Basic Environmental Engineering and Pollution Abtement
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Lecture 58
Management of special category waste-1

Hello everyone. Now, we will discuss on the topic Management of special category waste part 1. And in this class we will focus on biomedical wastes.

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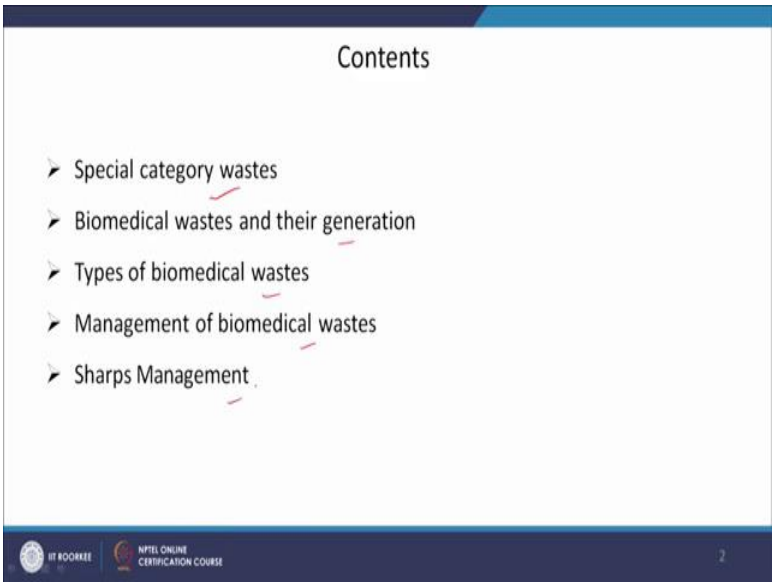

The contents are special category wastes, biomedical waste and their generation. Types of biomedical wastes, management of biomedical wastes, sharps management.

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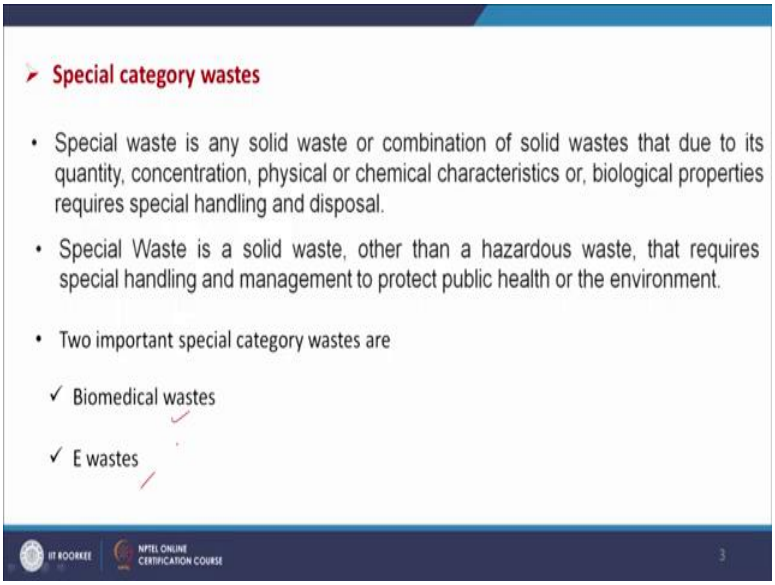

So, we will see what is special category waste, the name indicates that it is different from others wastes. So, special waste is any solid waste or combination of solid waste that due to its quantity, concentration, physical or chemical characteristics or biological properties requires special handling and disposal. It can also be defined like this, special waste is a solid waste other than a hazardous waste that requires special handling and management to protect public health or the environment.

There are many special wastes and two important types are mentioned here that is biomedical wastes and E wastes. And we will discuss the management of these two types of special wastes.

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Now you see the biomedical waste so now the name indicates that the waste will be generated from the biomedical sectors. So, biomedical waste or hospital waste is any kind of waste containing infectious or potentially infectious materials. It is generated from biological and medical sources and activities such as the diagnosis, prevention or treatment of diseases.

Common generators of biomedical waste include hospitals, health clinic, nursing home, emergency medical services, medical research laboratories, offices of physicians, dentist, veterinarians, home health care and morgues, or funeral homes.

Examples of infectious waste include discarded blood, sharps, unwanted microbiological culture and stocks, identifiable body parts, other human or animal tissue, used bandages and dressings, discarded gloves, other medical supplies that may have been in contact with blood and body and laboratory waste that exhibits the characteristics described above and personal protective equipments which are being used during COVID pandemic. So, those are also the part of biomedical wastes and some of the biomedical waste are hazardous in nature.

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Now we will see the generation of waste, so generation some hazardous wastes and non hazardous wastes both types of wastes are generated in these biomedical sectors in hospitals, nursing homes etc. So, source of non-hazardous wastes are administration, hostels stores restrooms, office, kitchen etc. And hazardous waste are generated from ICU, labor room, laboratory, dialysis room, CT scan, reduce missing words treatment room, dressing room and operation theatres also.

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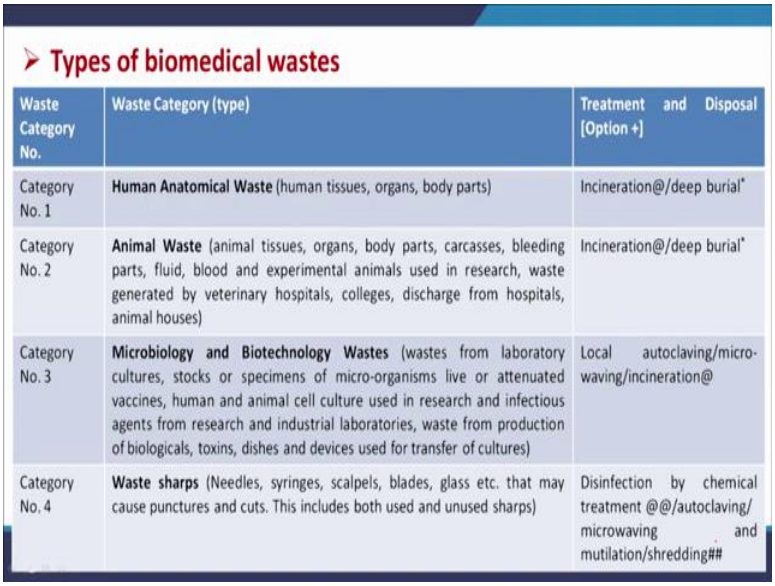

Now we can categorize the waste generated in hospitals into different category or different types. Let us see category one human anatomical wastes. So, these wastes are basically

human tissues, organs, body parts etc. And these can be disposed through incineration or deep burial. So, deep burial is recommended when the population of the town is lower than 2.5 lakhs and incineration does not include any chemical treatment.

