Health, Safety and Environmental Management in Offshore and Petroleum Engineering

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Module – 01
Lecture – 09
Hazard Management

Welcome friends to the online course on Health, Safety and Environmental Management. We are talking about Lectures on Module 1 where we are continued discussion on topics related to Environmental Management.

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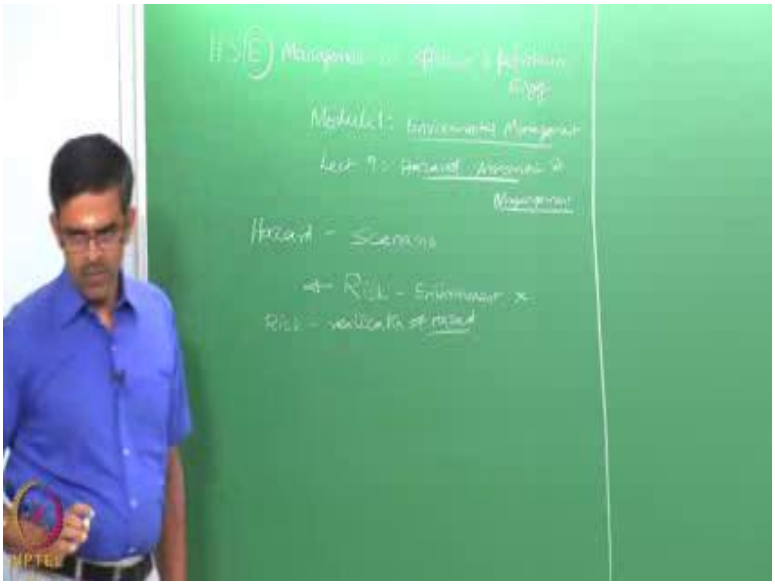

We are trying to focus our discussions only to those issues which causes ecological disturbance to the marine aquaculture which is essentially caused from the oil and gas industries alone. So, our focus was not actually to discourage the whole industry in terms of its exploration production, because that is one of the lifelines of economy of every nation.

We know that under the increasing demand of energy requirements for various industrial development etcetera we agree and understand that hydrocarbon exploration is one of the vital part there is no doubt on that, but however we cannot ignore certain facts and we are going to take care of them in advance before the environment start posing serious

threat to the livelihood of the human being or the habitant living nearby not necessary only the human being, but also the marine organisms.

So, we have seen the various facets of issues connected to drilling discharges, storage reservoirs where are the issues coming up what are the physical, chemical and biological issues related to environmental degradation, which occurs essentially from one of the process which affected seriously which is nothing but hydrocarbon oil exploration production processing and discharging.

But however, all these discussions what we had so far are may be intermittently or continuously monitored using ecological monitoring programs which we also saw in the previous lectures, but all of them do give a warning to the society on the offshore engineers, that yes there is a serious threat posed to the environment because there are industrial and regulatory agencies which control the limitations of these discharges both in ocean as well as in atmospheric pollution as we saw in the previous lectures. However, if these stringent measures are followed we will not be able to create or we will not be responsible for causing environmental degradation essentially as a part of the importance societal contributor as an offshore engineer.

But under the whole issue we have a very interesting scenario which is happening here. All these are discussion related to scenarios which are likely to happen, which are likely to exceed, which are likely to overcome the threshold values. So, any scenario which is likely to exceed or overcome which can pose threat is what we call as hazard. So, hazard actually is a scenario.

Please understand we are not saying that the hydrocarbon exploration production processing and discharge are causing risk to the environment, we have never said this statement. Risk is actually a realization of hazard. So, we will compare this more interestingly in the coming modules and in the different lectures in detail what are the different methods, but let us try to understand globally. Hazard is more generic whereas risk is more specific. Hazard usually is qualitative, risk usually is quantitative but there are qualitative risk methods also applicable to offshore industries.

So, if I can apply my management policies and assessment tools even at the general level itself I may prevent the scenario to get ripened or get matured to become a risk. The moment it becomes a risk it may land up in accidents and then the consequences are very

severe which can even bothered the (Refer Time: 05:03) financial index of the industry as well as the country even the global financial index.

So, our idea whole here as an environmentalist in terms of offshore engineering perspective is how the general level problems which pose threat to the environment can be managed, can be assessed, can be diagnosed, can be controlled, can be prevented, can be regularized so that at any given point of time they do not mature enough to become a risk you understand the point. So we are not saying that oil exploration production, oil and gas industry is actually a risky factor causing serious threat to the environment; we are saying the whole issue is likely to create the threat to the environment. Therefore, they are hazards.

