Safety in Construction
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Lecture-18
Fire Safety and Steel Construction

So, steel structures; so, we will be discussing about the fire hazard predominantly in the 2 topics which we will be discussing in today's class. So, predominantly steel, you can see so many structures right now coming up with steel equivalent to concrete. So, in steel there are so many hazards available. So, you have impalement, abrasion hazards and also during erection processes there is a primarily a fall hazard.

With the fall hazard only, you have impalement or abrasion which we will discuss in today's class and the major issue with regard to steel structures is especially in welding operations, you may have to do the connections predominantly with the help of rivet or bolts or other type of joints. So, now another issue is when you are having a bigger diameter reinforcement in the columns or in the footings.

Then you may not be able to overlap, it will be too congested. So, those places you may have to do welding, the only choice for you will be welding of the reinforcement rods. So, when you are bringing in welding operation there are so many types of welding are available these days and some of the welding are linked with electrical hazard and some of the welding are linked with fire hazard predominantly fire hazard.

So, we will be discussing one type of welding operation in this class and the fire hazard with regards to that and the precautions wherein you can avoid easily with the fire. So, this will be part of the today's class and after then subsequently we will be discussing in elaborate the fire also, so the fire protection, prevention mechanisms and how to handle fire in an upcoming structure.

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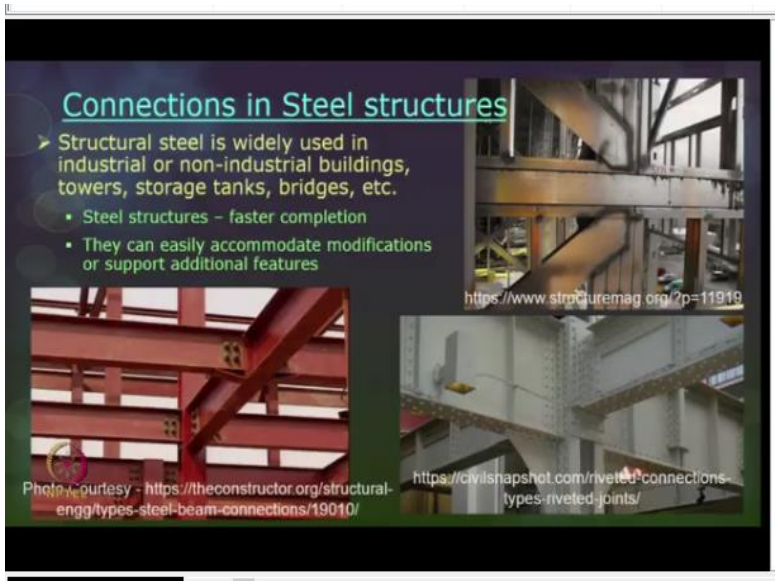

So, now let us begin the class. So, connections in structures, so there are primarily 2 types, one is rivet, wells and butt joints. So, steel structure is used very widely in industrial, non-industrial buildings, towers, storage, tanks and bridges because it is very fast to complete, it has a lot of strength and durability compared to a concrete structure. So, they can easily accommodate modifications also to support additional features. These are the primary the major issues for which why steel is predominantly used. Safety in reinforcement work.

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There are so many issues for example, you may do pre-stressing and post-stressing operations, wherein the reinforcement rods are actually strengthened using a pre-stressing jack. So, there the primary hazard is snapping of wires. I am not discussing all the hazards with regard to steel, but few issues I am just bringing in and primarily we will move on to welding operations only.

So, flying rods is another major hazard especially when you do shear cuts from the shearing machine. These broken wires can fly at a terrific speed and can pierce through any person standing in the travel path. So, you can always have a stout shield behind the prestressing jacks, so that the rods are not flying and they are safely collected. So, the major hazard with reinforcement is abrasion and impalement.

Abrasion is nothing but scratching primarily when you are handling the reinforcement while you are touching with your body on to the surface of the reinforcement, which is not that smooth. So, you may have some sort of scratches or minor cuts injuries and so one which we generally call as an abrasion injury and the other one is impalement.

So, this picture will tell you what is an impalement, accidentally you may fall into the reinforcement setups and you may have an impalement. So, you can see here there are a lot of injuries, workers have suffered in the past due to impalement hazards and what are the ways to avoid the impalement?

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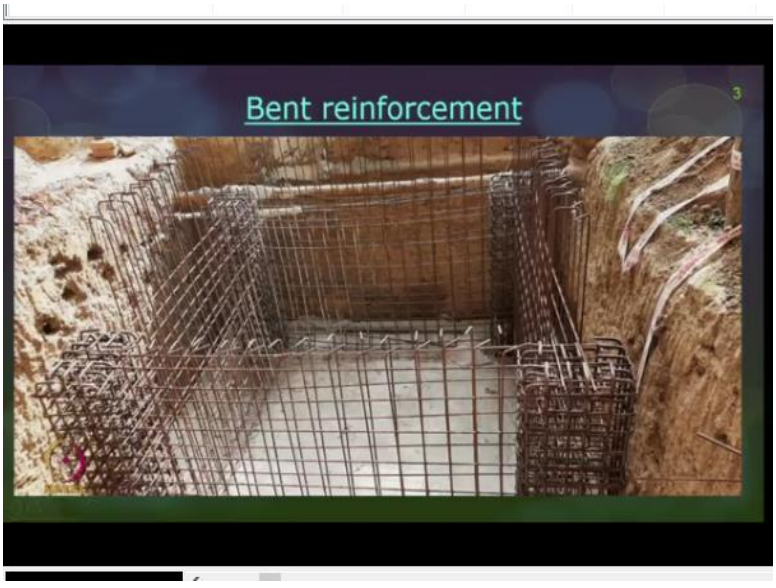

A simple suggestion is to keep bends in all the sharp corners. So, this is primarily a safe photograph for reinforcement, even if some worker has fallen in, they would not have any impalement injury. So, impalement is piercing of the reinforcement rod into the worker's body. So, primarily if you see here all the reinforcement are bent, so that there is no fall hazard, there is no injury with regard to impalement.

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The other that is a safer way to do in sites, other method is providing an anti-impalement cap. So, bend all the exposed rebar so that the ends are not upright, it is a natural way of protection. Otherwise, you can also guard all the protruding ends of the steel reinforcement bars either by using caps or by using troughs. Caps again there are 2 types; one is your mushroom cap or the scratch caps.

And the other one is a square rebar cap which comes with a square flat base. So, these are all mushroom caps and this is primarily a square cap. And suppose if there are too many reinforcements and providing all these caps sometimes it is not practically feasible you can also set up wooden troughs like this and this is also one of the viable methods. Collect all the reinforcements together and put a wooden trough so that even if a fall hazard happens the worker is not injured not too much.

And sometimes even what happens is even if you try to cap all these reinforcement rods with the weight of the faults sometimes what happens is even as you see here all these caps try to get inside and so on. So, it may get displaced. So, better to choose a wooden trough that is also one of the feasible methods to do. Sometimes you may not be able to do any of these methods and your site is such a way that none of these methods will work out.

Then what you can do the least option, preferred option is try to paint them in a bright colour so that it is visible from a distance away that that is a fall hazard, fall hazard with regard to reinforcements.

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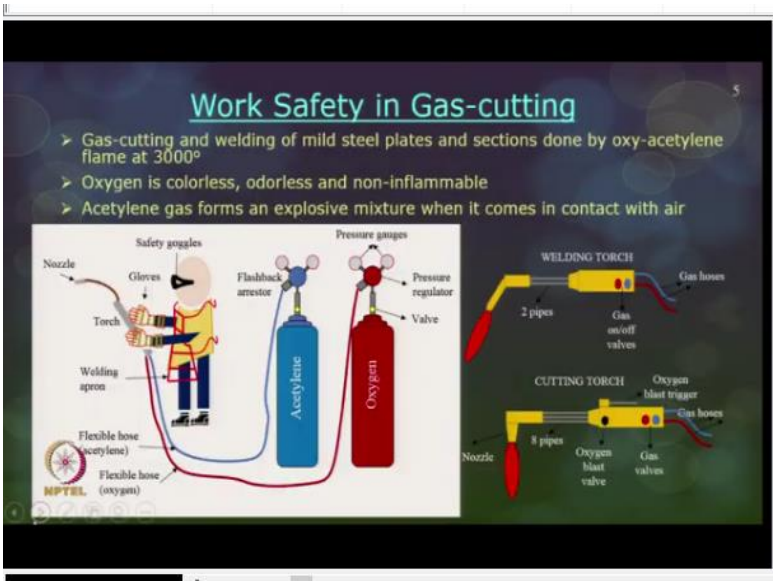

So, that you can still make the workers be aware of. Now, the major hazard with regard to steel is primarily gas cutting and welding operations. So, let us discuss about primarily on gas cutting and welding of mild steel plates and sections. So, this we call it as an oxy-acetylene flame cutting and welding operations. So, this gas cutting and welding operations by oxy-acetylene flame it starts at 3000 degrees or so.

So, it is very hard to place and with such a heat the 2 metals generally join together and become like 1. So, now, if you see what are the 2 gases generally used, one is oxygen other one is acetylene. So, if you can see here this is acetylene cylinder, this is an oxygen cylinder. And this oxygen is generally colourless, odourless and non inflammable and acetylene gas forms an explosive mixture when it comes in contact with the air primarily which is rich in oxygen. So, this is how the setup looks like, let us discuss more about this.

