Industrial Safety Engineering
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Lecture – 41
Human Error, Classification and Causes

Hello everybody, today we are staring a new topic difficult for engineers which is Human Error. So, today's topic is human error, its Classification and Causes.

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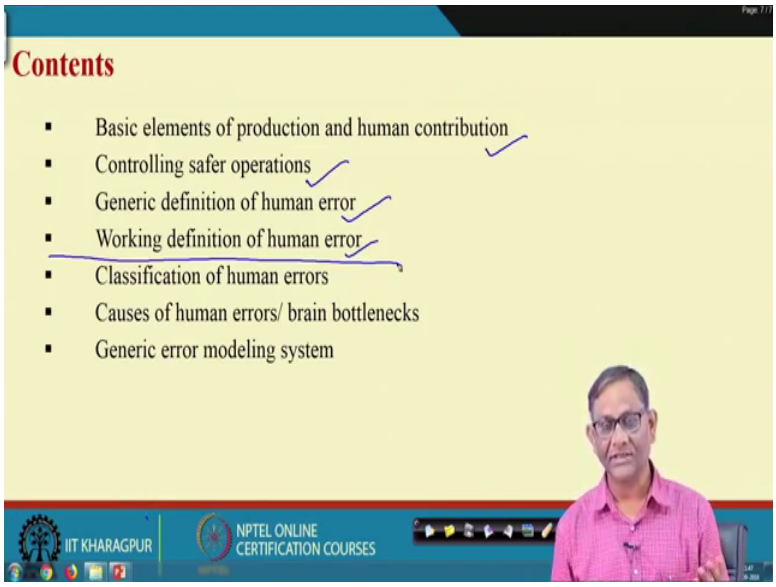

So, what are the things we will be discussing in half an hour to 40 minutes of time? So, we will start with basic elements of production system and then human contribution in production. Then if you want to make a production system safer so what are the controls that you should adopt. Then with these two important issues discussed we will go for human error. And we start with generic definition of human error, then some working definition, then classification of human error.

Then we discuss the causes very broadly and some of the brain bottlenecks, finally generic error modeling system. So, the lecture material was prepared with the help of many books, primarily the book written by James Reason that it is human error in 1990. And then other books like probabilistic risk assessment and management for engineer and scientist by Kumamoto and Henley. Then risk analysis method, theory methods, application by Marvin Rausand. So, some other articles also we have considered.

And those references or those sources I have given an under references. So, being a very difficult topic, so I will try to give you as much information as possible related to these. Some of the things you require practice to understand mean some kind of projects you required to do to go get into the detailed explanation and conceptualization of many of the concepts. I will try my level best to give some justice to this lecture.

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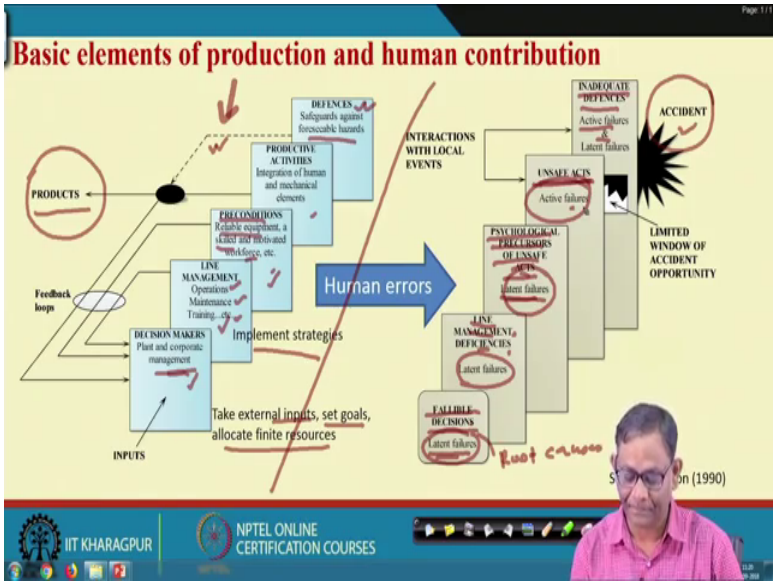

So, this is what is the element of production and as well as the human factors consideration. And that this was taken from James Reason 1990 that human error book. So, here you see this is the production part production system. So, any production system the basic purpose is ultimately will be producing products, it may be in products, it may be intermediate items, final product.