So, in this lecture we will talk about how to assess them very briefly. However, we are going to discuss hazard assessment tools in coming modules in detailed lectures with very good examples applicable to industries. But here we will talk about only the primitive methods of how hazards are actually assessed and managed, especially applicable to environmental management. We are not talking about any industry or any specific plant or any specific chemical not intrinsically at this level we will talk about that later. However, now we are planning how the hazard assessment management can be applied to environmental management which is one of the important tools in HSE.

So having said this, the hazard assessment and management procedure commonly used in oil and gas industry can be explained very well using a simple diagram, it is a flow chart.

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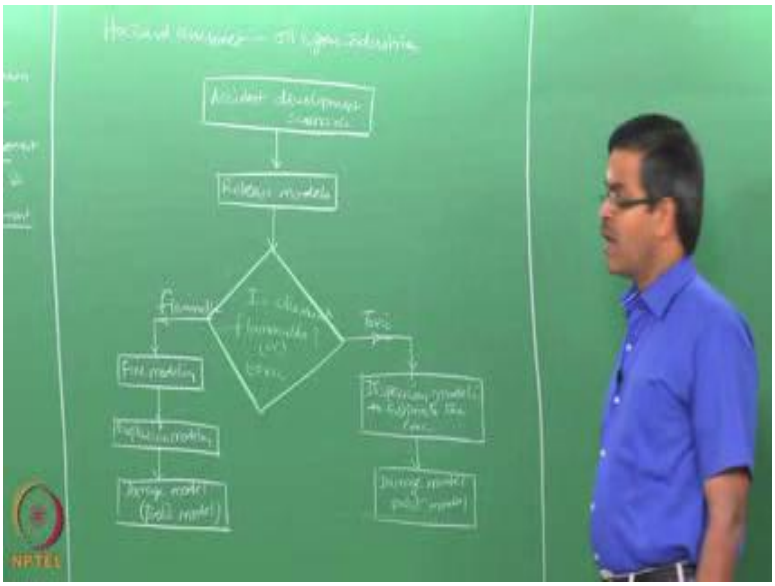

Let say hazard assessment as applicable to oil and gas industries can be explained with the interesting flow chart here. First let us try to see is there a possibility that accident development scenario. Once an accident development scenario is possible then via I got to go for release models. We have already seen continues release, intermittent release that is prew model, puff model we have seen them, for dense gases or vapor cloud we have seen equations we have seen charts and tables and empirical relationships we can use them and use appropriate release models. And foremost issue comes here, the chemical what we are talking about or the material in general is the chemical flammable or toxic. Because, we already seen that toxicity limits prescribe a various international regulatory agencies there are different methods by which you can check the toxicity limit. So, let us check is a chemical flammable or a toxic.

Now there are two branches from here; let us say they are toxic, let us say they are flammable. The moment they are flammable we should go for fire modeling to estimate the effect of this. We should also do explosion modeling, which we are going to discuss in detail in the successive module lectures we are talking only about the management part here. We should also than do damage models what we essentially call probit models. So, all these are applicable to flammable chemicals.

If it is non-flammable but toxic then one should go for dispersion modeling. We have already seen the dispersion coefficient etcetera in detail in the last few lectures, so one

should go for dispersion modeling. You have got to estimate the concentration of the toxicity of the material. Then one can again go for damage modeling which essentially is. So, whether the chemical is flammable or toxic in both cases we land up in the common assessment tool what we call as Probit model.

So, in this lecture we slightly elaborate this and see how a probit system can be carried out and what are the constraints and factors which govern the probit modeling tool. So, this layout or the flow chart clearly explains how a hazard assessment in terms of management perspective is to be carried out for oil and gas industry if the scenario can ripen into an accident development, which is most possible. Because in all our cases we have seen in the oil and gas industries the explosion or the fire or the flammability are always a risky issue and that result in lot of oil spills which is also considered to be an accident, so these are all possible. In that case we have to handle this in this manner.

Now, let us try to see how an accident scenario can be developed further in detail.

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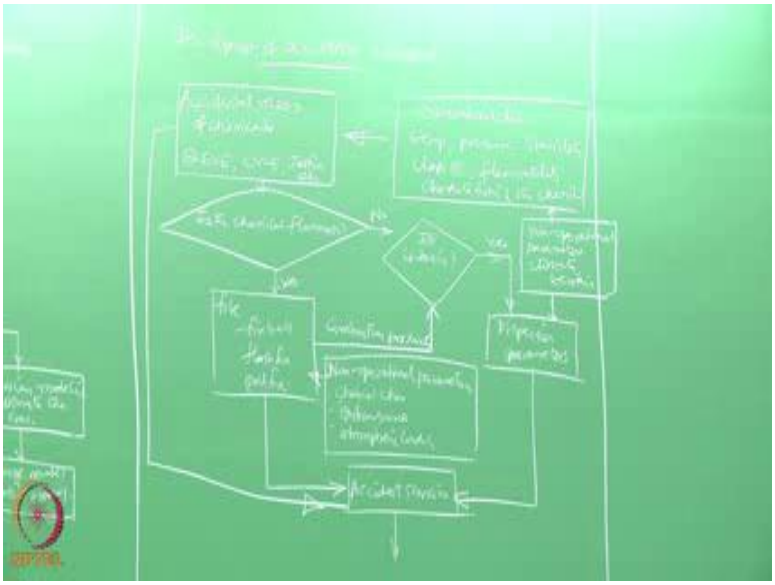

