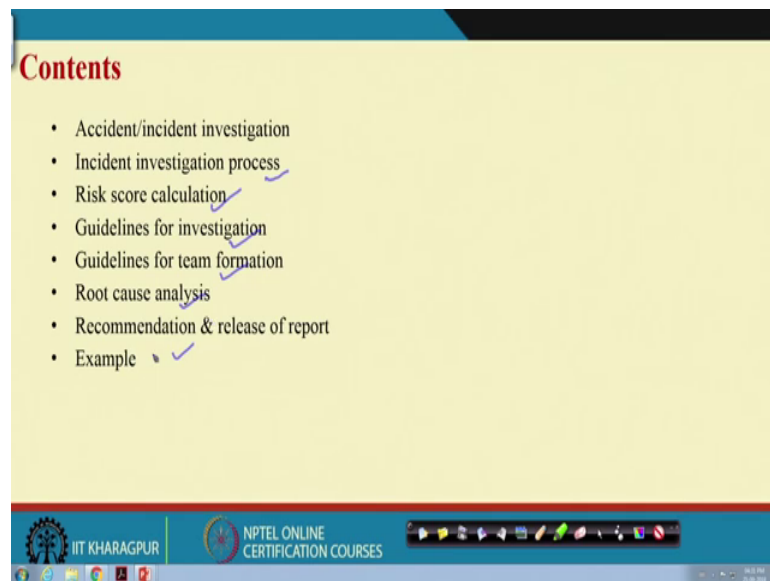**Industrial Safety Engineering**
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Lecture – 46
Accident Investigation

Hello everybody. Today we will discuss Accident Investigation.

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The contents of today's presentation include accident slash incident investigation, incident investigation process, risk score calculation, guidelines for investigation, guidelines for team formation, root cause analysis, recommendation and release of report with certain examples.

So, it is known to you by investigation we mean something has happened. Now a team will go there and see what has happened: Why that has happened? Who was responsible? When it was happened? What are severity of that happenings? What could have happened? What could have happened means what ores could have happened all those things we want to identify, we want to measure.

The purpose is you will you want the root cause analysis of that event happening. And based on this analysis you will take corrective as well as preventive actions, so that the same thing will not be repeated in future.

So, almost all industries factories this program accident investigation, some cases we say it incident investigation. The dividing line between accident and incident is known to you; incident includes every sort of events undesired events and where accident has considered those events which are having high impact primarily. Never the less incident investigation and accident investigation are now almost similar thing. So, we will focus on incident investigation.

So, whenever an incident has taken place in general the industry follow two phase of activities one is incident logging, and second one is incident investigation. So, incident logging means this page involves logging the basic incident details either by the victim if it is near means or very negligible severity case or the worker present at the time of the incident.

Now, the basic information what is included in the in the input is location of incident activity involved, immediate causes, incident narratives, risk scores etcetera. Now if the risk score is high suppose an incident takes place which potential score is high then further investigations are taken place by a team. Now that team comprises of different level of peoples depending upon the severity, and based on the investigation recommendations are made and those recommendations are likely to be implemented.