And then these production system requires a organization and in these organization there will be from the top to bottom there is hierarchy. For example, you will find out that in the broadly if you consider then you will find out that the top level decision makers, who are may be the your CEO or managing director and vice presidents and also independent in chargers.

Then immediately below to that who will be looking into the implementation of the decisions or strategies that were prepared by the decision makers, so they are called line management. Then ultimately the line management job these are at the soft floor level that will be in the day to day execution will be done by the workers. So, then we can say

that the long term strategic decision makers, then middlemen, line management; who will basically implement on the strategies and decisions and then workers who will actually do the work ok.

So, with this simple structure, I want to discuss this. First one is the production system which is developed based on actually the plant is also developed. And taking external inputs and different goals are set and accordingly finite resources are higher or borrowed. And they are nurtured and finally, used these are basically all those decisions comes under decision makers.

Now, then those decisions when the line management implements, these implementation through operation maintenance training there are so many line management functions. So, all those things will be done designated responsible group of people who are coming under line management. And then what happened there can be error in the decision making, there can be error by the line management, so those things ultimately leads to accident. And if I make the analogy between these and these whatever decision makers errors are took we say these are the valuable decisions.

These are all latent failure or you can see the root causes. Now, these decisions also enhance the error or the again the failures in the line management. Again line management may introduce some more failures, so these are basically line management deficiencies, so this is also a latent failure. So, there the definitely some of the latent failures here because of the valuable decisions and some may be added. But if traditionally we say this is a root cause, this is that intermediate cause.

Now, these failures ultimately what happened or successful operation is of these in terms of production if you see, successful operation of these error these this lead to precondition which is amenable for product successful production. What are the preconditions? Reliable equipment, scaled, motivated workforce, competent people so many things ultimately leads to productive activities or it basically does the productive activities means, integrating the component of the work system positively effectively that ultimately lead to the production.

And whatever maybe the reliability is there in all these layers this is the root layer, next layer, followed by next layer, next layer. But there is possibility of because you are dealing with the production system they will be hazards. So, the decision maker or

another designer of the plan they also look into forcible hazards and some defenses are put.

This is these defenses are for successful production these are not directly contributing to production. And that is why the dotted line is given for successful production. So, this when I am talking about the production system let this side this is basically that if things go successful things go well. Then you will basically get good production or you will produce. Now, when we talk about safety we basically talk about accident.

So, from accident point of view everywhere there will be whoever all the human being who are involved either at the decision making level, or the line management level, or the workers level. So, there is possibility of human errors and these human errors is basically in from when it is from the decision maker level it is latent failure from line management level it is latent failure. Latent means, it is not when an accident has taken place immediately you cannot find out what is the fallible decision or what is the line management deficiencies.

So, you require a systematic investigation procedure and then only through that an inquiry. And through which you will be finding out where in what are the latent causes. So, now I can say you just see that latent failures related to management. Line management means, in the operation in the maintenance, in the training, whatever that a implementations procedure that should have been should have been prepared and followed there may be mistake ok.

So, all those things what will happen these as successful work operation or a successful execution will lead to precondition for production. Unsuccessful execution will lead to psychological precursor of unsafe acts. For example, if your equipment is not reliable, it creates a condition that break down or may be if equipment is not safe, it condition for some unsafe conditions. If the workforce is not motivated or the work force is not competing enough that also lead to many latent failures which are the precursors of unsafe acts.

For example, your times schedule or the work schedule is bad it is it creating overload. The time given for work is less it, it create over pressure time. Or you want to produce more than what is what is basically recommended that is over pressure over production situations. So, all those time pressure, over production, overload all those similar kind of

things or maybe that unreliable equipment or unmaintained a maintained system. So, all those things are basically precursor to unsafe acts ok.

If these things is not done properly then overload, job pressure, job stress, time constant, overproduction so many things ultimately it will lead to, what happened unsafe acts. And when there is an accident takes place so you will find out this unsafe acts are very easily to identify and that because they are active.

So, that mean from this fallible decision, line management deficiencies, psychological a precursor unsafe acts; all those are basically latent, it is not immediately visible. But unsafe acts an active failures and unsafe act is basically immediately seen when you because one way or other it is possible to relate to the accident whatever happened to some people.

