Health, Safety and Environmental Management in Offshore and Petroleum Engineering

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Module – 01
Lecture – 05
Ecological monitoring

Welcome friends to the online course on Health Safety and Environmental Management in offshore and Petroleum Engineering. We are discussing lectures on module one where we are focusing on environmental management issues related to production from offshore on oil industries. In this lecture which is the fifth lecture in module 1, we are going to talk about ecological monitoring; we already said in the last lecture that environmental protection is implementable only when, the management schemes or the rules and regulations are framed by including the stake holders as the members.

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It also depends upon various factors, which we discussed in the last lecture out of which socioeconomic perspective. One important in major concern which governs the management laws rules and regulations, which are intended to save the environment especially the marine environment because, the contaminants or the pollutions caused by the oil spills the drilling discharges etcetera, as we have seen in the previous lectures, are

precarious and they are really very alarmy. If I talk about environmental management and let us say we lead towards establishing or framing standards and requirements.

Let us say we are interested to frame standards and requirements then, what we should actually consider when, we start framing such standards and requirements or when, we are revising such standards and requirements the standards which are essentially important to implement the environmental protection govern implementation of the management policies which should include the following factors.

The first factor which we must consider should be most importantly the content of mercury and cadmium. Which are very harmful for the marine species which, are present usually in the barite base of drilling fluid should be restricted should be kept as minimum as possible in the second point, I will come to the number later. The second point is that no discharge of drilling waste is permitted in waters within 3 miles from the shore. So, no discharge of drilling fluid is permitted within 3 miles from the shore. At any cost no discharge of diesel is allowed at any cost no discharge of free oil is allowed this, can be checked using a specific test called static sheen test is used to check the discharge of free oil sleek on the surface.

This test should confirm to lc 50 values.

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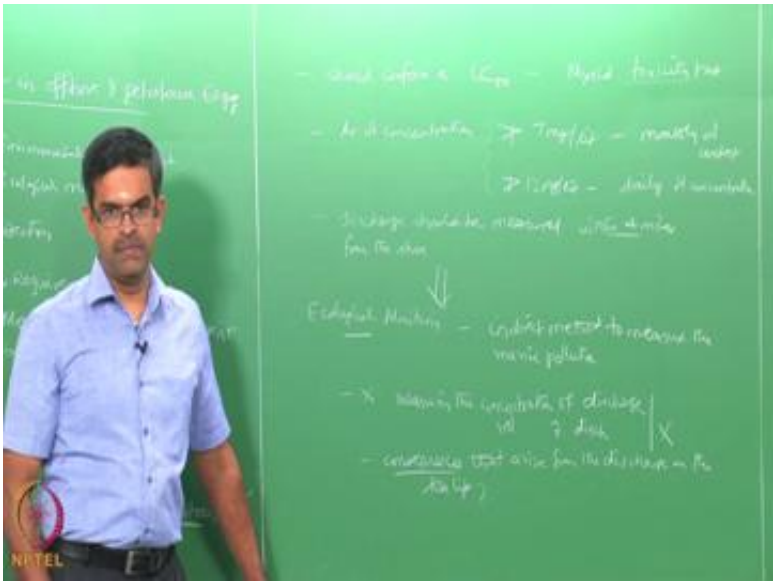

This test should confirm to lethal concentration 50, we already given the figure in the last lecture which should be arrived based on Mysid toxicity test. Now the average concentration in oil that is the average oil concentration, when it is discharged should not be more than 7 milligram per liter on a monthly basis or 13 milligram per liter on a daily oil concentration.

Now the question comes, when an oil sleek or oil concentration is found on surface waters you need to measure them because, you need to measure them take a sample do the test in the lab to find the toxicity also you have to take a sample and do the static sheen test to really check, whether the oil concentration is within the permissible limits on a monthly basis or on a daily basis. Now where will you collect this sample; obviously, when collects a samples very near to the source of discharge the concentration is likely to be higher when, you collect the sample far away from the point of discharge; obviously, they will be lower. So, you have got to also specify where you are going to collect this sample.

So, the discharge should be measured within four miles from the shore to check whether, it is toxic or non toxic or to check whether they are within the standards prescribed by the rules and regulations of the local agency or not. So, all these come under a single frame of discussion what we call ecological monitoring. Now ecological monitoring is an activity or a basic method which is used to control and manage activities related to marine pollution.