And category 2 animal waste, so, animal waste maybe animal tissues, organs, body parts, carcasses, bleeding parts, fluid, blood and experimental animals used in research waste generated by veterinary hospital's, colleges, discharge from hospitals, animal houses, etc. This type of BMW, biomedical waste can be disposed to incineration and the burial also.

Category 3 is microbiology and biotechnology wastes. So, these wastes from laboratory cultures, stocks or specimens of microorganisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories waste from production of biologicals, toxins dishes and devices used for transfer of cultures. So, these are the different examples and local autoclaving, microwaving followed by incineration can be used for the disposal of this type of wastes.

And category 4 these wastes, sharps likes needles, syringes, scalpels, blades, glass etc, that may cause punctures and cuts. So, this includes both used and unused sharps. So, disinfection is very important for its prior to its disposal. So, disinfection by chemical treatment or autoclaving, microwaving and mutilation or shredding. So, these are some root for disposal. Then this chemical treatment can be done by through hypochloride solution or similar type of agents which can kill the microorganisms and this shredding has to be done as per the authorized process.

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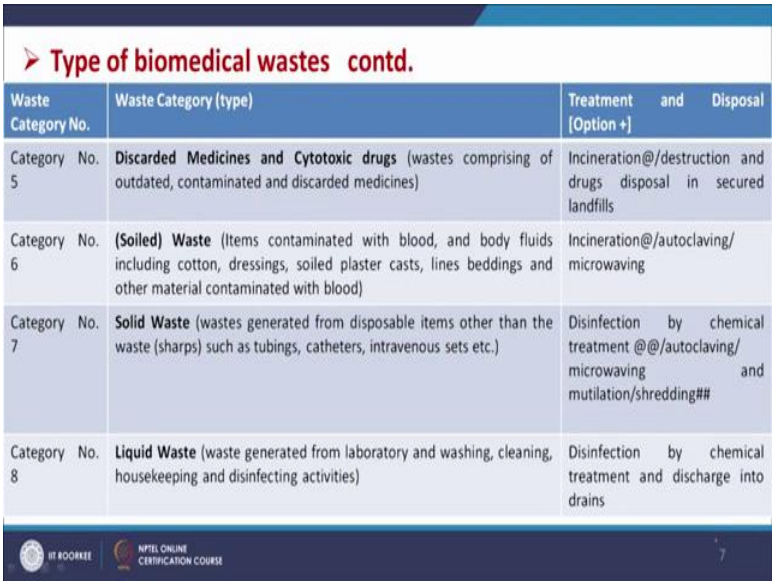

And then category 5 that is discarded medicines and cytotoxic drugs. So, this waste comprising up outdated contaminated and discarded medicines. So incineration and destructions and drugs disposal, insecured landfills these are the recommended route for the disposal.

Category 6 is soiled waste, soiled waste means items contaminated with blood and body fluids including cotton dressings, soiled plaster casts, lines, beddings and other material contaminated with blood. So, incineration autoclaving and microwaving are recommended route for disposal.

Category number 7 solid waste. So, wastes generated from disposable items other than the waste sharps, such as a tubings, catheters, intravenous sets etc. So, these are also important type of solid waste and disinfection by chemical treatment is necessary, or autoclaving or microwaving and mutilations asserting it also necessary.

Next category is liquid waste. So, it is generated from laboratory and washing, cleaning, housekeeping and disinfecting activities. So, disinfection by chemical treatment and discharge into drains, which are the recommended disposal route.

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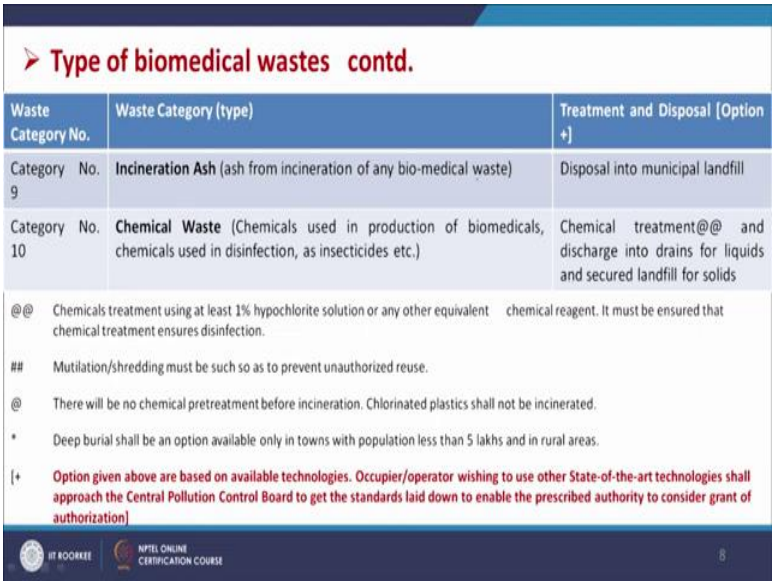

And category 9 is incineration ash. So, as from incineration of any biomedical waste, so disposal through municipal landfill. And category number 10 chemical waste, so, that is chemicals used in production of biomedical, chemicals used in disinfection, as insecticides etc, show chemical treatment and discharge into drains for liquids and secure landfill for solids. So, these are the recommended route for the disposal.

So, these are the different recommended routes for different types or subcategories of BMW biomedical waste, but if some new type of pollutants are generated for which the specified methods may not be properly applicable, then we need to take approval from the competent authority that is CPCB for its proper management.

