NPTEL

NPTEL ONLINE CERTIFICATION COURSE

Health, Safety & Environmental Management in Offshore and Petroleum engineering (HSE)

Module 1
Safety assurance and assessment
Lecture 10
Hazard classification

Friends will continue with the module 1 lectures on safety assurance and assessment now we are on the lecture 10 which we will discuss about hazard classification.

(Refer Slide Time: 00:28)

We will try to recollect some terminologies which were understood earlier hazard is a chemical or a physical condition that has potential to cause damage to people property or environment whereas incident is the loss of contamination of material or energy all instance do not propagate to accidents.

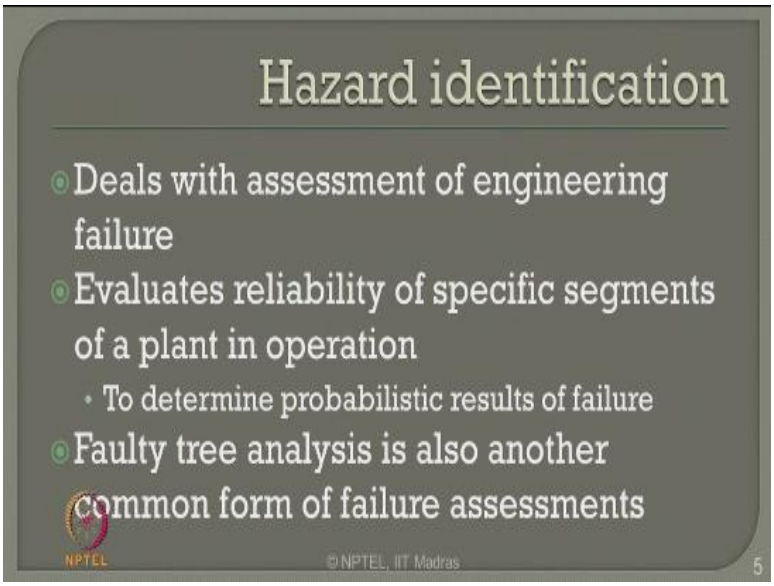
(Refer Slide Time: 00:51)

Hazard analysis is therefore a system or a scheme which represents identification of undesired events that lead to realization of a hazard. Hazard is a scenario analysis of the mechanisms by which these undesired events could occur will be a focus in hazard analysis estimation of the extent of hazard magnitude and likelihood of any harmful effects will be all as a focus of hazard analysis.

(Refer Slide Time: 01:20)

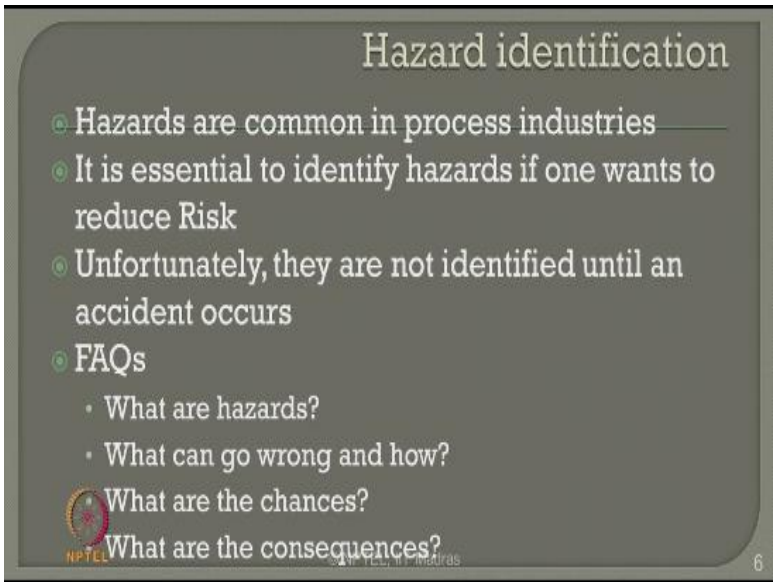
Let us quickly understand the comparison hazard and risk hazard is a scenario it is nothing but a situation resulting in more likelihood of an incident whereas risk is realization of a hazard the incident becomes an accident and therefore it becomes risk.

(Refer Slide Time: 01:41)



Let us talk about hazard identification hazard identification deals with assessment of engineering failure it evaluates reliability of specific segments of a plant in operation it is useful to determine the probabilistic results of failure interestingly hazard identification is generally done on plants which are in operation fault tree analysis is also another common form of failure assessment.

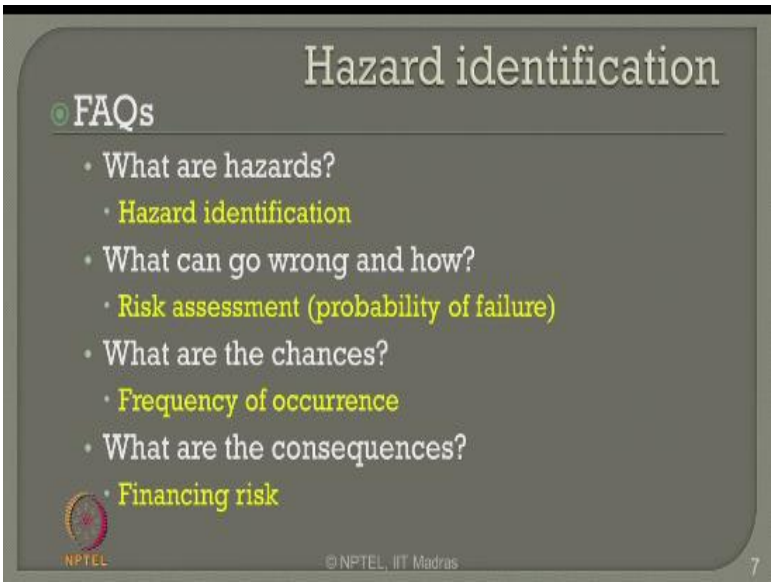
(Refer Slide Time: 02:16)



Which we will discuss later hazards are common in process industries we all know that because it is a scenario which a condition which can be always prevalent in any process industry of course oil and gas industry is no exemption it is essential to identify hazards if one really wants to reduce the risk involved in a planned process unfortunately they are not identified until an accident occurs therefore certain frequently asked questions should be there to make hazard identification an important parameter.

What are hazards what can go wrong and how what are the chances of they going wrong what are the consequences if they go wrong.

(Refer Slide Time: 03:01)

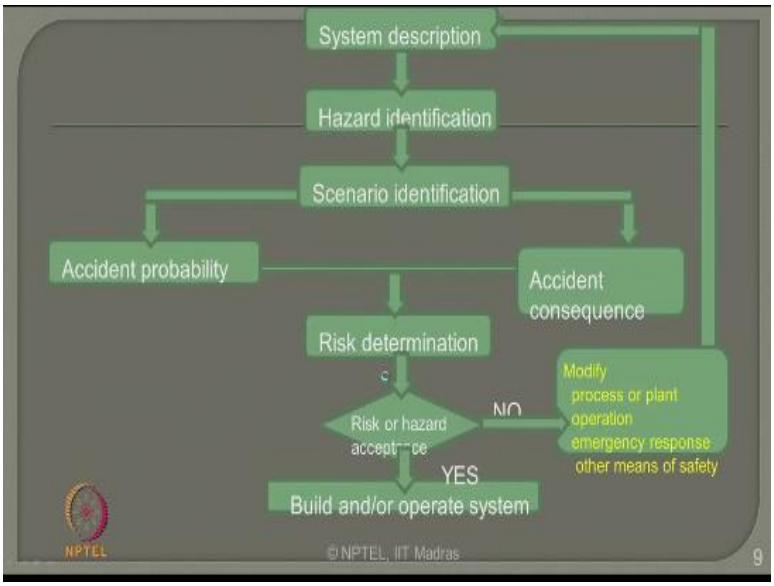


What are hazards will give you a result as hazard identification study what can go wrong and how will tell you risk assessment which will include focus on probability of failure what are the chances is determined by frequency of occurrence of the accidents what are the consequences we will tell you or lead towards financing risk which we understood in the earlier lectures of the same module.

(Refer Slide Time: 03:31)

Hazard identification and disc assessment combined together is called as hazard evaluation risk assessment is also a part of hazard analysis.

(Refer Slide Time: 03:46)



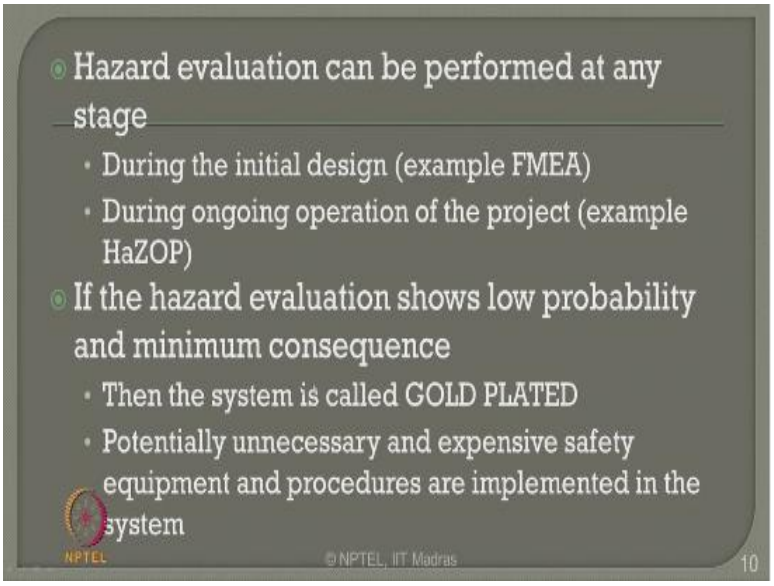
Let us quickly talk about the flow sheet of an hazard analysis we should identify the system first what we call a system description then based on the system description we must identify hazards present in the system based on the hazards present in the system we should be able to identify the scenario present in that system which will lead to two issues parallely one is called accident probability other is called accident consequence we all know that the product of probability of occurrence and the consequence of failure together gives me risk analysis or risk management.

So scenario identification will branch out into two one is talking about the evaluation of probability of accident occurrence and the second could be if they occur what would be the consequence both of them together will lead to risk determination risk or hazard acceptance level will be anyway established for a given industry because there is a decision box here every industry will have their own standards of risk acceptance levels which is suggested by oil and gas industry directorate.

So you must check whether the determine risk from your system identification is acceptable to your plant level if it is accepted go proceed and build and operate the system if it is not accepted modify either the process or the plant operation or prepare for emergency response otherwise

meaning for safety so get back to the system description again after the modification is done and follow the same process until your process or the description of the system reaches acceptable hazard level or risk level as suggested by the oil safety directorate.

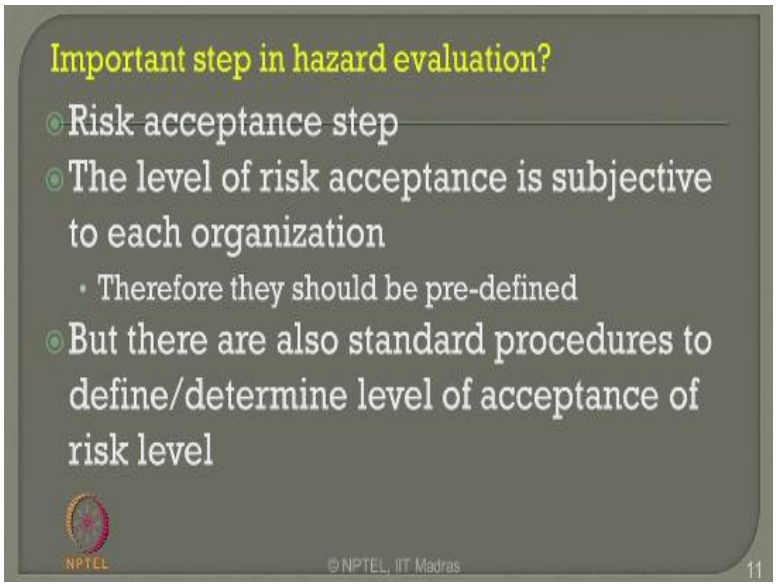
(Refer Slide Time: 05:42)



Hazard evaluation can be performed at any stage in a plant it can be performed during initial design stage of the plant itself because we already seen certain examples where safety can be done even the design stage itself one classical example which is attempted in industry is FMEA, FMEA stands for failure more effect analysis this is one of the very powerful mechanical tool which is used for initial design stage to do hazard evaluation.

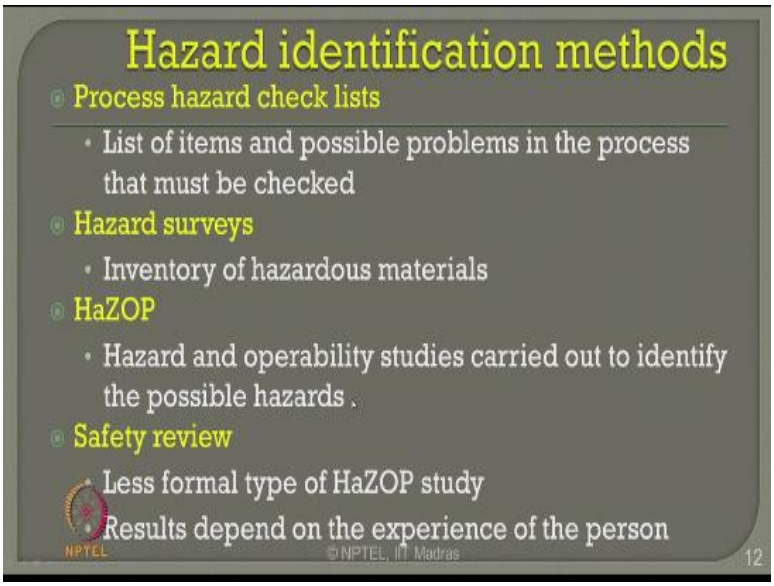
Hazard evaluation can also be done in a plant during ongoing operation example is HAZOP study if the hazard evaluation shows low probability and minimum consequence then the system is slated as gold-plated system unfortunately you must understand that gold plated system always have potentially unnecessary and expensive safety equipments and procedures in place which are implemented in the system. So the system otherwise becomes very expensive to maintain a system to remain as gold plated.