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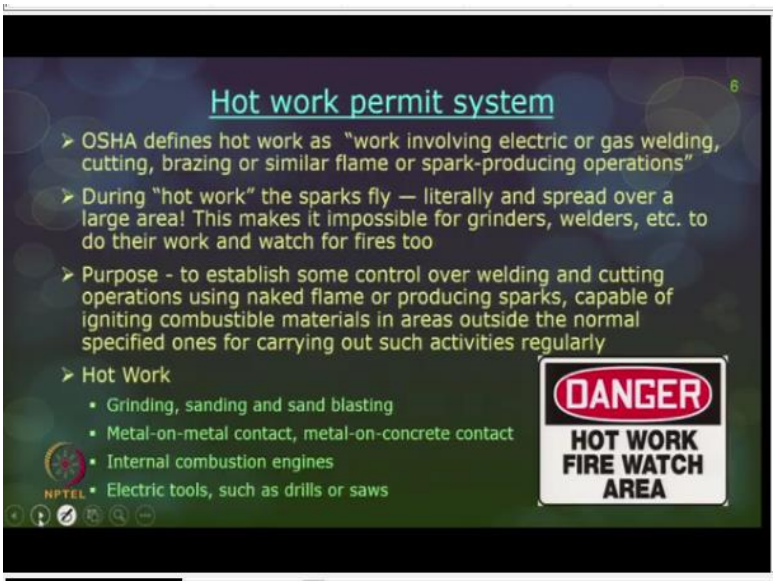

So, these places of welding operations we call it as a hot work permit system, because anywhere, any place there may be fire which can fly away and catch when it falls on some combustible material or normal material, it can catch fire very soon. So, these are all primarily called hot work areas and whenever you have to do work related to this you may have to get a hot work permit system which we also call PTW which is permit to work system.

So, this HWP which is hot work permit system, OSHA defines hot work as any work involving electric or gas welding, cutting, bracing or similar flame or spark producing operations. So, during the hot work the sparks can fly literally and spread over a large area because of the heat and the temperature with which you are working maybe in a closed cabin. So, it is very, very dangerous.

So, sparks start flying and moving away. So, this makes it impossible for grinders or welders primarily the operators who do this operation to really concentrate on their welding operation and also to look for fires. So, that is why we have to have a hot work permit system. Purpose of the hot work permit system is to establish some control on welding and cutting operations using naked flame or producing sparks capable of igniting any combustible material in the surrounding areas when the work is going on.

Some examples of hot work grinding, sanding or sand blasting, metal on metal contact, metal and concrete contact, internal combustion engines, electric tools such as drills are sauce. So,

now let us discuss about safety of men and then we will move slow on into gentle safety precautions.

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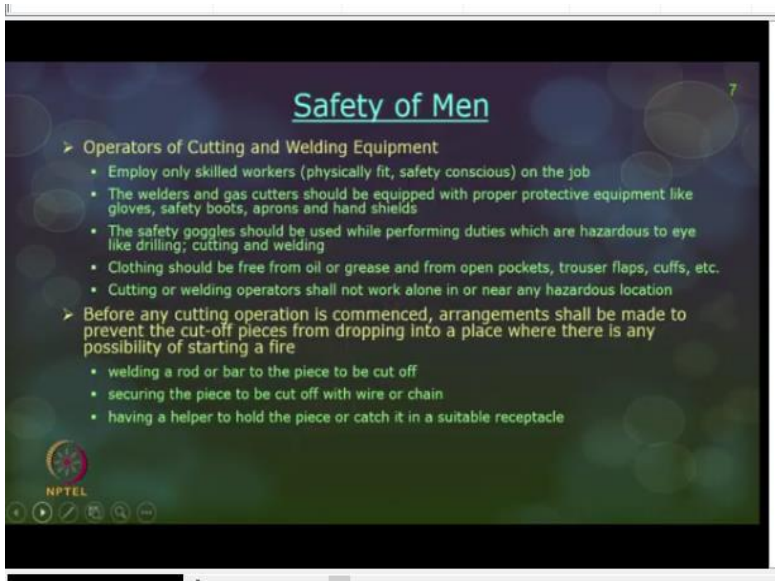

So, what are the special qualifications required for operators? So, this operators of cutting and welding equipment should be only skilled worker physically fit, why physically fit is every time he should be safety conscious and also have presence of mind when he is on the job with regard to any changing circumstance or any hazard, he should have the presence of mind to put off the fire and escape from the vicinity.

Welders and gas cutters should be equipped with proper PPE like for example gloves starting from gloves, safety boots, aprons, hand shields, so proper safety helmet and so on. The safety goggles should be used for duties which are hazardous to eyes for example drilling, cutting or welding. Accordingly, it should cover with proper lens and filtering lens as well. The clothing should be free from oil or grease because easily it can catch fire and it should not be having open pockets or trouser flaps and so on.

The cutting or welding operators should not work alone or in any other area which is very close to a hazardous location maybe where all your flammable materials are stored. It is primarily created as a hazardous location and this welding operation should not be carried out in those places. Before any cutting operation is commenced, arrangements should be made to prevent all the cut off pieces from dropping into a place when there is possibility of starting a fire, maybe you should cover the ground with a proper carpet and so on.

So, that these pieces are all collected in a safe place and gathered. Welding a rod or a bar to the piece to be cut off, securing the piece to cut off with wire or a chain or having a helper to hold the piece as soon as you start cutting it off. So, these are the 3 options you have primarily.

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So, PPE it starts from welding helmet and a flame proof skullcap and eye safety shield. So, primarily we call it as a welder's helmet. It comes with a protective filter and an opaque shell, then eye safety shields this is what it is, then dark flameproof clothing with full sleeves and neck fastenings and leather apron on top of that fire protection gloves, then you have full steel caped boots. So, these are the basic requirements of a PPE.

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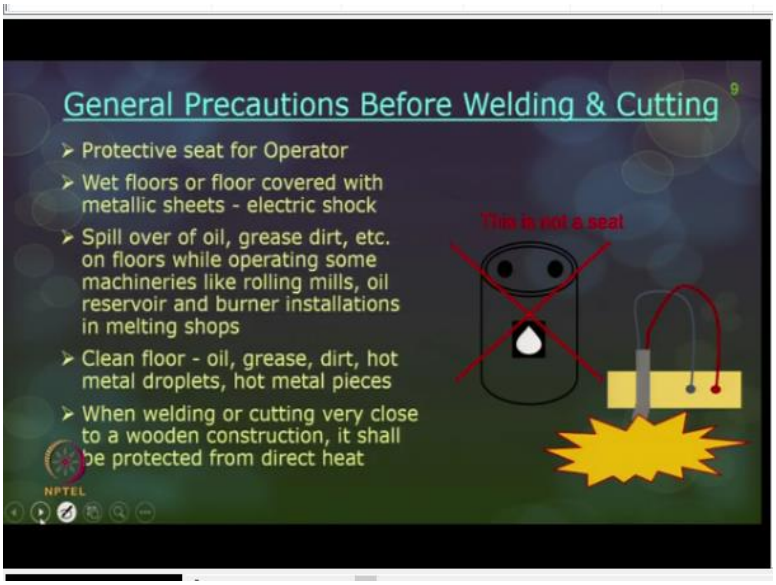

And hot work permit system will not allow workers to enter if they do not wear any of these PPE. Now, general precautions before your welding and cutting operations protective seat for operator, most often what happens? These operators they try to sit or kneel or they use an empty kerosene tank or any other tank which are available in the vicinity and they try to use it as a seat. So, always keep in mind so those bins are not at all a seat.

So, wet floors or floor covered with metallic sheets can always give electric shock, so you have to be very careful. So, spill over of oil, grease, dirt or something on the floor can also ignite your fire. So, you should be very careful. So, clean the floor from your oil, grease, dirt, hot metal droplets, hot metal pieces, all should be cleaned from time to time. When welding or cutting is very close to your wooden constructions you shall be prevented from direct heat because that is also a combustible material. Now work safety in gas cutting.

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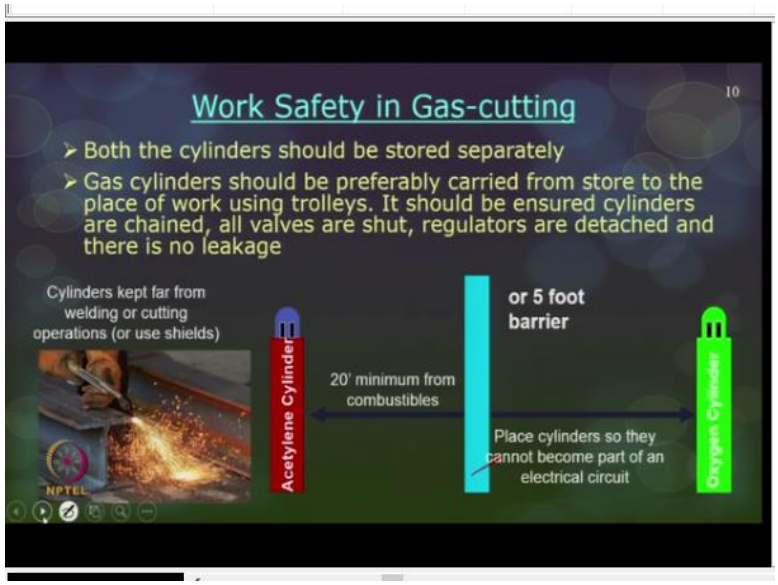

So, your oxygen cylinder and acetylene cylinders should be stored separately, they should never be stored together and the gas and industrial preferably carried from the store to the place of work using trolleys or any other suitable means, maybe by using even cranes, it should be ensured the cylinders are chained, all valves are shut, regulators are also detached and then there is no leakage and then it should be taken off.

