Chemical Process Safety
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Module 01
Lecture 02
Risk Management & Hazardous Substance Rules

Welcome to the second module of this safety course, in this particular module we are going to study about the concept of risk management, what are the different laws applicable in different context? Now before we go into this particular module just, let us have a brief glimpse about that what we have studied in the last module?

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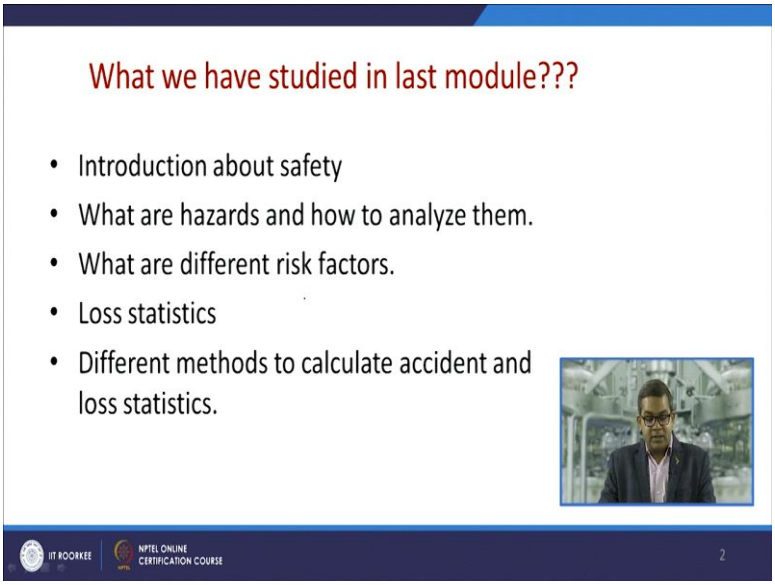

In the last module we have got an idea about what is chemical process safety? Hazards and risk, what are the different type of hazard present at workplace? And how we can analyse those hazards, what are the different risk factor involved at the working placed or in the process industries? Now to quantify the things you must, we had a particular analysis about the loss statistics, we have studied about the different methods to calculate the accidents and how do we can go ahead with the quantitative things.

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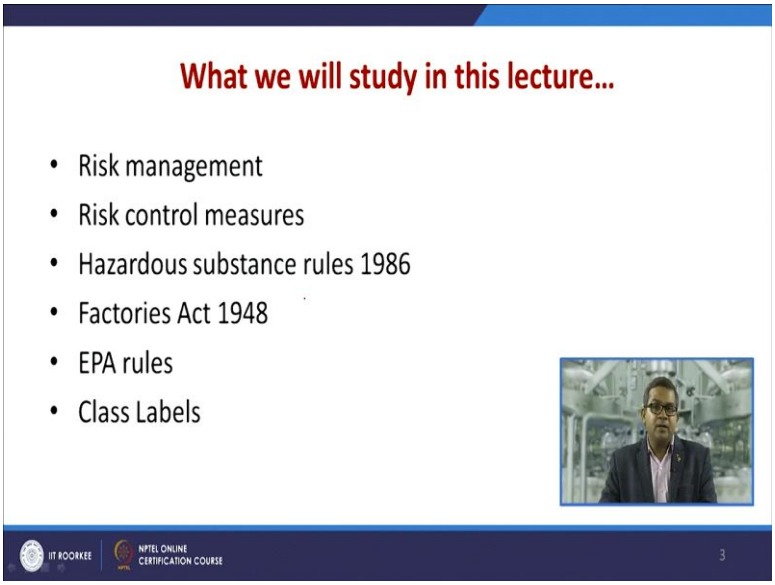

Now in this particular module we are going to study about the concept of proper risk management, different type of risk control measures, what are the different hazardous substance rules, factories act and different environmental rules, etc

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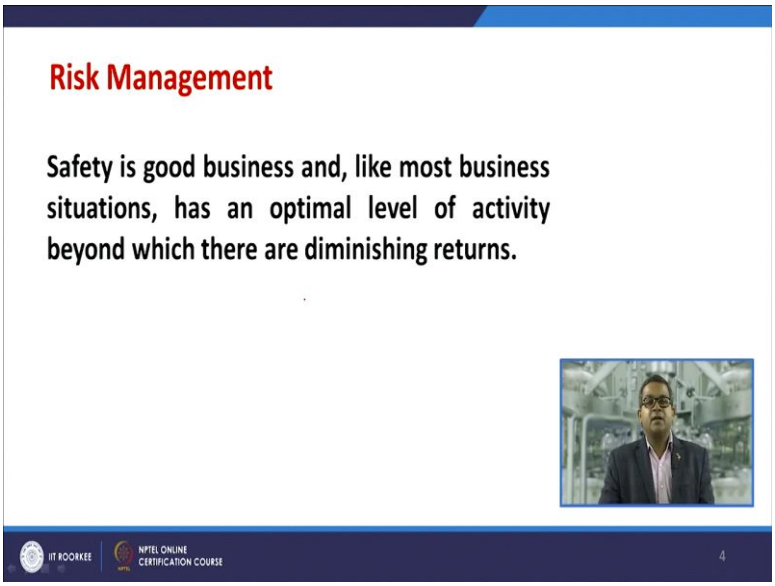

Now there is small concept of risk management because safety is a very good business and everywhere there is an involvement of economy, so suppose you are going through a road or through scooter or car, whenever you are putting your seat belts or helmet that means you are investing certain quantum of money towards your safe process, likewise safety is a very good business and has an optimal level of activity, beyond which there are diminishing returns.

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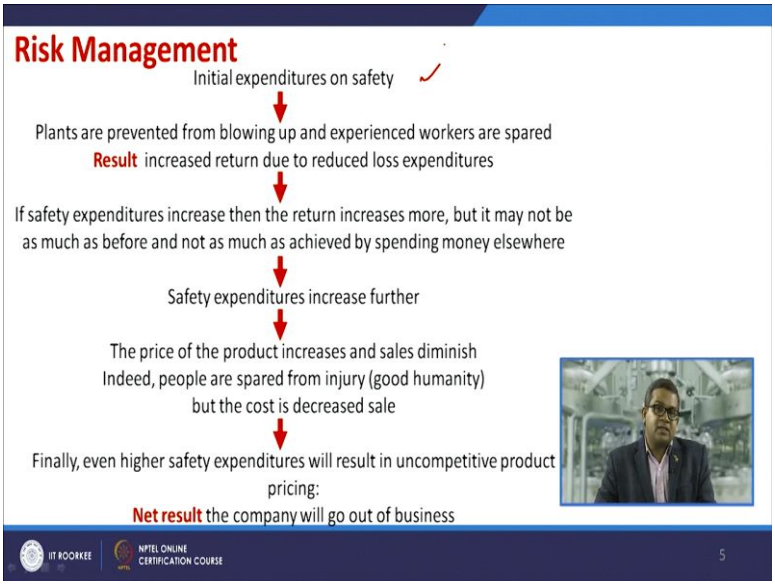

Now this is a brief glimpse about what is the risk management? Now at the startup you are having certain expenditure on safety, now obviously your plants are prevented from blowing up an experienced the worker safety because in the last model we have studied that everything is governed by the economy, now result is the increased return due to the reduced loss expenditure and reduced loss in the man-hour or workdays.