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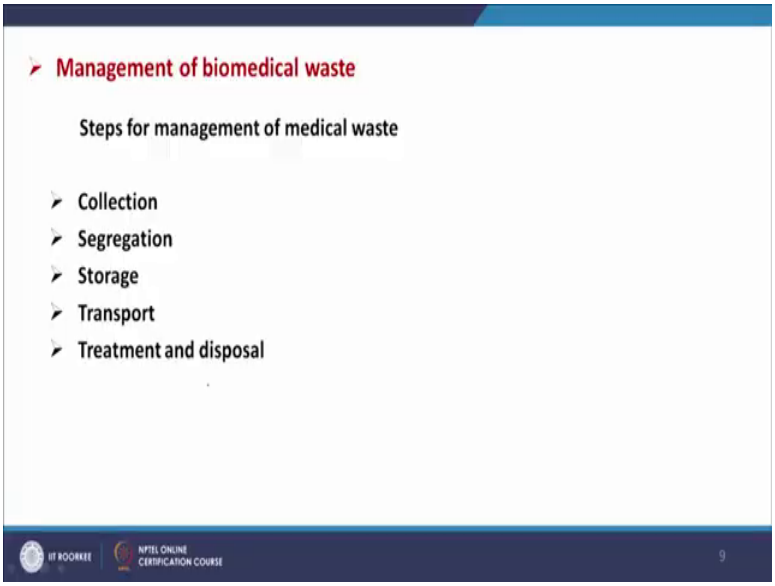

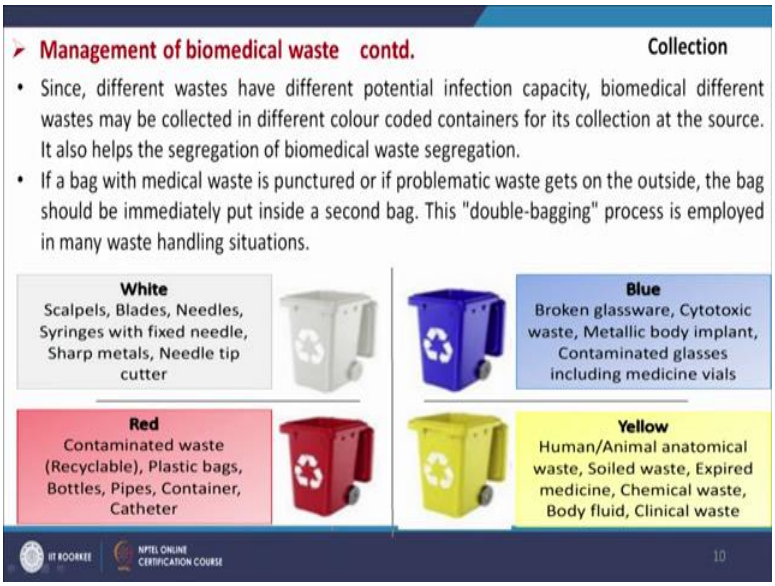

Now, we will see different steps for the management of BMW biomedical waste. So, the collection segregation, storage, transport, treatment and disposal. So, these are the different steps.

And if we see the collection, so these biomedical waste, we have seen that different types and they are they have different potential to create infections, or impact on the human health. So, these materials are collected and stored in different containers. Let us say, White, Red, Blue and Yellow some are the black is also there. So, this white container that scalpels, blades, needles, syringes with fixed needle, sharp metals, needle tip cutter etc.

In case of blue, broken glassware, cytotoxic waste, metallic body, implant contaminated glasses including medicine vials, and in case of yellow human, animal, anatomical waste, soil waste expired machine, chemical waste, body fluid, clinical waste etc. And in the red category, contaminated waste vehicle, plastic bags, bottles, pipes, container catheter etc. So, these are the collection. So, this collection takes place in the hospitals in the premise and then it is stored there it is collected in different container.

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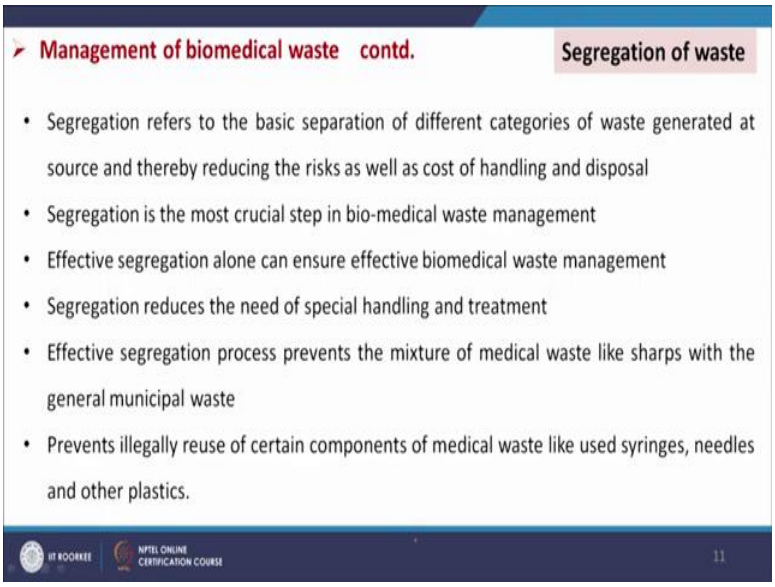

Then segregation, so segregation is very important. So, if we have some idea that there are different types of collection pot on pete and then we can segregate the pollutants at source and we can put these into the specified type of containers. So, that will help in a big way manage the biological wastes and it prevents illegally reuse of certain components of medical waste like use syringe, needles and other plastics as well.