Suppose if there is no separate place and they have to be stored together then there should be at least a 5-foot barrier in between these 2 storage places. Cylinders should be kept also away from welding or cutting operations or by using shields then only the operations should carry on and place the cylinder so that they will not also become part of the electrical circuit.

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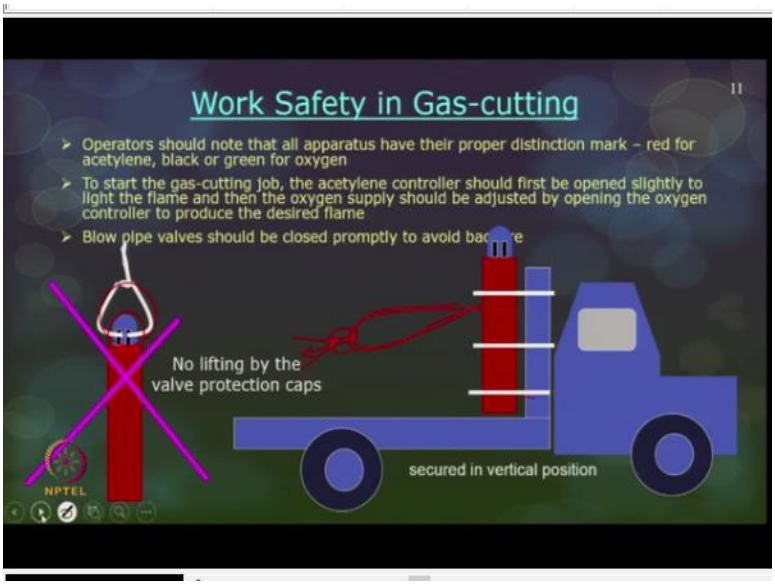

Now while you are transporting also you should maintain all the safety precautions with regard to the cylinders, the cylinders should be chained properly, sealed and then taken off and always carried in vertical position. Operators should note all operators will have the proper distinction mark; generally, they have a colour code. So, red is primarily for acetylene and black or green is generally for oxygen.

And they should follow those colour code for identifying even along with the hoses. To start the gas cutting job, acetylene controllers should first slightly open the flame to see for any blocks in the nozzle and to see how the flame is coming out and separately you should open both the hoses and then only you should together open the flames for the torch cutting and also first the acetylene flame should be opened.

Maybe it gives a black smoke in the end, but still it is always safe to open the acetylene flame first and then open the oxygen flame next and always ensure that you have this nozzle here and that is something called a tip and after then only the flame should start especially when you are igniting. So, because if you are allowing or permitting the fire to happen too close to the nozzle then there can be chances of backfire happening.

To start the gas cutting job the acetylene controller should first be open slightly to light the flame and then the oxygen supply should be adjusted by opening the oxygen controller and the blow pipe valve should be close promptly to avoid all your backfires, no lifting by the valve protection caps. So, generally do not handle the cylinders with the help of the caps that

is not at all a way to do. It has to be chained with some mechanism and then only it has to be lifted up.

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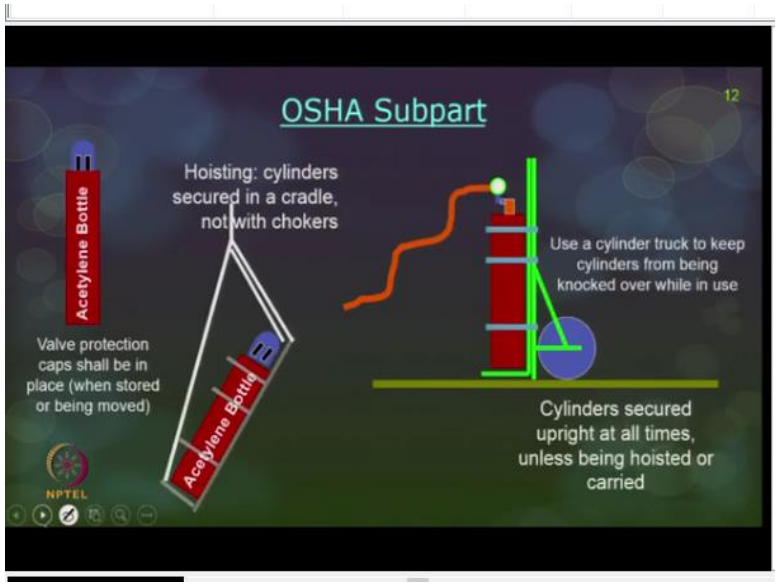

For example, this is the way to lift or not by the cap. So, especially when you are hoisting it by cylinders and securing in as cradle and you are transporting it, so, use a cylinder track to keep cylinders being knocked over and while in use always it should be properly sealed and capped. Cylinders also should be secured upright position at all times and not like in a slanting or in horizontal position.

Valve protection caps should be always in place and never you should be opening it at any time. To move cylinders by hand till them and roll them on their bottom edges. So, valves have to be closed when you are finished with the task when cylinder is empty and when you are moving the cylinders and all these instances the valve has to be closed.

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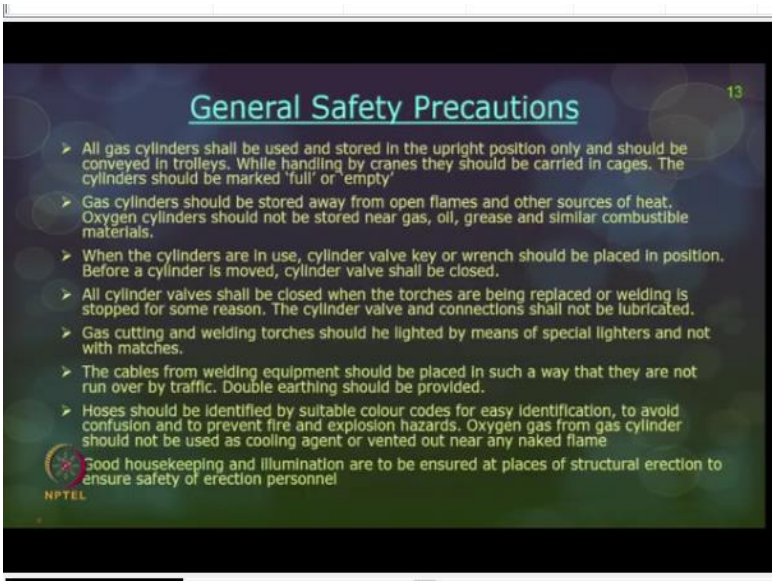

General safety precautions: So, all the gas cylinders shall be used and stored in the upright position only and should be conveyed in trolleys or any other suitable means, while handling in cranes they should be carried in cages and the cylinders should be marked as full or empty. So, that operators are also aware of the hazard linked with those cylinders. Gas cylinders should be stored away from open flames and other sources of heat.

Oxygen cylinders should never be stored near gas, oil, grease and other similar combustible materials. When the cylinders are in use the cylinder valve key or wrench should be placed in position and when the cylinder is moved the valve should be always closed. All cylinder valves should be closed when the torches are being replaced or welding is stopped for some reason and never lubricate the cap or anything so that you are actually trying to open the cap.

And also, before starting the operation when there is any spill of oil or grease on the cylinder and should be wiped off clean and then only the valves has to be open. Gas cutting and welding torches should be lighted by means of special lighters or not with matchbox and match sticks. The cables from welding equipment should be placed in such a way that they are not run over by traffic and immediately after the operation it has to be properly secured.

Double earthing also is recommended to prevent electric shocks. The hoses should have proper colour codes and that should be known to the operator for easy handling and to avoid confusion and prevent fire and explosion hazards. The oxygen gas on the gas cylinder should not be used as a cooling agent in case of for venting out any naked flames.

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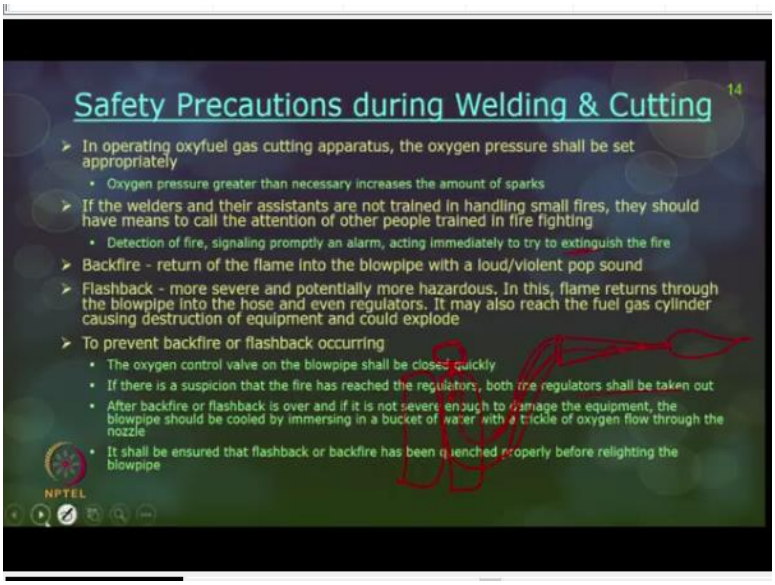

Good housekeeping and elimination should be ensured to prevent any fire or mess-ups happening in the site. In operating oxy fuel gas cutting apparatus the oxygen pressure should be set appropriately to the same level and never tried to overdue with those setups. On oxygen pressure greater than necessary will always have generate lot of sparks and which is really dangerous and can catch fire.