So, let us say development of accident scenario; the possibilities of accidental release of chemicals. This is true in case of processing industries which are related to oil and gas industries, so we are located not offshore but they are located onshore. So, they can result in BLEVE; Boiling Liquid Vapor Explosion, CVCE, Jet fire, etcetera which we will see in detail in the flammability models later. So, one has got to check whether the accident release of chemicals will lead to this kind of situation.

So, one need to understand the operational data which can lead to the accident releases; what is the operational data. On the other hand at what temperature, at what pressure, at what stability class, pasquill stability class, etcetera the plant is operating. And what are flammability characteristics of the chemical etcetera. So, these all require to really know whether the accident release of chemicals can result BLEVE, CVCE, jet fire, pool fire etcetera.

Now, the question comes once you know the accident release has happened is the chemical flammable. If it is yes, then one should talk about fire which leads to fire ball, flash fire, pool fire etcetera. Then you can come back to the accident scenario which will lead to the (Refer Time: 14:23) scenario. We can also directly come from this to the accident scenario, we can also connect this or you can also connect this directly to come back to understand the accident scenario.

Now if it is no; then we ask a question is it toxic, if it is yes then one should understand the dispersion model. To understand this we should also have an idea about nonoperational parameters. What are the nonoperational parameters? Climate, terrain, wind direction, etcetera. So, we should have nonoperational parameters which can also supply information to the dispersion model as well as to the accident scenarios as well.

The moment I have fire which comes from the chemically flammable issue then it can also result in combustion products. Now these combustion products can also become toxic in nature, so one has got to be clear. So, understand fire again we have some nonoperational parameters like; chemical characteristics, ignition source, atmospheric condition, etcetera which are necessary to really check whether it will result in a fire ball or not. The moment I understand the dispersion parameters for a toxic chemical then I can compute to the accident scenario.

So, dear friends once I have the accident scenario identified which can get from or ripen from a hazard scenario then I come back to this argument again this is where we were in the beginning and that is how, so these two can be tailed. On the other hand, the accident scenario can further lead to hazard management which follows this flow chart where the release models and we were talking about two flammable and toxic and then you keep on going ultimately the hazard management tool ends up in estimating characteristics of the probit model.

So, now let us look at what is a probit model.

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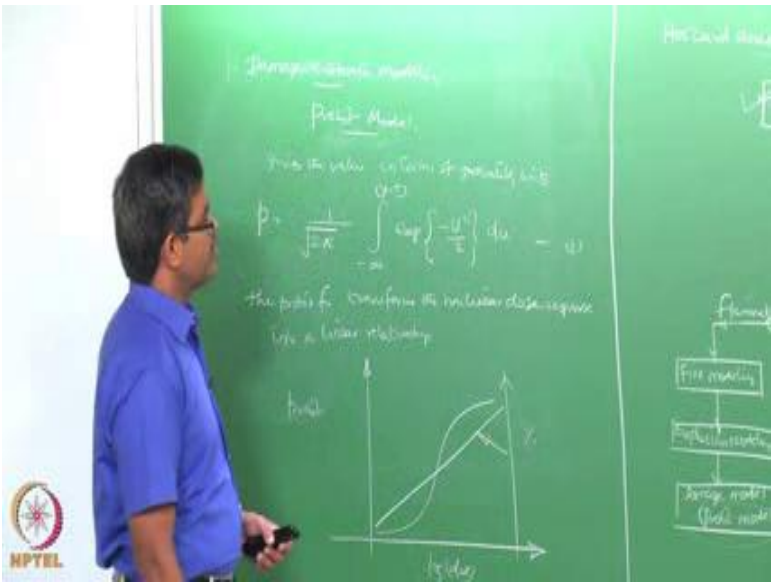

Probit model is a kind of damage estimate. Generally the probit model gives the value in terms of probability units. So it tells me from the following equation. The probit function what you see in equation 1 actually response non-linear dose response in to a linear relationship. This is log dose and this is the probit data. And of course, you can also explain this in percentage. It is actually converting the non-linear behavior into linear behavior. That is what actually the probit function is doing.

Now, here interestingly you have to estimate y.

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So, y is given by k 1 plus k 2 natural algorithm of v, where k 1 and k 2 are constants and v is the dose variable. The dose variable can be affected by various factors; what are those factors? The factors can be over pressure, it can be radiation, it can be impulse, it can be also due to concentration of dispersion. These are the factors which will contribute to the dose variable, which is an input for estimating y.