Ecological monitoring is actually a system which collects information about the changes in the natural parameters that occurred due to oil pollution in an open sea. So, actually it is an indirect method to measure the marine pollution, one may ask me a question why it is an indirect method, we are not interested in measuring the concentration of discharge volume of discharge etcetera. Then what are we measuring we are measuring the consequences that arise from the discharge on the sea lip. Now one may ask me a question why are we interested in measuring an indirect way of consequences and then checking whether the pollution is within the standard limits.

The basic reason is pollution arising from oil cannot be measured directly because of its complex composition. So, oil pollution cannot be measured directly because of its complex composition.

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That is one reason the second reason is availability in different forms physical chemical and biological forms therefore, we always measure the consequences on the marine organisms which is caused by the oil pollution and we try to check whether they are within the permissible limits that is why you can see very clearly here to measure the consequence we always talk about the lethal concentration and we are we are not talking about the turbidity or the content in terms of its concentration though we say the limits are.

So, which can be also measured directly, but this alone will not help us to really know whether environmental protection is enabled. So, we are always interested or in terms ecological monitoring is always a method which collects information about the changes in the natural parameters of the marine organisms which occurred due to oil pollution. It is actually indirect method of monitoring you can also monitor this using a biological manner the biological monitoring is based on a technique which measures the molecular and cellular effects under low levels of impact, which cannot be measured by chemical analysis because the levels of impact are so, low. The chemical analysis cannot capture them you can always see here again biological monitoring is also a technique which is indirectly measuring the molecular and cellular effects on the marine organisms.

Therefore friends the ecological monitoring in offshore production is done at the local level. You cannot do this at global level because, the concentration is more local then

regional and then if it is very severe, it can get globalized which we have already seen in the previous lectures. Now ecological monitoring is done in different stages. The first stage you have to identify the possible potential hazards, which can arise from the impact sources.

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So, possible potential hazards are identified in the first stage. In the second stage you make regular observations at periodic intervals on the Marine Biota. So, it is a indirect way to qualitatively assess the responses of biological organisms under the impact of oil pollution. So, we are measuring the biological and the qualitative assessment on the biological organisms, how do they behave how the functionality is affected how the reproduction is retarded or increased etcetera. So, you are measuring the consequences you are having a qualitative assessment that is the second stage in ecological monitoring.

So, based on this you develop what is called because effect relationship is established or developed between the documented biological effects, on the species and the impact factor the total impact by an environment and the biota, including the impact on the commercial species on biological resources are assessed at this stage. Finally, in the third stage we suggest corrective measures for checking the marine pollution. We can also recommend certain preventive measures, if necessary. So that the marine pollution can be kept under control within permissible limits accepted globally regionally and then locally.

Let us slightly move on the discussions on environmental pollution or environmental management from offshore to onshore. We already know once the oil or hydrocarbon is identified it is produced or drilled from a specific source as a crude oil, it will be transported to shore for processing. However, these days processing is also done on the offshore platform itself. So, that you can save the cost of transporting crude oil which after processing gives about 60 to 65 percent waste. So, people are not interested in transporting the crude oil from the platform to the onshore for processing, they would rather like to process the commercial product in the platform itself, and only transport the pure commercial product for sale directly.

So, that the discharges or the effluent waste which are actually exit from this kind of processing plants, can be discharged back in sea waters. So, there is another precarious movement which an offshore engineer or an environmentalist should seriously focus, that if the processing does happen in the offshore platforms itself. Now the discharges which are coming from the oil by accident will now become intentional because this oil will be discharges from the processing plants.

However in the present scenario these discharges do come to the sea there is no doubt on that, but they do not come from the offshore platforms, but they do come from the onshore processing refineries. So, we include them in this case as well, now most important aspect here in terms of onshore activities where we talk about processing industries which do refinery for converting the crude oil into commercially available trade species the most important concern generally comes to atmospheric pollution.

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Atmospheric pollution essentially cost only by the refinery industries, which are associated closely where in oil and gas production scenario, to understand the atmospheric pollution, we have in the literature two exclusively specific models which are called release models and dispersion models. The release model identifies the type of release of the material this model is essentially, used to assess the release rate of the toxic material into atmosphere. It of course, includes estimation of downwind concentration of the released material alternatively the other model is also used to capture or understand atmospheric pollution that is called dispersion model. As the name suggests very clearly this describes the dispersion of vapor in the down wind direction.

Now, there are three different kinds of vapor cloud behavior and one can relate the corresponding time released models in the given literature.