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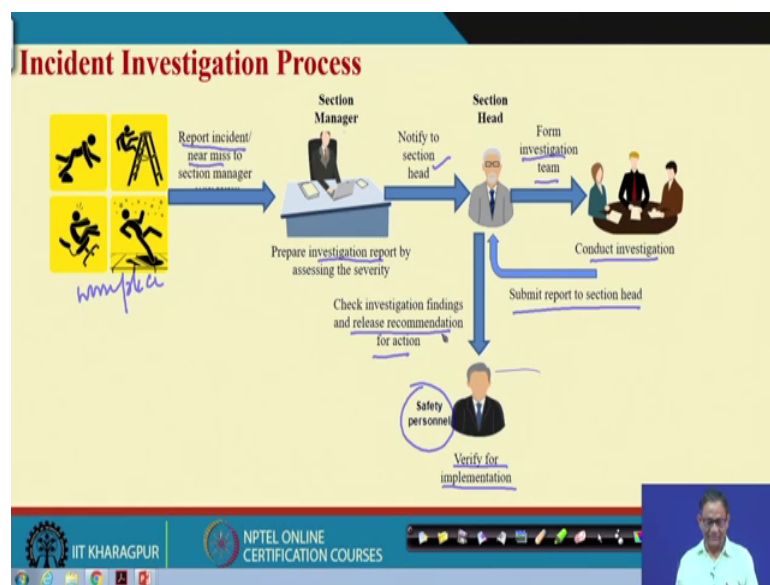
So, it is a pictorial representation of incident investigation process. So, this is work place work place anything undesired event taken place here that that incident or near miss will be reported to section manager. And then what will happen? The section manager prepare investigation report by assessing the severity. Then notify the section head then section head ultimately form investing team and then the team will conduct investigation submit the report to the head. Then what happened that? Head again check investigation finding and release recommendation for actions and this then safety personnel will come into picture safety personnel verify for implementation.

So, let me tell you incident taken place it will be first logged it will go to the section manager section manager prepare investigation report by appearing by assessing the severity. It will be notified to head, and then head form a team then team conduct team conduct investigation; investigation report will submitted to head. And then head pass on

these things to the section safety personnel safety personnel also see that may that that recommendations are implemented or not it should be implemented.

In certain cases what happened? These things will be exploited to the higher level also. This is more or less the process which practiced by large industries there will be little bit little bit that deviation here and there, but this is more less the process of incident investigation.

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Then what information are collected during that investigation. So we can list down several such what I can say issues. But primarily if you classify the issues that is to be reported during the investigation one is process related, technology related physical environment related and human resource related that is what Daniya Mal productive safety management has enlisted, so it is in not exhaustive list to me.

So, some of the issues are written down here need not be that you have to follow in this fashion. You must you may have your own way doing this things, but moral is the questions are similar from process related questions are: where the safety procedure are adequate? Where the safety procedure not available? Was the safety procedure not followed? Was the procedure followed incorrectly?

Then technology wise whether it was safe, whether the correct technology was used? Whether they are maintained and operated in good conditions or not all those things.

Physical environment primarily related to the physical related to lighting, related to heat humidity and other things, so that those things must be comfortable for the workers to work. So, similar questions can be asked. The human resource related that was the person concerned was doing his her normal duties? Whether wearing appropriate PPE? Whether competent or not? Was the person trained on safety procedure? So, many things are there. So, it is a only few questions I have added here.

So, if you see an incident report from any good organization you will be finding out that the report contents many things. There will be as thing like the time stamp when the accident has taken place, location stamp where the accident has taken place? Then so many causes immediate causes, intermediate causes, root causes. Then there will be the potentiality of those accidents in a situations some actions recommended actions. So and so also a narratives report on narratives, so many things will be there.

And in fact, the accident report analytics for incident analytics is a important I can say topic today. So, needless to say that your main work in incident investigation is to find out the root causes; these root causes further can be classified in terms of process producers, technology, physical environment, human resources, and other things.

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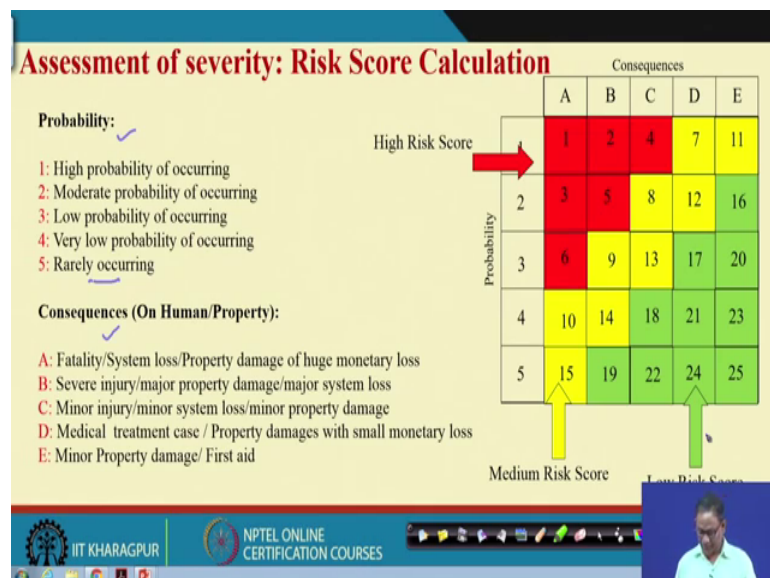
Now, as you have seen that any incident when it takes place. So, it is logged on to the system either it is online system or offline system? But it is recommend it is recorded and then the risk of that particular incident is calculated.