(Refer Slide Time: 06:54)



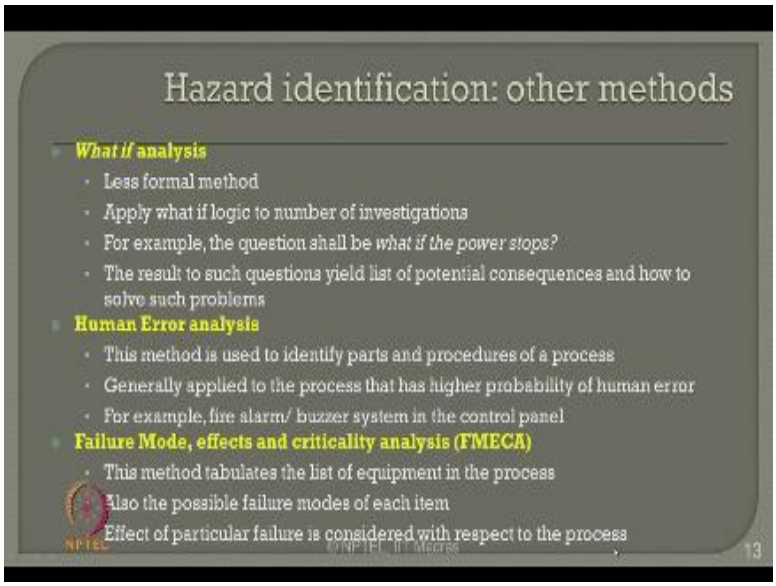
Let us ask a question now what is an important step in hazard evaluation the most important step in hazard evaluation is to establish the acceptable level of risk the level of risk acceptance is highly subjective to each organization therefore it is very important that your organization should pre define the acceptable level of risk but there are also standard procedures to define or to determine the level of acceptance of risk level in a given plant.

(Refer Slide Time: 07:29)



There are different methods are hazard identification process hazard check list is one amongst them which deals with listing of items and possible problems in the process that must be checked frequently the second method is hazard surveys hazard service deal with checking inventory of hazardous material the third study is HAZOP study hazard and operability studies which are carried out to identify the possible hazards in a process plant which is in operation, the fourth could be a safety review program which is a less formal type of hazard study this can result on experience of a person therefore the views are the recommendations made by the safety review program dependent on the experience of the person who is conducting the review program.

(Refer Slide Time: 08:22)



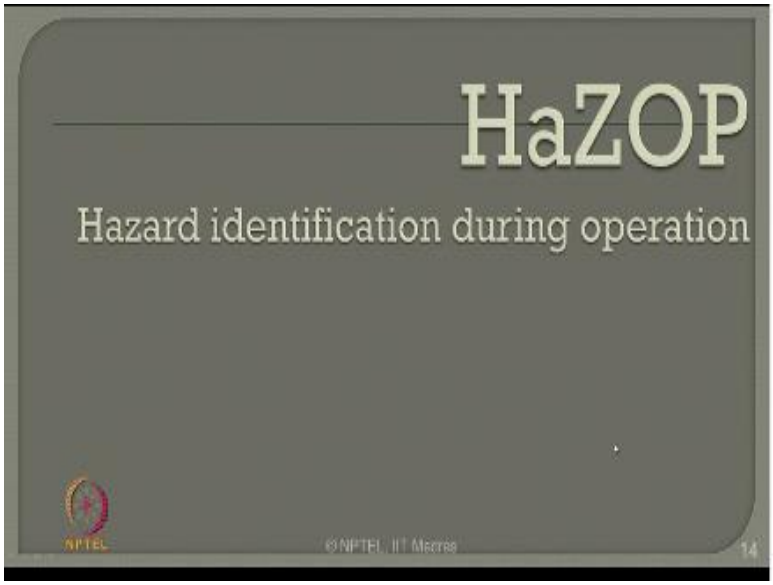
There are other parallel methods for doing hazard identification, the one which is top most the list is what if analysis, it is a list formal method it applies what if logic the number of investigations for example the question shall be what if the power stops. So you identify the consequences of failure because of stoppage of power and identify the hazards leaving to the scenario.

Therefore what if analysis is a less formal type which is a result of series sufficient asked based upon the process or the industry available, the result to such questions will definitely healed to list of potential consequences and how to solve such problems, the second the list is human error analysis this method is used to identify the parts and procedures of a given process plant, generally it is applied to the process that has higher probability of human error.

For example failure of fire alarm system, failure of buzzer system in a control panel which will have an higher probability of human error generally is conducted under this kind of survey or human error analysis, the third one is of course the most important one is an hazard identification which is FMECA failure mode effects and criticality of such analysis is FMECA, this is highly formal method.

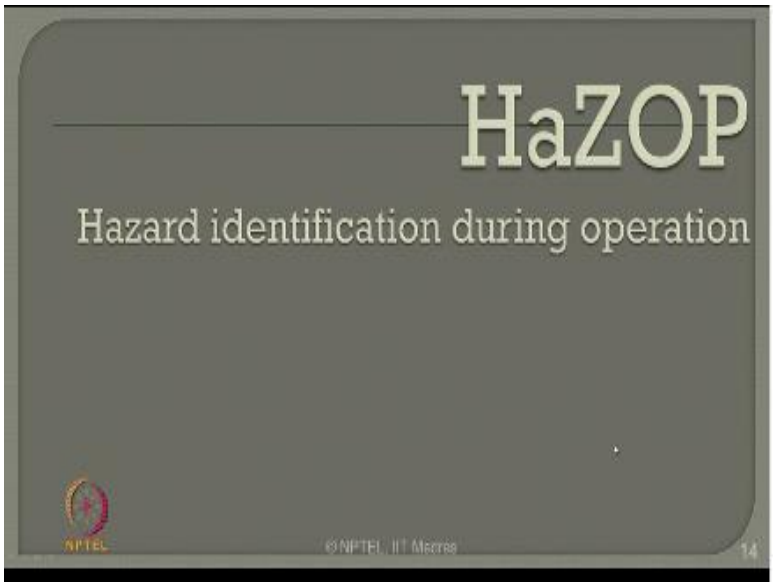
Which tabulates the list of equipments in a given process it also finds out the possible failure modes of each item present in the process plant and the effect of particular failure is considered with respect to the process as a whole. So this gives me a detailed diagnosis of failure in time in fact in the component level as well as in the product level as well.

(Refer Slide Time: 10:12)



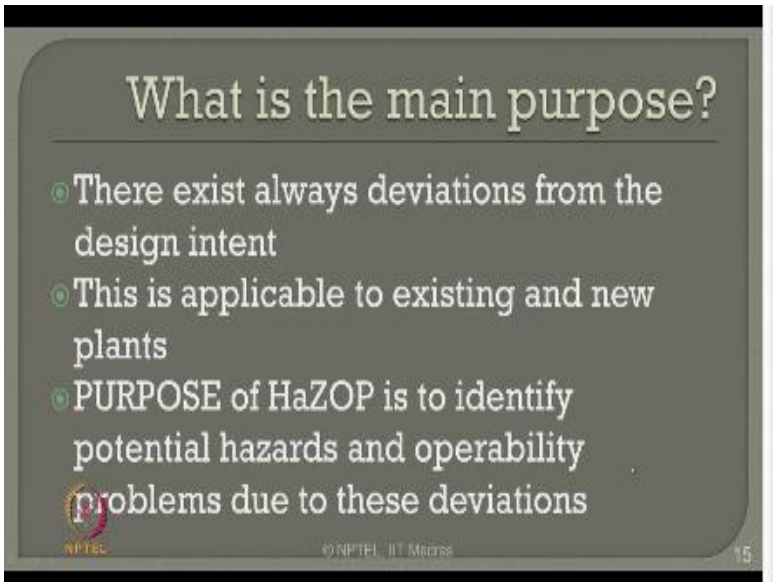
Let us detail open out the discussion on HAZOP study, HAZOP expands for hazard identification during operation.

(Refer Slide Time: 10:23)



So the OP stands for the operation and HAZ stand for the hazard identification.

(Refer Slide Time: 10:27)

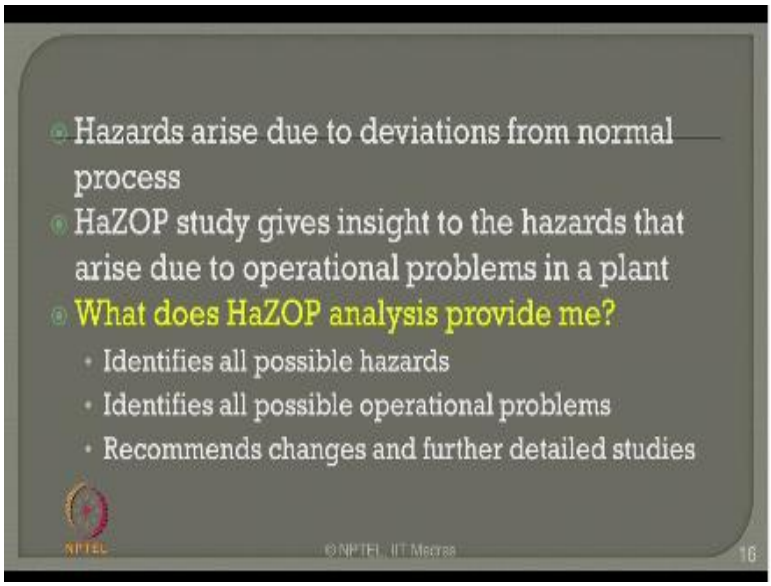


What is the main purpose of conducting an HAZOP study? There exist always deviations from a design intent, now one will get confused with these two terms newly introduced now on the slide what is a deviation, what is the design intent, I will give classical examples to make you to understand what are these terms referring to, this is applicable to an existing or to a new plants as well.

You can do HAZOP study for a plant which is an operation or a plant which is already prepared for operation but not at commissioned, so it is a design stage. The main purpose of HAZOP is to identify the potential hazards present and the Operability problems which occur due to any deviation in a given plant. Now the emphasis of HAZOP study dear friends is based upon only identifying the deviations of a given plant.

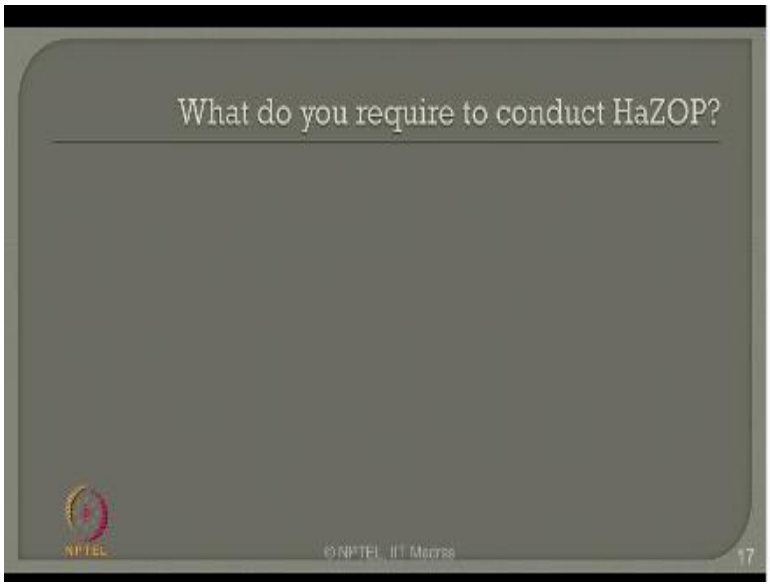
The deviations can either occur during the design stage or can occur even during the operational stage.

(Refer Slide Time: 11:32)



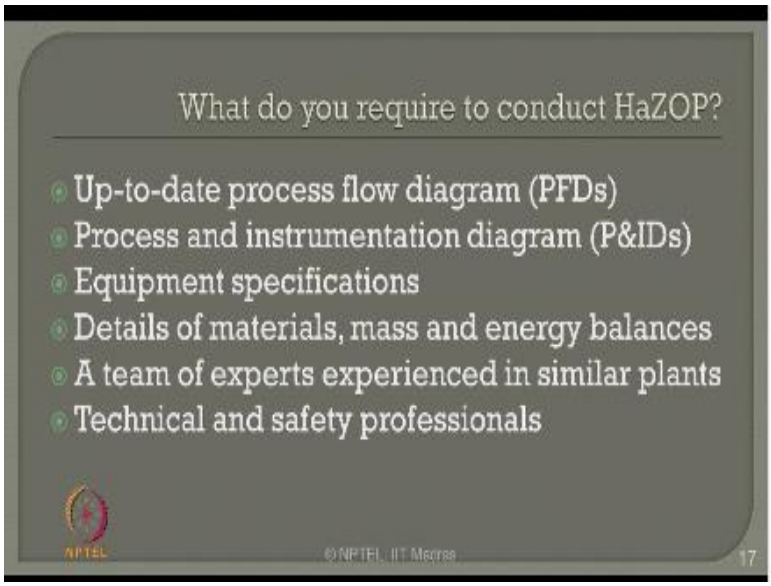
Hazards can arise due to deviations from a normal process, HAZOP study therefore gives insight to these hazards that arise during the operational problems in a given process plant, what does HAZOP analysis provide me? It identifies all possible hazards, it identifies all possible operational problems, it recommends changes and further detailed studies required if the process correction needs to be made for a given plant.