If the welders and assistance are not adequate or they are not trained properly or they are not able to be watchful in terms of handling the small fires and primarily we call it as a watch fires, then there should be a proper additional help or maybe a fire fighting service there. So, that they should be able to identify detect fire, signal the other people properly and action immediately to be taken in case of extinguishing the fire.

So, all these have to be there. Now, what is this backfire and flashback? Backfire is return of the flame into the blowpipe with a loud or violent pop sound. So, primarily this is your nozzle and there is a nozzle tip and then you have the flame coming out and here you have the 2 hoses. So, this flame starts entering inside. So, that is primarily call as a backfire. Flashback is really more severe and potentially dangerous.

Here the flame returns through the blow pipe into the hose and what happens it even moves to the cylinders and the regulators. So, it can go here and if the operator is really watchful of the flashback, then he knows how to know operate the regulators and prevent the flashback to happen, primarily he can stop the exploding to happen. Suppose if he is not trained for all

these unnecessary precautions and so on. Then what happens is this fire can enter into the cylinder and it can explode.

In this the flame returns through the blow pipe into the hose and even regulators it may reach even the fuel gas cylinder causing the destruction of equipment and easily it can explode. To prevent backfire or flashback occurring the oxygen control valve on the blowpipe should be closed quickly because oxygen is the only one which will supply the air for the flame for the flames to happen.

If there is suspicion that the fire has reached the regulators, both the regulators shall be taken off and after backfire or flashback is over then after maybe even after 60 minutes or something you may have to really check whether anything has happened by immersing the blow pipes into a bucket of water and you have to really check for presence of any fire still existing, then only you can to restart the operation. It shall be ensured flashback or backfire has been quenched properly before relighting the blowpipe.

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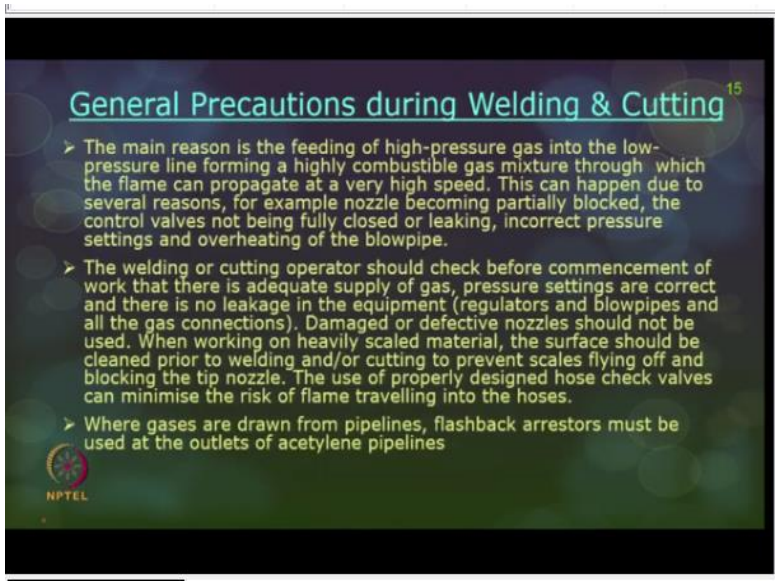

Some more precautions; the main reason is feeding of high pressure gas into the low pressure line forming a high combustible mixture through which the flame can propagate at a very high speed. So, this can happen with several reasons. So, these backfire or something can happen either nozzle is partially blocked, control valves are not fully closed or leaking, incorrect pressure settings, overheating of the blow pipe and so on.

And whenever the nozzles are damaged or defective they should not be used, when you are working on heavily scaled material the surface has to be cleaned prior to welding or cutting. To prevent scales flying off and blocking the tip nozzle.

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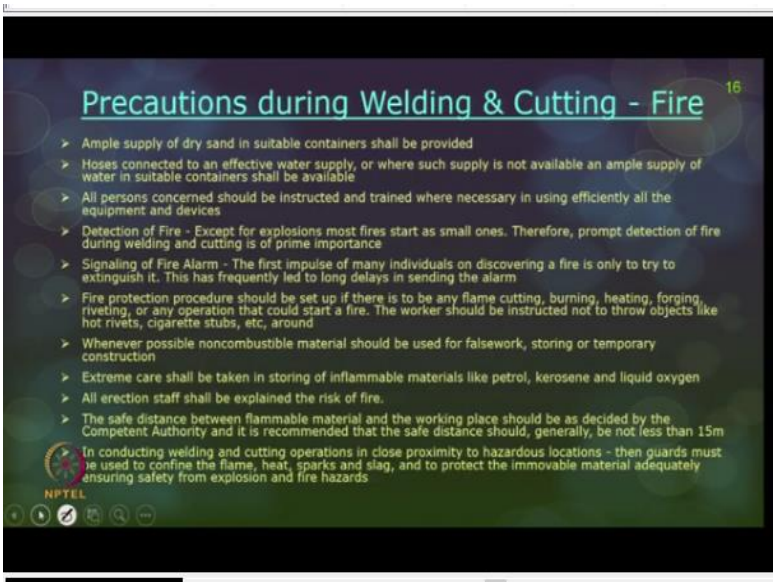

So, always that is where before you start the operation you have to know blow off both the pipes one after the other to check for the flow of air coming out, only when you identify that there is nothing blocking the nozzle and the hose then only you are supposed to start the welding operation. Even then after all these precautions still fire may happen. So, in case of fire happening then you may have to have a sufficient firefighting apparatus and equipment. So, that you are actually putting off the fire.

So, ample supply of dry sand in suitable containers should be placed. Hoses connected to an effective water supply also should be available and so that you can put off the fire. All person concern should be instructed and trained wherever necessary in using efficiently all the equipment and devices starting from firefighting and other devices. Detection of fire, so what happens is generally the fire starts in a small pace only.

So, if you put all your measures in putting off that those small, small flames then it does not spread, the minute the fire starts spreading it becomes like too much for you to control the fire because its spontaneous reaction starts happening. So, there should be watch fire person allotted by the hot work permit system itself. So, during that system itself we should identify who are all the watch fire personnels and they should be really looking for all the small fires which are other sparks which are spreading on out of your welding operations.

And you should be trying to put off all these small, small flames instantaneously before it spreads off into a very wide fire explosion. Signaling of fire alarm. So, the first impulse of many individuals on discovering a fire is to try to extinguish, suppose if you are not trying to extinguish then you are supposed to inform without any delay through an alarm system to all the person inside the site to inform that there is a fire which has blown out.

The fire protection procedure should be set up if that is to be flame cutting, burning, heating, forging, riveting operation that could start a fire. The worker should be instructed not to throw loose objects are scrap like caught, rivets, cigarette, stubs etcetera around which are primarily substances for igniting the fire. Wherever possible non-combustible material should be used for false work, storing or temporary construction.

Inflammable materials like petrol, kerosene or liquid oxygen should be stored with proper care. All erection staff primarily with the steel erection because we are discussing in terms of steel should be explained the risk of fire, the safe distance between the flammable material and the working place should be decided by the competent authority and generally the safe distance is not less than 15 meters.

In conducting your welding and cutting operations especially when you are close to hazardous locations, try to barricade or guard those hazards and then maybe you put a thick fire shield and then start doing all your operations. So, this content was taken from all these references.

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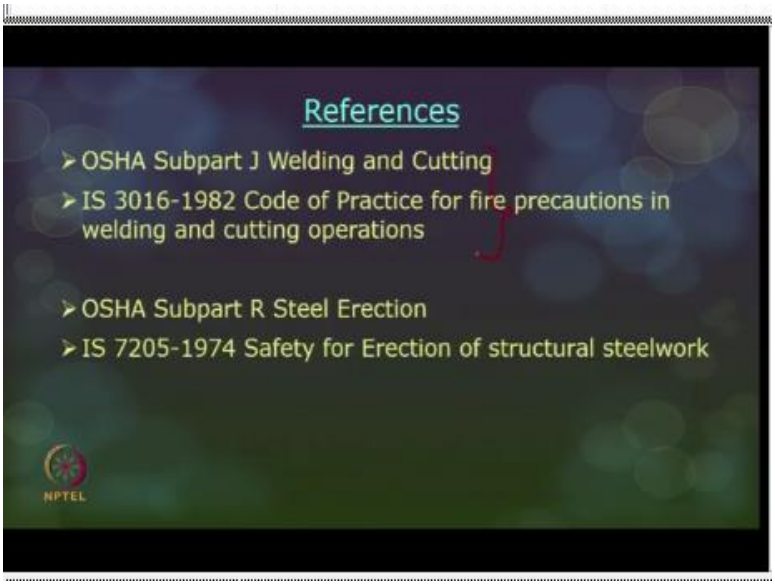

So, these are primarily for your fire precautions, cutting and welding in fire precautions and these references are for general steel erection which includes crane operations and fall hazards and so on. So, with this the topic on steel and your welding operations is over. We will continue with fire hazard.