Now if safety expenditure further increases, then the return increases more, but it may not be as much as before and achieve by the spending more money elsewhere, then again you are pumping more money towards safety expenditure, the price of product increases and sale, obviously the sale will be on lower side and people are spared from the injury, of course, this is the good humanity, but the cost has decreased sale.

Now, finally, if you are pumping more and more money, then ultimately you will be uncompetitive and the cost of product will be on the higher side and as a result, you will be out of the business, so each company needs to determine an appropriate level of safety expenditure, beyond which the product cost or your process cost will be on the higher side and you will be out of the business.

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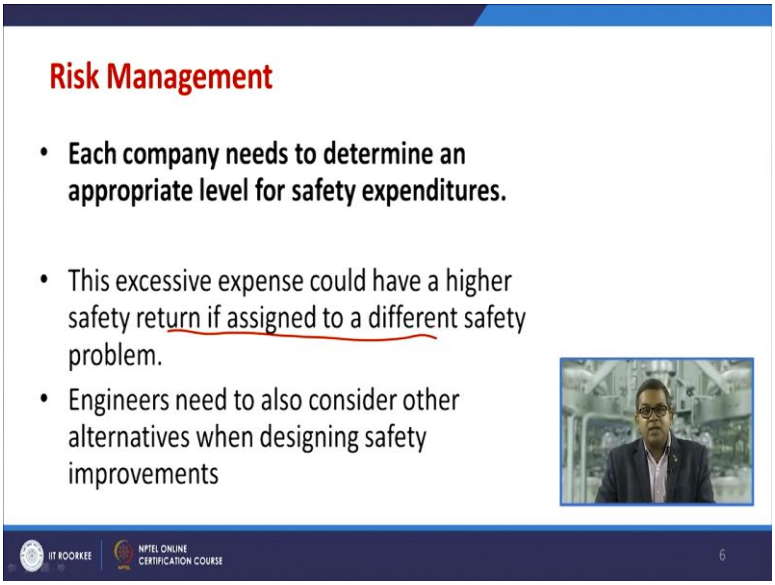

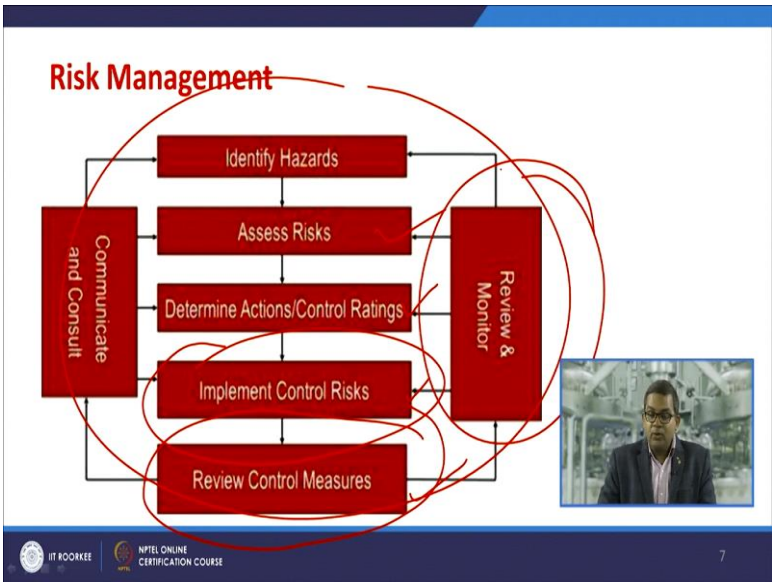

So this excessive expenses could have a higher safety returns if assigned to a different safety problem, so as an engineer, your objective is need to consider other alternatives while designing proper safety devices, now this is the particular concept of risk management, first thing as per the last module you need to identify the various hazards, you need to assess the

consequences as well as the risk, what kind of the risk present? Because if you recall the last module we have analysed that what is risk? Risk is the probability of any accident occur.

Then you need to determine the action control rating that what is the consequences and based on those consequences, based on the probability of the risk you must implement control measures to control the risk, now whenever you are implemented these type of, this control risk, then you must review the risk control measures, so based on your control measures you need to review and monitor continuously.

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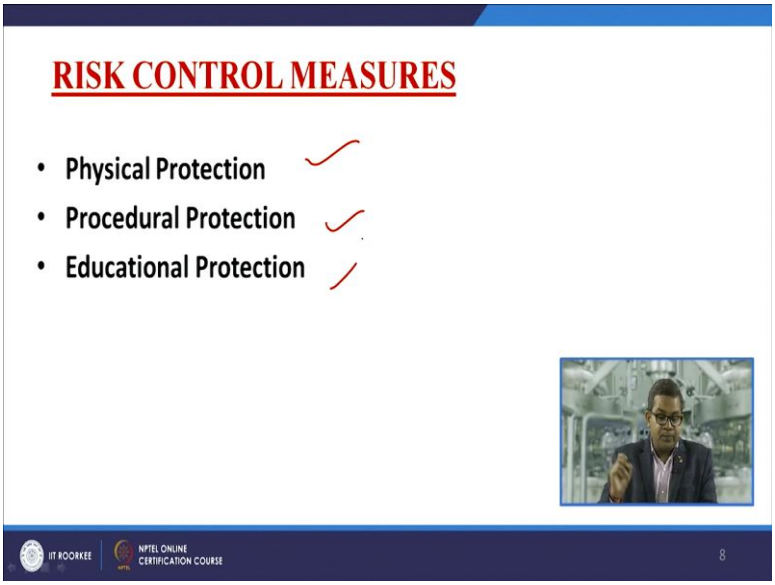

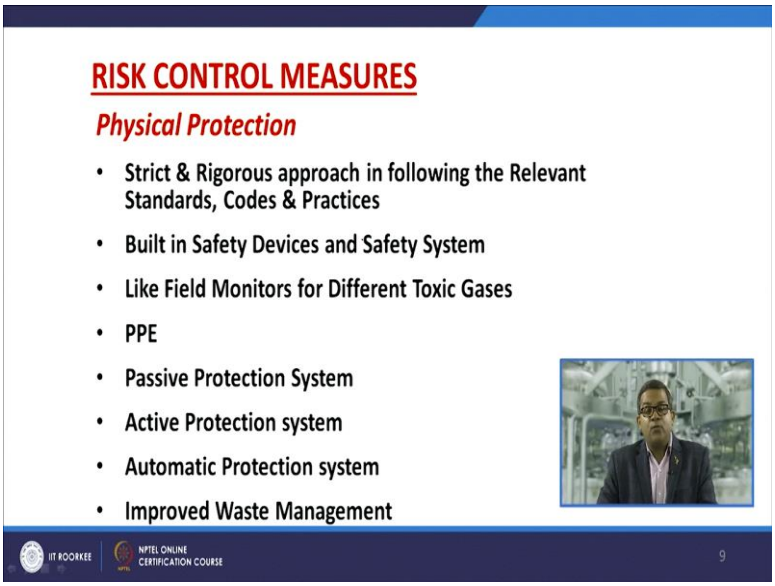

Now there are three different type of risk control measures physical protection, procedural protection and educational production, I am going to give a glimpse about that, what kind of all three different protections, now first thing is the physical protection, you must follow the

strict and rigorous approach in following the relevant standard, codes and practices because in every country, in every state at every zone they are having set of standards, every industry they are having set of standards, every state, every legislation they are having the set of codes and the usual safety practices, so you must follow all those safety standards, codes and practices.