In a simplified form the probit value which is actually y can be transformed to a percentage affect. So, this can be say the probit value in terms of percentage will be equal to 50 1 plus y minus 5 of mode of y minus 5 error function of y minus 5 by root 2; equation 3. Where, erf is what is called the Error Function

Now, the probit correlation for various damages which will help you to estimate the value of k 1 and k 2 constants are now seen on the screen, please look at the screen.

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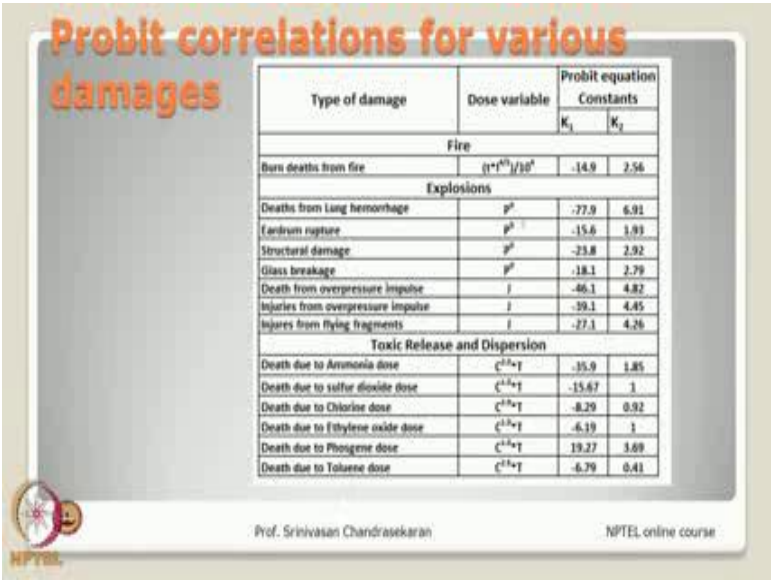

For understanding the probit correlations for various types of damages one can see here the damage may be due to the burn deaths from fire, it may be lung hemorrhage, (Refer Time: 23:11) rupture, eardrum rupture, structural damage, glass breakage, and so on as you see in this table. Now the dose variable is what is given in this column and there are three kinds of possible hazards which can arise; it can be from fire, it can be from explosion, it can be also from toxic release and dispersion. For all these incidents, for all these categories the probit equation constants which are used to estimate the equation k 1 and k 2 are available here in the tabular form. So, one can easily find out these values directly for a specific kind of damage for a kind of scenario may be fire, explosion or toxic release.

If you look at this table basically there are various variables shown in the table let us write down these variables and try to explain what are they.

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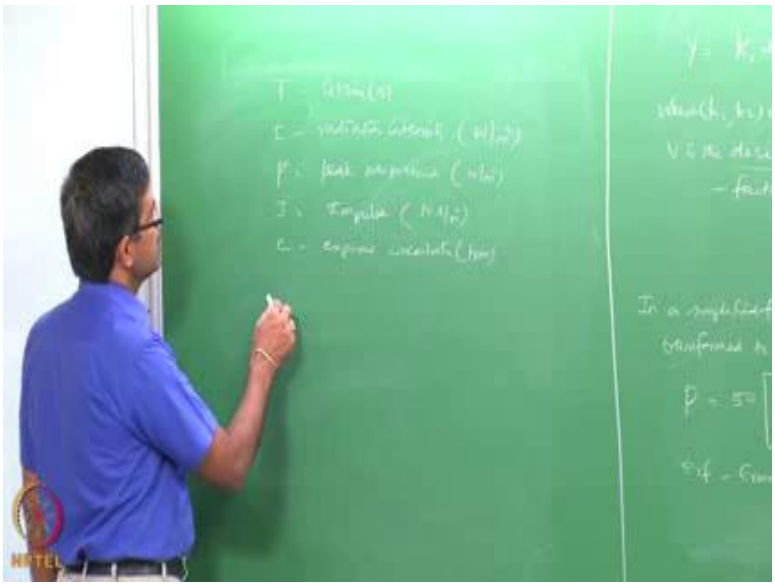

So, the indication of T is actually the time in seconds, I is the radiation intensity to find out the probit constant which is generally given in watts per square meter, P 0 is actually the peak over pressure usually given in Newton per square meter, J is the impulse usually given in Newton seconds square meter, C is the exposed concentration usually given in parse per million, and of course duration.

As we explained the other alternative hazard management essentially focuses on fire and explosion, because these are very common scenario which can happen in oil and gas industries.