So, there can be many way of computing risk one of the way which is usually practiced in industries, in good industries that is probability and consequences. Now probability from 1 to 5 scale, high probability of work occurring to really occurring. And consequences A to is 5 point scale again from fatality to minor property, minor property damage or first aid. Now when you utilize this 5 plus 5 and 5 consequence scale you will be getting a qualitative matrix like this.

And here you see that there are 3 different colored zone, red colored zone all those cells they represent high risk, yellow colored zone cells represent the medium risk, green colored zone represent the low risk or other way I can say that 1, 2, 3, 4, 5 and 6; where 1 means there probability is 1 and consequences is A.

So if the incident falls under this category high risk category, so what will happen? Then your investigation team will be different, then the incident having the medium risk category and in again in comparison to low risk category. Sometimes we do not require to go for further investigation and, but for high risk cases it is always recommended that you must go for a team based investigation ok.

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So, how do go for investigation? What are the guidelines? So, first of all investigation should commence immediately for high risk incidents, so 1 to 1 to 6 scores. Investigation techniques should be clear to the team. Then following steps must be followed first is

visit the site collect and analyse evidences, listing the finding from analysis, preparing report with corrective actions.

And usually the report contains that: what has happened? What was the effect and who was affected? What happened just before and after the accident? What was the operational environmental other conditions? That means, you want to find out may be who involved? What happened? Where happened? Why happened? When happened? How much loss? So, many or why analysis will help you in finding out many of the root causes ok. Then you required to form team.

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So, you please understand the team is very important. If team is competent enough for investigation then find. Otherwise what happened? The investigation will be (Refer Time: 12:56) in the sense that the key issues may not be identified by the team if the team is not having appropriate experts.

So, that is why the personnel come from area or site expert, investigation technique expert, site or area safety personnel, HR personnel. And if the incident is of high risk nature, then the team should be lead by senior management. If it is medium risk nature led by section head, if it is low risk nature then site or section manager ok. So, this is what is the qualitative nature or feature for the team. And this is based on the risk calculation given in earlier slide. So, who will be leading the team?

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Then once investigation is completed then what you do? You will do root cause analysis. So, there are many root cause analysis techniques in fact, we have described so many techniques for hazard identifying and risk calculation. And I can say that if you want to do proper that incident investigation many of the techniques what we have described earlier would be useful while you go for root cause analysis.

So, like here some of the techniques I have further enlisted like why analysis? Fish bone analysis, human factor analysis, barrier analysis, many other analysis can be added here ok. Like I can say this bow tie is a very good tool that can be used for root cause analysis of an incident. So, here fault tree and event tree are event tree are merged.

So, I hope that you can relate this to the pervious techniques what we have discussed so far.