Now there can be there can be what happened there are basically it is because why unsafe acts and accident takes place it is because of inadequate defenses. Active failures and latent failures are result of here you are talking about the defense proper defense here we are talking about inadequate defense. Inadequate defense for all or these kind of latent failures as well as active failures. So, there should be a valuable decision should not have been taking line management should not create a situation that where over pressure or job stress will be created.

So, if it is done or created then you must know that there is a failure of the defenses or barriers whatever you can say. So, these by from these explanation what I wanted to put in front of you that human error can occur not only at the worker level it, it occurs at all levels. But their activities that their responsibility that their actions are different, but it can happen. So, as a result if you analyze accident and you will find out that that they are at any some anyone some of the levels in the organization there is human involvement and that human I mean human error each committed.

So, as a result it is very easy to I cannot say easy, but I want to tell you that it is possible to relate accident to human error. But unfortunately what happened that we relate accident to human error and those humans are basically the workers who are working at the software level. But that should not be the proper analysis that is not the proper analysis that should not be the proper way of doing things. Because any accident precursor are basically when you consider the latent failures are very important.

It these are all long term and issues and they have large impact in terms of accidents. By saying this I am not saying that the worker level that failures should not be constant there are the first step because you are able to see. Then the unsafe acts and unsafe conditions what is there that is to be removed. So, if this is the case so that mean it basically a proposed a hypotheses like these any production system whatever may be the level of protection there can be chances of accident.

And those accidents actually can actually can be related to human problem or human errors and that human are not necessarily at the worker level at the up to the decision maker level. So, when thing errors are committed at the decision maker line management level that basically we are talking about the management level basically. So, accident if you analyze you can find out the 85 percentage problem lies at their management level may be 15 percent at the at the sub floor level otherwise.

So, that when you do find out the human error across all levels when it is at the management level then they are high level errors and they are is basically knowledge level issues. But when at the at the worker level it may be the skill and rule level errors. So, all those things we try to find out.

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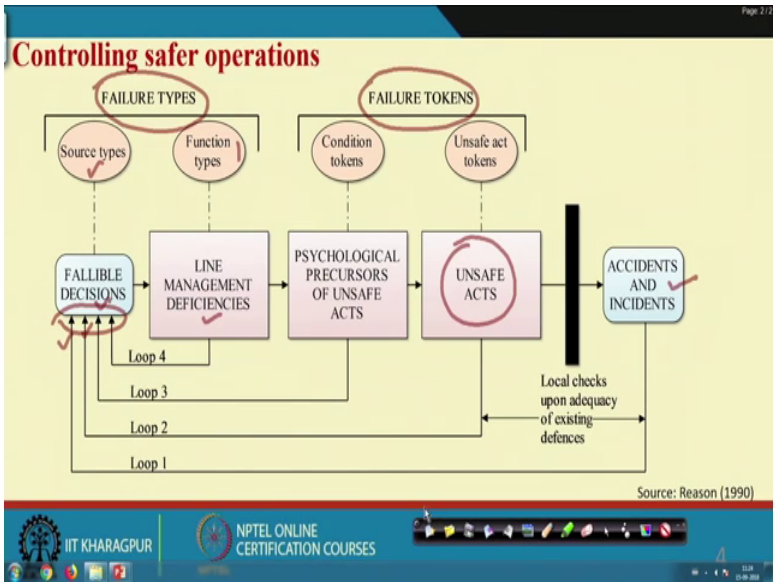

So, now based on these the region has given this diagram, where it is said that that basically the decision maker and line management deficiencies. This basically from there he has he has derived this failure types as per he his reasoning that source type. So that

means, the valuable decision is the source and because, because the line management actually implement the strategies and decisions met by the decision makers.

So, they basically line management talks about the line functions. So, that are these failures are function types failures. So, source type failures leads to function type failures and then what happened then another important terms he has used that is failure tokens. These are failure types and failure tokens because the precursor to unsafe act or unsafe acts what is committed by the worker at the sub floor level are the condition what is created at the sub floor level they are failure tokens. So, and it is because of the deficiencies of the line management.