(Refer Slide Time: 12:05)



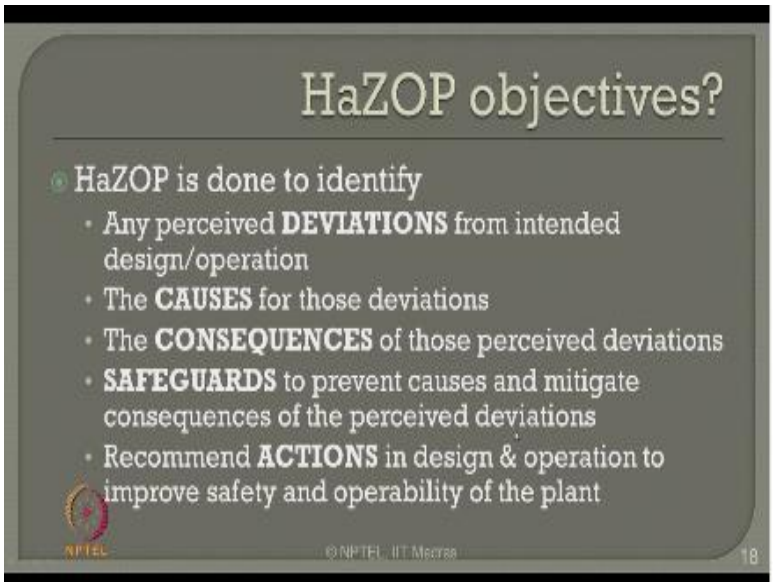
Now the fundamental question asked apart from not understanding the differences between deviation and design intent, what are you required to conduct an HAZOP study, what is the data required to conduct an HAZOP study?

(Refer Slide Time: 12:20)



Up to date process flow diagram is essentially vitally important to carry out an HAZOP study, that you must also have a detailed process and instrumentation diagram in place what we call PID's, equipment specification should be available to the HAZOP manager, details of material inventory, mass and energy balances practiced in the process industry must be made available to the HAZOP team, HAZOP team actually consider of experts experienced in similar plans elsewhere. And they comprise of technical and safety professionals together.

(Refer Slide Time: 12:56)

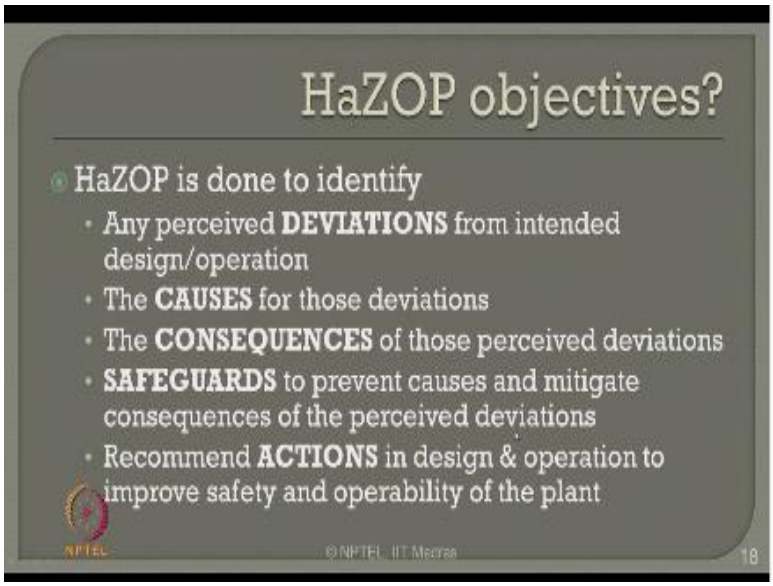


Now what are the design objectives of a an HAZOP study? HAZOP is generally done to identify the following, any perceived deviation from the intended design and operation should be the first catch of any HAZOP study, then subsequently after identifying the deviations from the design intent it will result in certain causes for the deviations. So you have to diagnose and find out what are those causes responsible for these deviations.

The causes of those perceived deviations should be then resulting in consequences one should identify and list the consequences resulting from these deviations then one has to examine whether in the existing safeguards are present in the system because these safeguards can prevent the causes and mitigate the consequences of the perceived deviation to a larger extent because no plant in oil and gas industry is constructed or Commission.

Without any enough safeguard procedures, therefore one must give a due respect to the existing safeguard systems present in the scenario and see what are they can and how they can prevent the causes and mitigate the consequences.

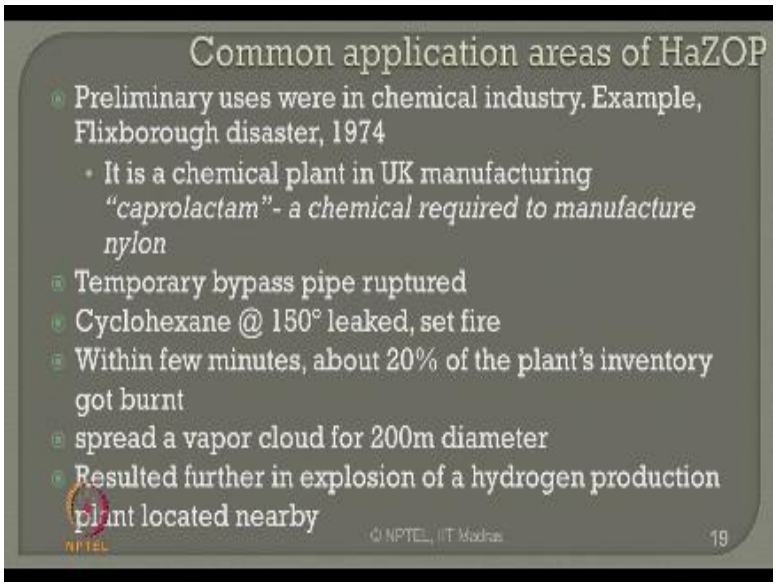
(Refer Slide Time: 14:13)



Based upon the presence of safeguards based upon detailed analysis of the causes and consequences HAZOP report also gives detailed recommendations of actions in the design as well as an operational modification which results in improving safety and operability of the plant. Remember friends the main focus of HAZOP study is not enhancing the commercial production of the plant at all.

The main focus or objective HAZOP study is to improve safety in design and operation, so the entire focus at the thrust in an HAZOP study is only to improvise ought to practice or to stringently follow the safety regulations and make the operations further safer.

(Refer Slide Time: 15:00)



Now the question asked is, where are the common areas where HAZOP study can be applied? The preliminary uses where essentially in chemical industry, I can go to an example from the site, the Fix borough disaster happened in 1974 Fix borough plant is a chemical plant located in UK which manufactures caprolactam which is a chemical basically require to manufacture nylon. So there was a temporary bypass pipe which was ruptured during the scenario.

Cyclohexane chemical at a temperature of 150^{O} leaked out with cost explosion more interesting 20% of the plants inventory went ablaze in few minutes after the pipe ruptured and the gas exploded. So it spread a vapor cloud for a radiate diameter of over 200meters around the plant which caused a very high societal risk to the location where the plant was situated. Resulted further in explosion of a hydrogen production plant located in the nearby area, so this is very important the societal responsibility of any process plant is also saved got the plants nearby.

(Refer Slide Time: 16:19)

The second application where HAZOP study was applied immediately was to study the explosion of a rocket fuel plant located at Nevada Las Vegas in United States. The plant was destroyed in few seconds you can easily guess the reason for the accident Windstorm destroyed the roof structure and the glass the essential reason for this accident was employee was using a welding torch which set fire, because the welding torch was situated in location where the wind direction was not considered appropriately.

Therefore this actually touched off the roof structure in the glass and the whole plant which the rocket fuel plant got a placed in a specific time interval. And that is the photograph this shows a thick smoke and lavvy which is on the around the plant situation.

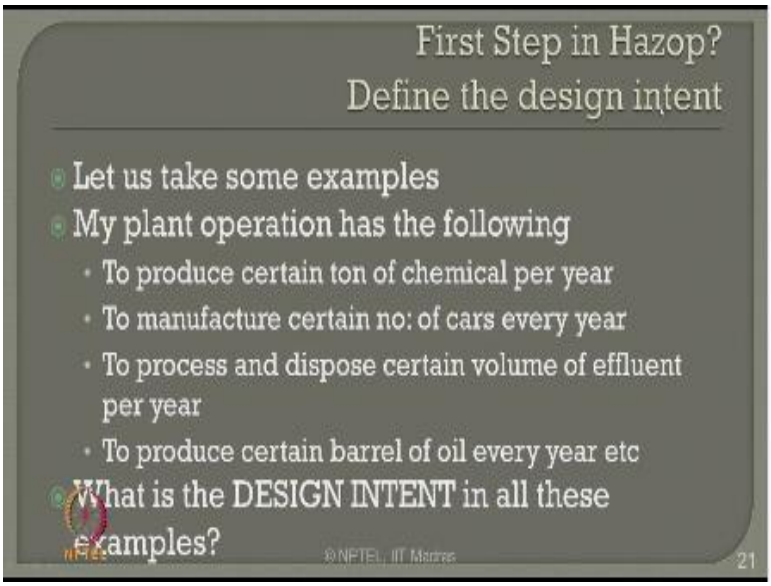
(Refer Slide Time: 17:08)

So HAZOP studies essentially were applied to understand risks after the accident was happening HAZOP study can also be done to avoid such accidents. So what is the first step in a HAZOP, the first step in HAZOP study is to define the design intent of any given plant. Now the question is what you understand by design intent?

(Refer Slide Time: 17:31)

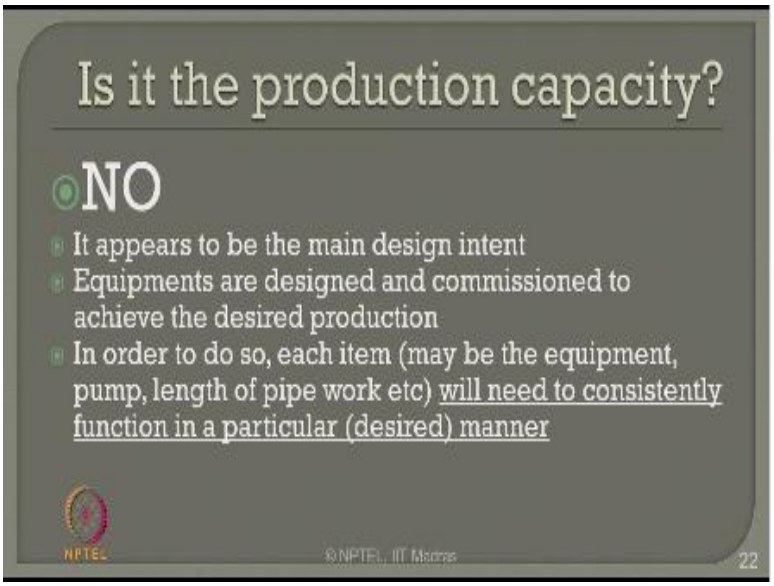
Let us take some examples to understand design intent, let us say you have a plan which does the following. It produces certain ton of chemical per year. It manufactures certain number of cars every year. The plant is a process plant which disposes certain volume of effluent every year. We have also a plant which produces certain barrel of oil every year, for example oil and gas industry.

(Refer Slide Time: 17:56)



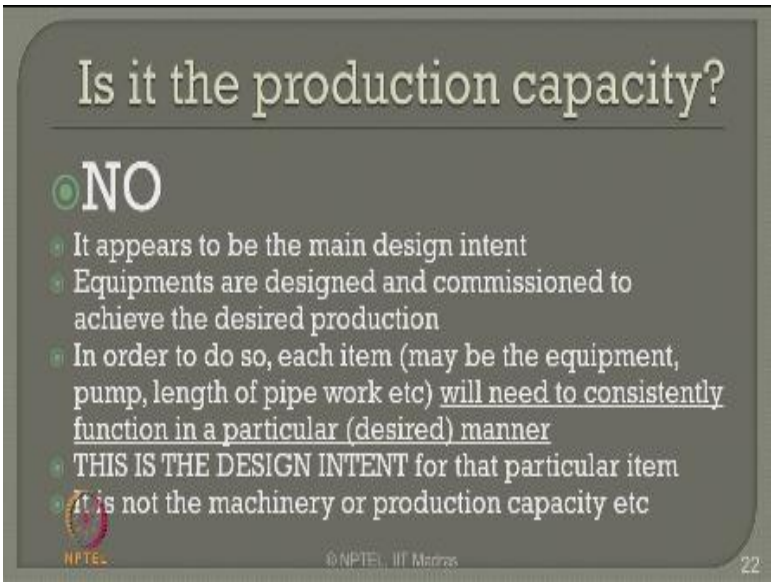
Now there are four examples shown here, one is chemical manufacturing plant otherwise auto by manufacturing plant otherwise effluent treatment plant otherwise oil gas industry is a production or process plant. In all these plants, let us try to see what is the design intent?