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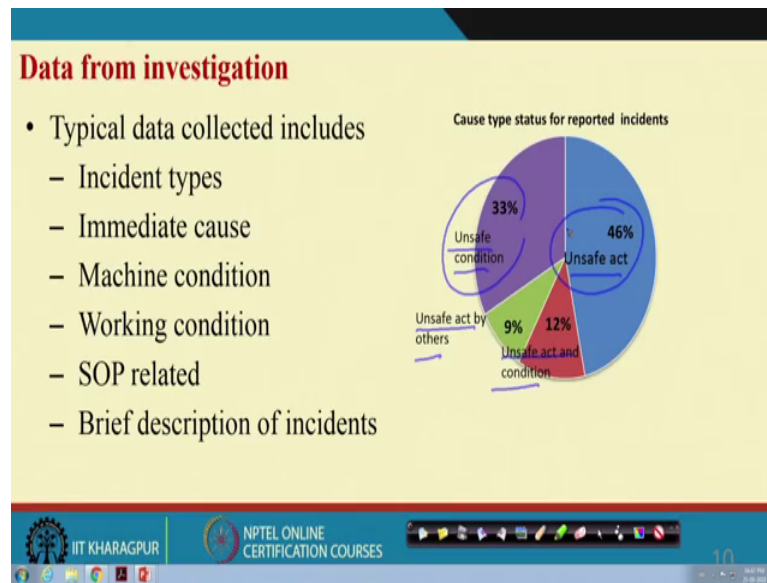
So, let us see some of these techniques. So, suppose you have data and you collect data in this format incident types, immediate cause and something like this. Now if you analyze the cause and you may find out that the cause type like unsafe condition, unsafe act, unsafe act by others, unsafe acts and condition. And then, if you have accident to investigation reports for several incidents. So, you can very easily frame such pie chart, this pie chart will tell you which condition which causes that basic causes are causing the accident or incident in your plant.

So, here we can say that unsafe act is responsible for 46 percent of the accident that has taken place. Whereas, 33 percent by unsafe condition and rest basically either unsafe act by others or unsafe acts and condition both. This is basically data collected from a plant.

And the when they analyzed the reasons for those accident, whether unsafe acts, or unsafe condition, or unsafe act by others, or acts and conditions both then that the frequency analysis says that it is unsafe acts is the major contributor followed by unsafe condition ok.

So, this is one kind of description if you when you do accident investigation and record the data over years you have several incidents, several incident reports you. And those reports if you analyze in one of the way of for cause wise you can find if you classify cause in these four different classes then what happened? You will ultimately find out

such frequency analysis ok. We will see later also some descriptive statistics part related to accident data.

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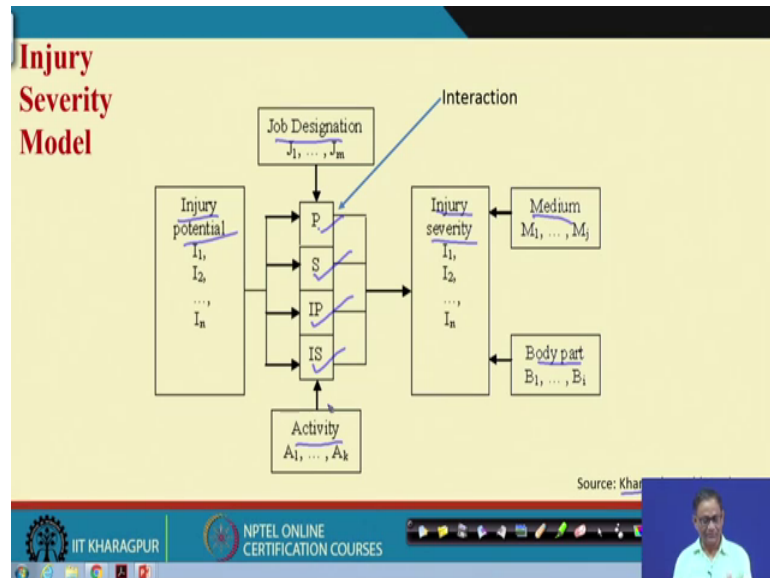
Now, suppose you want to go little your team is very good and you have when you have investigated you have also investigated apart from job designation of the big team, activity that you have also identified injury potential, injury severity, the medium which basically causing the injury severity which body parts are involved.

