inspection maintenance these are the for this risk control system. These are the lagging indicator, these are the leading indicator.

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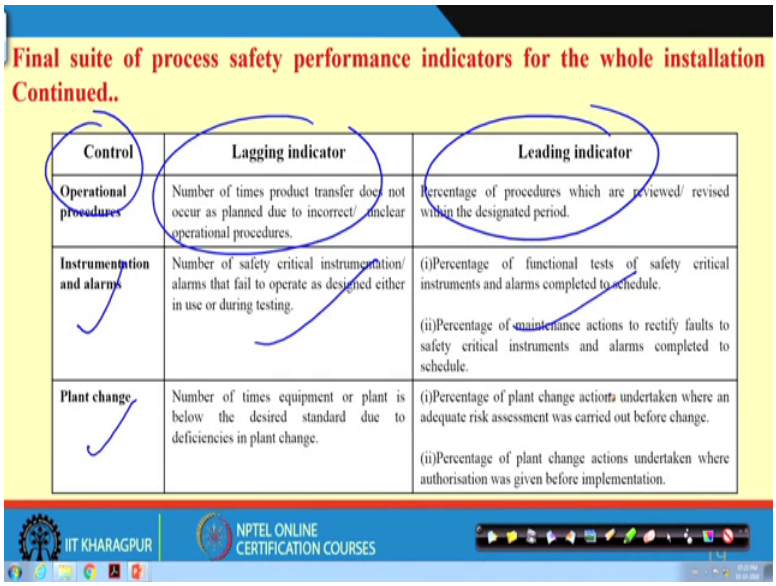

We are not put more initiating mechanism; only few initiating mechanism. For that I am writing here, if you put all initiating mechanism probably this list will be much more. So, this is a risk control system; these are the lagging indicators; these are the leading indicators. This is the plant change leading lagging indicators, we are discuss already these things ok.

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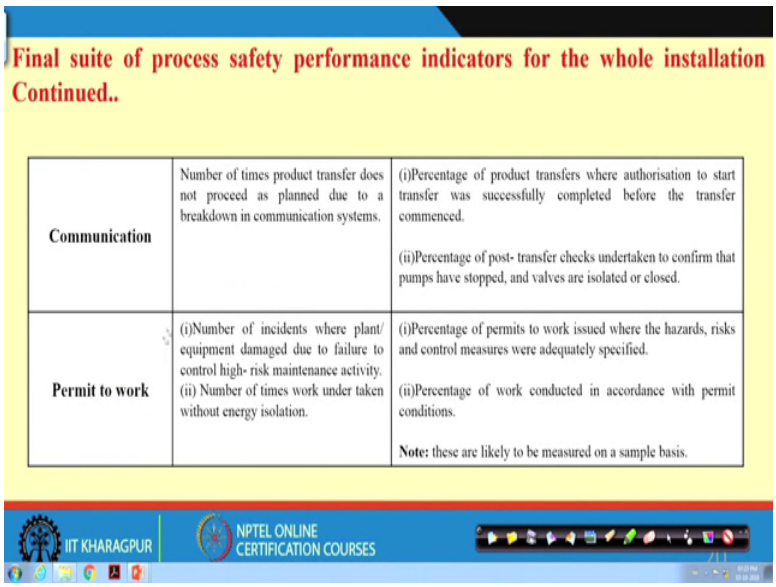

Communication, permit to work, what are the lagging indicators, what are the leading indicators; actually this permit to work has to be done much more elaborately. So, this is

very little it is written, in my view we should take much more in the permit to work. All energy isolations, we should put together is control system. And from there we should take out lot of lagging and leading indicators, plant design, emergency arrangements.

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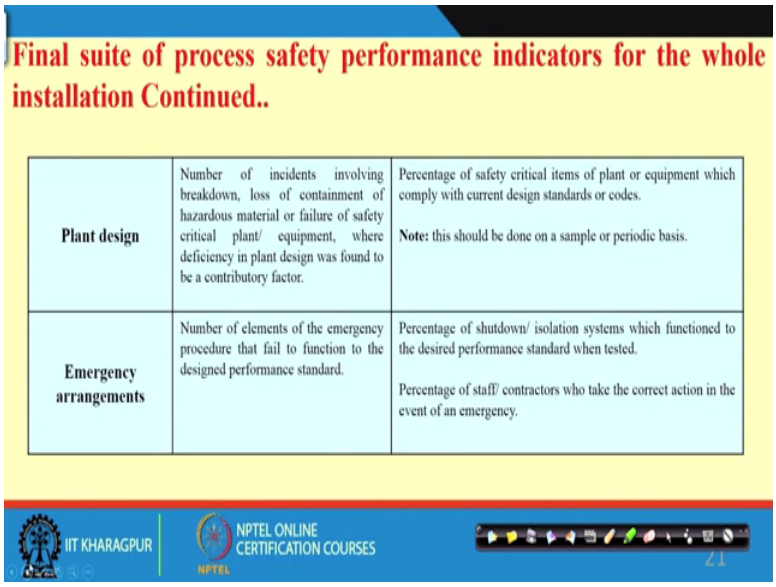