(Refer Slide Time: 18:15)



If you understand the design intent is the production capacity of the plant then we are wrong, it is not the production capacity of the plant. It appears to be the main design intent of the plant. But the equipments are generally design and commission to achieve the desired production capacity there is no doubt about that. In order to do so, each item may be the equipment, maybe the pumps, maybe the length of the pipe works extra are all designed carefully to achieve this design intent. Therefore, these equipments are these items will need to be.

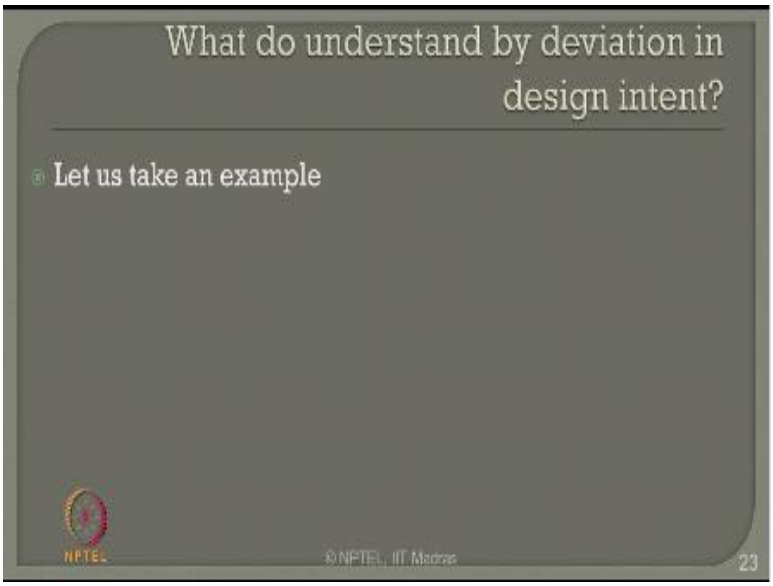
(Refer Slide Time: 18:50)



Consistently functioning in a particular manner to achieve the desired production capacity so this is the design intent of the particular item. So the design intent is not the production capacity but to check whether the equipments, the pipes, the pumps the accessories are in place and working consistently to deliver the desired output which all will lead to the desired production of the plant capacity. So it is not the machinery or the production capacity it is actually checking the proper functioning of these equipments.

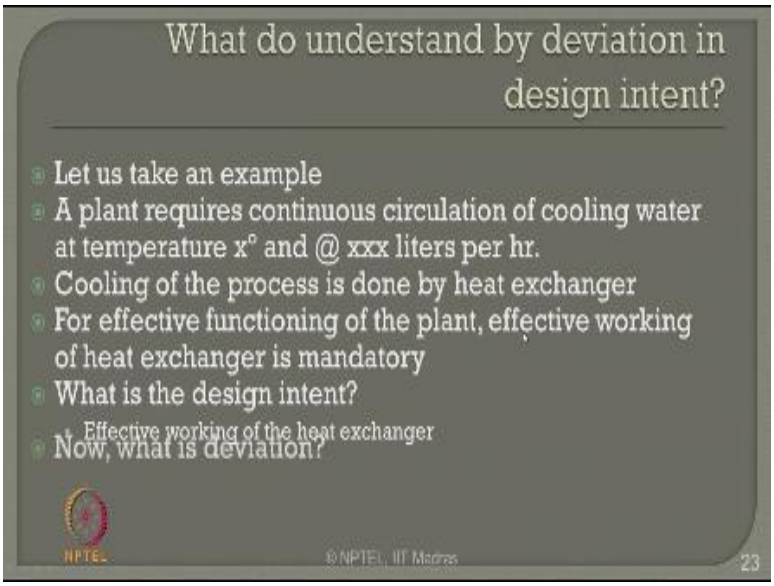
Therefore, HAZOP deals with production in turn dealing with the equipments connected to the production.

(Refer Slide Time: 19:33)



Now what do you understand the deviation in a design intent, again let us take an example.

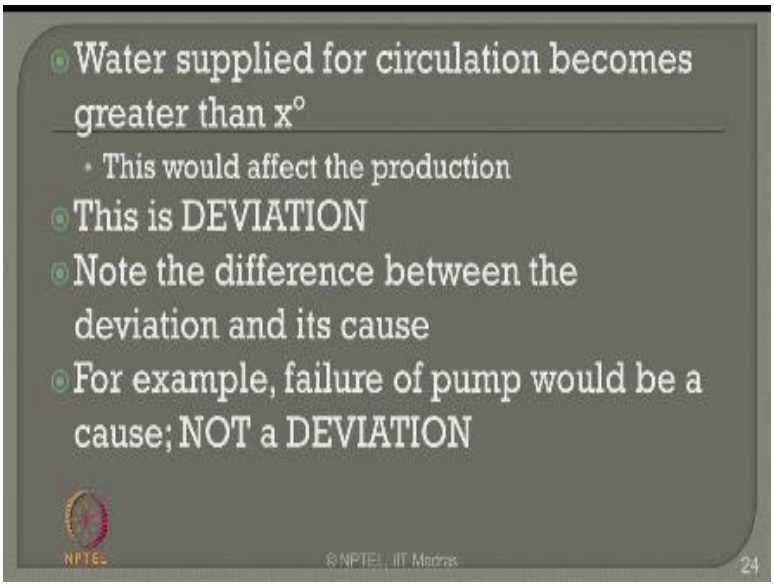
(Refer Slide Time: 19:40)



Let us say for example a plant requires continuous circulation of a cooling water at a desired temperature. Let the temperature x˚ and the volume of water required for cooling is about xxx liters an hour. Cooling of the process is done by heat exchanger. For effective functioning of the plant effective working of heat exchanger is mandatory. Now what is the design intend here, the design intent here as we understand from the previous slide is the effective working of the heat exchanger.

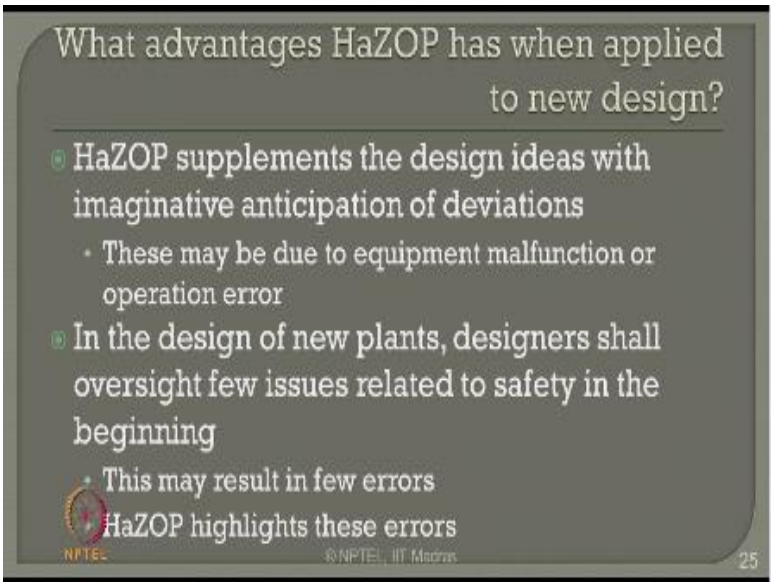
Because, effective working or heat exchanger alone can try to make the plant in a circulation of a cooling water. Now what is a deviation.

(Refer Slide Time: 20:22)



Water supplied for circulation if it becomes more than x˚ centigrade temperature this would affect the production very seriously. Therefore, the deviation is the temperature of the circulating water it means which is the process or the plant or the equipment or the machinery which maintains this temperature that becomes the deviation. Note the difference between the deviation and the cause. For example, failure of a pump which will pumping this water would be a cause not a deviation, so the mechanical fault in a given process plant will not result in a deviation can be a cause for the deviation.

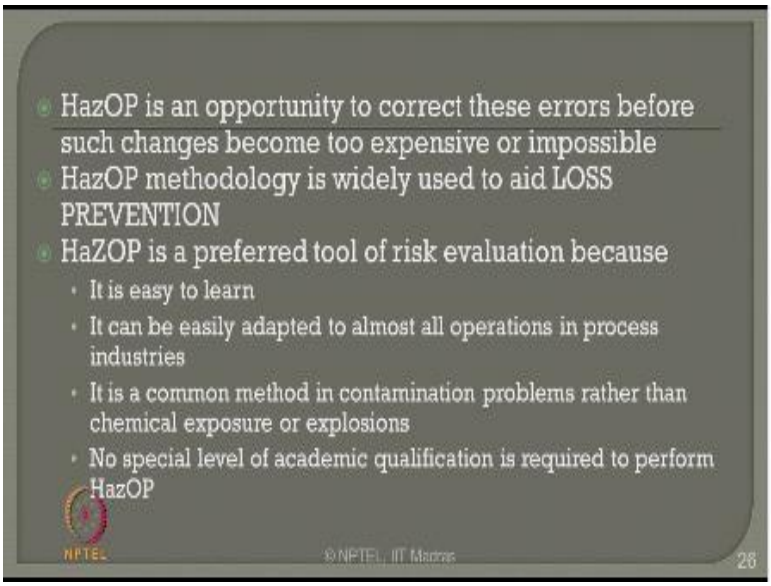
(Refer Slide Time: 21:08)



Now one can ask a question, if a conducted a HAZOP study what would be the advantages again when I do it for a new design. One can easily understand if you do it for an existing process plant I will know what are the fault present in the given system. If I do it for a new plant what gain I will get from a HAZOP study, HAZOP supplements it is an ideas with imaginative anticipation of deviations, these may be due to equipment malfunctioning or other operation errors which are not perceived by the design engineers.

In the design of new plants generally designer shall oversight few issues related to safety in the beginning, this may result in few errors HAZOP fortunately highlights these results in advance.

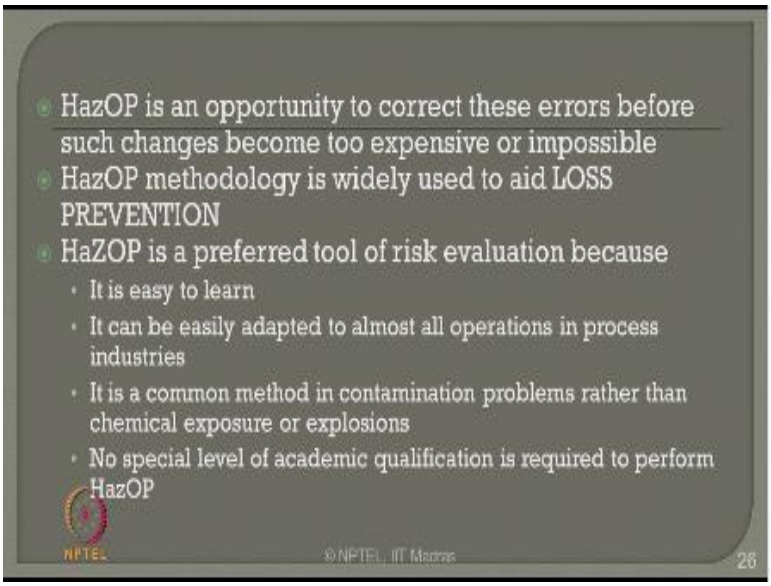
(Refer Slide Time: 21:57)



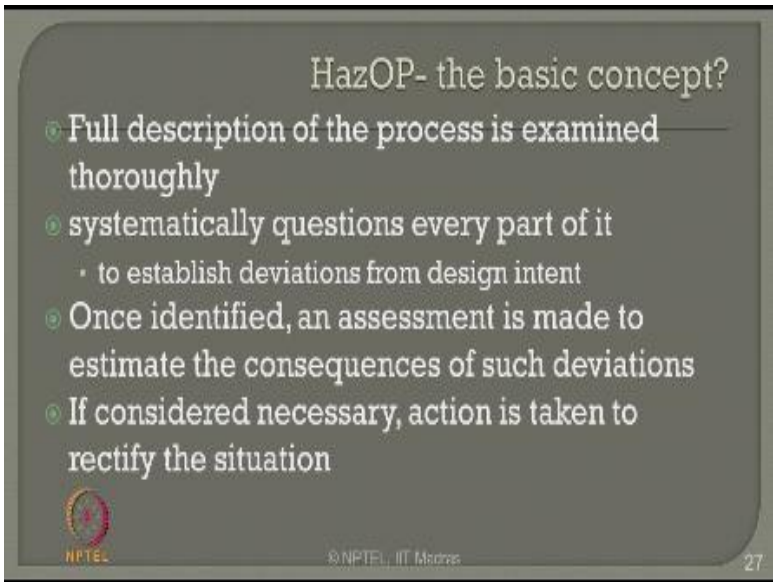
HAZOP is therefore an opportunity to revisit and correct these errors before such changes become too expensive or impossible. HAZOP methodology is widely used to aid loss prevention which one of the main focus of safety in oil and gas industry. HAZOP is therefore, a preferred pool of risk evaluation. It is very simple the reasons are the easy to learn, it can be easily adapted to almost all operations in process industry, it is a common method in contamination problems rather than chemical exposure or explosions.

Most importantly friends there is no special level of academic qualification is required the performance HAZOP analysis.