So, then what happened? You can create and also the interaction part because if you if you recollect the negative interaction during accident. You will find out that the negative interaction because of person, because of system, or because of interface between that where system in person. But person is responsible and interaction negative interaction between system and person but system is responsible.

So, such analysis so when you have data large data collected then such analysis can be possible and such analysis we have done. And in 2010 that is available in Khanzode et al 2010 in applied ergonomic journal. They are basically how injury potential is converted to injury severity that part we have shown through mathematical modeling.

But for the first place it is not necessary to know all those mathematical, neither you must know; what are the things to be collected during accident investigation ok. So, the injury potential, injury severity medium, body part, job designation activity.

These are the some of the activities that should be collected. There are many other attributes what we have discussed about earlier those will be there like location stamp, location stamp, time stamp, your causes, different kinds of causes, the SOP process then technology. So, many things are there, so all those attributes to be collected.

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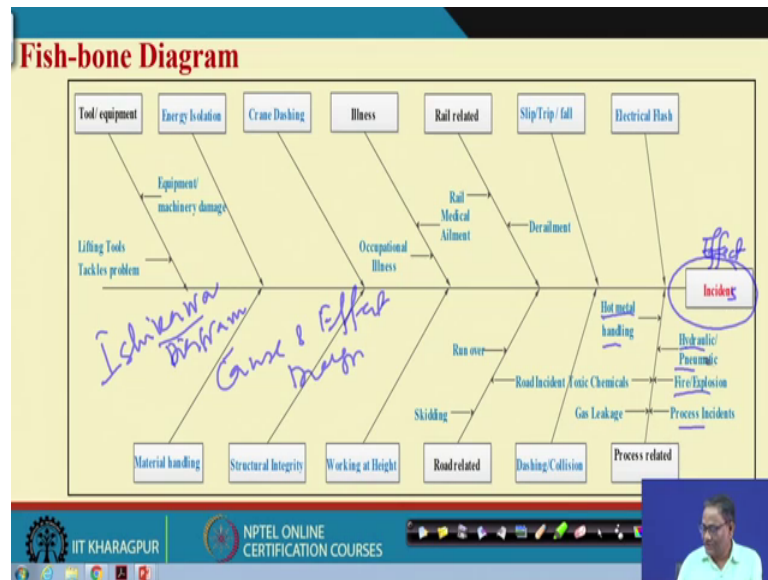
Another way of going for root cause analysis is that you just develop the Fish bone diagram which is also known as Ishikawa diagram, Ishikawa diagram. This is very popular in quality domain. What it does basically? It basically it is the effect; it is basically also known as cause and effect diagram, cause and effect diagram. So this cause in effect diagram basically the effect is this one that is (Refer Time: 20:31) and causes are basically fish bones.

So, this is a one such diagram we have developed from x incident records of a plant in India. And then we found out that these are the reasons electrical flash, slip trip fall, rail road, illness, crane, energy, tool equipment, material handling, structural intergerity, working at height, road related, dashing collision process related, so many causes are involved.

And again if you if you try to find out the further dig down the causes related to process related, then this hot metal, hydraulic, fire explosion, many things are there. In this manner what will happen? You can you can go into the depth of the causes which is may be at the bottom level causes which are the root causes.

So, incident these are the board immediate causes, then further you are going to every elevate causes is dig down to lower level. And in this way the fish bone diagram will give you a very good idea of why an incidents are taking place at the industry or the plant or the soft floor? And also if we have sufficient amount of data you can find out frequency of a all of the broad causes, immediate causes, then intermediate causes, then also the root causes ok. So this is a very good tool to go for root cause analysis.