And the line management deficiencies, is again is basically because of the fallible decisions. So, know as a result what happened if you want to control all those deficiencies or you want to remove errors or recover from errors. So, you required to get feedback from across all levels. First feedback will come once you have any accident takes place. So, that accident will give you feedback to the decision maker ok.

So, so that mean accident if you analyze there is a one week lecture on accident and investigation analysis. There I will show you that if you analyze the accident you will be finding out many regions of accident and those regions may be great input to the decision makers ok. Then you have unsafe you will find out several unsafe acts. I am not going into telling what are those acts I have already discussed earlier classes. So, those unsafe act there will be checklist for unsafe act that checklist will be input here.

Then similarly the precursor like overload time pressure production pressure. So, many things those things will ultimately another feedback loop. And then line management deficiencies also feedback loop please remember that actually all those feedback loops they are basically input to the fallible decisions. So, because this is the source, so here if we improve subsequently if we will definitely remove the problems.

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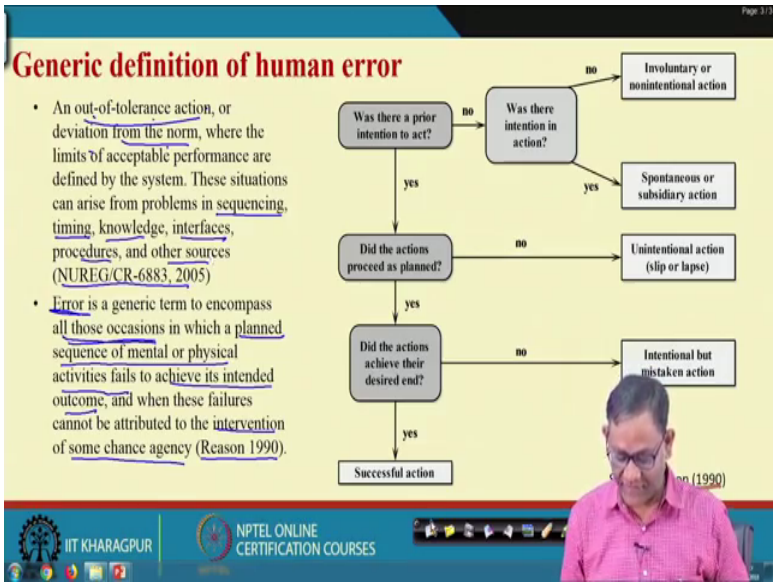

Now, with they that background I will give you some that definition of human error. That also we have taken from the same book by James Reason ok. So, what it is said suppose what reason said about the error. He said that errors is a generic term to encompass all those occasions in which a planned sequence of mental or physical activities failed to achieve its intended outcome.

So, all those occasions planned sequence of mental or physical activities fail to achieved the intended outcome and when these failures cannot be attributed to intervention of some other chance agency ok. So; that means, suppose you have you have a task or a particular work to be completed. And you know that what is the why this work is needed and what is the ultimate outcome if you complete the work. So, there may be some kind of physical activities or some kind of mental activities are involved.

So, you may find out that there will be occasions when those activities are not performed or the planned a they are not planned as required. And then if you analyze those outcomes you may find out that there is no intervention of any agency involved for those valuable outcomes. Then those occasions are coming under human error and accordingly you can classify the human error ok. So, these are basically region say these are the errors.

Now, if it when human involvement is there that is human error. Then another that nuclear regulatory board giving another definition, an out of tolerance action or deviation

from the norm so out of tolerance actions or deviation from the norm where the limits of acceptable performance are defined by the system ok. So, what they further said that this situation arise problems in sequencing timing, knowledge, interface, procedures, and other sources so this is what is the definition.

Now, obviously, it is definitions are not straight forward one to one you have to have a case and then you know that what are the ultimate out end objectives or goals and what are the procedure to achieve those adjectival goals and whether they are performed correctly or not those things you have to consider. For example, you have seen the pressure tank system so in the pressure tank system, pressure tank system I think you know these things system.