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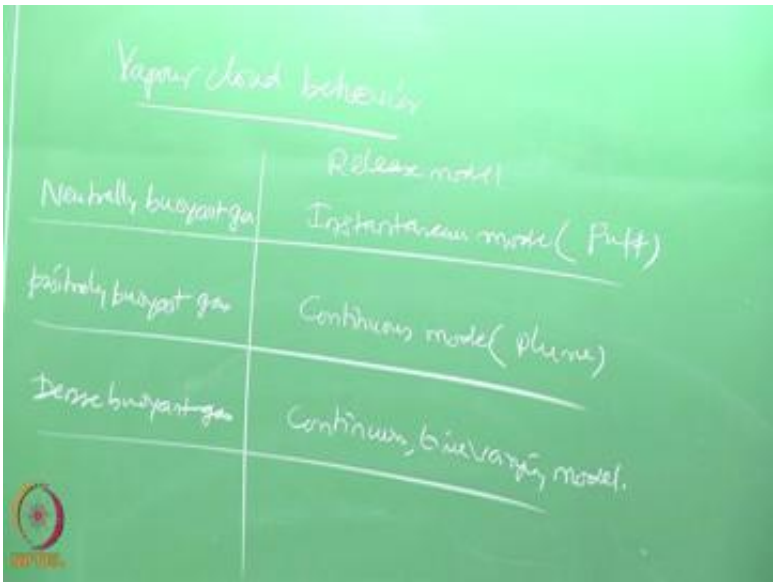

The vapor cloud behavior has three essential features one it could be a neutrally buoyant gas. It can be a positively buoyant gas it can be a dense buoyant gas which can form a cloud the release model which is, suggested to mathematically model this is for example, in neutrally buoyant gas people use instantaneous model, which is called as puff model to capture the vapor cloud behavior, which arise from positively buoyant gas one can use continuous model which is called plume model in the literature, if you want to model the vapor cloud behavior that arises from the dense buoyant gas. One can use a continuous time varying model. So, these are the three ways by which the vapor cloud behavior which arises from different types of gas can be captured in terms of dispersion release model, please look at the screen you have a picture which shows you the continuous release model which is a plume model.

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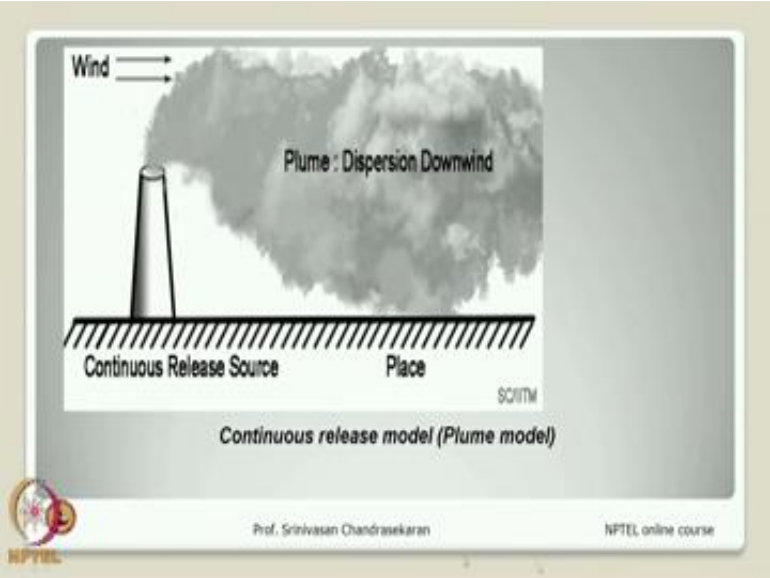

If you look at the screen here, let us say this is a source which is releasing continuously the atmospheric pollutant, which comes in the atmosphere. We already said that if it is a positively buoyant gas, one can go for a plume model which has to capture the dispersion on the downwind side using a continuous release. So, this picture very clearly shows dismiss this is my downwind area. So, the dispersion is continuous. So, my model is supposed to capture the continuous variation of concentration of the pollution in air, which arises essentially from the source which is called Continuous Release Source.

The next could be an instantaneous release source let us say, the resource released instantaneously please look at the screen here.