There are certain built-in safety devices and safety systems, so you must follow and you must be aware about those system and devices, there are certain things like field monitors for different toxic gases, flammability metres to analyse any kind of, presence of any kind of flammable mixtures, so you must be aware of all those things, there are certain personal protective equipments through which you can protect yourself as well as your workers like aprons, like safety goggles, like helmets etc, so you must be aware and all the workplaces must be equipped all such kind of PPEs.

There are certain inherent passive protection system, so everybody should be aware of those kind of passive production system, there are certain active cum dynamic protection system, so these active or dynamic protection system, everybody should aware and everybody should be well acquainted how to use all those kinds of protective system, there are certain automatic production system, those like fire monitors, fire sensors etc they can be actuated at the time of eventuality, there must be certain improved waste management concept, we will go in detail that what is this include waste management and good housekeeping in subsequent models.

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Apart from this, there are certain procedural protections like there must be fire and emergency procedure, if you go to any hotel, a good quality hotel you will find that the behind of every door you are having the fire protocol like what is the, where is the exit? Where is the fire emergency exit etc? So you must, for every process industry, you must have all kind of fire emergency procedure if you are dealing upon.

There must be certain disaster preparedness plan, there is a concept of mutual aid systems, so if anybody is in problem or if it is in danger, suppose anybody inhales the toxic substance, then you must provide aid to that particular person, there must be no smoking policy, you must investigate all kind of accidents, even if there are near misses because sometime all those near misses play a very vital role and sometimes, these near misses may lead to a big disaster.

There must be certain hazard identification through the safety committees, good housekeeping committees, safety audit committees, remember in the previous module we have discussed about the two tire audit system, internal audit and external audit, so you must follow that particular procedure, conducting plants survey and safety survey that is a must, there must be work permit system, work permit system means suppose if you are in a particular arena where you are dealing with a toxic substance, so everybody should not be allow to enter in that particular arena because there may be certain toxic vapours, those who may part, become the part and parcel of that particular visitor.

So without having any kind of safety equipment or safety devices, he or she should not be allowed to enter that particular things and before releasing the permit system, everybody should ensure that he is well equipped with all kind of safety system, you need to follow the statutory requirement as laid down by either state government or federal government or central government, there must be certain safety promotional activities because nowadays everything is related to economic, apart from this safety is everyone responsibility, so there must be some safety promotional scheme from the managerial aspects.

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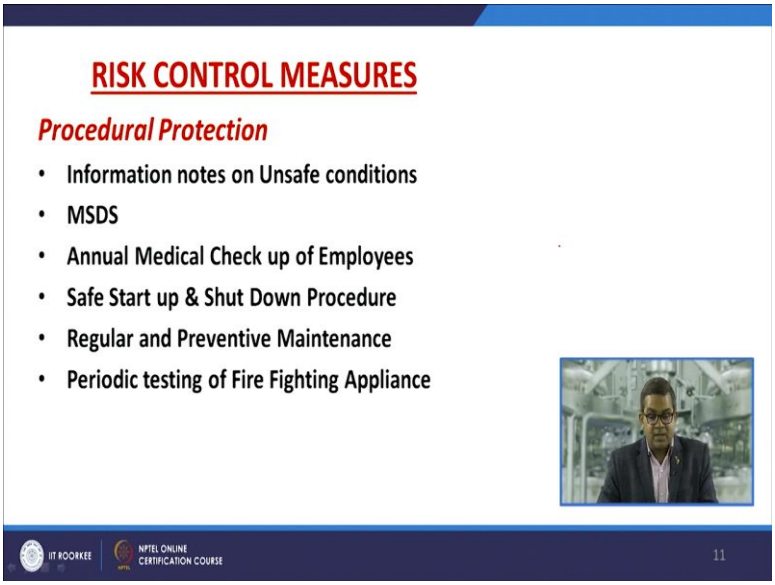

There must be certain information should be placed regarding the unsafe condition, if you are entering into any unsafe arena, then the proper notes, play cards should be displayed for all kind of unsafe condition, people must be aware about material safety data sheet MSDS stands for material safety data sheet, in the subsequent model we have discussed in detail that what is material safety data sheet?

There must be annual medical check-up for employees so that you can be aware about any kind of toxic release and sometimes because of body structure we make get to acclimatize to this toxic substances, if anybody goes into the medical check-up, annual medical check-up, then definitely any kind of release may be detected and the impact of that particular release to the employee may be detected, there are regular and preventive maintenance, well audited regular and preventive maintenance, the periodic testing of all kind of firefighting appliances, apart from all kind of toxic substance detection devices.

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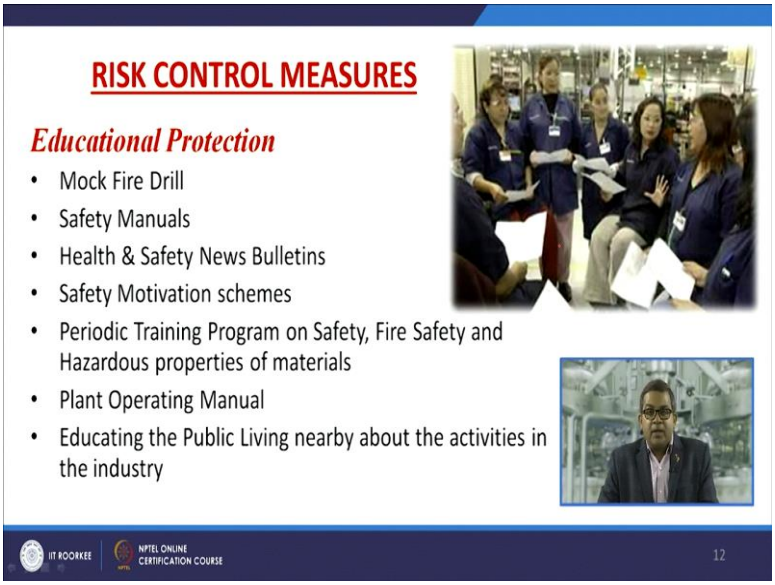

There are certain educational protection, everybody should go for mock fire drill if applicable in that particular plant, there are certain safety manuals and everybody should follow, all those safety manuals, there are regular safety and health news bulletins, so that you may be aware that what is going on inside and outside the world, there are safety motivation schemes and all these safety motivation schemes should be supported by management.

There must be periodic training program on safety, fire safety and hazardous properties of the material so that your plant worker and officials they are well aware acquainted with what kind of hazardous process is going on and what kind of things moving on within the plant, so training program is a must, the plant operating manual should be readily accessible to each and everybody, those who are involved in that particular process, educating the public living nearby about the activities in the industry and that is a must because I would like to give a brief example of Bhopal.

In Bhopal when the MIC was leaked, the public nearby, they did not know that what is the particular chemical? In the prima facie information given to the public nearby was it is a chlorine gas, so they did not know that how to handle such kind of scenario, now educating the public living nearby about the activities in the industry is must, reason is that the people should know that what kind of different activities is going on within the industrial premises, so that in case of any emergency, they should be in a position to handle such kind of scenario, so educating as well as the training for the people nearby is essential.