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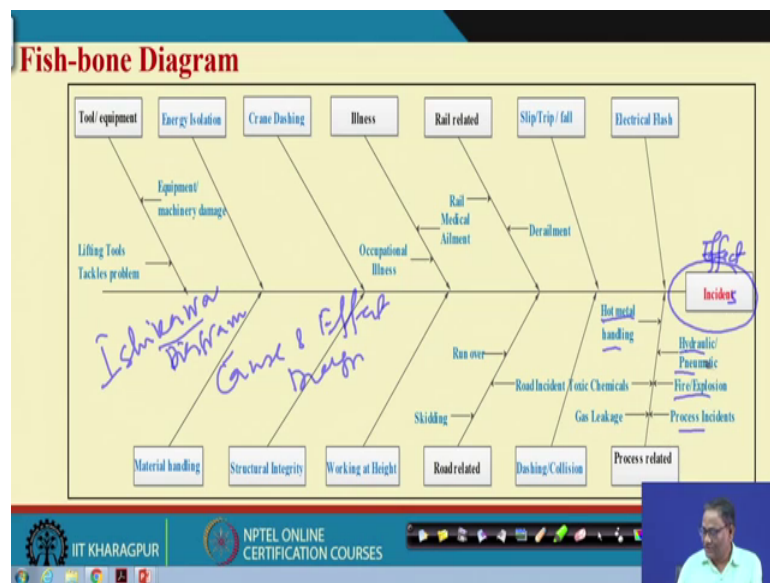
Then you will see that if you say that unsafe acts that is the important one. Then unsafe act primarily I mean some cases unsafe conditions are also related to the human problem. So, human factor analysis which another important thing that is to be done or data related to the human practice to be collected while investigating.

So, what are the threats related to human? That procedure work preparation, job factors, personal factors, competence, team work, supervision, safety culture, work environment, human machine, interface tool equipment. And then these are the threats this threats finally, you see that the situational awareness is important. Like attention, detection, memory, interpretation, decision assumption response.

And then there are lot of error and in fact human error and in fact human error we have dealt little bit in around 5 lectures we have discussed for human error. So, there you have seen that all those defined kinds of error we have discussed. So, ultimately these threats with the lack of situational awareness led to different kind of errors.

And that lead to that lead to accidents and ultimately those errors can be recovered, or if the errors are recovered and ultimately lead to the near miss accidents. So, it is very good one and a thing that while investigating please keep in mind that this human error part, or human factors part must me looked into. And the relevant information must be collected, documented, and given in the report.

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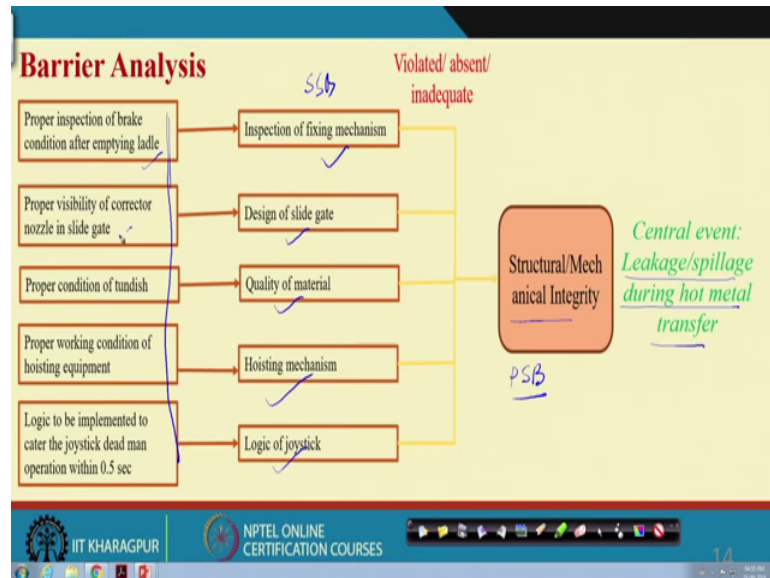
Then we have seen barrier analysis. So, barrier analysis here we are showing you once barrier analysis where leakage and spillage during hot metal transfer. So, it can be because of structural mechanical integrity, because of operator's integrity, because of many other reasons.