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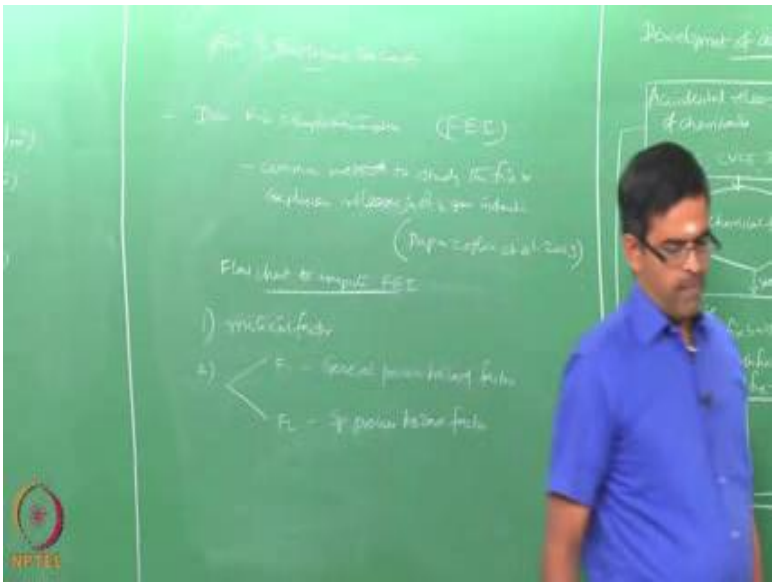

Fire and explosion hazards; to understand the scenario which can arise from fire and explosion one can use what is called dow fire and explosion index which is called FEI, Fire and Explosion Index which is very useful and a common method to study in the fire and explosion releases that happen in oil and gas industries. Interesting data and authenticity of this particular method which can be apply to oil and gas this is can be seen from Papazoglou et al at 2003.

Let us quickly see the flow chart to compute the FEI that is fire explosion index.

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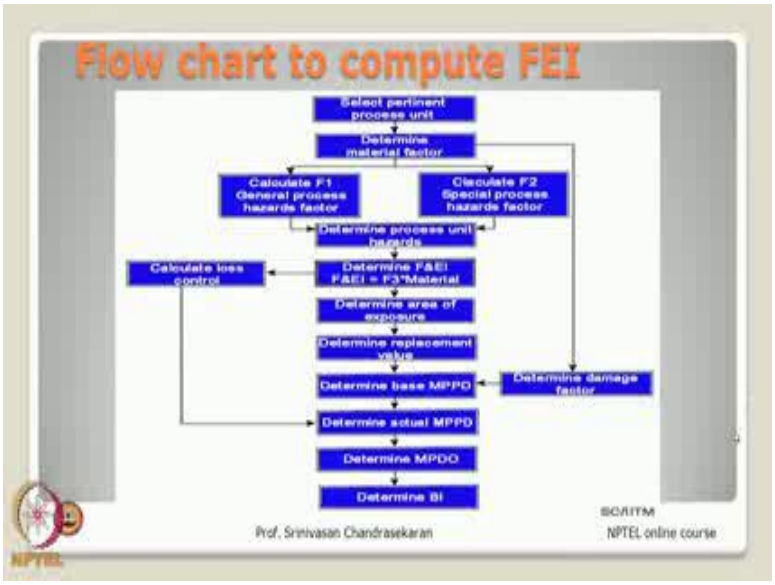

I request you to pay attention to the image shown in the screen now which is showing me the flow chart to compute FEI. We have to select the application for a specific process unit then one can determine the material factor. Then calculate f 1 and f 2; one is for general process hazard factor another is called special processor hazard factor. So, let us quickly list it here. The steps are very simple find the material factor which is responsible to cause fire and explosion. Second workout constant f 1 and f 2; one is for general process hazards other is for special processor hazard factor.

Please look at the screen now. Once you estimate both the factors f 1 and f 2 then get back to the process unit hazards determine F and E I that is nothing but fire and explosion index, which is nothing but f 3 into the material factor which we already got it here. Once you understand this calculate the loss control, from the loss control one can always determine what is called MPPD which will discuss. From the F and E I estimate the areas of explosion estimate, the replacement value, estimate the base MPPD and then arrive at the actual MPPD and check for the MPDA value and then look for the base index. One can also determine the damage factor directly from the material factor itself. So, let us explain this slightly in a different manner.

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Step number 1; we will estimate the material factor let us say MF. Material factor depends on various parameters; one is the vapor pressure, other is the flammable or explosive characteristics of the material. Based on this you estimate material factor.

The step number 2; compute f 1 which is the general process hazard factor. The general process hazard factor covers or addresses hazards such as reactions, material handling etcetera. In step number 3; try to compute f 2. F 2 is a special process hazard factor which essentially comes from the special conditions that prevail at the site. In step number 4; compute what is called process unit hazard, so this can be easy relation given by the equation 1 plus f 1 1 plus f 2. Then compute the F and E I index fire and explosion index which is given by dow, which is simply the fire and explosion index nothing but the product of PUH multiplied by the material factor.