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Now there is a growing importance of risk management, this is basically attributed to the proper legislation, the customer attitude, the societal expectations and the management attitudes, now every government and everybody is sceptically aware about that this is the gravity of not only environment as well as for the human being, so they frame the proper legislation.

There is a customer attitude as far as then as a customer, we used to buy anything than in the subconscious mind we used to follow the concept that did they follow all the legislation, all the environmental norm or the human aspect, there are certain societal expectations, I am going to detail in the subsequent slides, there must be the management attitude, the reason is that ultimately everything is again govern by the economic.

So whenever there is loss in company that means there is a diminishing return to the company, so management attitudes is growing nowadays just to safeguard not only that environment but to the human being within the company because ultimately whenever there is any kind of problem, then they need to pay the compensation.

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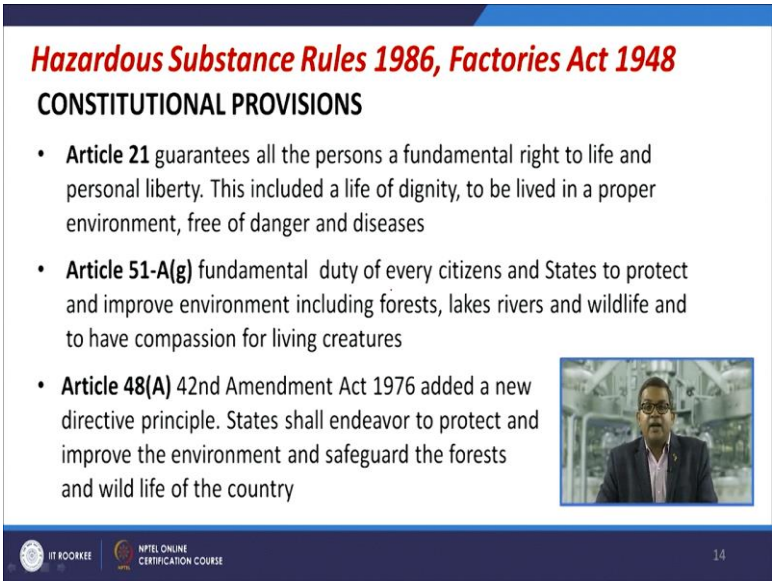

Now the second part of this particular module deals with the hazardous substance rules, 1986 and factories act 1948, the previously before 1986 we use to follow the factories act 1948, now there are certain constitutional provisions before we go into detail what is the hazardous substances rule 1986?

Now the constitution says, as according to the article 21 this guarantees all the persons a fundamental right to life and personal liberty. This included a life of dignity, to be lived in a proper environment, free of danger and diseases, that means to live in a safe and healthy environment is my fundamental right. Article 51, says the fundamental duty of every citizen and a state to protect and improve the environment, including forests, lake, river and wildlife to have a compassion for living creatures.

So these two articles, not only deals with the fundamental right and fundamental duty, so as a citizen I am not allowed to encroach, I am not allowed to distort any kind of environment, which may cause danger to anybody else, now article 48 i.e. 42nd Amendment act 1976 added a new directive principle, State shall endeavour to protect and improve the environment and safeguard the forests and wildlife of the country.

So all this three constitutional provisions need a clear that no industry is allowed to discharge any kind of toxic, flammable or any kind of dangerous thing within the factory premises as well as the outside, so that in the event of any release the problem may created.

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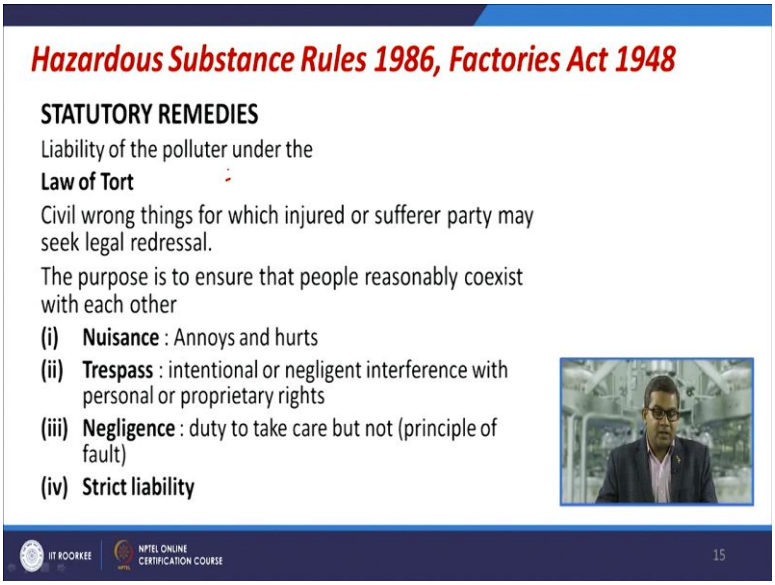

Now there are certains statuary remedies that is liability of the polluter under the law of tort, now what is law of tort? Law of tort says that civil wrong things for which the injured sufferer party may seek the legal redressal and the purpose is to ensure that people reasonably coexist with each other, so this, the law of tort is applicable to industry as well as the people those who are living outside the particular industry.

There must be certain avoidance of nuisance which annoys and hurts of everybody, sometimes the whistle, sometime of other machinery part, they may cause hurts or annoys, any kind of person, which is either nearby or working within the factory premises, the trespasses, the intentional or negligent interference with the personal or proprietary rights, etc. The negligence duty to take care but not too principle of fault i.e., there must be certain strict liability, so based on this law of tort the government, both the central as well as state government, they are liable to frame certain statutory laws.

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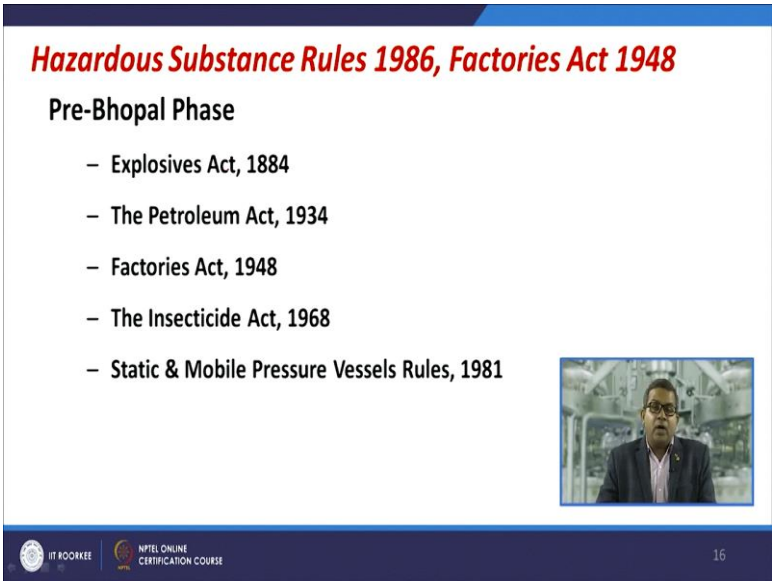

Now in a broad spectrum we can divide our legislation into two aspects. One is the pre-Bhopal phase another one is the post Bhopal phase, no doubt after independence or pro-independence era, we did have certain laws like explosive act, 1884, the petroleum act, 1934, the factories act, 1948, the insecticide act, 1968 and the static and mobile pressure vessel rules, 1981.