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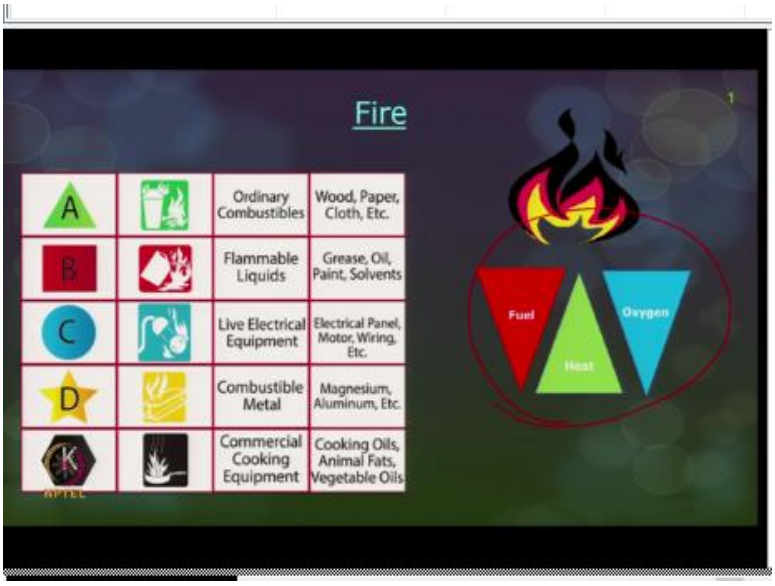

So, what is a fire? So, far we have discussed fire can happen. So, even in electrical safety we have discussed fire is one of the hazard and in your steel welding and cutting operations there also fire is a major hazard. So, what is this fire and how to take care of? If you look at all the disasters known so far like for example flood, hurricanes or typhoons, earthquake and so on. All these are considered as natural hazard.

The only one manmade hazard is we call it as a fire, fire does not happen naturally and when the 3 things are generally put together then fire always happens. So, what are the 3 things? The three things are your fuel, oxygen and heat. Primarily you need a hot medium for the fire to be ignited, you also need some supply of fuel it can come in any form and you need oxygen, primarily the air.

So, which will be igniting immediately a fire. So, there are so many types of fire classification A, B, C, D and K. So, A is primarily ordinary combustible wood, paper, cloth and so on. These flammable liquids, grease, oil, paint, solvents and etcetera. C is live electrical equipment, electrical panel motor, wiring and so on. D combustible metal, magnesium, aluminium and so on.

And the last one is commercial cooking equipment, all your cooking oil, animal fats and vegetable oils all will fall under this category. Now when you want to take efforts in putting out the fire, the easiest means is trying to cut off any one of the 3 sources. Only when the 3 sources are coming together, fire can easily happen. So, if you want to put off the fire or if you want to prevent fire from occurring, so you have to either stay away from oxygen in the sense do not give me supply of oxygen or primarily we call it a starvation process or do not produce do not allow heat to be accumulating in a place.

So, that fire will not happen. So, like this try to take off one of the sources so that fire generally does not occur. So, how do? If you look at fire safety many of the completed buildings, hotels or any construction generally follow all fire safety norms, and you will see a lot of fire safety norms available for completed construction and you will find very few materials or maybe even very less material on fire hazard, especially when it comes to an ongoing construction**.**

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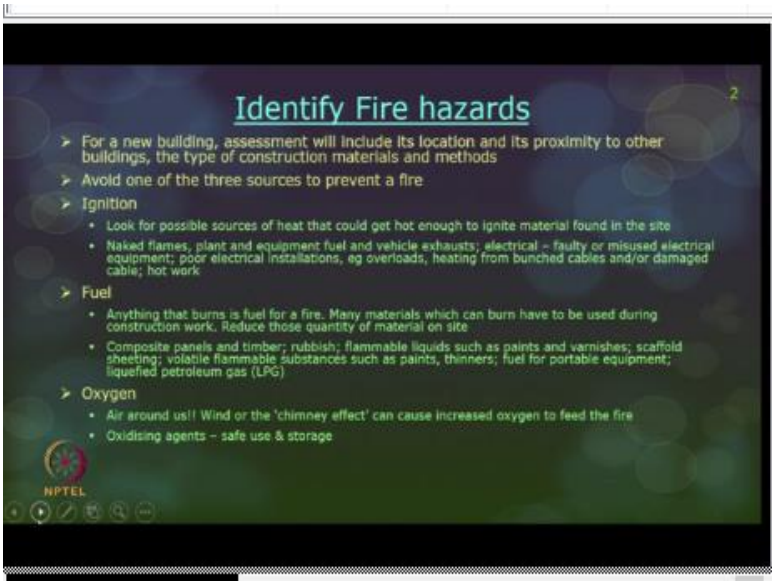

So, if you see a new building assessment includes not only the location of the structure, but also the other buildings which are in close proximity to the structure which you are building it. So, the easy way is to avoid one of the 3 source to prevent a fire. Now, let us discuss one after the other. Ignition: So, look for possible sources of heat that could get hot enough to ignite a metal found in the site.

For example, naked flame, plant and equipment fuel, vehicle exhaust, electrical, for example faulty or misuse analytical equipment, poor electrical installations or heating from bunch to cables, damaged cables, hot work and so on. These are all sources of ignition which we see which can actually ignite a fire. So, there is probably a source of ignition there. Fuel anything that can burn in a site is generally called a fuel for a fire.

And if you see in construction site many of the material that you use in construction sites are all susceptible to burn which will all burn very easily. Only one suggestion is reduce the quantity of those materials on the site at least and do not try to store too much of those category of material in the site. Examples include composite panels, timber, rubbish, flammable liquids like paint, varnishes, scaffold sheets.

Volatile flammable substances like paints, thinners and so on. Fuel for portable equipment or your LPG. So, all these are fuel for the ignition. The last is oxygen air around us will give you enough supply of oxygen when are the chimney effect can actually increase the feed of oxygen or the fuel to fire and when you are using oxidizing agents in the site you have to use safely and store it carefully.

So, how to reduce the risk of fire? Avoid wherever people are gathering, do not try to store these substances which can cause fire in those vicinity. Suppose if you know the construction site in a particular locality has more people gathering in, so you have to keep an alternate storage for storing all your oxidizing agents, flammable substances and so on. So, you have to plan your site accordingly.

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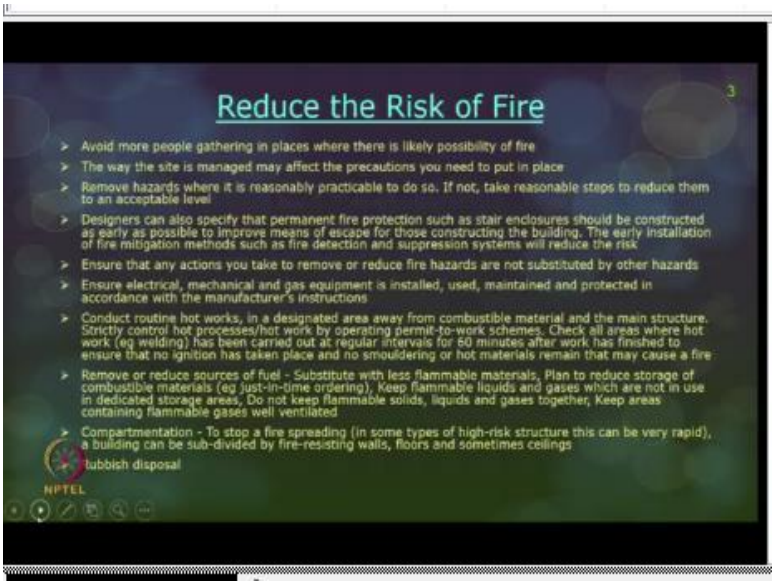

The way the site is managed may affect the precautions you may need to put in place. So, you may also have to think of fire precautions well in advance, sometimes you may also have to think of fire precautions while designing itself. Designers have to specify permanent fire protection such as stair enclosures should be constructed as early as possible. So, that it can serve as a means of escape while constructing the building.

So, best suggestion is to put permanent stairs, well in advance. So, that you can avoid all the falls from the scaffolds, you can also use it as an escape route in case of fire. So, generally these fire mitigation methods are installed once the building is constructed. If as and when possible, if you can install all the fire mitigation methods like fire detectors, fire suppression systems and so on will reduce the risk on fire.

So, ensure any action you take in terms of reducing the fire hazard should not substitute another hazard or should not aggravate another hazard. Primarily when you are working on electrical, mechanical and gas equipment it should be stored with all manufacturer's instructions. All routine hot works what we call building, cutting operations should be done

in a designated area away from combustible materials and also away from main structure which you are constructing.

So, that you are not encouraging fire happening in the building. Strictly control the hot processes or hot work by operating permit to work schemes and check all areas where hot work has been carried out at regular intervals for 1 hour after work has finished to ensure no ignition has taken place and no smouldering or hot materials remain that may cause a fire. So, smouldering is not a fresh fire or primarily it comes with a blackish shade or on it looks like an ash form, but it still has the heat hidden beneath is primarily called smouldering.

Remove or reduce sources of fuel. So, you can substitute materials with less flammable materials. Plan to reduce storage only by just in time ordering. Do not try to keep too much of all these flammable materials stored in your worksite. So, keep all these materials in as designated storage places and where it is earmarked or planned in the layout. Do not keep all these memorable solids, liquids and gases together.

And also, these areas should be properly well lit and ventilated and best advice is to do compartmentation. So, instead of having walls like general brick walls and primary load bearing walls and partitioning walls, it is also advisable to think of fire resistance walls. So, you can think of compartmentation and try to store all these materials inside the structure itself which is very safe for as a storage purpose, other one is rubbish disposal.