(Refer Slide Time: 22:40)

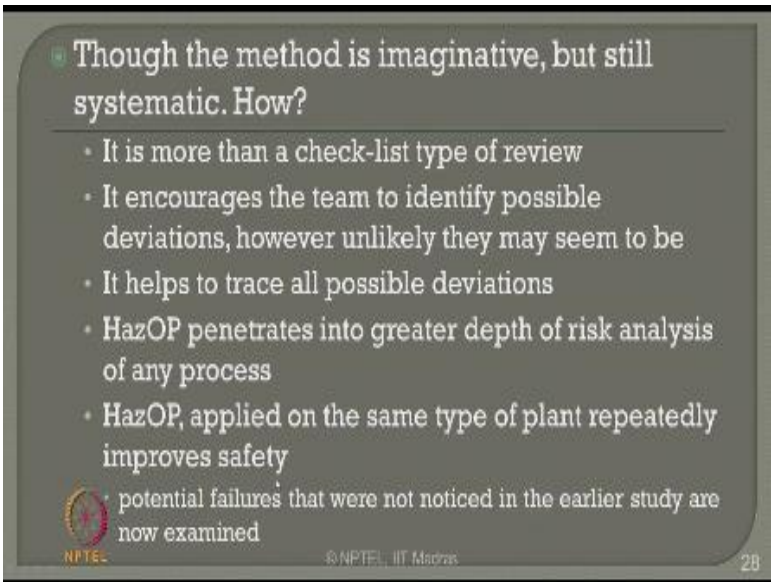


(Refer Slide Time: 22:46)



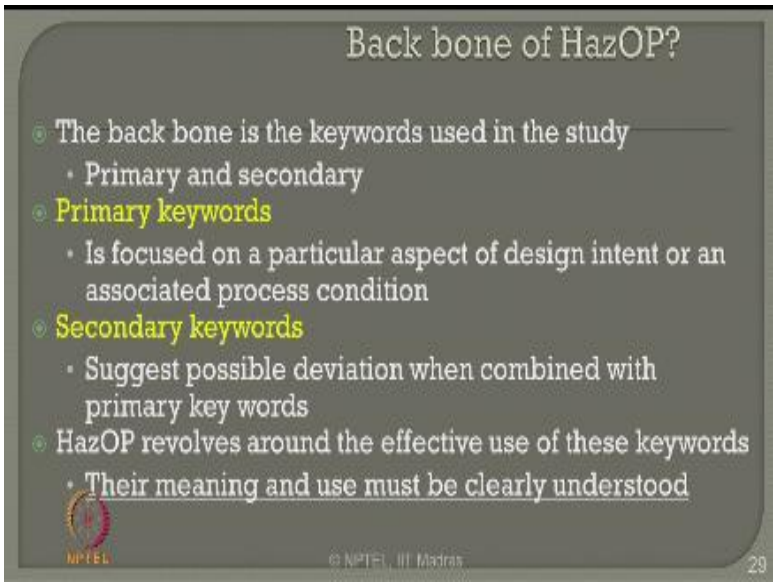
Then what is the basic concept of HAZOP, the basic concept of HAZOP study is full description of the process. It examines the field description of the process thoroughly and detailed documentation of this is HAZOP report. A systematically questions every component or every part of the process industry to establish deviations from a given design intent. Once these deviations are identified an assessment is made to estimate the consequences of such deviations. If considered necessary actions are recommended to rectify the situation.

(Refer Slide Time: 23:24)



Though the method is imaginative but still systematic, let us ask how. It is more than a checklist type of review. It encourages the team to identify the possible deviations. However unlikely they may seem to be. It helps to taste all possible deviations HAZOP penetrates into greater depth of risk analysis of any process. HAZOP therefore, if applied on to the same type of plant repeatedly will improve the process safety undoubtedly. The potential failures which were not noticed in the earlier study will be now reexamined by conducting this kind of a HAZOP study repeatedly.

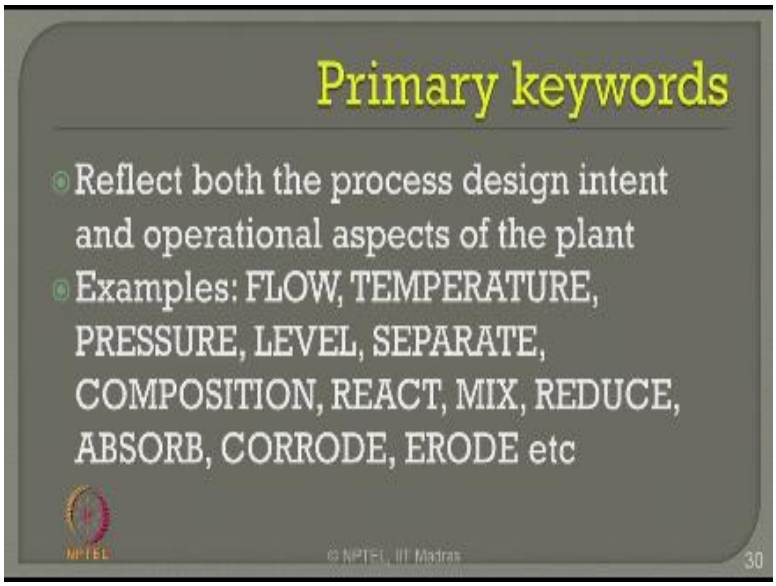
(Refer Slide Time: 24:07)



No containers of study what will be the backbone of this kind of this kind of study the backbone of the HAZOP study is essentially the keywords used in the study there are two set of keywords generally used the HAZOP study one is called primary the other one is called secondary keywords primary keywords are generally focused on particular aspect of design intent or an associated process condition whereas secondary keywords suggest possible deviation when combined with the primary keywords as I said design intent and deviation are essential to functions of another report design.

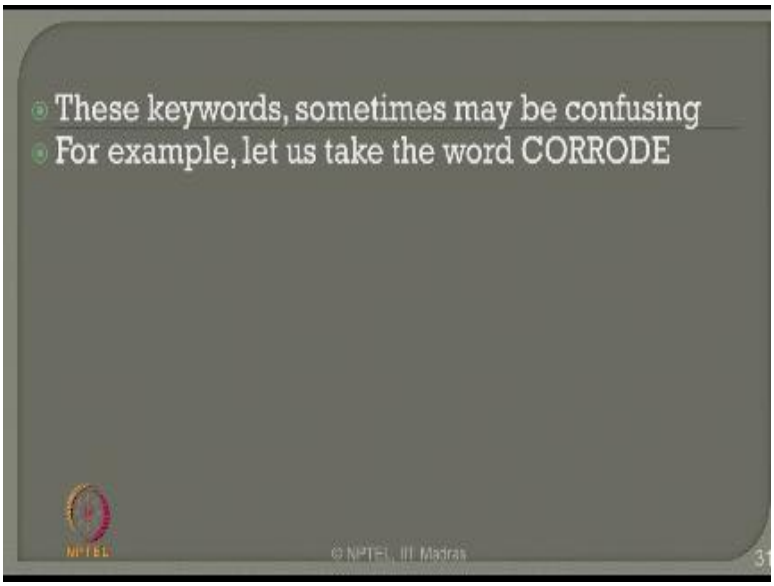
Intent is focused by the primary keyword and deviation is addressed by the secondary keyword so design intent and deviation together should be need to understand for a process manager therefore HAZOP report revolves around two set of keywords not independently but combined together will give a meaning in a HAZOP report has out there for revolves around the effective use of these keywords therefore it is important to know what are the difficult keywords of primary and secondary in order what is the meaning of these keywords on how to use them if at all we have to write an HAZOP report.

(Refer Slide Time: 25:29)



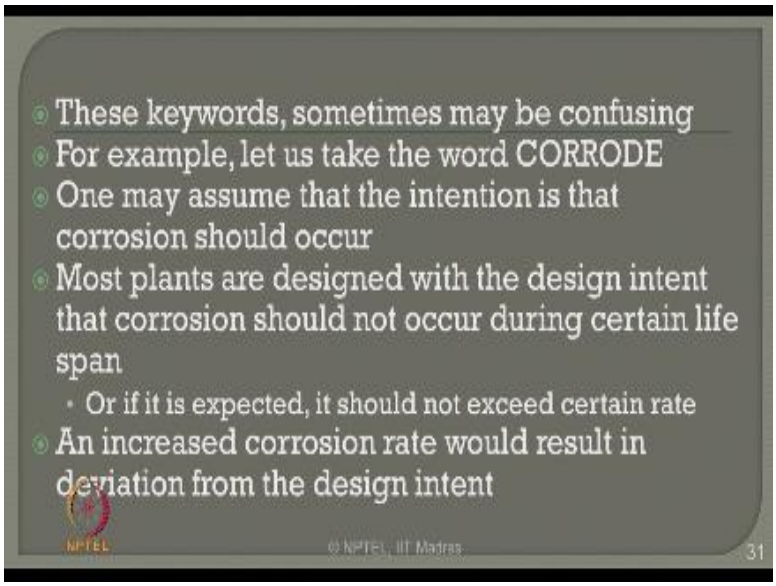
Let us quickly see what are primary keywords primary keywords reflect both the process design intent and the operational design intent of any aspect of the plan there are some example you stood here flow temperature pressure level separate composition react mix reduce absorb color 0 etc. So these are some examples of primary keywords.

(Refer Slide Time: 25:59)



These keywords sometimes may be confusing let us take an example let us take the word CORRODE which is one of the important primary key work now primary keyword addresses design intent if I say CORRODE is a primary keyword one may get confused his corrosion here design intent obviously in any given plant.

(Refer Slide Time: 26:22)

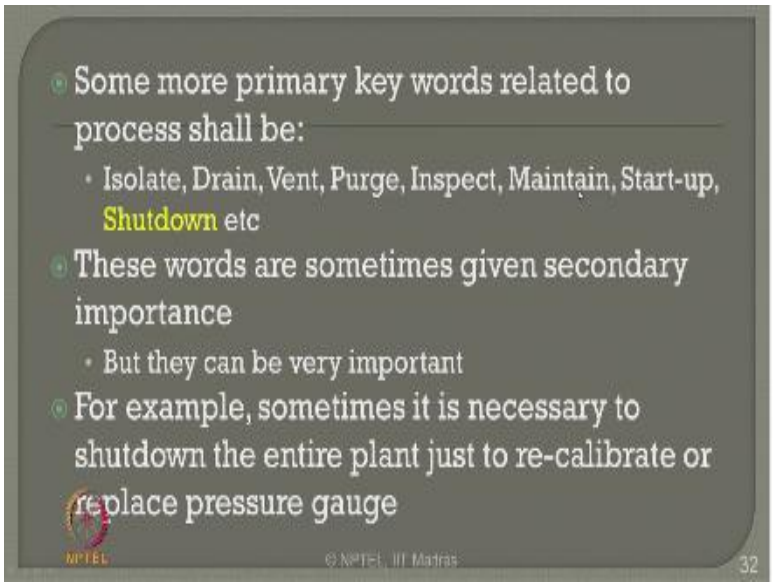


Corrosion should not occur that cannot be a design intent because most plans are designed with the reason intent that corrosion should not occur during certain lifespan of the structure even is expected to occur the actually some corrective means to reduce this corrosion rate and increase corrosion rate so therefore result in deviation from there is an intent.

(Refer Slide Time: 26:44)

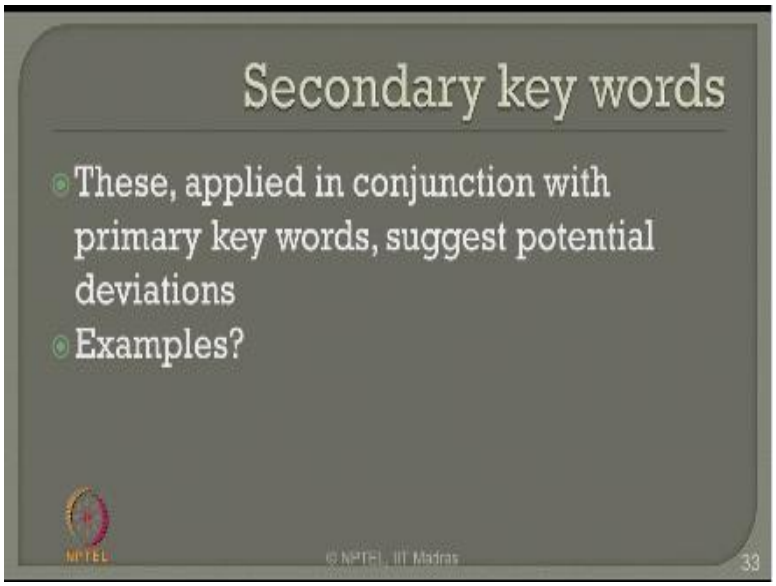
Therefore CORRODE is a word which activates deviation from the design intent.