Now, after Bhopal gas tragedy because all the qualitative and quantitative parameters they have change after the Bhopal accident because of the death of thousand and thousand people, then government of India they regulated and they frame the different laws which are covered under the hazardous substance rules, 1986.

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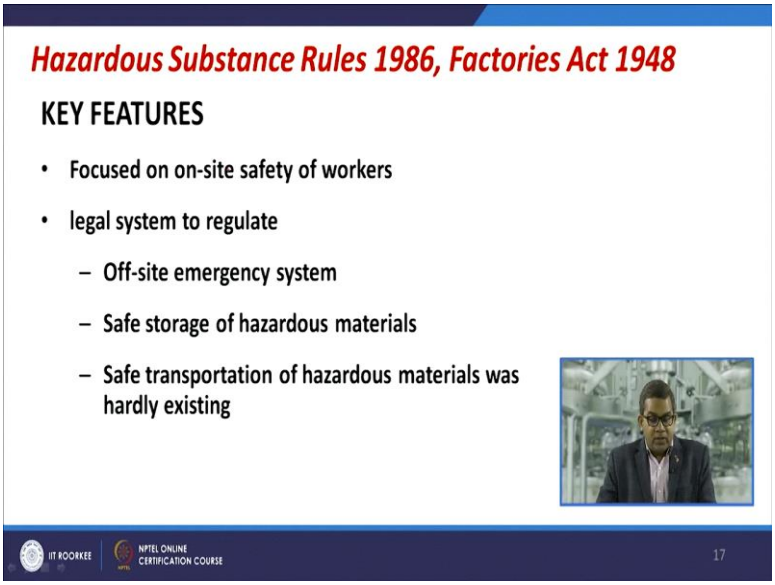

The key features of all these law are focused on on-site safety of the workers because again, these are the key players, the legal system to regulate is to off-site emergency system, the safe storage of all kind of hazardous material because there are certain laws through which you cannot store more than the stipulated things within the premises, the safe transportation of all kind of hazardous plus inflammable materials, now previously it was never in existence, but after the certain accident they frame this type of rules.

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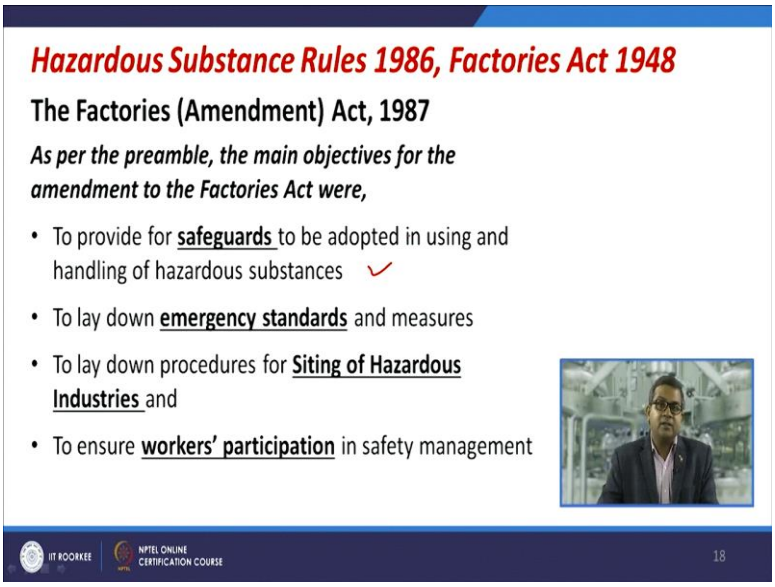

There was again a factories act, Amendment in 1987, now as per the preamble, the main objective for the amendment of the factories act was to provide the safeguard to be adopted and using and handling of hazardous substance because previously there was hardly existence of any law in such periphery, now to lay down the emergency standards and measures sometimes any kinds of hazardous substance may get leak, then what kind of measures emergency standards or emergency protocols we need to follow.

To lay down the procedure for setting of hazardous industry, now there are several types of zones in which you can lay down all kind of these industries plus there are certain zones where you cannot lay down or you cannot start those hazardous industries, so the government laid down the procedure for setting of hazardous industry, to ensure the workers participation, in the previous module we studied that is an everyones responsibility, so the legislation ensured that it should be the workers participation baseline for effective safety management.

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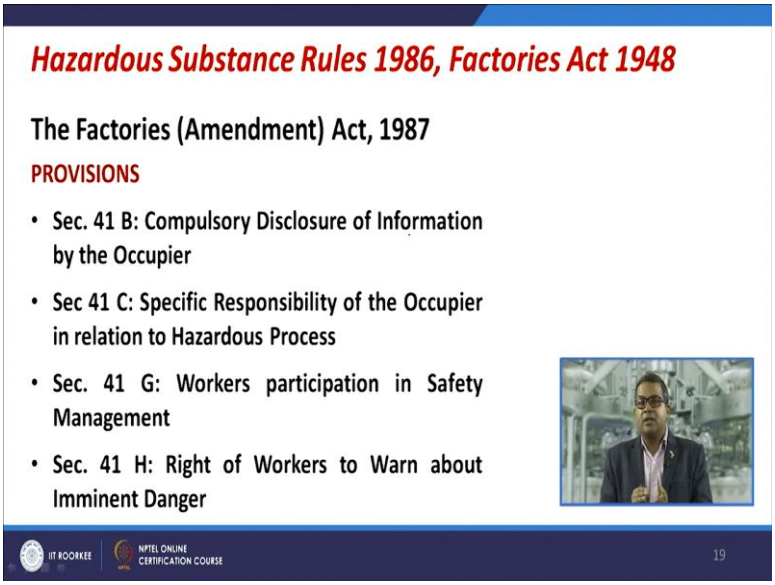

There are certain provisions made by these factories, Amendment act in 1987, the provisions are section 41 B, compulsory disclosure of information by the occupier, in this case, the occupier is the industry owner or the Corporation those who owns that particular industry, there must be in a position to disclose the information, now these information are of various categories.

There is a specific responsibility of the occupier in relation to the hazardous process, this is in listed in section 41 C, the section 41 G, deals with the workers participation in the safety management, this includes the training as well as the safety knowledge, those we have discussed in the first module that is the cup of tea with five ingredients, the section 41 H says the right of workers to warn about the imminent danger, that includes that as a worker, it is my right to have a knowledge that what kind of hazardous activity is going on within my workplace, so it is my right, so that mentally I should be prepared to be handle such kind of situation, because if I am not prepared with this kind of things, then definitely I will not be in a position to help others out.