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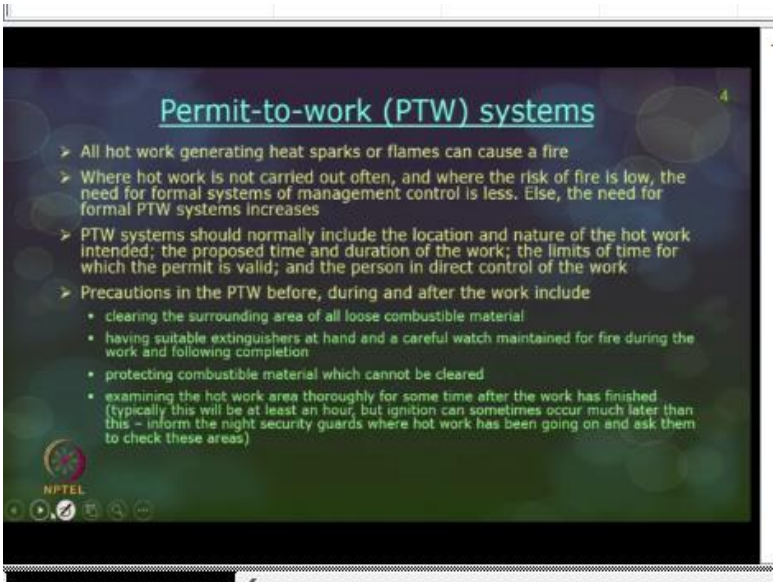

So, small, small clearances of this rubbish from the site can also prevent fire. For example, more than the real timber or something the dust or scrap from the timber, especially when you are doing carpentry work that can be more combustible compared to the timber itself. So, you have to understand so the scrap or the debris of your either demolished site or the new construction can is primarily a source of fire to catch fast.

So, maybe you have a plan of daily throwing off all your scrap away from the site. So, that you do not know allow or give a chance for fire to happen. Permit to work system, this is primarily for hot work surfaces including fire. So, all hot work generating heat sparks or flames can cause a fire. So, when a hot work is not carried out too often, so that the risk of fire is very low.

So, you need not have a formal well laid policy on how to do the fire those tasks. Suppose if you have to do these types of works very frequently and you have to do continuously then you may have to have a well laid permit to work system in place. So, we should also include the location or nature of the hot work intended. The proposed time and duration of the work limits of time for which the permit is valid and the person who is in direct control of the work all these should be identified.

Precautions and the permit to work system before during and after the work includes cleaning the surrounding area of all lose combustible material, tried to collect all the scrap and keep it in a separate place which is really safe for disposal. Having suitable extinguishers in hand before you start your work under careful watch, primarily a fire watch maintained for fire during the work and following completion.

Protecting all the combustible material which cannot be cleared and examining the hot work area thoroughly for some time even after the work is completed. And so at least 1 hour even after the work is completed you have to look for visible watch fires there.

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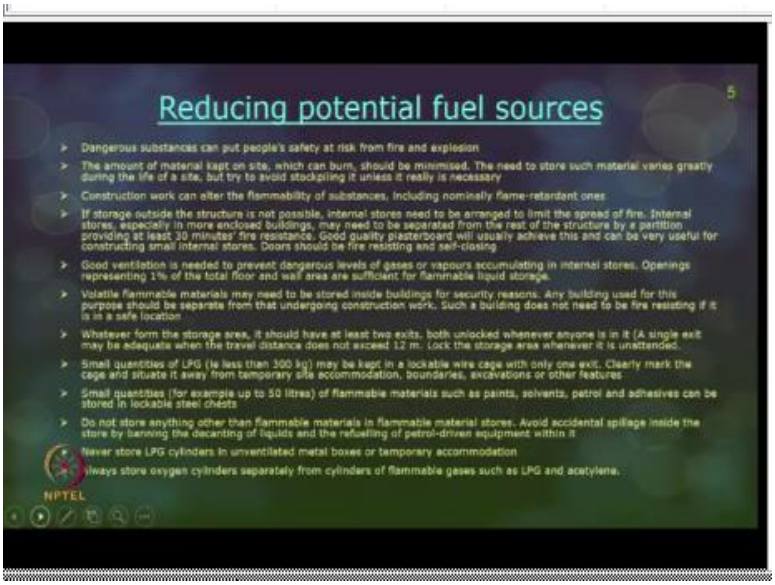

Reducing potential fuel sources so primarily you are flammable, combustible materials all should be stored separately and number 1 is do not try to store too much of these material in an ongoing construction site. Dangerous substances can put people's lives at risk from fire and explosion. So, the amount of material kept on the site which can burn should be minimized, that is an easiest way to handle.

So, just in time delivery will always meet the purpose. So, order the goods which are required for that particular 2 or 3 days in advance only and do not store the materials too much. Construction work can alter the flammability of substances and if storage out with the structure is not possible internal storage should be maintained and when you are trying to do internal storage so you have to have a partition wall which should have at least 30 minutes of fire resistance.

So, you should have good quality plaster board, will usually achieve this and can be very good for constructing small internal stores and when you are keeping a storage there should be a door which is also fire assisting and self closing. Good ventilation is primarily ensured and openings for all these storage places should be 1% of total floor and wall area when you are storing flammable liquid storages.

Volatile flammable materials asked to be stored inside the building for security purposes. So, any building which is used only for storage purpose of all volatile flammable materials should be separate from the normal construction work and this building should be the fire assisting and it should be in a safe location. Whatever form the storage area takes place, it

should generally have 2 exits and both should be unlocked when any person has entered into the storage area.

Suppose if the nearest exit location is just 12 meters you can just go ahead with only one exit. But whenever the any person has entered in the storage area then it has to be opened first and kept it open till the person comes out. And as soon as the person has exited the doors should be properly closed and small quantities of LPG, LPG do not store more than 300 kgs, it should be kept in a lockable wire cage with only one exit.

And small quantities only up to 50 litres of normal material such as paint, solvents, petrol, adhesives shall be stored. Do not store anything other than flammable materials in a flammable material store and avoid accidents spillage of all these materials and you may have to do a proper housekeeping**,** never store LPG cylinders in unventilated metal boxes, even for a temporary accommodation. So, always store oxygen cylinder separate from the cylinders of flammable gases like LPG and acetylene.

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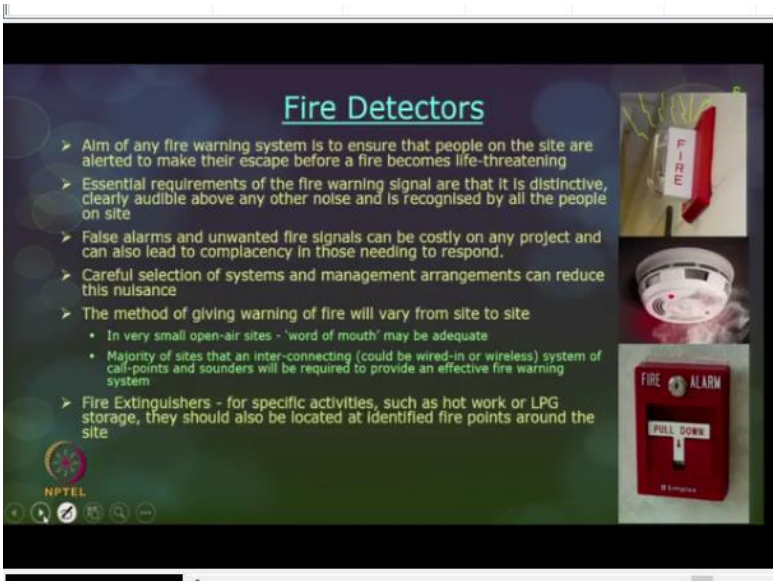

Now in case so these are primarily precautions. Now, if fire happens, how to put off the fire and first of all how to detect a fire? That is the number 1 issue here. So, we have to discuss about fire detectors and fire extinguishers Fire detectors are generally in an ongoing construction fire detectors are not that prominently seen. Generally, fire detectors are not that easily seen in any of a new construction.

So, aim of any fire warning system is to ensure people on the site are really safe and they have to escape, because fire is a life-threatening issue. Essential requirements of fire warning signal are that it is distinctive, clearly audible and so one on it is also organized by all the people on the site. So, now what happens is in a very small open site word of mouth is generally yeah like an alarm system.

In majority of the sites, they have a little upgraded system of fire alarms, which is primarily a walkie talkie sort of system or wired in system to just do sounders or signals or caution points that fire has occurred and they have to evacuate the room, the next is fire extinguishers.

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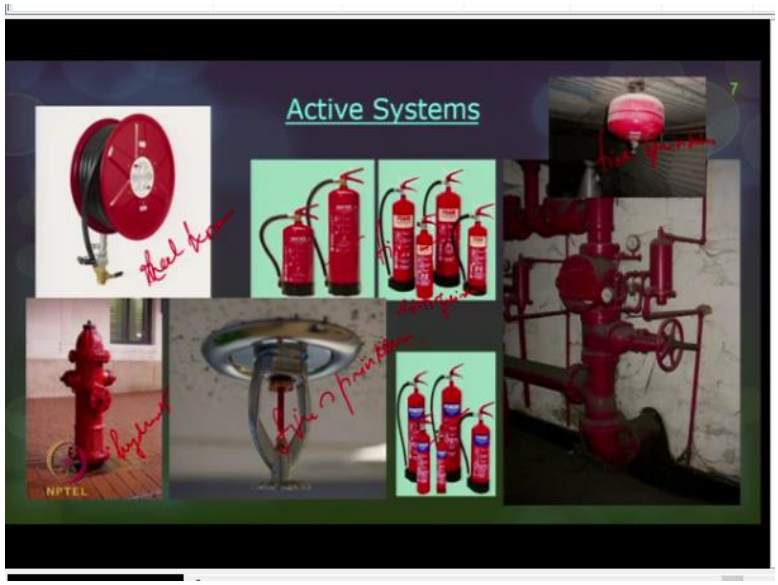

Fire extinguishers should be kept wherever you have a hot work in place. So, if you look at the fire put off mechanisms. There are 2 ways of fire put off, one is active system, other one is a passive system. Active system is after the fire has happened you primarily try to put off the fire so it comes in terms of fire sprinklers. So, this is primarily the fire sprinklers. So, these are the fire sprinklers and this is hydrants, this is the fire reel hose.