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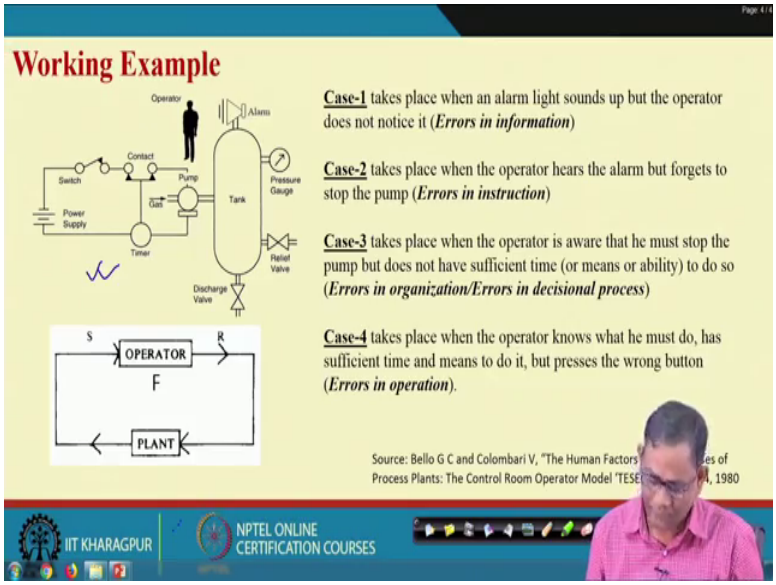

In the pressure tank system what is the ultimate goal and goal is what. That this tank will be tank will be filled with required amount of gas and those this gas will be that the storage gas will be used by some other equipment. Now, when you are filling the gas, it should there should not be over pressure condition and that tank raptures should not takes place from accident point of view.

So, that mean before over pressure condition you will you will close the pumping. If I considered the system is this much only. So, there are sequence some steps sequences starting from the that means, the timer setting the timer, then running for a pre set time. If

and then that will be that mean normal condition. And then some cases the timer may not work alarm will sound operator will intervene.

So, the operator intervention will and there are many issues you have discussed earlier. So, that mean, there is some physical activities some mental activities involved. So, there can be out of control actions or some upland actions. So, those things ultimately will be treated as error.

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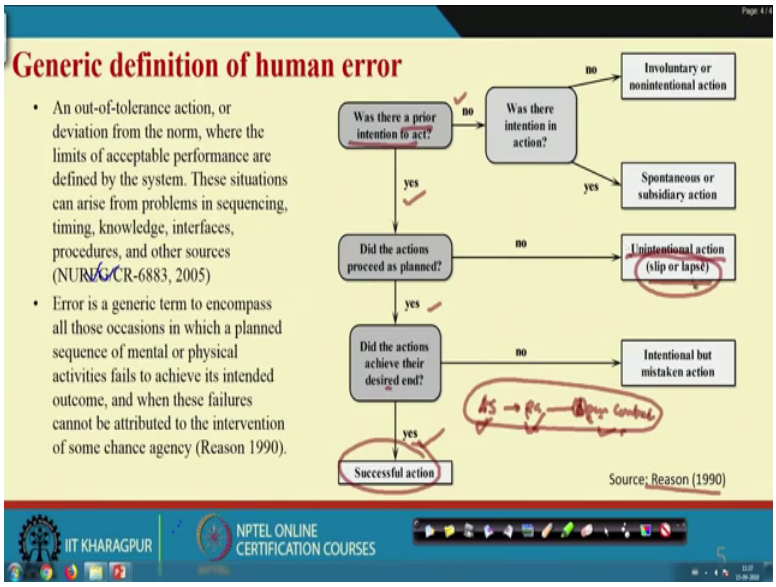

Now, let us let us see that what is the basically how do we consider, classify the errors or some further description of understanding the human error. As I told you that there will be definitely prior intention to act. If I consider the operator in this pressure tank system and if I consider that operator rule only these only one aspect I am discussing.

That when alarm sounds operator will see the pressure gauge and then alarm when alarm sounds alarm sound when there is over pressure condition at is at is basically more likely. But from operative point of view alarm sound and check the pressure gauge. And then accordingly if the pressure is high he will basically open the contact open contact. So, what is the, what is the ultimate intention that over pressure conditions should not arise over pressure condition should not arise.

Now what happened that is means prior intention is tanks should be filled below the desired just below the desired just below the desired pressure that is what I am saying

just below over pressure conditions. And to protect the over pressure condition so that tank rupture will not take place this is the system. So, I am talking about this system not the entire tank pressure tank that pump all those things.