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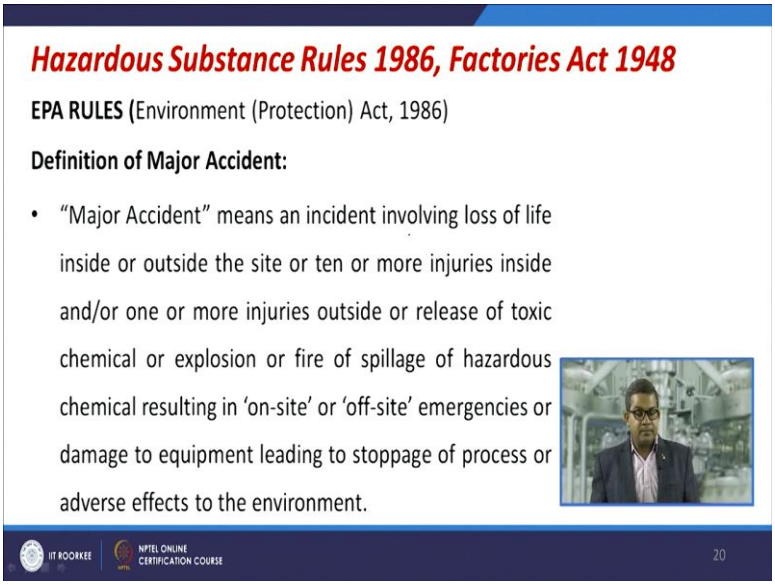

There are certain environmental protection act and the first Amendment or first act was passed in 1986, the definition of major accident is a part and parcel of this particular act, the major accident means an incident involving loss of life inside or outside the site or ten or more injuries inside and one or more injuries outside or release of toxic chemical or exclusion or fire or spillages of hazardous chemical resulting in on-site or off-side emergencies or damage to equipment leading to stoppage of process or adverse effects to the environment.

Now if you go through this particular definition we can see that all kind of hazardous activities are covered, maybe on-site, maybe off-side, maybe within the plant, maybe the outside the plant, so all occupier or industrial person must be aware that particular basic definition.

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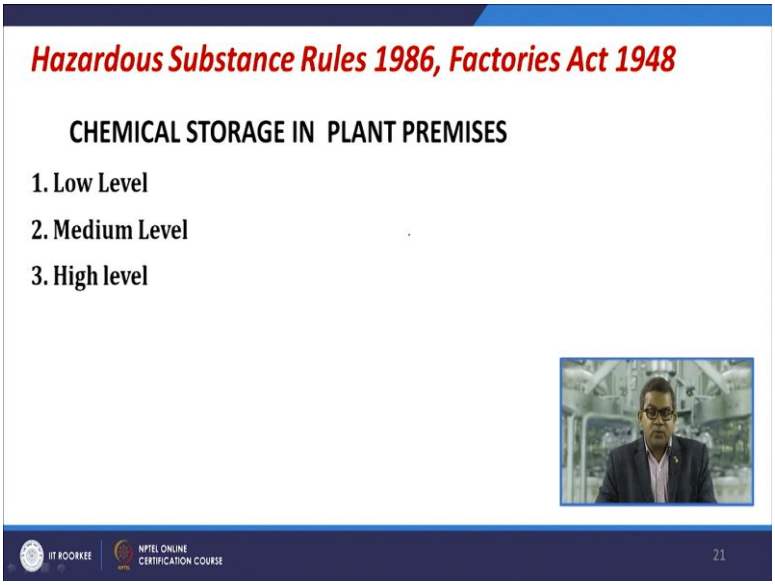

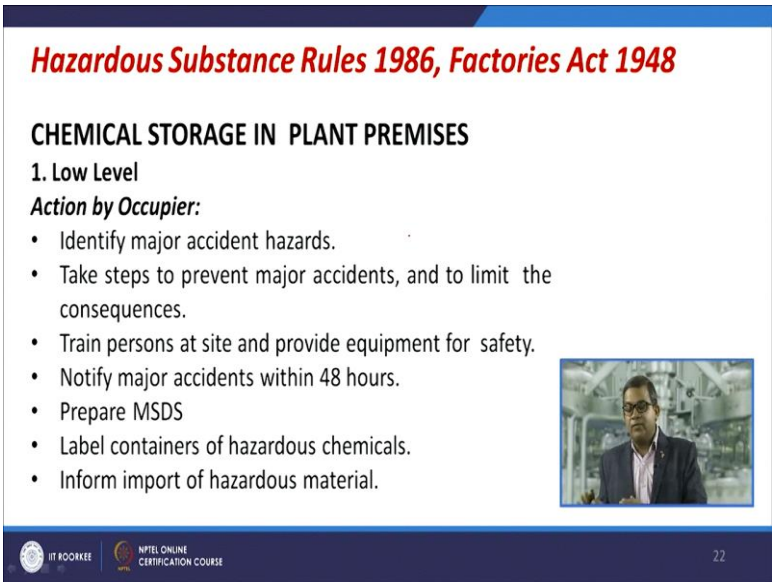

Now as far as the storage in the plant premises is concerned, we are having three different type of aspects low-level storage, medium level storage and high-level storage, now low-level storage there are certain actions needed by the occupier and that has to be carried out by the occupier as far as the losses, you must identify the major accident hazards that is the first thing, the second thing is that you need to take the steps to prevent the major accidents and to limit the consequences because previously we have identified those accident, those hazardous scenarios, we know that what are the consequences, so we had to take the proper steps to prevent such kind of major accidents.

That you have to train the person at site to provide equipment for safety, these safety maybe, these equipment may be in terms of the personal protective equipment, these may be in terms

of active or passive protective equipments, you need to notify the major accident within 48 hours, the reason is that the civilian authorities may take the appropriate action accordingly, it is the responsibility of the industrial person to prepare the MSDS of all hazardous plus all the novel chemicals present within the plant promises.

This MSDS gives you all kind of information physical, chemical, reactivity, name of the supplier, all kind of information, in different modules we will discuss that what are the integral part of this MSDS? There must be the responsibility of industry person or occupier to level all containers containing the hazardous chemicals, so that it is well notified by all the person, those were working within that particular arena, inform import of hazardous material, so all the regulatories bodies must be properly informed about the import of any kind of hazardous materials, so that they may inspect, they may check, they may audit that whether you have follow the safety norms or not.

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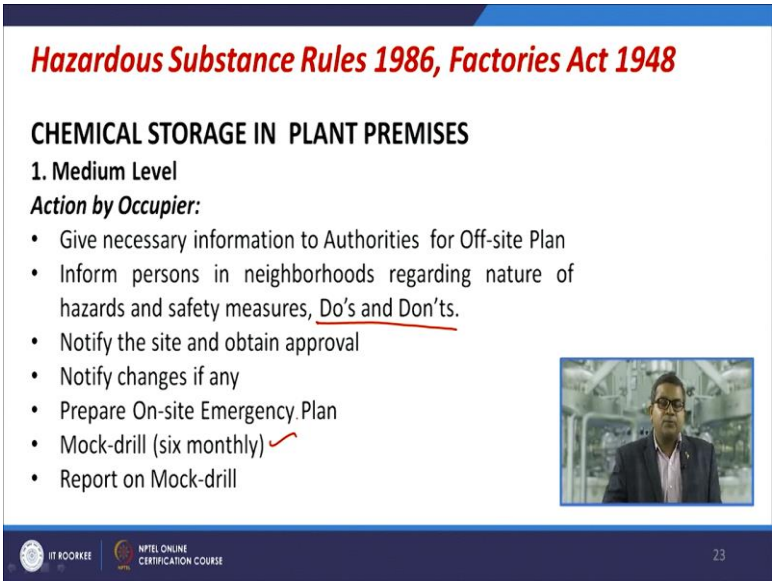

The medium level aspect says to give the necessary information to the authorities for any kind off-site plan, you must be in liasoning with the local authorities or local person, the inform persons in the neighbourhood regarding the nature of hazards and safety measures and you must supply the proper information dos and donts, so you must inform, you must train the neighbour or the person, those who are leaving outside the particular plant zone that what kind of hazardous activity is going on within the plant promises and in case of any eventuality, how we can handle the scenario, so dos and donts, you must provide all kinds of information because one of the major accident took place, because of this person they did not follow the dos and don'ts.