Once you know the fire explosion index computed by this procedure then one can always say whether the process what have been assessing is hazardous or not. It means we must then find out qualitatively the degree of hazardous associated to this whole example.

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So, dow has given a procedure and suggested a table depending upon what is the value of dow FEI you want you can always claim the degree of hazards based on simple this number or this index. If the value what we get is between 1 to 61 can say it is a light degree of hazard. If it is from 60 to 96 we can it is moderate degree of hazard. If it is from 97 to 127 one can say it is intermediate degree of hazard qualitatively and comparatively. 128 to 158 we can say it is heavy and more than 159 or more than 158 one can say it is sever (Refer Time: 33:54).

So, in a given process if you are able to estimate the material factor and based upon the

physical and special properties identify the factors f 1 and f 2 and get the process unit hazard where tables are available in chemical engineering hand book for various kinds of chemicals one can easily find out the dow FEI. From the dow FEI one can conclude very quickly what is the level or the degree of a hazard this scenario is going to create to the environment, is it going to be light or is going to be severe. So one can access very quickly, one can try to plan or manage this kind of hazards depending upon whether you want to ignore it or you want correct it.

Now, the question comes after assessing this hazard we have to move to the management of this. So, the solutions to safety and injury hazards, health and illness hazards are implemented through rules and regulations. Interestingly the awareness of this kind of hazard management came into play in the literature in the societal benefit only after the international labor conference in the 91st session held in 2003.

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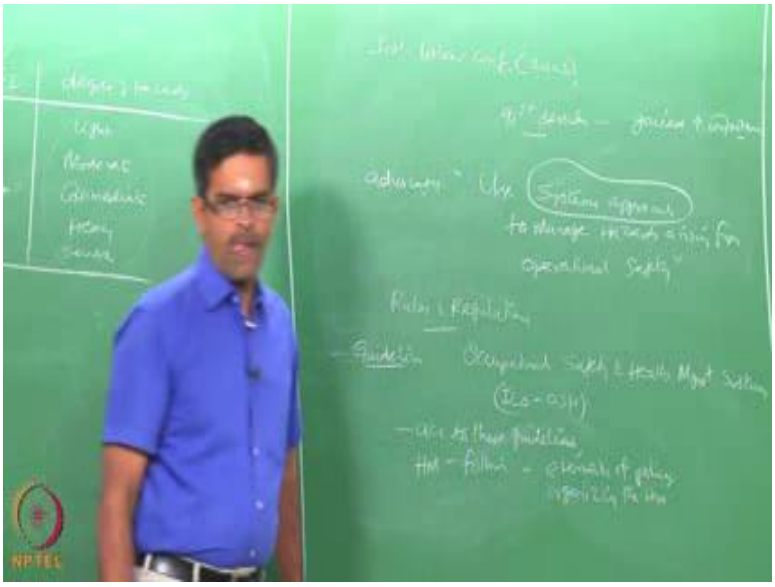

After the international labor conference held in 2003 in the 91st session the hazard management on environmental issues related to oil and gas industry become or gain high importance which is conducted by US department of labor. Interestingly the resolution of this conference on this session advocates a very important parameter; it says that use systems approach to manage hazards arising from operational safety. So, what is the system approach? We will talk about this explain in detail with silent examples applicable to oil and gas industries with certain process industries. But it was a very

interesting resolution which was made from the specific session of this conference based on which and the hazard management are essentially hazard assessment on the environmental issues come into line light after which rules and regulations where formed and many countries started insisting this regulations very strictly on the stakeholders.

In addition to this people have also refer to various guidelines given by; there are other guidelines which are also useful in following or maintaining the environmental issues or environmental hazard level which arise essentially from oil and gas industries. One can look at the guidelines given by occupational safety and health management system which is ILO - OSH which is essentially a frame work for occupational safety and health management systems advocated to oil and gas industries.

According to this guideline it is very interesting that in the hazard management program should contain the following; elements of policy, organizing the hazard management, planning and implementation, evaluation and action for improvement. So, they become the back bone of any hazard management schemes.