So, that mean we have prior intention and we have also state different state, alarm sound, pressure check, pressure gauge. And a user operator must listen to alarm must check the pressure gauge and then contact this. So, we have intention will be time pump will be stopped because once contact is opened. The current to pump will be stopped and pump will sees running no more flow or no more gas input to the our this tank that is the case.

So, definitely there is intension fine yes or no if there is no intention. So, then they are involuntary and spontaneous subsidiary actions. So, this is not our part primarily we are not interested, but interest if you are interested please go through this book there is explanation. So, I am considering the other part suppose intention was there. Means the planning was done that for over to put it over pressure condition operator will do these, these, and these.

There is perfect planning related be like this or the planning may be in prefect also. Suppose intension is there then did the action proceed as planned when sound this check and these. It may so happened that operate suppose the operator should be there around. But operator is absent, but he should be there during this charging cycle. Then this is the why he is absent? It may be it is will intentional work.

So, in that case what happened we are not considering those intentional issues. Intension mean the operator knows that worker knows that a person knows that this is the time you have to be there and you have to perform all those things. Suppose intentionally he is not doing some of the things then that will go to violations. Another one is that all the actions suppose did the action process explained if it is yes, that mean all those things done correctly.

Then did the action achieve their desired end yes; that means, pump stops over pressure condition is arrested that is the successful action. So, there are two issues; one is I have the operator has particular goal to achieve. And in order to achieve that goal there are some sequence of activities to be performed may be somewhere it is physical activity, somewhere it is mental activities, but activities are performed. And desired goal is achieved that is the successful condition.

There are another other part is there the operator knows that these are the activities to be performed, but intentionally or some other regions that is known to the operator based so, he has not done so that is a violation. But in between is that successful operation and violation there are human error ok. What are those human error? The plan is known plan is good that mean intention is there is prior intention and accordingly intention is there intension means for successful actions that is the case.

Then the actions processed as planned. If it is no I mean these things should be done, but it is not done means the actions required is not process as per plan. Then an it is not intentional or it is not violation then this is unintentional actions slip or lapse. Because of may be when alarm sound pressure gauge to be checked then open the contact it may so happen that alarm forgot to alarm sounds.

But and then open the contact without seeing the pressure gauge because pressure gauge will tell whether alarm may be false alarm. Pressure gauge is the second depends that to put it the false alarm situation also. So, in that case some steps is some step is to be done, but not done. So, now, if it is a routine types of things and then he forgot to do or here seen a forgot to do.

There can be when this is not the action is not performed as per plan it will come under slip or lapses. Lapse will be basically it is related to memory when it is not done because of forgetfulness forget because lapse from the memory otherwise it is slip. Now, suppose planned are that actions are taken as planned, but the desired result is not achieved, desired not achieved, then what is the problem? Problem in the plan itself, problem in the plan itself, for example, suppose pressure gauge of it is not planned.

So, alarm sound open up in this one. If I say that it is a pressure over pressure condition it if it is correct and an action is also done that is a different that is a recover issue basically. So, what I mean to say here? If there is a problem in the plan or planning stage, so, this is basically planning error and this one is execution error, planning error and execution error ok.

So, I hope that you got some idea because there are basically from the regions classification point of view say that slip and lapses and then mistakes and then violations ok. So, how do you understand which one is slip, which one is lapse, and which one is

mistake? Which one is violation, easy to understand and which what is correct action that is also easy to understand.

So, in between successful action and violation there are errors in terms of slip and lapse slip or lapse or in terms of mistake. When I say slip or lapse basically plan is correct you have all the steps, but you forgot to do is. Suppose, you required to you for inadvertently pressure pressure button which is not to be done ok, so, that was the slip case ok.

So, anyhow so there will be there is overlap between slip and lapse. And sometimes we also are mistaken with the mistake and lapse all those things. But it is not as easy as I am telling here ok. So but you have to carefully understand in and create a case or example for it. And then try to apply this concept what I am discussing now.