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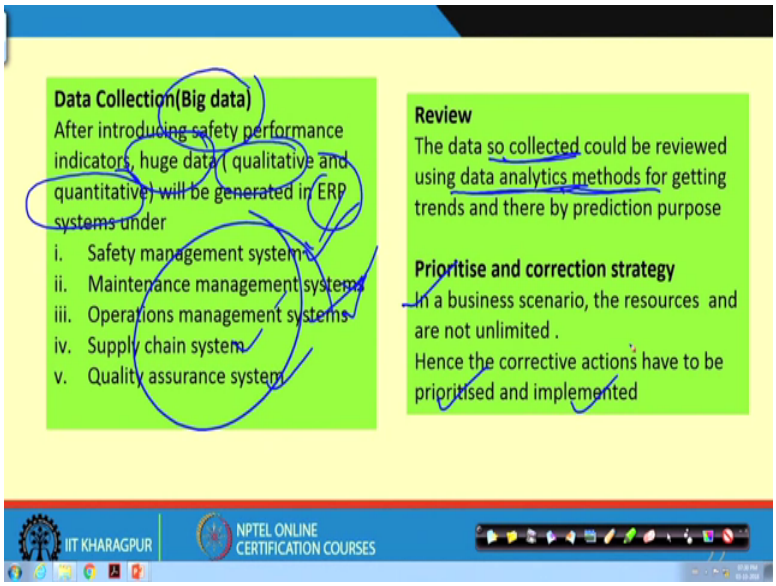

So, you by putting lagging indicators, leading indicators for all your hazardous elements with different initiating mechanisms; you will get huge date of lagging indicators, leading indicators. Believe me one of the failures of the occupational health and management system is you do not have data. People see fatalities incidents of the data;

you have very little data, from there you do not you cannot do any analysis analytics. The age of today is analytics; analytics data analytics in any field, if you have plenty of data with you, which is called descriptive analytics. How to generate data? We have I given you inputs, how to generate data, lagging indicators leading indicators. That means, if you do that properly that is called you are done descriptive analytics. From the data, you can have predictive predictions, which is called predictive analytics. If you predict correctly then you can stop it, which is called prescriptive analytics.

So, data analytics will help you to reduce the incidence, to control the incidents, to manage very well. So, safety is one of the area where analytics has got in. For that, the data is required I told you, how to generate data safety performance indicators; so, how do you. After collecting the data from the safety performance indicators, you have huge data; qualitative and quantitative. Qualitative means you may have rubbish data, it will not help you, from the lagging and leading indicators you will get very qualitative data right data, very impressive data and high quantity numbers you will get huge data.

This will be generated in ERP systems; if you are got Enterprise Resource Planning, every organisation will have it, maybe SAP system. In the SAP system you can generate, you can put all the data; under safety management system, under maintenance management systems, under operation management systems, under supply chain systems, under quality assurance systems. This data will not be available at one place, the lagging indicators, leading indicators for the plant maintenance will be generated by maintenance management systems, not safety management systems. But to address your safety management system oh systems you have to pick up from the maintenance management system.

Similarly, operation procedure not followed properly operation fluctuation, operation problems. It is available in the operation management system, not in your safety management. Safety management system what you have is the accidents, (Refer Time: 36:48), some fatalities are the incidence all those things. That is the very very small part of the data, minute part of the data major data will get from maintenance management systems, operation management system supply chain system, quality assurance system. All these systems you will get the both lagging indicators leading indicators. These are normally available in the ERP.

Now, nowadays no organisation runs without ERP system, maybe different some somebody may have SAP ERP system, somebody may have their own ERP systems, but they are all available the ERP systems. Then when you have all these data with you, which we call big data, very big data available; then you have to review. The data so called could be reviewed using data analytics; data analytics methods not pie charts and bar charts. Pie chart and bar charts all those things will come in the district analytics, data analytics means using when you have data collected from here, you have to stop it, you have to predict. Prediction analysis, prediction is brought using many data analyticities statistical tools. Many statistical techniques people use to and to bring the what is going to happen. Then you can put the prescription.

So, only collecting these data and sleeping on that will not help you. You have to put data analytics and get finally, the prediction and prescription. You get, so many so many items to take action; after all taking action will cause resources will cause money. You may not be able to do everything at a time then you have to prioritize, seeing your business scenarios, seeing your resources nothing is unlimited. Money is not unlimited, resources are not unlimited.

Rightly you have to prioritize which actions you have to take first, which corrective actions you have to take. Hence corrective actions are to be prioritised and implemented, if you do this you are occupational health and safety management system will really work very effectively and you will be able to protect people, property, community, environment effectively. So, that is how safety performance indicators is going to help, in the collection of safety performance indicators. In the whole of occupational health safety management system, I said energy isolations are going to play a very important role. Hence next session we will speak on energy isolations one session.

Thank you.

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