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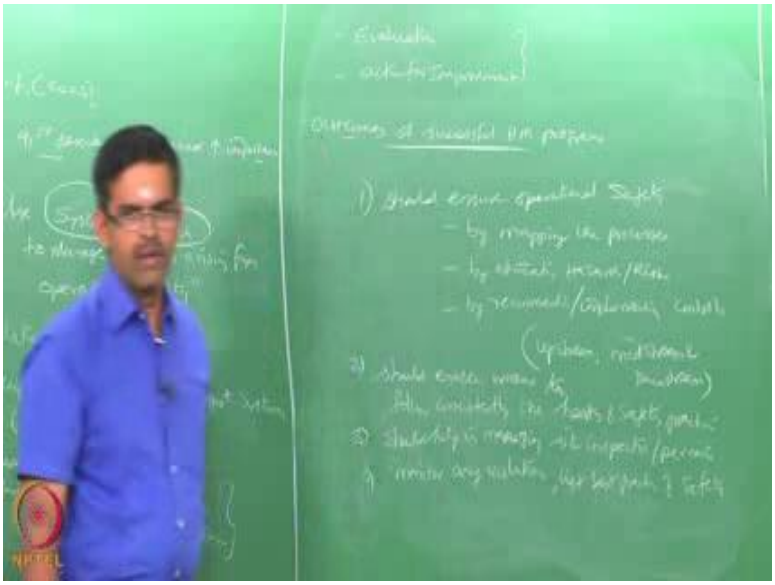

So, what are the necessary or preferable out comes of successful hazard management programs? The hazard management programs foremost should ensure operational safety. How this can be done? By mapping the business processes, by estimating hazards and risks, and then by recommend and implementing controls on all the three areas upstream, midstream and downstream. That is a first goal or first desire outcome of any hazard

management program.

The second should be it should enable workers to follow consistently the health and safety practices. The third outcome should be it should help in managing site inspections or permits which essentially come from the planning site. It should monitor for any violations and it should also list best practices of safety.

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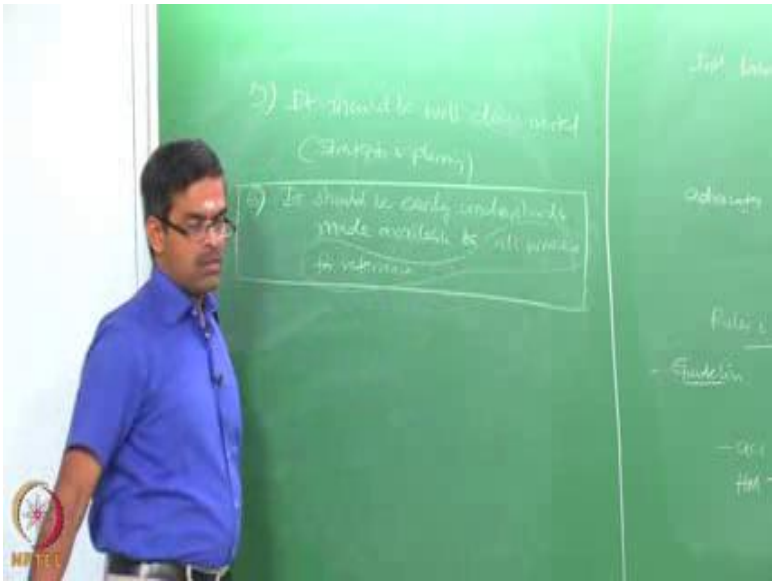

Most importantly it should be well documented indicating both the strategies and planning. And it should be easily understood that is very very important and made available to all workers for reference. Is a very important issue where in the oil and gas industries stakeholder themselves are involved in policy making of hazard management. So, that is very effective tool and that is one of the desired outcomes which is expected from a successful hazard management program. Alternatively one can also go for health and safety plan.

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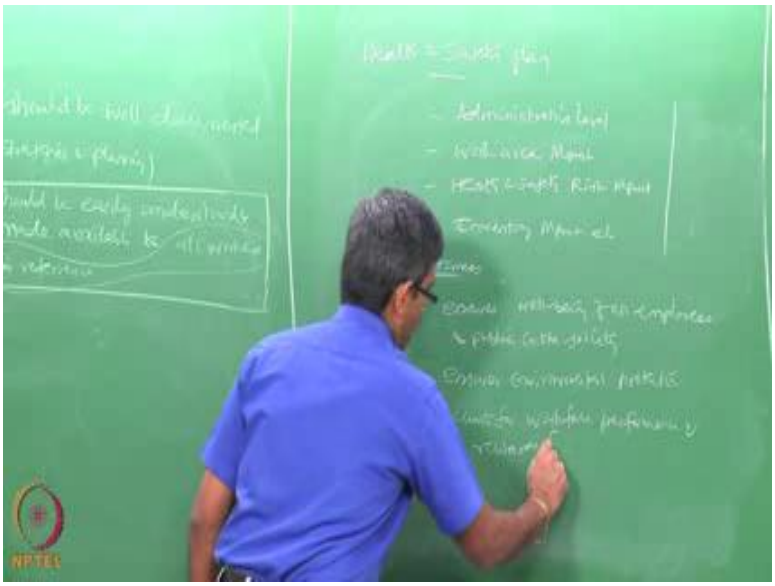

One can go for health and safety plan. This will include planning at administrative level, work area management, health and safety risk management, inventory management, etcetera.