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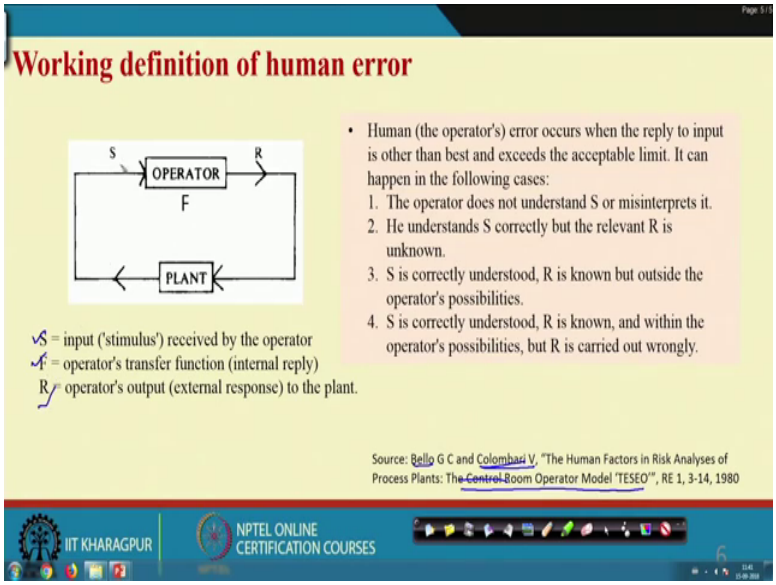

So, then I will give you a working definition because that one was so that one more psychological in nature. But here it is from operator control room operator point of view, control room operator model TESEO. It was given by Bello G and Colombari V, their model is like this that means, there are few issues one is S, F and R. What is S? S is the input received by the operator.

Then what is F? Operator transfer function operator will once input is received operator will use his brain in that processing mental process And then operator outputs means operator take action some response to stimuli. So, with these three, the he has given they

have given this kind of definition. Human error occurs when the reply to input when the replied to input is other than best because there is given a stimulus there must be response and that response should be appropriate to the stimulus and there is a best response.

So, what they are saying what they are saying that reply to input to other than the best and exceed acceptable limit it can happen in the following cases. The cases are what the operator does not understand S could not understand this and misinterpret it. He understand S; that means, stimula correctly, but the relevant R is unknown it does not know what is similar response.

S is correctly understood R is known but outside the operator possibilities. May be possibilities may be competency maybe beyond his reach or something like this. Then S is currently understood, R is known and within the operators possibilities. But R is carried out wrongly responses now wrongly ok. So, four different situations so I just I will relate these with the with this pump pressure tank example and then we.

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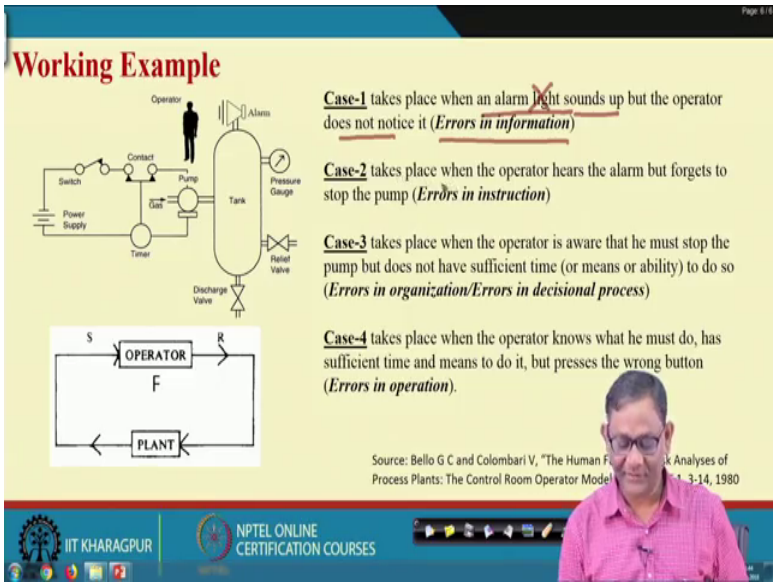

So, what is there? Case 1; takes place when an alarms sounds up alarm sounds up, but the operator does not notice it. So, this is the way I interpreted the things ok. So, it is not it is this example is not taken from this Bello and Colombari that from Bello Colombari these book I have taken the concept.

And then I put into the pressure tank example, so you if you find that it is not correct you can rise in the discussion forum. But anyhow I think it is correct; so, error in information, so information problem. Why I am saying error in information here? Basically that takes place alarm sounds up. But operator does not notice it may be the alarm is not that sufficient enough to maybe the sound is not sufficient enough so error in information.