(Refer Slide Time: 26:52)



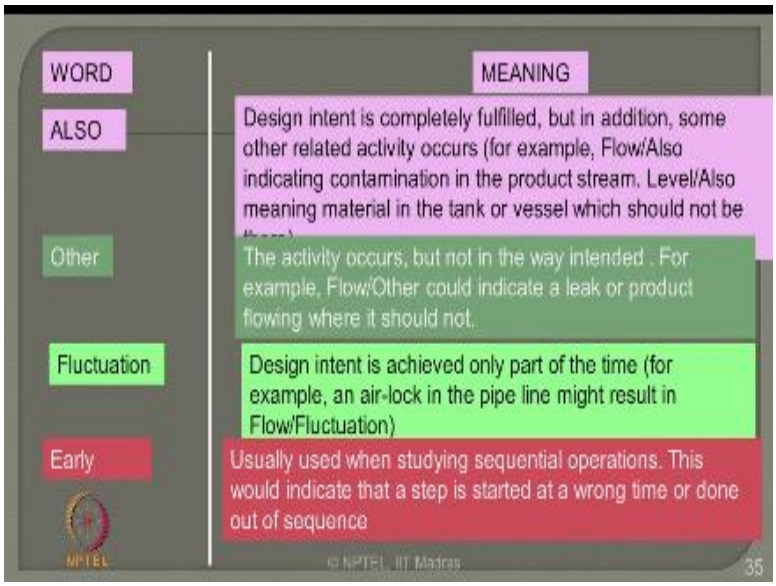
Somewhere primary keywords related to process shall be isolate drain, vent, purge, inspect maintain, startup, shutdown etc. Again there is a word here which can cause confusion because one of the primary keyword indicated here is shutdown now how shutdown can be a design intent it is a design intern certain cases where he really wanted to recalibrate or replays the pressure gauge you have the isolate certain segment of the plant therefore you over to shut down certain segments of the process plant so that recalibration can become very important and this has got to be carried out therefore even such keywords can also indicate design intents for a given process plant.

(Refer Slide Time: 27:38)



Now let us see what our list of secondary keywords secondary keywords when applied in convention the primary suggest potential deviations.

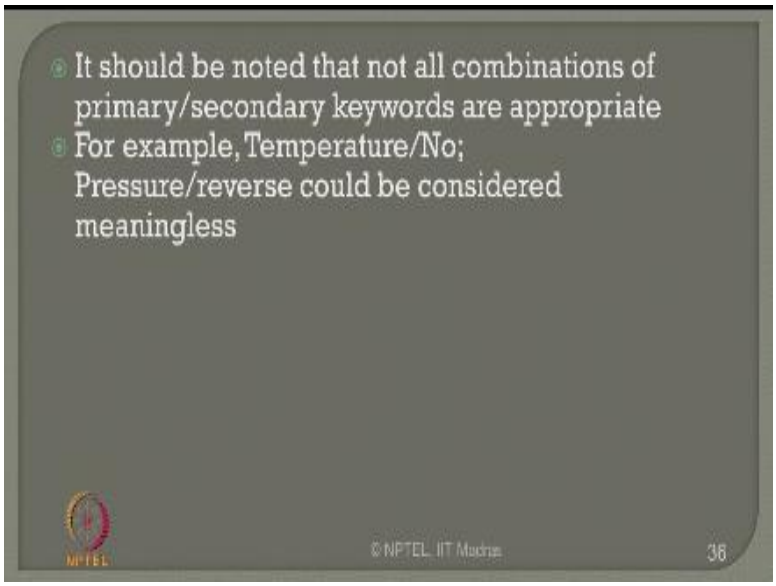
(Refer Slide Time: 27:51)



There are some examples let us say no is a secondary keyword less more reviews etc. Now the design intent does not occur for example flow is a primary keyword no so secondary keyword so if you combine these two then one can say there is no flow which causes a deviation for example let us say less pressure is a primary keyword less say secondary keyword we use both of them together in conjunction less pressure is an indication for a cause it can result in some consequence similarly all these secondary keywords will have a specific meaning when they are addressed along with a primary keyword.

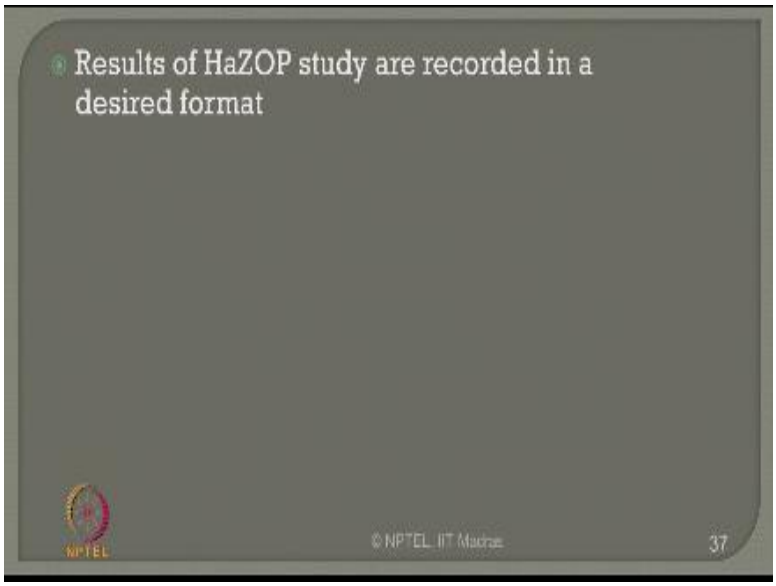
For example, other words like also other fluctuation early can be some of the secondary keywords.

(Refer Slide Time: 28:45)



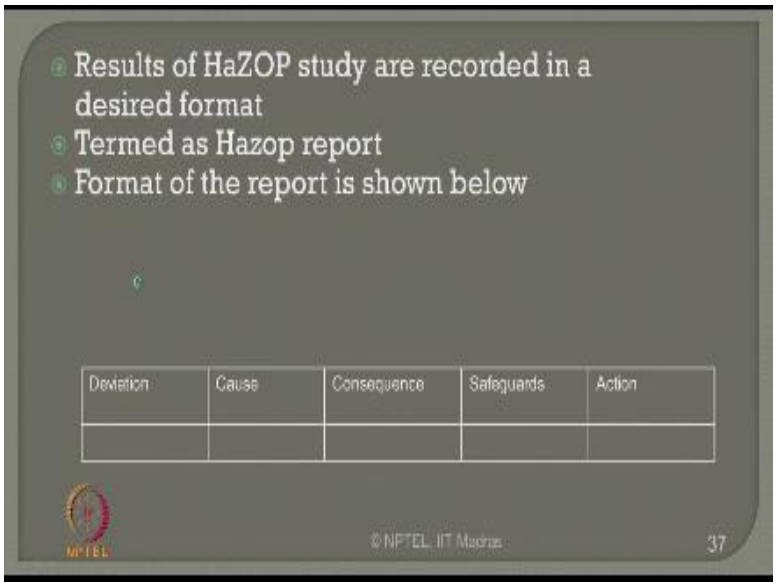
Please note that all the combination of primary and secondary will not work out for example temperature pressure reverse will have no meaning because temperature no means there is no process at all pressure reverse means there is no pressure flow in the forward direction at all so all combinations of perversion secondary cannot be considered for Adina sub report then the question comes which combination should be used.

(Refer Slide Time: 29:17)



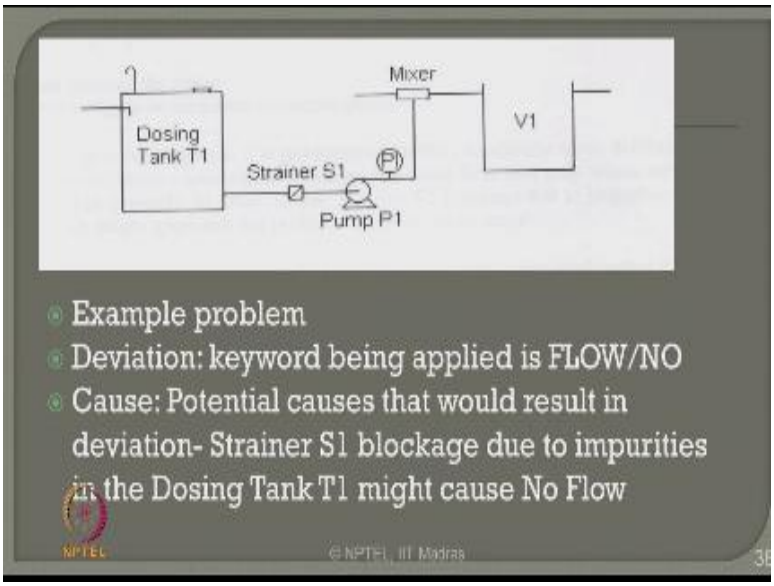
And then so results of our study essentially is pattern of recording in a desired format terms are used in a HAZOP report.

(Refer Slide Time: 29:30)



Format of the report is shown below the first column shows deviation the second column shows causes the third column shows consequences the fourth columns were safeguard the fifth column shows that commanded action now one may ask the question said Hazop report deals with primary and secondary keywords primary keywords dictate the design intent secondary keywords dictate the deviations now in this table I could see deviation but we are rather design intent that is very interesting.

(Refer Slide Time: 30:01)



I will take an example and show you how design intent is incorporated as a primary keyword in a HAZOP report let us take an example here this is addressing tank T1 which has to supply some chemical mixture to the Container V1 and the container also receives chemical from a mixture as a third line now the basing banked even has got two components mixed together and these components can be even containing floating suspended particles therefore I use a strainer S1to filter the suspended particles and of course I want to pump this chemical.

To the container V1 therefore require a pump P1 now the components identified here are the dosing tanked even the strain a race one it is nothing but a filter the pump P1 the mixture and the container V1 let us quickly see this is an example problem the deviation in this particular problem taken for example is flow know for example flow is a primary keyword which indicates the design intent that is an intent of this problem is flow because I need to have your flow along the line to maintain a specific composition of mixture at the container Viva.

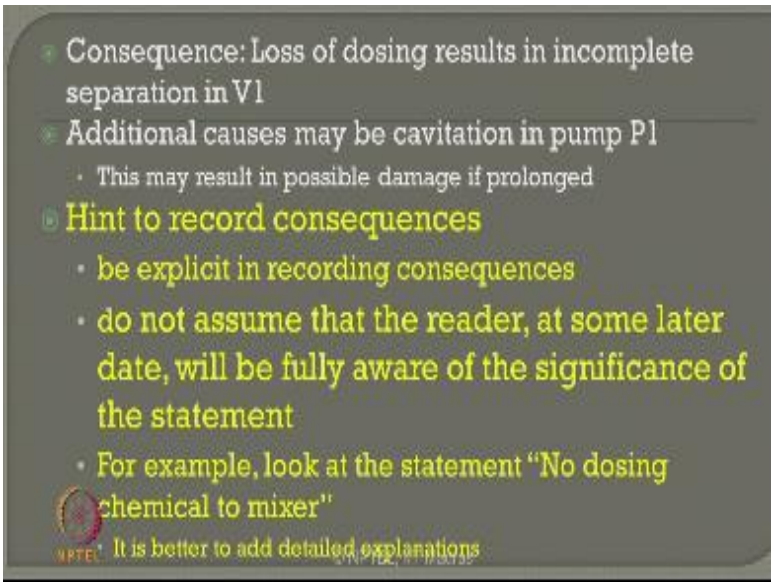
If there is no flow occurring in the line which does not receive any chemical from the dosing tanked even then it can cause serious deviations result in consequences and that can cause

accidents therefore flow know is a combination of primary and secondary keyboard which now describes that is in intent and the deviation in a given process plant as seen here potential causes. That would result in deviation can be the strainer less one can get blocked or checked off which can be due to the suspended impurities or the dissolved impurities present in the dosing tank day were, the filter present in strainer S1 make be blocked completely.

Therefore, the flow in the pipeline causing the strainer S1 may not be there or the desired flow in the pipeline segment here may not appear because the strainer S1 is blocking the flow from the line crossing the strainer then there is no desired flow on the pipeline pump will run empty and pump will not require the pump the remaining quantity required for the chemical view on from the pump P1.

Therefore strainer S1blockage due to improve this in the dosing cannot even might cause your condition which is no flow which is one of the deviations in a given plant.

(Refer Slide Time: 23:49)



Now let us see the consequences if there is no flow the consequence can be the loss of dosing results in incomplete separation in the tank V1 the additional costs can be cavitations in the

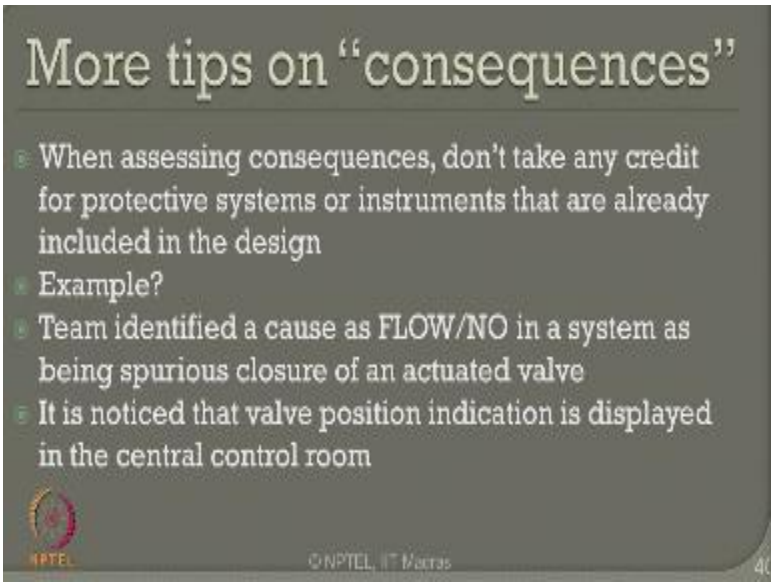
pump even because the pump does not require or receive required amount of quantity of water or the flow after the strainer S1, therefore this may result in possible damage to the pump if it is prolonged.

Now how will I recall the consequences, consequences if they are recorded in hazop report should be explicit in recording the consequences do not assume that the reader at a sometime later date will be fully aware of the significance of a statement for example do not make statements as no dosing chemical to the mixer, it is better always you elaborate the statements with full explanations.