This plan has got again desired outcomes; one it ensures well being of all the employees and public in the society. It ensures environmental protection. It also accounts for work force performance and rewards for efficient management.

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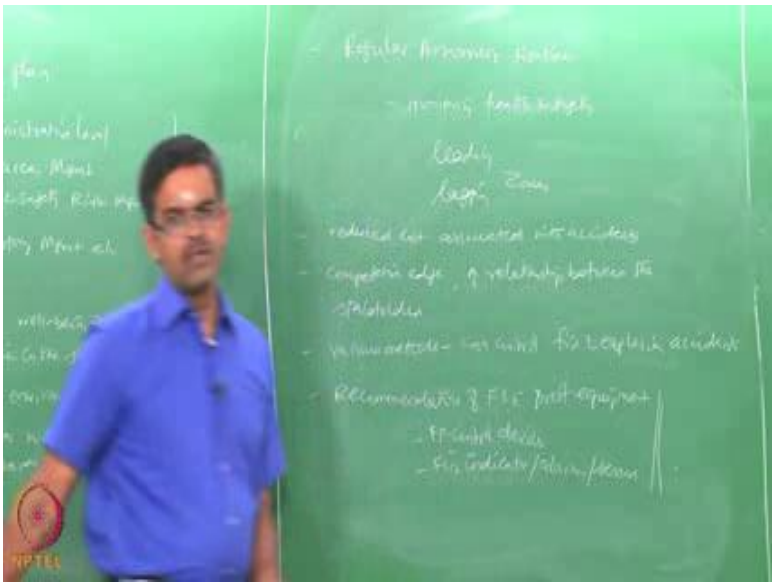

It should also lead to regular assessment routines in terms of monitoring health and

safety practices both in leading and lagging zones. It also enables reduced cost associated with accidents. It gives a competitive edge in the commercial market and improves relationship with the stake between the stakeholders. It also has or addresses various methods that can control fire and explosion accidents.

So, it leads to various recommendations of fire and explosion proof equipments, fire fighting and control devices, fire indicators, alarms, sensors, etcetera. So, all this put integrally the management into a very successful result as far as hazard. There are various ways by which we can do this; there are varieties of software available to do this.

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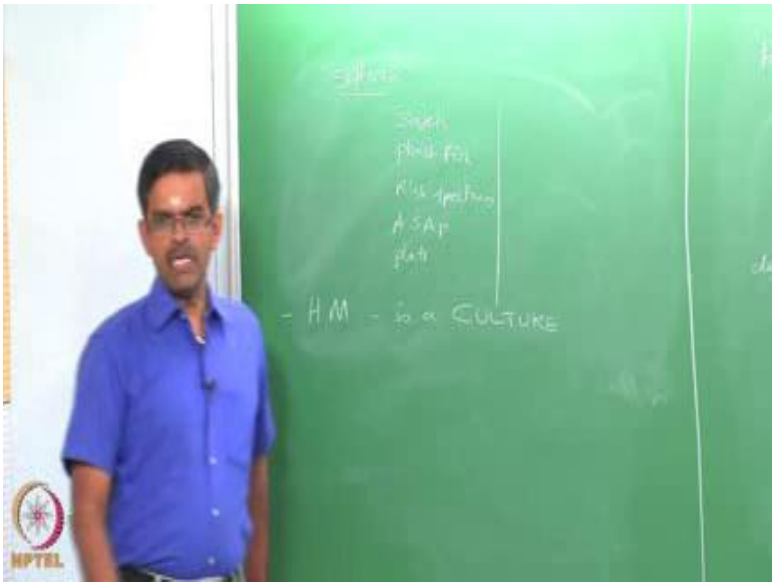

The software could be safety, phast risk, risk spectrum, ASAP, plato, etcetera. So interestingly hazard management is actually a culture, it needs to be practiced, it needs to be trained; it cannot be educated. Process hazard analysis is of course a throw, orderly, systematic approach which can used for identifying, evaluating and controlling hazards in the process industry which is one of important application in oil gas industries in the present scenario.

Therefore, the employer must perform an initial process hazard analysis to ensure that the system does not create hazard to the environment. The process hazard analysis must be appropriate to the complexity of the process and must therefore identify evaluate and control the hazards which it can post to environment back.

So, the whole issue can be bracket in one term called process safety management, it can protect the work force, it can protect the contractors, protect visitor to the plant, etcetera. The risk management programs which are also derivative of this kind of hazard management programs; protects the community, protects the general public, and the facility and of course protects the facilities such as school, hospitals, near by the process industries which are all connected to offshore industry which are located on show.

So, in this lecture we discussed about various tools that can used for hazard management related to the environmental management what we have been talking about essentially from the top oil and gas industries.

Thank you very much.