Notify the side and obtain the necessary approval because sometimes we feel that this kind of approval takes time and unusual delay that it again give a safeguard to the industry, notify the changes if any, sometimes process modification or sometimes environmental norms or energy efficiency norms, they force us to change our process methodology, so in case of any change over please notify all kind of things.

Prepare on-site emergency plan and that is a must, because in case of anything because anything can be hazardous like even water may become the fatal, so in case of any emergency, you must prepare on-site emergency plan, frequently you must go for the mock drill, usual protocol says every six months, but as quickly as possible or as early as possible you must go for this mock drill concept and you must prepare the mock drill report because sometimes any kind of deficiency, any kind of lackness give you proper review, sometimes it may lead to the correctiveness of your system.

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Another thing is the high-level chemical storage and this is the very severe one, this is the action that is the forward copy of safety audit with the comments to the authorities, you must perform before handling such type of scenario, you must perform the safety audit and you need to forward a copy of this particular safety audit with your comments as an engineer with your comments to the authority, so sometimes you may suggest any corrective measures, so authority may take an appropriate decision and those decision can be implemented on-site.

You must prepare a safety report, you must update safety report based on your mock drill, based on the chemical in question, based on even weather reports, etc, you must perform the

independent safety audit by an external expert, that is a must, so that because sometimes you may acclimatise to the scenario, so we may ignore the certain type of lackness in the safety, so external auditor may trap all those lackness and this gives you a corrective measures, the carry out the fresh safety audit once in a year, apart from your regular internal audit.

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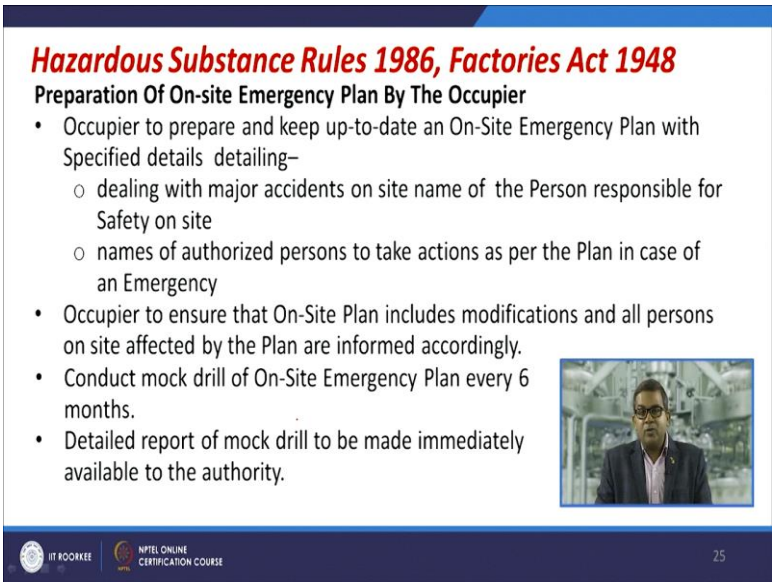

Now there must be certain things related to the on-site emergency plan by the occupier, occupier to prepare and keep up-to-date and on-site emergency plan with the specific details detailing, dealing with the major accident on-site name of the person responsible for a safety on-site at the time of eventuality, name of the authorised person to take the action as per the plan in case of an emergency, suppose a toxic substance releases, now if a worker who is, sometimes, who is illiterate, he or she may not be in a position to provide the adequate information to handle such kind of scenario, what kind of the remedial measures? So the notification in this regard that the person who is in charge is contact his or contact detail, give a proper help in that particular aspect.

Occupier to ensure that on-site plan includes modification and all person on-site affected by the plan they are informed accordingly, they must conduct the mock drill of on-site emergency plan in every 6 months, detailed report of mock drill to be maintained immediately available to the authority so that in case of any deficiency the corrective measures can be taken up.

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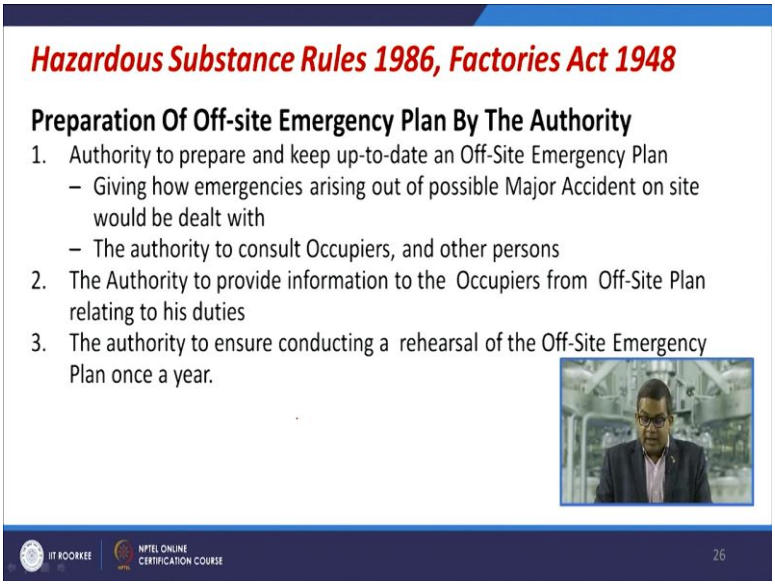

Authority to prepare and the keep up-to-date offsite emergency plan giving how emergencies arising out of possible major accident on-site would be dealt with, in case of any emergency, they must design because sometimes the modification on a building where your hazardous activities is going on, sometimes you need to modify those building plants, etc, it is the authority who usually takes the decision, the authority to consult the occupier and other persons.

The authority to provide the information to the occupiers from off-site plan relating to his duties, the authorities to ensure the conducting or rehearsal of the offsite emergency plan once in a year because this is the legislating binding and the authorities they may enforced this activity to the occupier, occupier in this particular case is the industrial person.

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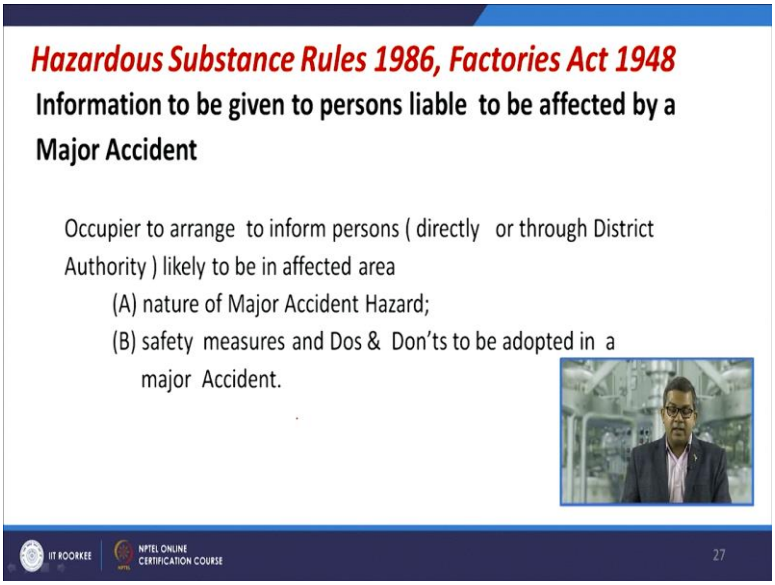

Now information to be given to the person liable to be affected by a major accident, now the occupier or industry person to arrange, to inform person directly or through district administration or authority likely to be the affected area, the nature of major accident hazards, the safety measures dos and donts to be adopted in case of any major accident and remember in the Bhopal gas tragedy, there was a lack of communication between the occupier, occupier in that particular case was union carbide and the civil authorities that was the Bhopal administration because as the prima facie Bhopal administration did not know that what this particular gas is.