And these are all your fire extinguishers. So, based on the classification of the fire you can use water, you can water, you can use foam, you can use powder for putting off the fire. There are lot of ways of putting of the fire. So, now these are a primarily a quick way of putting off the fire which we call it as an active system. The next one is passive system.

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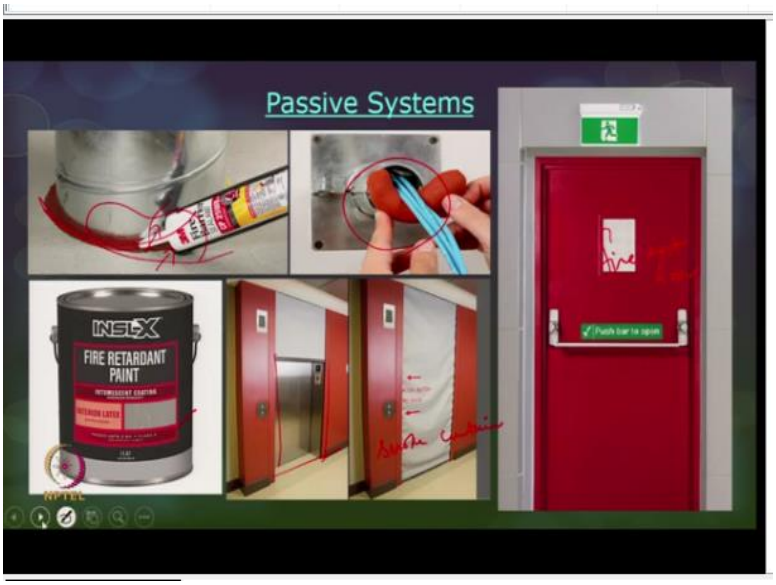

Passive systems generally tried to seal off the fire without spreading the fire. Active system will not try to suppress the fire, but it just puts off the fire through a forced manner mechanism. In passive it tries to conceal or seal. So, there are so many ways again here. Number 1 is fire door. So, this is primarily used for an exit, this is fire door. It also seals in the fire inside the particular room itself and this is called smoke curtains.

The minute the fire happens so either by manual means or automatical means so these sensors can smell the smoke and it can try to put off and seal the complete building so that the smoke or fire is not transferred outside. This is mouldable putty. These are the seals which are available for putting off the fire. And this is primarily a fire-retardant paint. So, one case I can discuss varying fire can be easily prevented by using this putty.

There was an incident which happened 5, 6 years back in one of the regions in Delhi only. So, what happened is the fire spread through the complete building because there were a lot of service lines which were not sealed completely. So, these service lines are generally sealed only after the building is completely constructed. So, during the course of construction, normally in any construction company, they do not emphasize on sealing these holes.

Now what happens is through these holes, the smoke and other know airs starts coming out, it starts spread from room to room, it starts spread from floor to floor, room to room and the fire that is how it spreads very easily, if you can put an mouldable putty or maybe even a mortar can is a very good way of sealing up the smoke inside a room. Only that particular room may get damaged but it does not spread to the other rooms and other neighbouring places.

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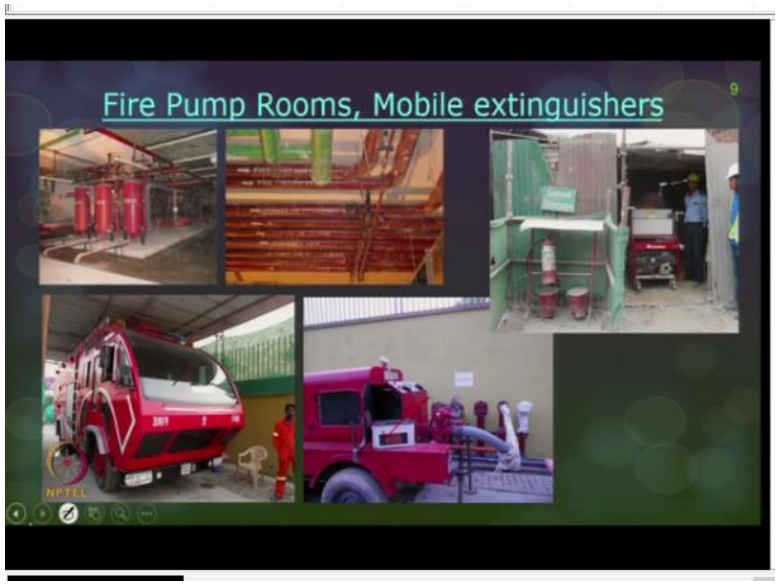

The other setups are fire pump rooms. So, this is primarily a site with primarily a metro construction site, but they have even a mobile fire extinguisher also in place which is helpful for putting off the fire. So, underground excavations are more prone to fire because they may have flammable gases, toxic gases and so on. So, you may have to have a well set up a proper setup for putting off the fire. So, they even have a mobile or a mobile extinguisher van.

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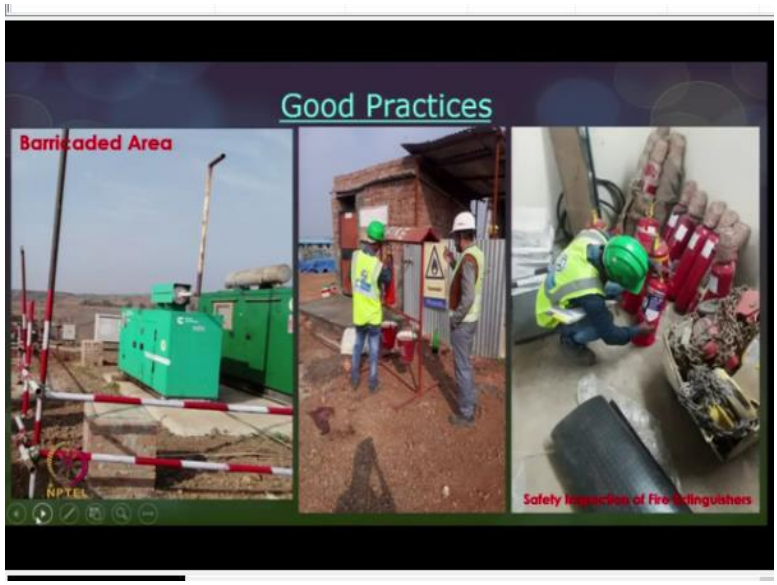

Underground sites, these are some of the good practices. So, wherever you see that places are more susceptible to fire, they are all barricaded and not allowed for people to enter. This is primarily inspection of fire extinguishers which is happening. So, all these flammable materials are all stored in a godown and they are all kept safely away from the ongoing construction site.

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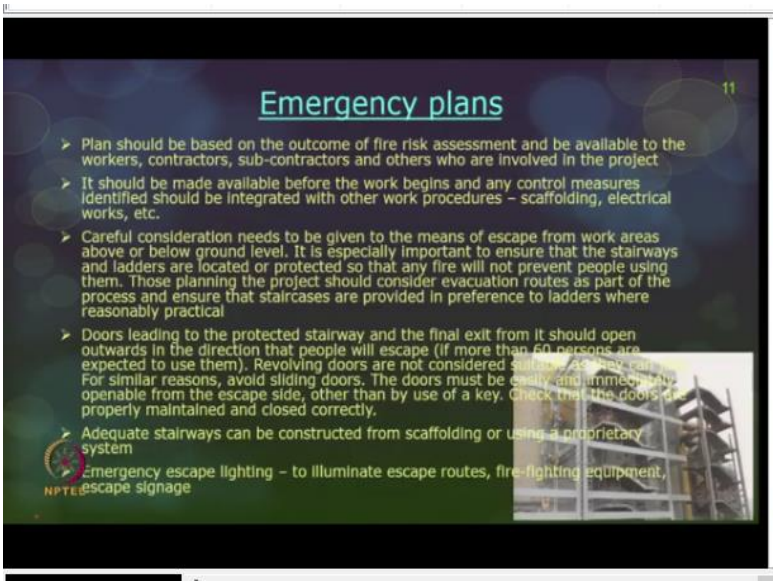

Emergency plans: So, the other issue is you may also have to think of safeguarding the people and apart from putting off the fire so emergency escape plans that we have to discuss. So, before even you think of fire suppression, you may have to think of emergency plans. Suppose if you are thinking of evacuating the people through scaffolds, you should not be thinking of timber planks for the scaffold, you should have a material which is really fire resistant.

So, all these has to be brought in mind, that is where I said while designing itself you should be putting in your fire safety measures from that point of time itself when you are thinking off**.** So, this is primarily a site where they use scaffolds and this permanent stairs as a means of emergency escape mechanism and these stairs and other means also had a lot of sprinklers so that the fire can be easily put off.

So, even this emergency plan should be based on the outcome of fire risk assessment, what is the choice of material, what type of structure is going on? So, all these matters and it should be available to the workers, contractors, subcontractors and anyone who is involved in the project. And this emergency plans should be made available before the work starts. And any control measures identified should be integrated with other work procedures.