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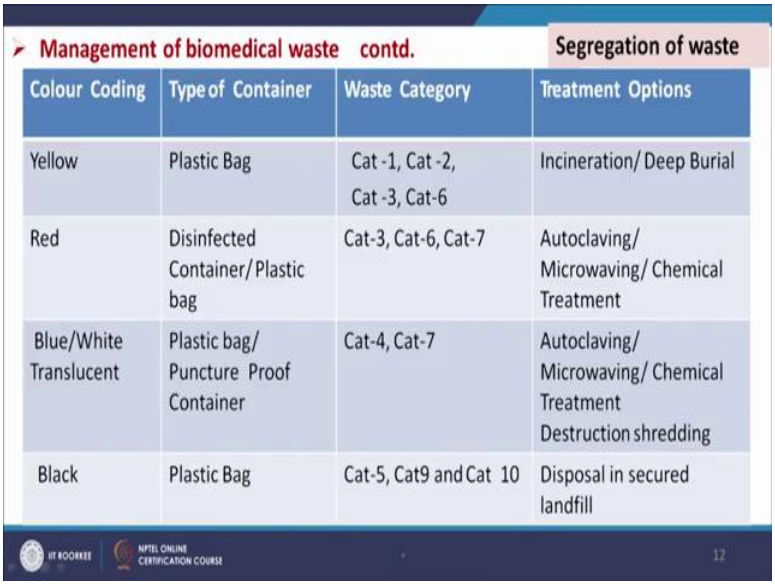

Now, the segregation, for segregation, so different types of container and different color coding and different waste category. So, different waste category, they will be put in different type of container different colored and they will be made of this plastic bag, disinfected container plastic bags and then plastic bag, puncture proof container and then plastic bags they will be collected in this type of container and treatment options already we have discussed.

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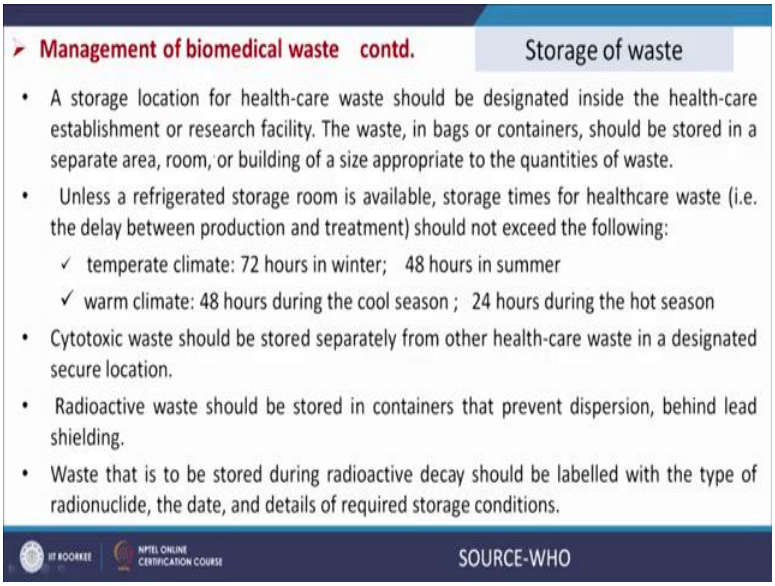

And storage of waste is also an important. So, in the premise, we need to identify some area where the waste will be stored safely. A storage location for the healthcare waste should be

designated inside the healthcare establishment or research facility. The waste in bags or containers should be stored in a separate area room or building of a size appropriate to the quantities of waste.

Unless a refrigerated storage room is available storage times for healthcare waste, that is the delay between production and treatment should not exceed the following. So, if it is say temperate climate, so 72 hours in winter and 48 hours in summer, this can be stored and for warm climate 48 hours during cold season and 24 hours during the hot season. So, these are the recommended storage time.

And cytotoxic waste should be stored separately from other healthcare waste in a designated secure location. So, radio activists should be stored in containers that prevent dispersion, behind the lead shielding and waste that is to be stored during radioactive decay should be labelled with the type of radionuclide the date and the details.

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Then transport of waste, so transport of waste is needed at the on site and off site also, so on site transport etc. that healthcare waste should be transported within the hospital or other facility by means of wheeled trolleys, as shown here containers or carts that are not used for any other purpose and meet the following specifications.

They should have certain specification that is easy to load and unload, no sharp edges that could damage waste bags or containers during loading and unloading. There should not be any sharp edge and easy to clean. So, these are the basic requirement for the transport of

waste using trolleys. The vehicle should be cleaned and disinfected daily with an appropriate disinfectant. All waste bag seals should be in place and intact at the end of transportation. So, these are some guidelines for the transportations on site.

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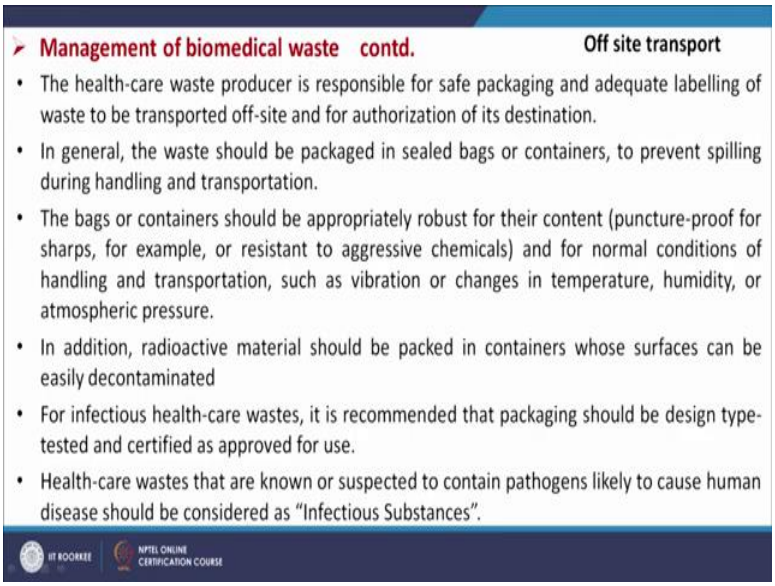

But when off site transportation then the healthcare waste producer is responsible for safe packaging and adequate labeling of waste to be transported off-site and for authorization of its destination. In general that waste should be packaged in sealed bags or containers to prevents spilling during handling and transportation.

The bags or containers should be appropriately robust for their content and for normal conditions of handling and transportation such as vibrations or changes in temperature, humidity or atmospheric pressures that will not have much impact on the container.

In addition radioactive materials should be packed in containers whose surfaces can be easily decontaminated. For infectious healthcare waste, it is recommended that packaging should be designed, type tested and certified as approved for use.