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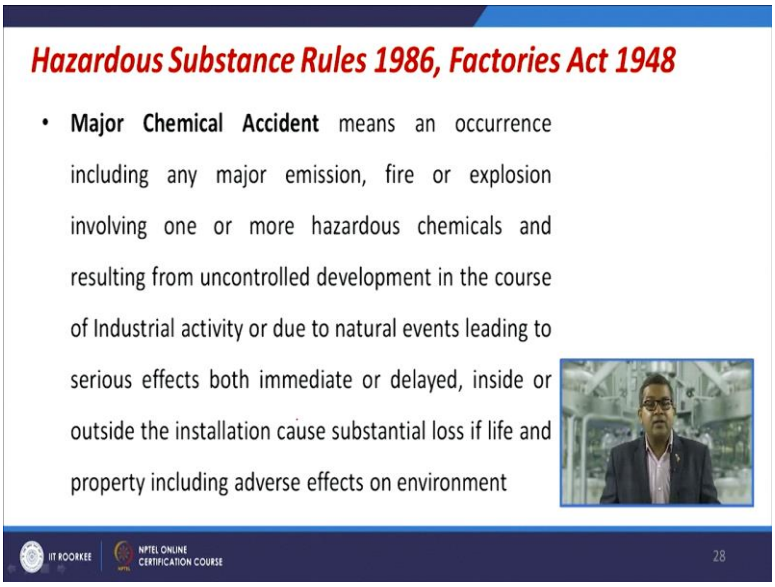

Now the major chemical accident means an occurrence, including any major emission, fire or explosion involving one or more hazardous chemical and resulting from uncontrolled development in the course of industrial activity or due to the natural event leading to serious effect both immediate or delayed, inside or outside the installation, they cause a substantial loss of life and property, including the adverse effect on the environment and sometimes these kinds of major accident may lead to the permanent environmental conditional damage, so remember this particular definition must be in your mind so that you must be aware that what kind of control because sometimes the chemical thermal runaway reaction, these reactions are practically uncontrolled, so you need to identify that what can go wrong.

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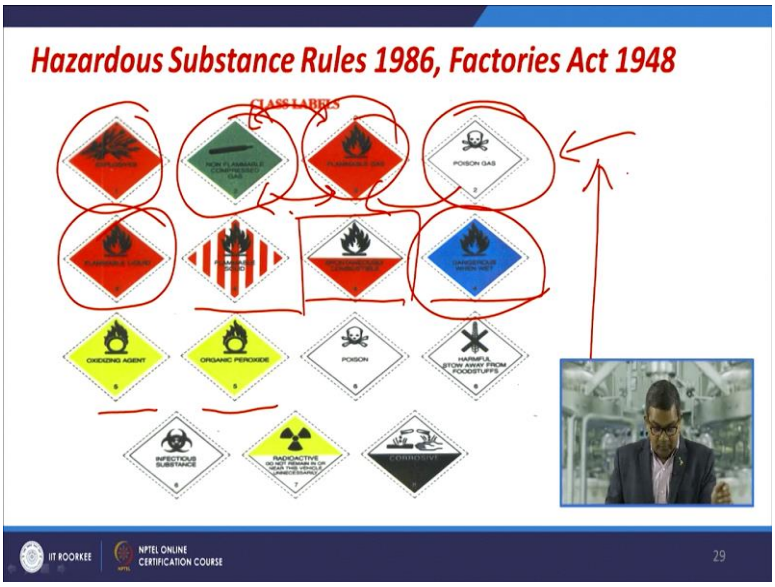

Now there are different class of labels and everybody should be aware and all the plant workers, they should be aware about these kind of labels that what it means for? Like this is the explosive one and sometimes non inflammable compressed gas they are there and flammable gas, so you cannot have the same type of protocol for both the scenario, so these labels indicate because sometimes, some of the workers may be illiterate, so this kind of labels or depiction gives proper idea.

They are certain poisonous gases, so the activity or the safety measures would be different those with the compared to the flammable gases etc, there are certain flammable liquids, so sometimes the workers may not be in a position to identify the things accordingly, there are certain flammable solids, spontaneously combustible, there are certain chemicals in the industry, they are spontaneously if they are becoming the contact with air.

They can be combustible and this may lead to the several other accidents, there are certain dangerous scenario, those are dangerous when wet, there are certain oxidising agents like benzoyl peroxides, et cetera, there are certain organic peroxides, so all kind of things must be listed not only in terms of text form, but also in the pictorial form.

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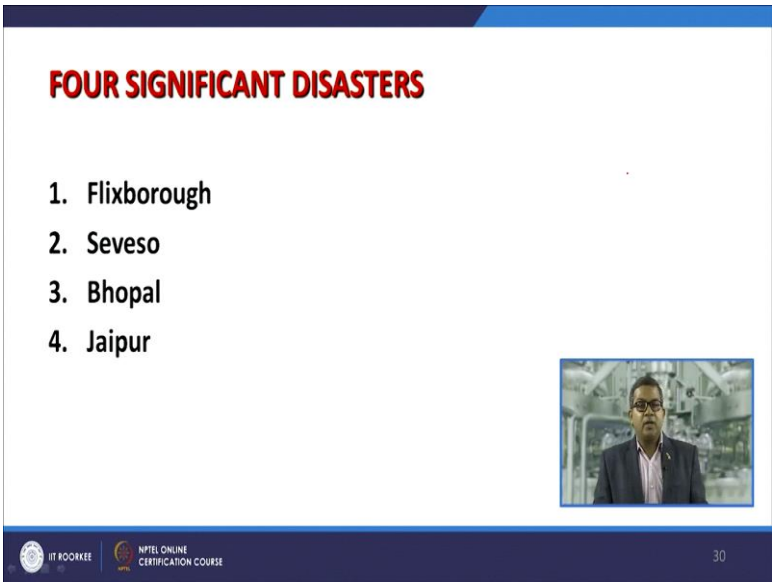

Now in the subsequent modules will discuss the four significant disasters, the reason is that three major things occur in any kind of chemical industry in terms of disaster, fire, explosion and toxic release, so there are four significant accidents or disaster in the chemical industries, these are the landmark accidents, a lot of things happen after the accident, a lot of theories been proposed, a lot of statistical information has been changed after these accidents, Flixborough this dealt with fire, Seveso, Bhopal and Jaipur, in the subsequent modules we will discuss all these accidents in details.

So in this particular module we have discuss about the various hazardous rules applicable in Indian context and every state and central government, they are free to choose, free to frame the different laws based on the benefits of the citizen and we fix the, we have chosen the concept of fixation of responsibilities, so by these words I am summing up this particular module. Thank you very much.