So, suppose one structural mechanical integrity then what happened? This is the primary safety barrier primary safety barrier and then you will find out the support safety barriers like this inspection, then design, then quality of material, hosting mechanism, logic. And you further if you see that the implementation level what is happening? These are all or I can say the probability initiating or influencing factors. So, this proper inspection of break condition after emptying ladle, proper visibility of this, so this these things are basically ultimately gives you at the shop floor level, bottom level what kind of x what kind of barrier failures are taking place?

So that means, you when you develop the in team you must know that ultimately the investigation report also should be able to make you the barrier failure make you

identifying the barrier failure. So that is why the team must be having the technical person who will be able to tell what kind of problem technical problem has taken place as well as the administrative problem.

So, the team must be very good one. And so that the report will ultimately come in such a manner that not only the preliminary that immediate cause analysis, intermediate cause analysis, root cause analysis in the sense we have discussed now possible. It is also lead to human factor analysis lead barrier analysis, and then ultimately the purpose of accident and incident investigation will be successful or may be achieved.
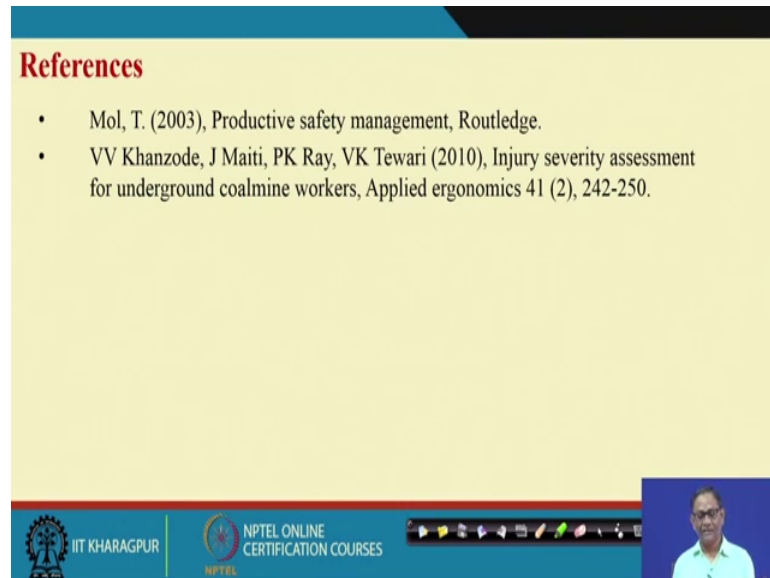
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So, then we will see that a once you do the investigation. Ultimately what are the things recommendations you will be giving and when will be report what are things should be there? Past recommendation should be searched to find out a repeat of similar incident.

Recommendation should be smart specific measureable, achievable, relevant, time, bound. After making recommendations the team should submit the report to the site area head. The report must contain information on effected particulars, facts of incident, details of evidences, technical analysis, finding from analysis, recommendation for corrective actions. The head should examine the report on the basis of these things ok.

So, this is basically based on our interactions with industries, and we are able to find out many documents. And people different people have written different way this is one of

the way that that recommendation should be made and reports would be prepared, so this is what is the descriptive part of accident investigation.

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References

- Mol, T. (2003), Productive safety management, Routledge.
- VV Khanzode, J Maiti, PK Ray, VK Tewari (2010), Injury severity assessment for underground coalmine workers, Applied ergonomics 41 (2), 242-250.

So, nutshell what happened; when accident has taken place or incident has taken place immediately it should be looked in to and the big team or the worker at that work place. They will ultimately inform the concerned person and they will basically record this one. And then the concerned person what he will do? He or she will do? She will see the risk of that accident or incident and depending on the risk form team with different team members. Then team members visit the place and thoroughly they review on what has happened, why had happened all those things.

The (Refer Time: 28:25) and I also record the information. The information should be of such high quality that it will not; it will go it will lead to root cause analysis involving process, procedure, technology, human environment related factors. And also it will lead to find out the human error, it will lead to develop the barrier failure analysis and so on and so forth.

Thank you very much. I hope that this lecture will really help you in future.