For example, scaffolds, electrical work, welding work and so on. So, that it is all well linked together and any measure that you take today may not work out later on. Sometimes what happens is scaffold planks are really fire are prone to fire, then it is not a safe means for

evacuating the workers. If you have identified it as a safe means of making the workers come out, careful consideration has to be given to the means of escape from work areas above or below the ground level.

So, it is especially important to ensure stairways and ladders are located are protected. So, that they are free from obstacles and it should be clearly marked for evacuation and it should not be also it should be totally fire resistant. So, those planning the project should consider evacuation routes as part of the process and ensure that staircases are provided in preference to ladders were reasonably practical.

So, revolving doors are not considered for fire protection and for similar reasons also sliding doors. The doors should be open from the inside so that the workers can escape out and it should not be locked or closed. So, these doors should be easily and immediately open up from the escape site. Other than searching for a key and opening the lock and so on. And check out the doors that should be maintained and closed properly and properly opened.

Adequate stairways should be constructed from scaffolds or using appropriate systems. So, you have to have a proper means of thinking on that. Suppose if these issues happen in the dark, emergency escape lights also has to be provided in addition to these precautions in terms of escape routes, so that the people are able to escape safely and whenever the workers are escaping, so, the workers should also be aware of all your signages in the sense routes and means of escaping.

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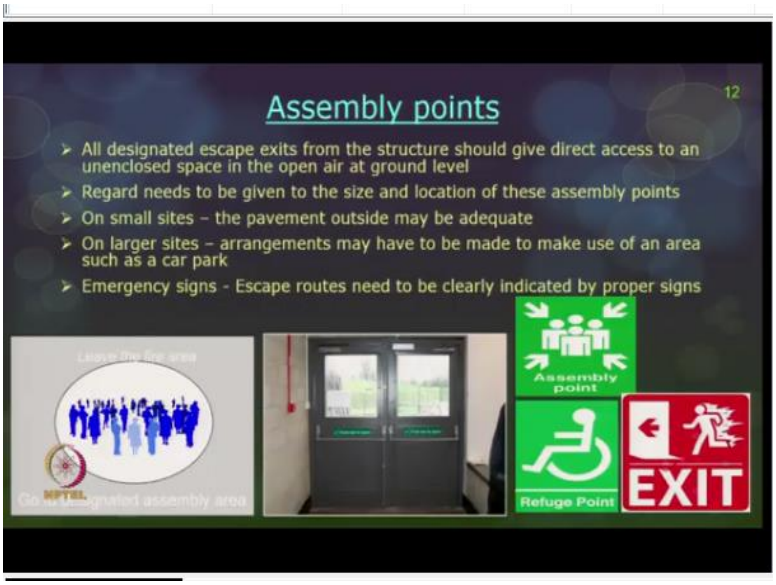

So, there should be proper firefighting signs and also evacuation signs. I think while we were discussing about sign, signals and barricades, we have discussed all these at that point of time itself. So, these should be identified and immediately after coming out of the building or escaping out of the building, they should be known where is the assembly area primarily it is an assembly point.

So, that should be identified, in small sites a payment outside may be adequate suppose if you have a very large site, arrangements have to be made maybe in place of a car park or you should choose a designated place which is away from the hazard and you are able to evacuate the workers safely. So, suppose if this area is outside the site, then that particular gate should be open, it should be the workers to quickly escape from these particular places. So, escape routes have to be clearly marked and identified.

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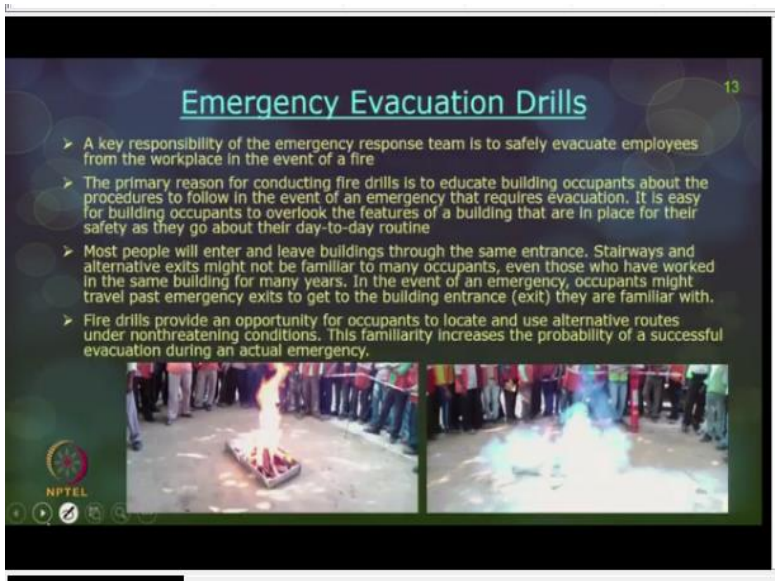

Next is emergency evacuation drills. Most of the time, what happens is the worker start getting panicked, when some incident or some hazards outbreaks. So, especially in terms of fire, so, since fire is a manmade hazard. So, these workers should be trained of how to take care of themselves and escape from the fire hazard. And the one easy way to do this emergency evacuation drill, which we normally call it as a fire drill.

So, fire drill should be happening wherein they actually create a fire and make these workers to escape out and then know put off the fire. So, that instead of training through a theoretical form it is actually done in a practical form. Now, these workers are used to coming in and

going out of the same structure every day now when then. So, they know how to enter, how to come out and so on.

So, even when some hazard happens in a sense, fire breaks out the workers will be very clear on how to know come out of the hazard and how to know put off the fire. So, this fire drills happen, it depends on the sometimes it happens once in a month, sometimes it happens once in 6 months.

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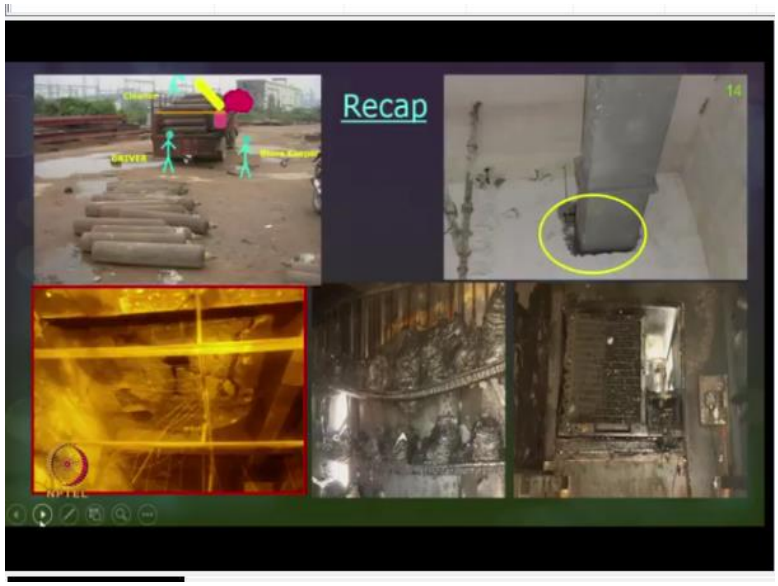

So, recap to everything. So, fire is very dangerous and although it is a manmade hazard. So, it is easy to know think of where the hazard can exist and you can still try to know even if fire happens it should not be affecting person or damaging the structure. For example, more than lives of the people you can see here all these photographs shows, how much damage has happened.

So, this is primarily a godown and the complete godown has not totally gone off with the help of fire. This is also an ongoing construction worker shed which caught fire and total structure got damaged. So, primarily small, small issues like this, not properly closing the service lines or hydrants and so on all these can trigger off the fire. So, you have to be very careful and most of these issues are unsafe acts only.

This is also an example for unsafe act. For example, if you see here, all the cylinders are stored in a horizontal manner lying here and then one after the other. So, these are not the ways of storing all the cylinders. So, if the workers are trained properly and they are made

cautious on how to take care of the fire precautions, then you can easily put off the fire. So, I have taken all this material from all these references.

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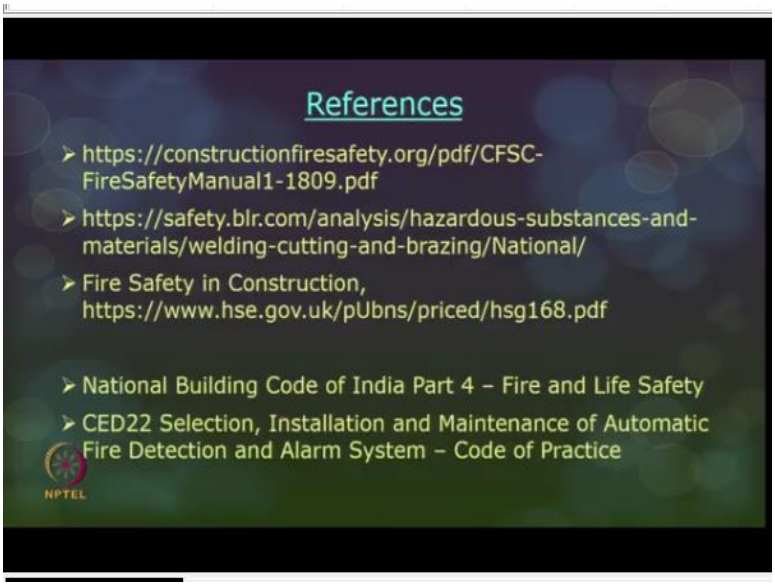

So, thank you.