(Refer Slide Time: 33:46)

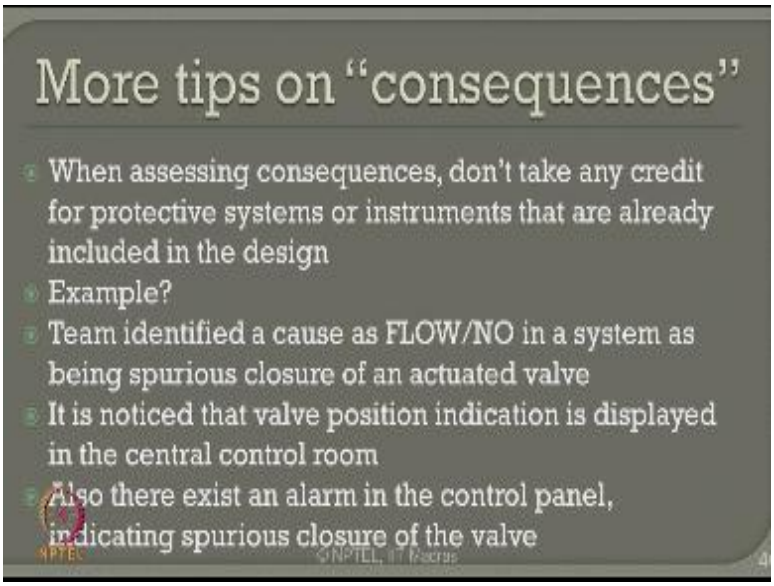
When assessing consequences kindly do not take any credit for protective system or instruments that are already in place for example in a design there can be a little save gauds do not take the credit of the safeguards and do not mention them in the consequences.

(Refer Slide Time: 34:03)



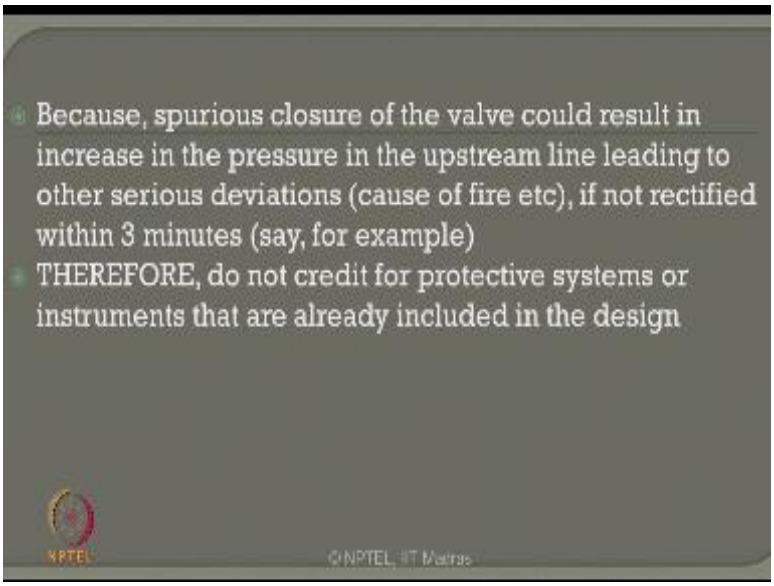
I can show an example the team identified a cause as flow or no in a given system as being spurious closure of an actuated valve it is notice that the wall position indication he displayed the central control room one can imagine that the central control room has an indication of a closed equation of the wall that is a safeguard in the design, do not try to assume that since this is available consequences cannot occur.

(Refer Slide Time: 34:30)



Also there came in alarm existing control panel which will indicate the closure of this valve, these are all already present in the design system do not try to take an advantage of this and do not try to over wrote these while writing the consequences in a given report.

(Refer Slide Time: 34:46)

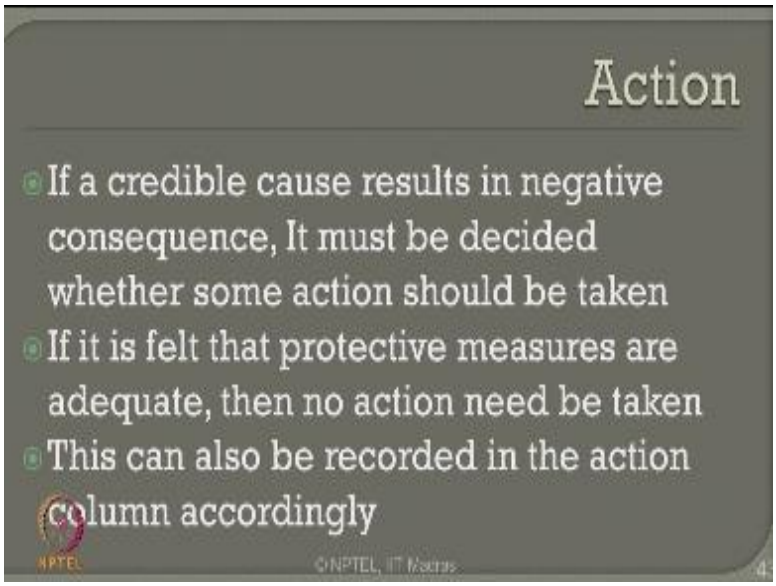


Because the spurious closure of the valve could result in increase in pressure in the up streamline which leads to see these deviations can result in fire if not rectified within few minutes for example it can cause explosion, therefore do not credit for productive systems or instruments that are already in place which included in the design in your consequences column of the report.

(Refer Slide Time: 35:10)

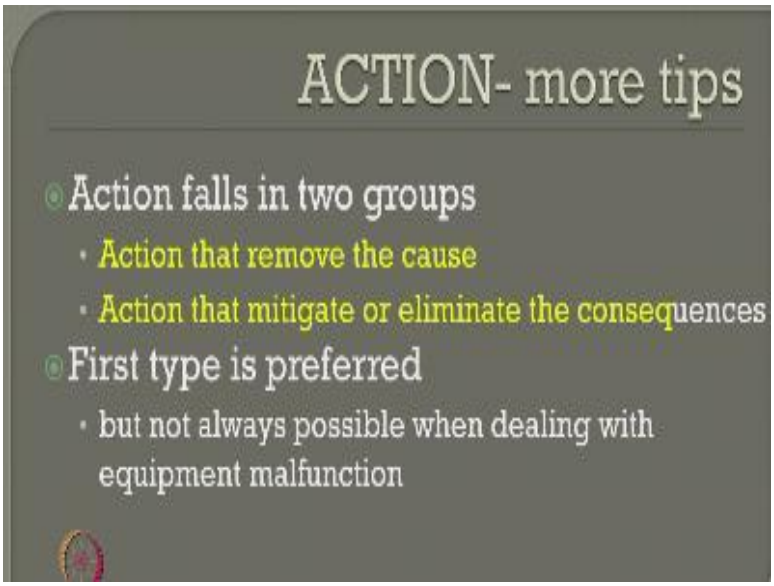
There is come to safeguard column I want hazard report any existing particular devices that either prevent the cause or safeguard the adverse consequences should be recorded in this column safeguards need not be restricted to hardware alone even periodic inspection maintenance schedule can also be a part of safeguard column given in HAZOP report. Be sure that these inspections must be carried out if you really take an advantage of these as a safeguard column in HAZOP report.

(Refer Slide Time: 35:42)



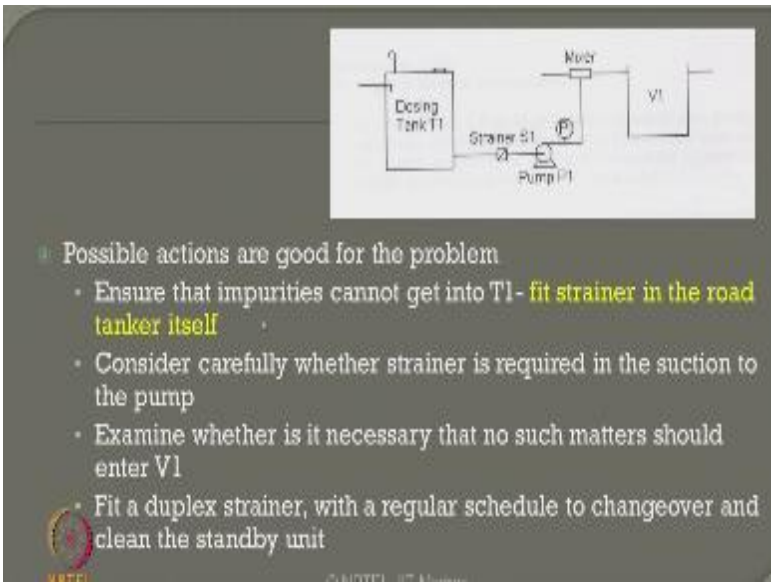
Let us come to a recommended action column there is the last column in HAZOP report in a credible cause results in negative consequences it must be decided whether some action should be taken or not, now recommended actions are generally stated only depending upon accepted level of risk in a given plant which highly subjective it is therefore become important that protective measures are kept adequate in a given system if it is so then you can simply say no action need to be taken. This can also be recorded if the action column is appropriately done in hazard report.

(Refer Slide Time: 36:22)



Action falls into groups action that remove the causes action that mitigate or eliminate the consequences first step is mostly preferred when you record in HAZOP reports but not always possible when dealing with equipment malfunctioning.

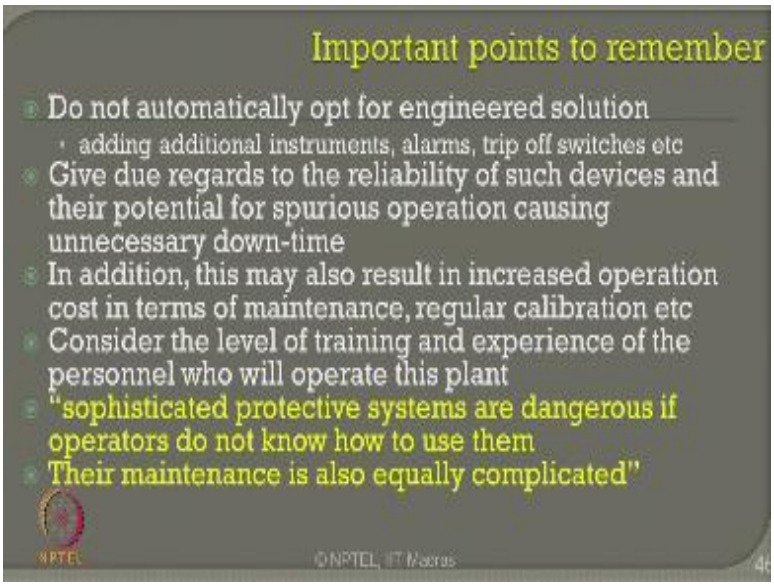
(Refer Slide Time: 36:40)



Therefore, it is not required let us see for this example what are the possible actions that are required for a good problem it ensures that impurities cannot get to T1, so fit a strainer in the road tanker itself we supplies chemical to the strainer tank T1consider carefully well as strainer is required in the suction to the pump. Whether you can put the strainer here or not you have to very carefully design the system for its low volt.

Examined whether is necessary that no such matters should enter viewer for example if the container V1can allow the suspended impurities do not put strainer S1 in this location because channel S1 can cause no flow to this line fit a duplex strainer with a regular schedule to change over and clean the standby unit appropriately.

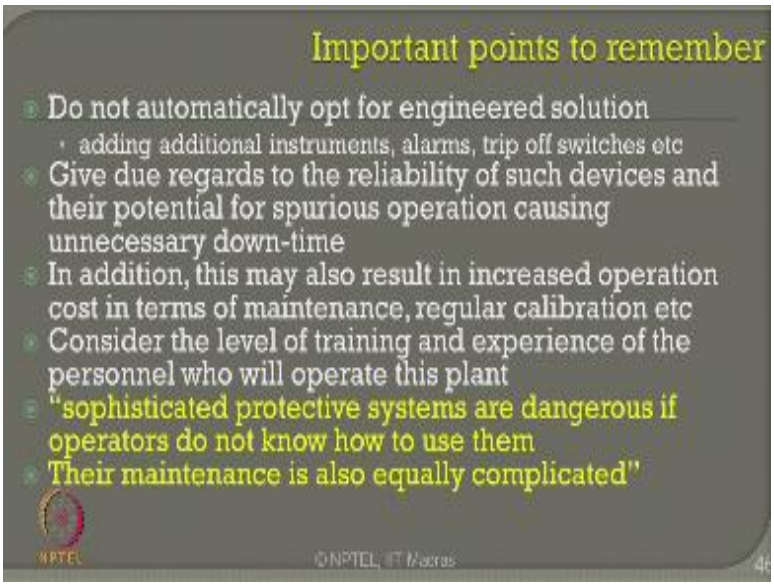
(Refer Slide Time: 37:37)



Now let us discuss few important points that are to be carried out or remember while writing HAZOP report do not automatically opt for engineered solutions adding additional instruments alarms trip of switches etcetera is not a good recommendation for an HAZOP report give due respects and regards the reliability of such devices and their potential for spurious operation in addition.