Healthcare wastes that are known or suspected to contain pathogens likely to cause human disease should be considered as infectious substances. So, special care should be taken for this transportation.

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And all waste bags or containers should be labelled with basic information on their content and on the waste producer. The information may be written directly on the bag or container or on pre printed labels, securely attached and the transport vehicle should fulfil, all the requirement and follow all the rules set by the governing body. So, these are the transportation method.

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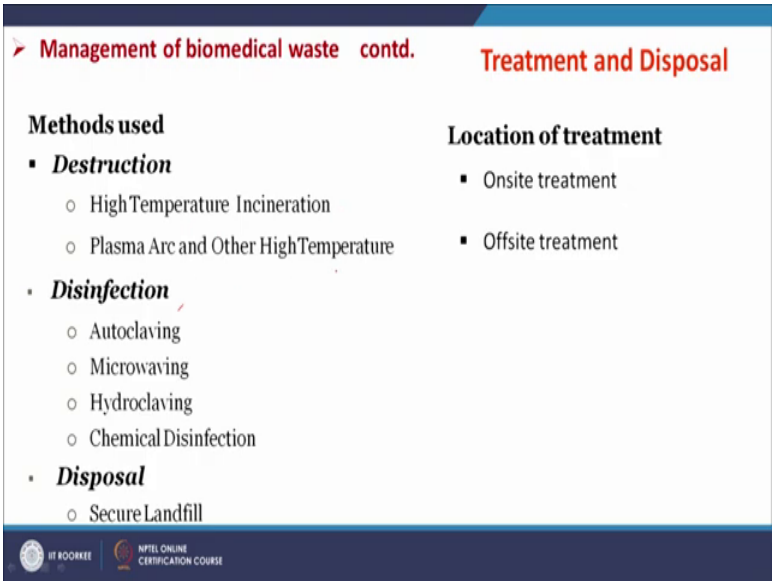

Now, we will see the treatment and disposal. Basically, two types of treatments are necessary. One is your destruction and other is your disinfection. So, destruction is done through high temperature incineration and plasma arc and other high temperature operations. And

disinfection is done through autoclaving, microwaving, hydroclaving and chemical disinfection and the residual part is disposed of through secure landfill or some other methods as well. And location of this may be on site treatment and off site treatment, treatment can be done on the on-site and can be done on the off-site, basically the disinfection is done on-site.

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So autoclaving is on site treatment methods. So, as you know that autoclaving means we are applying steam and high temperature and pressure to sterilize the equipments or the items we are interested to manage. And in this case, the sterilization is most important, the killing of micro-organisms is very important. And these appliances range from 100 liters to 4000+ litres in volume for bulk waste treatment.

And modern autoclaves are also automated to minimize human involvement and needle-stick injuries and contamination. Decontaminated, sharps and other medical waste that is been autoclaved can then be handed over to medical waste removal vendor to be disposed of as non-infectious waste.

So, this is the preliminary stage for the disposal and autoclave operating conditions normally 121 ^{o}C and 32 to 60 minutes duration and 15 Psi pressure, but here different temperature can be used different pressure can be used and different duration will also be used.

So, as mentioned here 121 ^{o}C, 15 psi 1 hour or, 135 ^{o}C, 31 psi and 0.45 hour and 149 ^{o}C, 52 psi and 0.30 hour. So, more the pressure and temperature, lower the duration for the sterilization.

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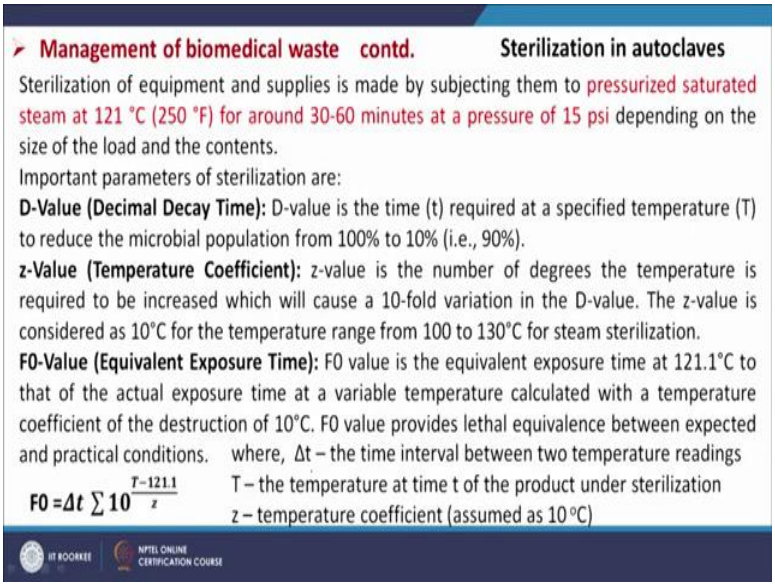

Now, we will see the objective of the autoclaving is to sterilize the items that means to kill the micro-organisms associated with this. And this is normally done at 121 ^{o}C for around 30 to 60 minutes and at a pressure of 15 psi, but we have seen that different duration different temperature and pressure. So, there are some important parameters, which we should have some idea, or what you should know. So, that is D-value, z- value and FO-Value.

So, D-Value is the decimal decay time. So, the D-Value is the time required to a specify temperature to reduce the microbial population from 100 % to 10 %. And the z-value that is temperature coefficient. So, z-value is the number of degrees the temperature is required to be increased, which will cause a 10-fold variation in the D-Value, the z-Value is considered as 10 ^{o}C for the temperature range from 100 to 130 ^{o}C for Steam sterilization.

And FO-Value that is equivalent exposure time. This FO-Value is the equivalent exposure time. This FO-Value is the equivalent exposure time at 121.1 ^{o}C to that of the actual exposure time at a variable temperature calculated with a temperature coefficient of the destruction of 10 ^{o}C.