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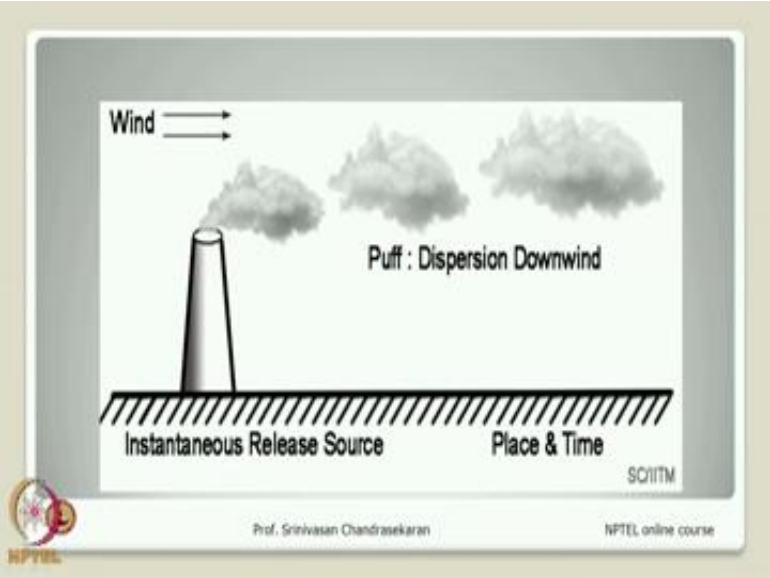

Now for any instantaneous released source in the downwind side if you want to really capture the vapor cloud behavior one can go for a puff model which is instantaneous release model. So, one can see here the concentration is instantaneous, but not continuous unlike you saw in the plume model. Now let us look at the factors which affect dispersion.

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Foremost could be the wind speed depending upon the wind speed the spread distance and the intensity and the area of spread will also be governed. So, essentially wind speed

is one of the important characteristic which should be considered in the model, the second could be the terrain effects if the terrain is rough and vegetative it will have a different effect on the dispersion conversely with that of an open terrain. The third could be atmospheric stability what do you understand by atmospheric stability, atmospheric stability related to the temperature, weather conditions humidity of course, the wind velocity and weather climate etcetera. So, atmospheric stability the fourth could be the height of release of the gas above the ground and lastly and very importantly the initial momentum of release.

So, these are the factors which affects the model that accounts for dispersion in the downwind side amongst this let us talk about the first effect which is the wind speed.

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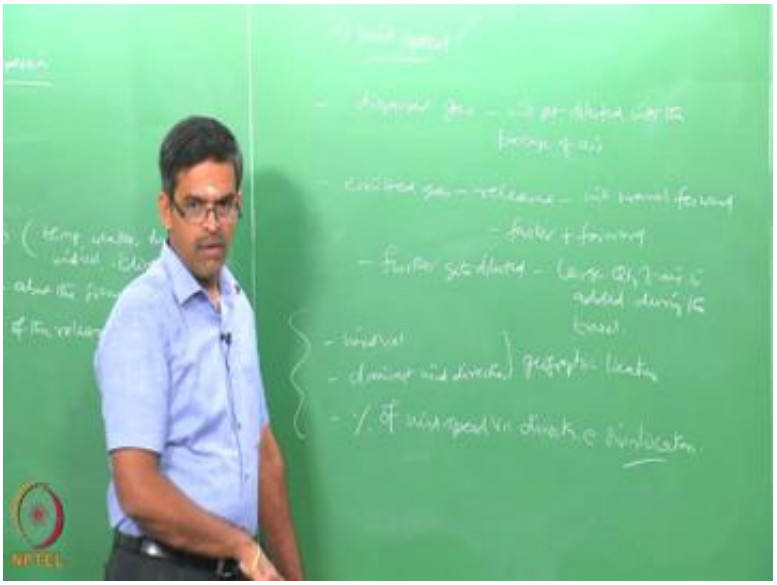

The dispersed gas will initially get diluted with a passage of air. So, let us look at the process physical process the dispersed gas or the cloud the vapor cloud will get diluted with the passage of air. Now the emitted gas which is released will now travel forward it will also travel faster because of the wind speed. So, forward plus faster, while it travels forward and faster it further gets diluted because large quantity of air is added during the travel.

So, the foremost issue here is one would like to know what the wind speed at any specific location is. So, what is the wind speed or wind velocity at any specific location one would also like to know, what is the dominant wind direction which is

predominantly present in that geographic location one would also like to know what would be the percentage of contribution of wind speed versus direction at any given location of our choice, what does it mean is does the wind flow at that location circumferentially at sixty degrees or is it predominantly at any specific direction if at all. So, what is that percentage of contribution of wind speed in that specific direction?