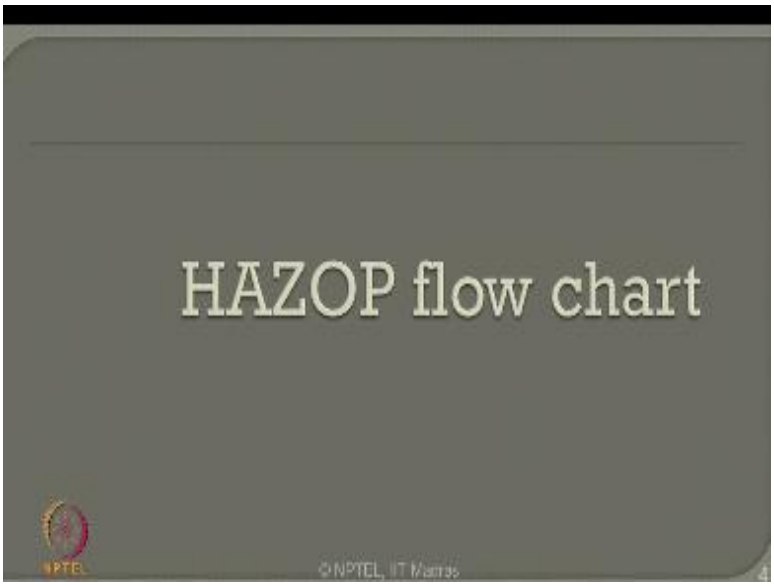
This may also result in increased operation costs because the maintenance schedule they will a calibration all will be affected if you recommend artisan instruments in a given PID consider also the level of training inverted to these people who are experienced to operate this kind of alarm types and instruments please understand sophisticated protective devices or dangerous if operators are not trained how to use them therefore maintenance also becomes equally complicated. So advocating addition instruments.

(Refer Slide Time: 38:42)



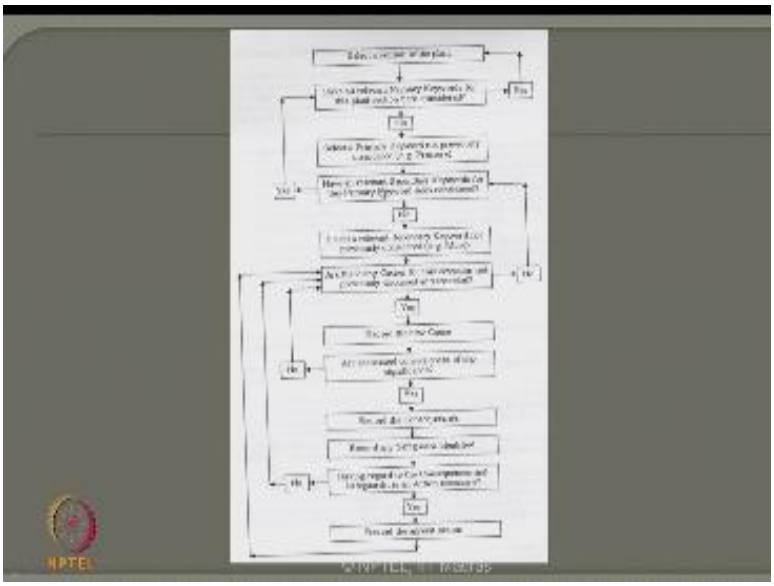
Alarm types trip of switches should not be the only solution in the recommended action of an HAZOP report.

(Refer Slide Time: 38:50)



Let us quickly see how a HAZOP flow chart looks like.

(Refer Slide Time: 38:54)



Select a section of the plant have all relevant primary keywords in place if the keywords are not available select a proper primary keyword which is applicable to the process plant have all relevant secondary keywords in place because we will talk about the deviations in a given process if they are not available select a relevant secondary keyword then identify what are the causes arising from the deviations.

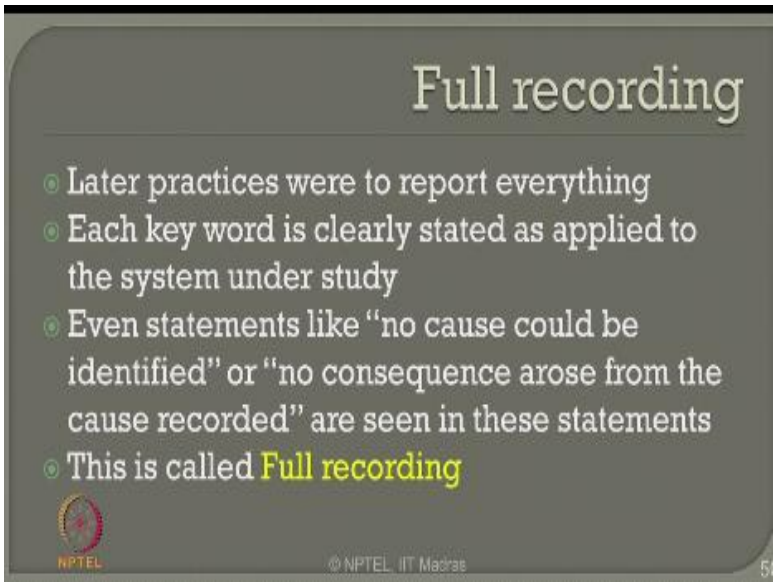
If not they are listed if you have listed them they record the new cause if they are not listed go back to a secondary keyword identify the causes from the deviations and keep on recording them once a record the new causes parity check whether the consequences associated with this causes are available if they are not available go back to the cost column again try to check the deviation list the consequences if they are available records the consequences and record the safeguards present in the system.

If you are not able to identify them then go back to the process again check for the safeguards record them the deviations then the causes then the consequences. If they are agreed upon the actions already taken then check with a required level record them in the agreed action and get back to this for different segments and continue and complete the entire report.

(Refer Slide Time: 40:19)

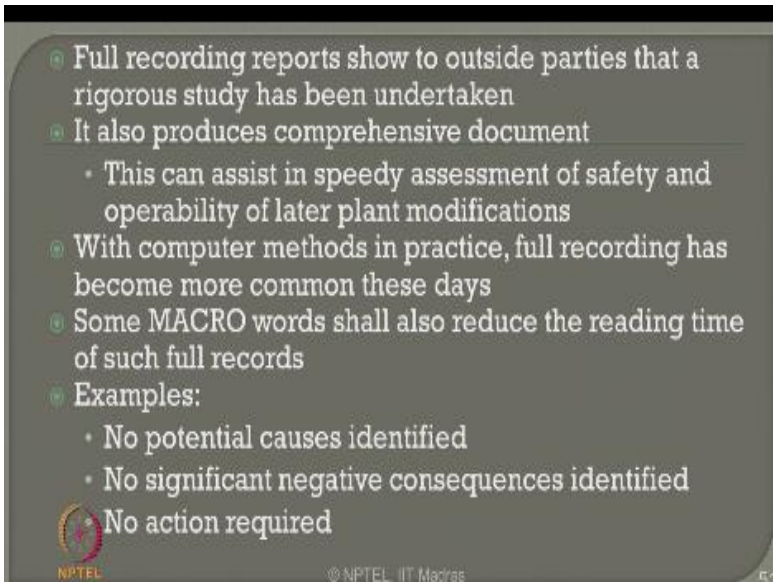
While recording a job report you got to conference in the recording one is called full recording as it is called recording by exception. In earlier HAZOP reports made in 80s only potential deviations with negative consequence were generally recorded because they were used for internal use only also their reports were mostly hand written therefore, to reduce the volume of the report and the time in reading the report only potential deviations were reported. Such methodology was called as recording by exception. In this method it is assumed that anything that is not included is deemed to be satisfactory.

(Refer Slide Time: 40:05)



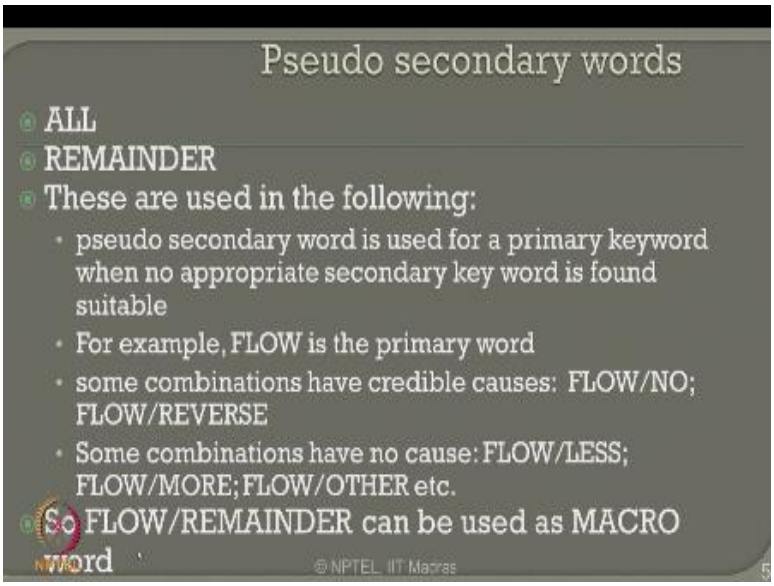
Whereas in the present scenario people follow full recording, full recording is followed because nowadays HAZOP reports are purely electronic in nature you can generate these reports automatically using software each keyword is clearly stated as applied to the problem even statements like no cause could be identified or no consequences are raised from the cause recorded are also seeing in such statements is called full recording.

(Refer Slide Time: 41:33)



Full recording reports show to outside parties that a rigorous study has been undertaken, it also produces comprehensive document this can assist in speedy assessment of safety on operability of the plant at a later stage, with computer methods in practice full recording has become more efficient and easy in these days, some macro key words shall also be used in recording first full records, examples can be no potential causes identified, no significant negative consequence identified, no action required.

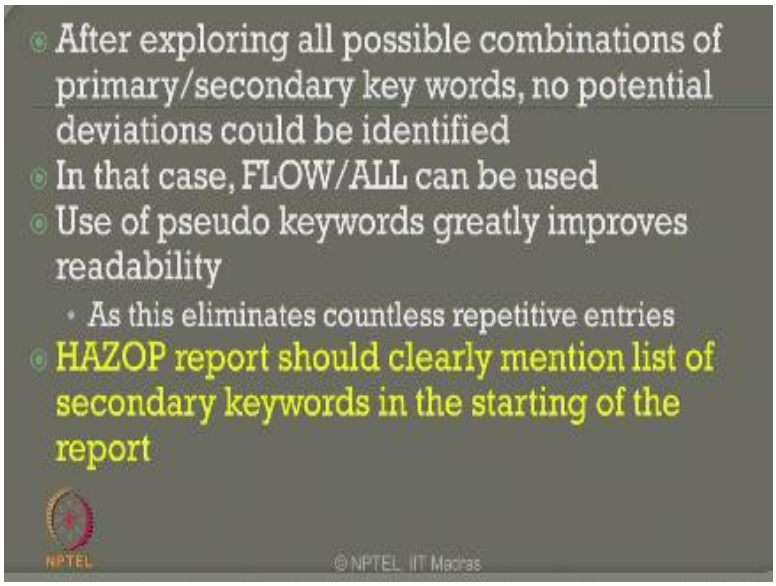
(Refer Slide Time: 42:13)



There are some pseudo secondary keywords which is also available All, REMAINDER, these are used in the following situations pseudo secondary keywords are used for a primary keyword where no appropriate secondary keyword is found suitable. For example, let us take an example of FLOW as a primary key word, some combinations with primary keyword which will have credible causes can be no flow, can be reversed flow some combinations will have no consequence or cause which is called less flow more flow and other flow etc...

So they can be pseudo keywords, therefore, flow remainder can be used as a MACRO word instead of writing flow less, flow more, and flow other the remainder term will cover all the secondary keywords of less, no and other. The other consequences are deviations of no and reverse are explicitly reported therefore REMAINDER can be an example of a MACRO keyword which substitutes less, no and other.

(Refer Slide Time: 43:18)



After exploring all possible combinations of primary and secondary keywords no potential deviations could be identified, in that case you simply say flow all can be used. So all becomes a MACRO word which can substitute all deviations that can offer from the design intent. So use of potential pseudo keywords greatly improves readability because this eliminates countless repetitive entries in HAZOP report. HAZOP report therefore should clearly mention the list of secondary keywords used in the study in the beginning of the report itself.

So in this example and in this lecture we have studied how to do hazard evaluation, how to document an HAZOP report, what is a design intent, what are deviations, what are causes which result from the deviation, what would be the consequences, what would be the safeguards present in a given system, how to record them and advocate recommended actions in a given process plant.

So HAZOP report essentially circumscribes only safety in a given plant, HAZOP can be done in an operation stage which is called HAZOP report can also be done in design stage which is called HAZID report which is HAZ ID which identifies the hazards the design stage itself, thank you very much you.

Online Video Editing /Post Production

K.R. Mahendra Babu

Soju Francis

S. Pradeepa

S. Subash

Camera

Selvam

Robert Joseph

Karthikeyan

Ramkumar

Ramganesh

Sathiarai

Studio Assistants

Krishnakumar

Linuselvan

Saranraj

Animations

Anushree Santhosh

Pradeep Valan .S. L

NPTEL Web & Faculty Assistance Team

Allen Jacob Dinesh

Bharathi Balaji

Deepa Venkatraman

Dianis Bertin

Gayathri

Gurumoorthi

Jason Prasad

Jayanthi

Kamala Ramakrishanan

Lakshmi Priya

Malarvizhi

Manikandasivam

Mohana Sundari

Muthu Kumaran

Naveen Kumar

Palani

Salomi

Senthil

Sridharan

Suriyakumari

Administrative Assistant

Janakiraman .K.S

Video Producers

K.R. Ravindranath

Kannan Krishnamurty

IIT Madras Production

Funded by

Department of Higher Education
Ministry of Human Resource Development
Government of India
www.nptel.ac.in