So, FO-Value provides lethat equivalence between expected and practical conditions, and FO can be calculated by this formula

$$F_o = \Delta t \sum 10^{\frac{T-121.1}{z}}$$

where Δt is the time interval between two temperature readings, that means the duration of the sterilization and T is that temperature at time t of the product under sterilization. So, this is the temperature which is maintained during the sterlization and z is the temperature coefficient assumed as the 10 ^{o}C.

So, if we use this formula, then we will get FO-Value, that will be the the equivalent exposure time so, if we increase the temperature, so, our FO- value will be changed.

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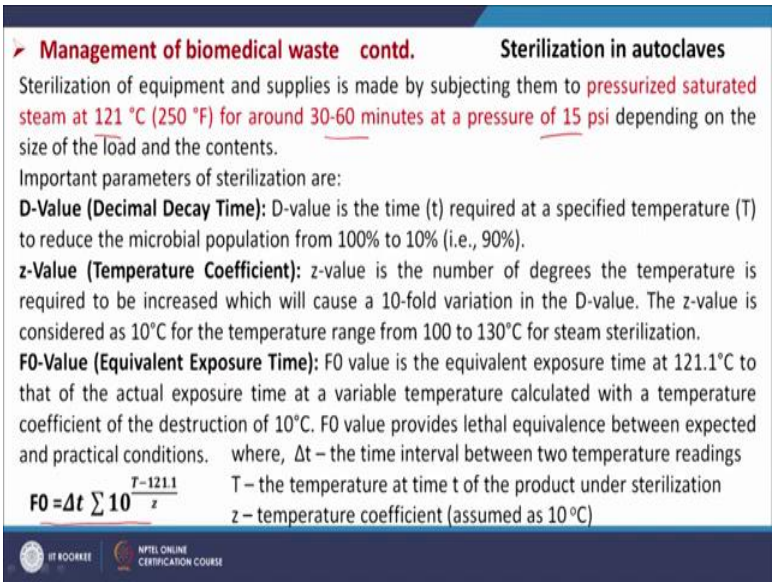

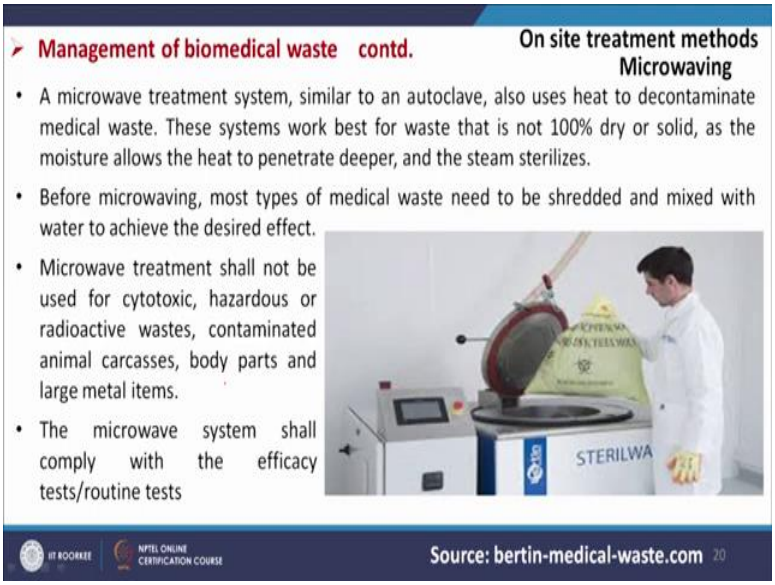

Now, another onsite method is your microwaving. So, microwaving again we are going to put heat with the help of microwaves. But in this case, the moisture is added and which is 100 % dry that type of materials is not used.

Basically, water present in the material is heated and steam is produced and that helps for the sterilization purpose. And microwave treatments are not be used for cytotoxic hazardous or radioactive wastes contaminated animal carcasses, body parts and large metal items. And the microwave systems shall comply with the efficiency test and routine tests. Before microwaving most types of medical waste need to be shredded and mixed with water to achieve the desired effect.

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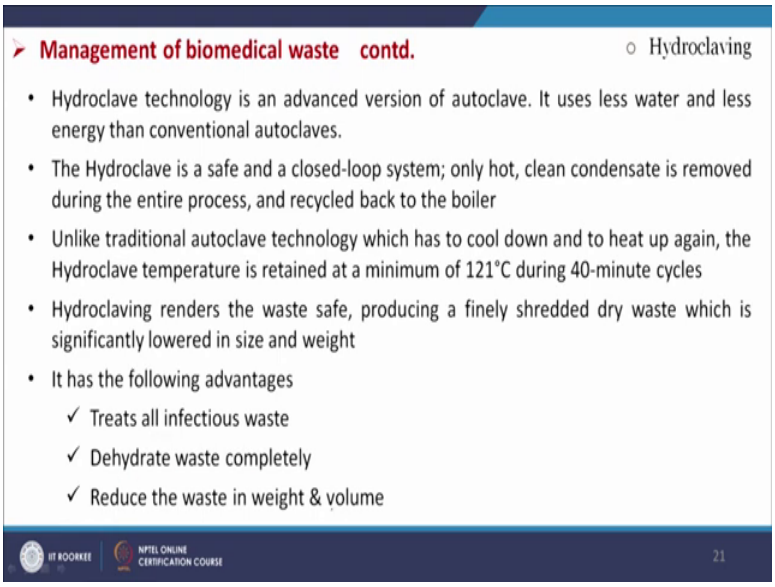

Then hydroclaving that is another advancement of the autoclaving. In this case, the operation takes place in a closed loop and condensed water is separated and recycled in the boiler for the production of steam.

So, unlike traditional autoclave technology, which has to cooled down and to heat up again, the Hydroclave temperature is detained at a minimum of 120 ^{o}C during 40 minute cycles. And hydroclaving renders the waste safe producing a finely seeded dry waste, which is significantly lower in size and weight. So, it has some advantages like it treats all infectious waste it dehydrated waste completely and reduce the waste in weight and volume.