Two case 2 takes place, what is the case 2? Error in instruction, you just go back, let us sorry. What is the case 2? He understand S correctly and stimulus is the alarm currently, but relevant R is known not known, R is response is not known. So, first one stimulus could not understand this, second one understand S, but response is unknown. Third one understand S response is known, but the operator cannot do it, fourth one understand S, R is known and operator it is within operator possibility, but done it wrongly; four different cases.

So, second case error in instruction that takes the operator hears the alarm, but forgot to stop the pump. Third case takes place when the operator is aware that he must stop the pump, but does not have sufficient time to do so. Error in organization, error in organization or error in decisional process; so he hear these then check the suppose the check the pressure gauge and then he has gone for this one removing the contact, but this entire process takes more time.

So, that is why the over pressure condition is not valid state. Case 4, that takes place when the operator knows what to do and has sufficient time to do it, but he press the wrong button, so errors in operation. Instead of maybe removing the that opening the contact he might have press something wrong which have which ultimately does not remove the contact. So, this is what is basically the definition of error and the precursors.

So, what we have we started with we are started with these with these. So, what we have completed? I have given you this one. I giving you this safer operation then generic definition of error and working definition of error. So, I hope that you have understood these, the primarily I have given you the concept with the one example.

And you create your own example that I am requesting several time you create your own example. So, then essentially what I have discussed? I said that we are discussing human error with reference to safety and primarily industrial safety where many people work and these human error contributes a lot to the accident. Because the human error is not

only the operators error, it is error up to the strategic level the decision maker, the boss of a company.

So, in the organizational hierarchy starting from the top level management, the line management and then the worker. So, everywhere there are different somewhere decisions, somewhere implementation, somewhere execution. So, everywhere human involvement are there and there are errors. So, those errors can be classified in different ways. Only one classification we have given in terms of that one is the intentional which is basically violation. Another and in between violation and successful actions there are human error in terms of slip or lapse or mistake. Slip or lapse means when you do any activity or any work there is end goal and in order to achieve the end goal you have series of activities either physical or and or mental to be performed. Suppose, in you have committed errors in planning all those activities then that is will be mistake.

But suppose the planning is correct but the person who is executing it he committed some of the steps maybe because of it will go to slip or lapse. When you talk about lapse the memory component is important because lapse from the memory. And then I have given you another definition from that responds stimuli, stimuli response model. What happened? There are four conditions we created.

The stimuli understood, stimuli not understood, action taken correctly, action not taken correct correctly or responds correctly, response not correctly ok. So, these are the different ways of basically understanding errors and with reference to pressure tank system we have tried to understand it.

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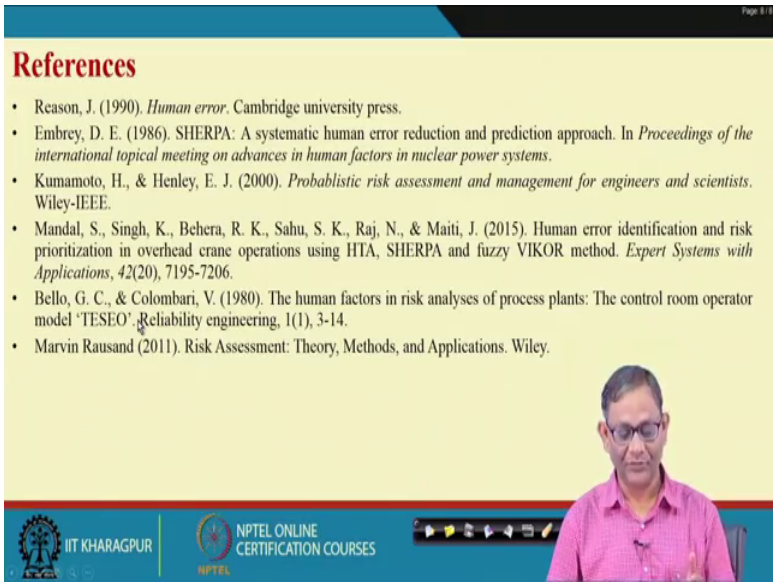

The references as I said listed here primarily Reason. And then I have given you this Bello, C G and Colombari V; 1980. And there are few more references which will say the huge of all those references we will be seen in the next lecture.

Thank you.