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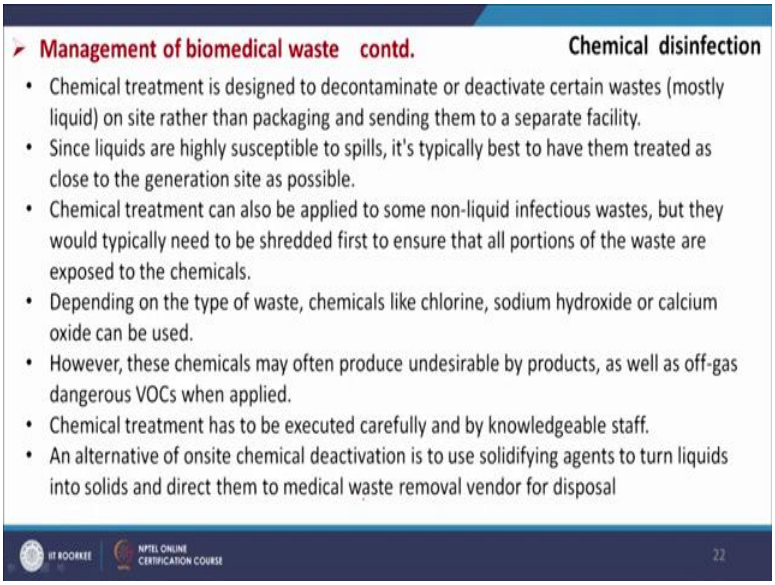

Now, we will see chemical disinfection. So, chemical treatment is designed to decontaminate or deactivate certain wastes mostly liquid on-site rather than packing and sending them to a separate facility. So, some special type of liquid waste so they are contaminated on spot and for that the chemical disinfection process is followed. And since liquids are highly susceptible to spills, it is typically best to have them treated as close to the generation side as possible.

And chemical treatment can also be applied to some non-liquid infectious wastes, but they would typically need to be shredded first to ensure that all portions of the waste are exposed to the chemicals. Depending on the type of waste chemicals like chlorine sodium hydroxide or calcium oxide can be used. However, these chemicals may often produce undesirable byproducts as allege of gas dangerous VOCs when applied.

So, chemical treatment has to be executed carefully and by knowledgeable staff. An alternative of onsite chemical deactivation is to use solidifying agents to turn liquids into solids and direct them to medical waste removal vendor for disposal.

Now we will see, offsite treatment processes. One important is incineration. Already we have discussed in our previous classes on solid waste management that Incineration is a proven technology for the management of solid waste containing carbon and hydrogen.

So, at the same time, energy can also be recovered. So, biomedical wastes many times are having carbon hydrogen in it and that is also having some heating value. And that can be used

through the installation process, and heat recovery and the pollution treatment and waste treatment can also be possible.

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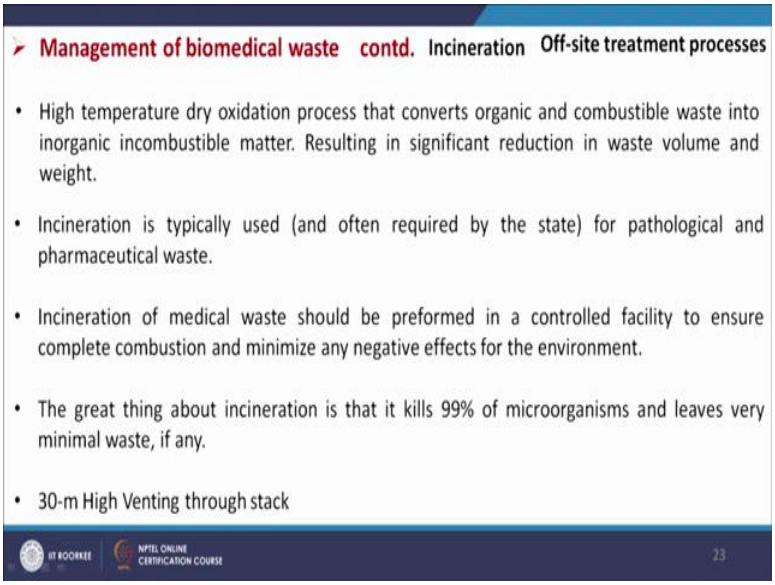

So, high temperature dry oxidation process that converts organic and combustible waste into inorganic matter, resulting in significant reduction in waste volume, and weight. Incineration is typically used for pathological and pharmaceutical waste. Incineration of medical wastes would be performed in a controlled facility to ensure complete combustion and minimize any negative efforts in the environment.

The great thing about incineration is that it kills 99 % of microorganisms and leaves very minimal waste, if any, and 30 meter high ventilating through stack. So, we have already discussed in our previous chapters how the incineration of solid waste takes place, and the same method can be applicable here also.

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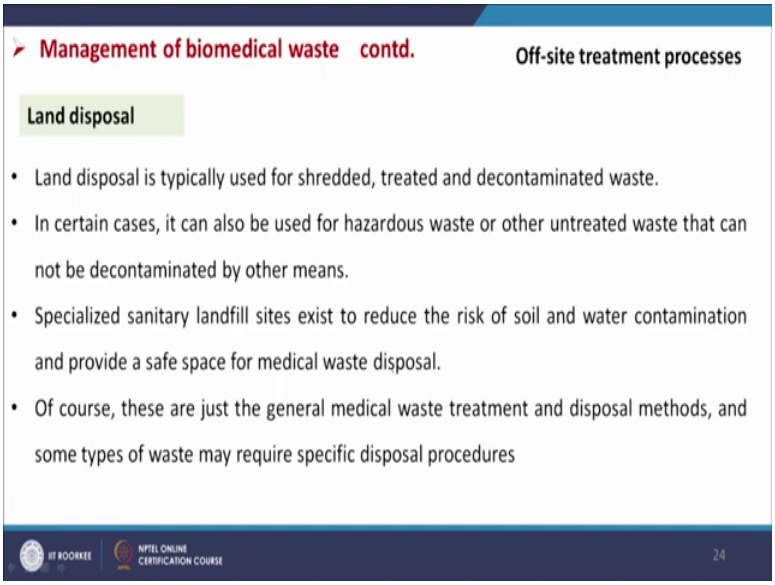

Another offsite advantage is Land disposal. So, after disinfections of certain type of biomedical waste, those can be disposed on land. So, land disposal is typically used for shredded, treated and decontaminated waste.

In certain cases, it can also be used for hazardous waste, or other untreated waste that cannot be decontaminated by other means. Specialized sanitary landfill sites exist to reduce the risk of soil and water contamination and provide a safe space for medical waste disposal. Of course, these are just the general medical waste treatment and disposal methods and some types of waste may require specific disposal procedures.

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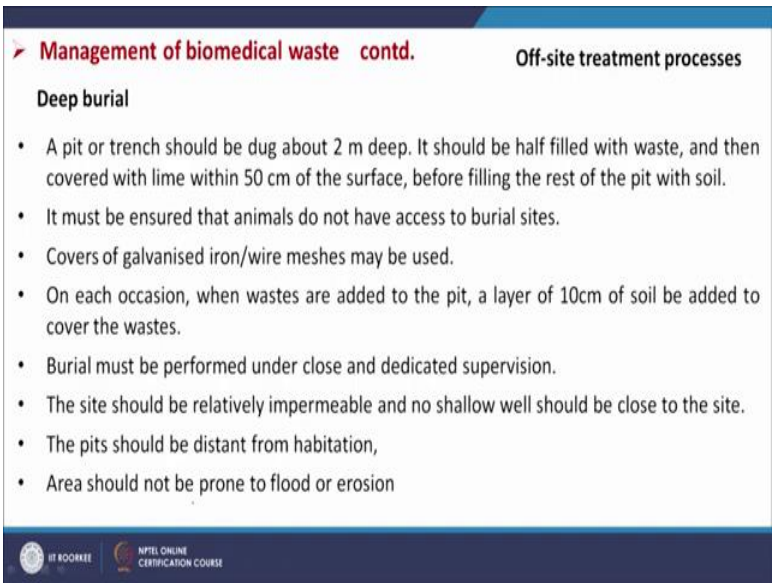

And other offsite treatment is your deep burial. A pit or trence should be dug about 2 meter deep, it should be half filled with waste and then covered with lime within 50 cm of the surface before filling the rest of the pit with soil.

So, it must be ensured that animals do not have access to the burial sites. Covers of galvanized iron wires meshes may be used. On each occasion, when wastes are added to the pit, a layer of 10 cm shall be added to cover the waist. These are some guidelines and burials must be performed under close and dedicated supervision.

The site should be relatively impermeable and no shallow well should be close to the site. The pits should be distant from habitation and areas should not be prone to flooding or erosion.

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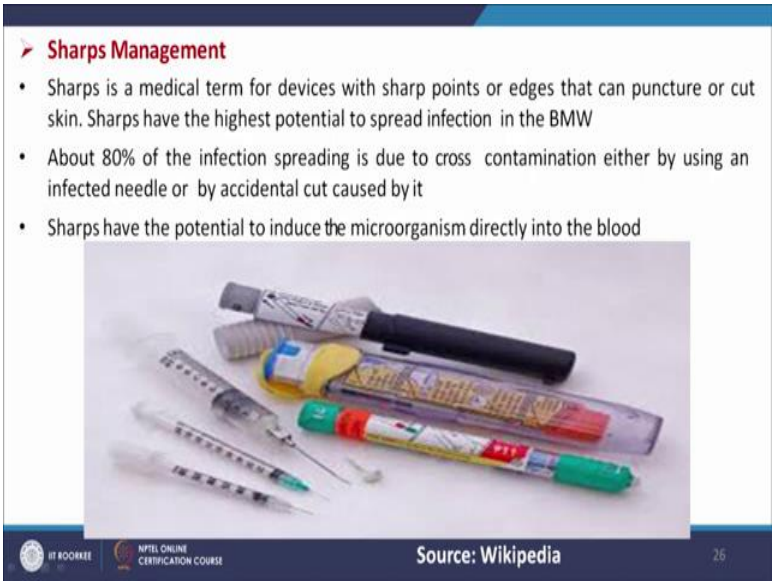

Now, we will see how the sharps can be managed. So, we have seen what the sharps are. So, sharps is a medical term for devices with sharps points or edges that can puncture or cut skin, sharps have the highest potential to spread infections in the BMW.

About 80 % of the infections spreading is due to cross contamination either by using an infected needle or by accidental cut caused by it. So, sharps have the potential to induce the microorganism directly into the blood. So, these are the photographs of some sarps items.

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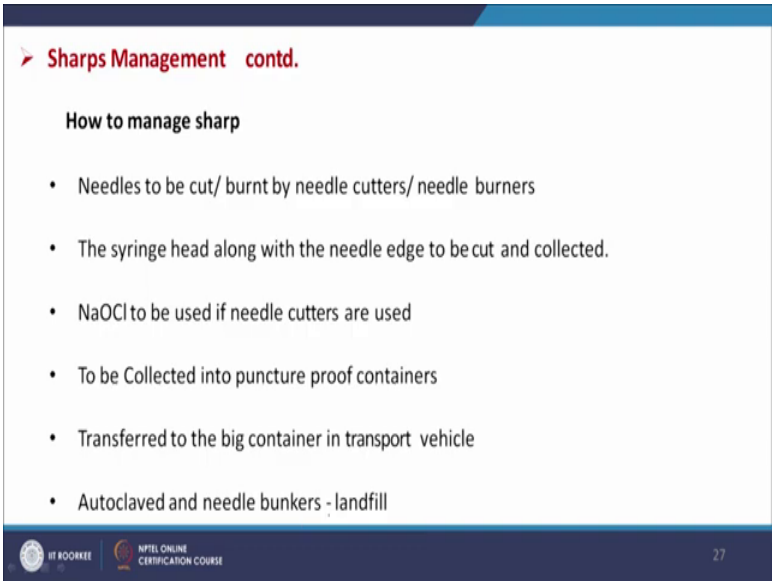

So, how to manage it? So, needles to be cut burned by needle cutters, needle burners, the syringe head along with the needle age to be cut and collected NaOCl to be used if needle cutters are used to be collected into puncture proof containers transferred to the big container in transport vehicle and autoclaved and sent to needle bunkers for landfill. So, we have made overall discussion on the management of biomedical wastes, so up to this in this class. Thank you very much for your patience.