So, on the other hand you can always locate very easily the predominant down wind direction, if you are able to locate the predominant down wind direction in a specific geographic location of your processing plant you can always design your dispersion system in such a manner that, the dispersed gas or the emitted gas can get diluted in much faster rate therefore, the pollution concentration can be diluted or reduced. So, where do you get this data from we can get this data from what is called as an wind rose diagram.

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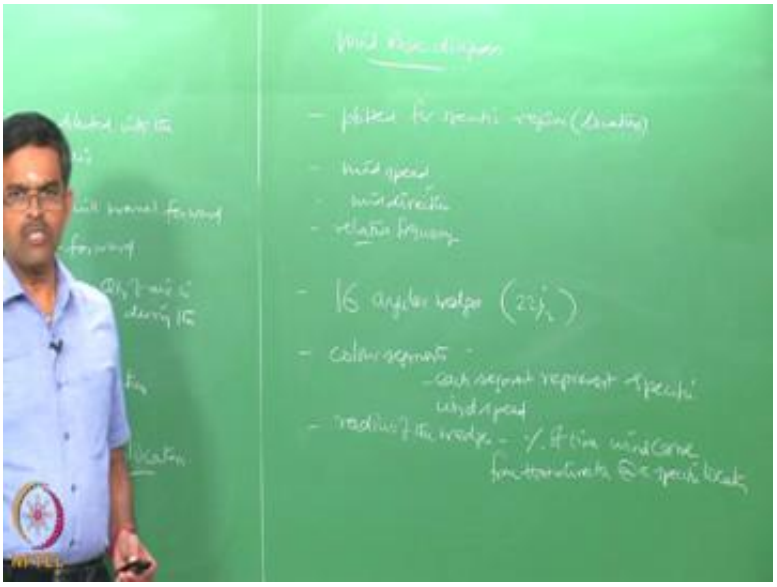

Wind rose diagram actually are plotted for specific regions I can even say specific locations of interest this should show wind speed wind direction and relative frequency at which the wind is blowing. Why I say relative because compared to all directions circumferentially at that particular point what is the relative frequency at which the wind is blowing in a specific dominant direction. One should like to know this then, only you can design the dispersion system in such a manner that, if at all the emitted gas is dispersed by accident it can get diluted much faster because, the wind speed and the

wind velocity in the direction is designed in such a manner that a system can get diluted much faster.

So, wind rose diagram comprises of actually 16 angular wedges. So; obviously, 360 by 360 each wedge will be 22 and half degrees equally divided. It contains colour segments each segment represent a specific wind speed. When blowing from a specific direction the radius of the wedges in the wind rose diagram represent the percentage of time wind came from the direction at any specific location.

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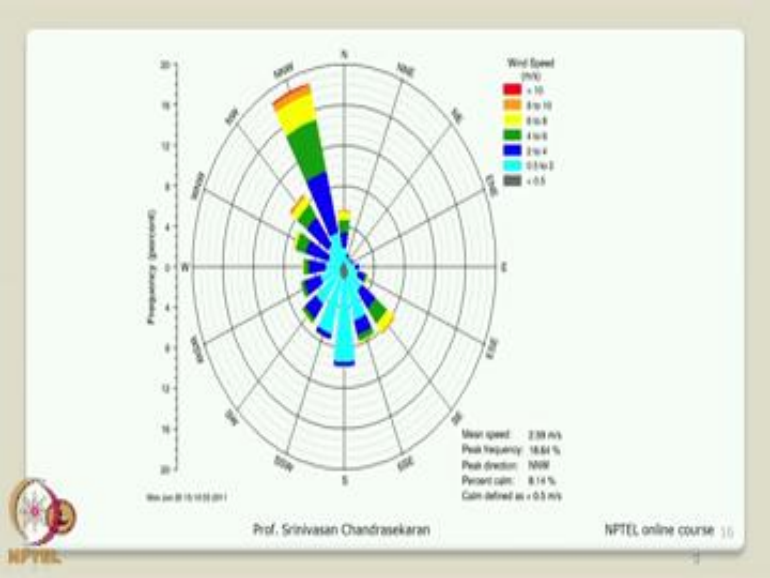

So, please look at the screen you can see a typical wind rose diagram which, as may taken as a data on June twentieth 2211 at about 3:10 in the afternoon, you can very well see here please look at the board here.

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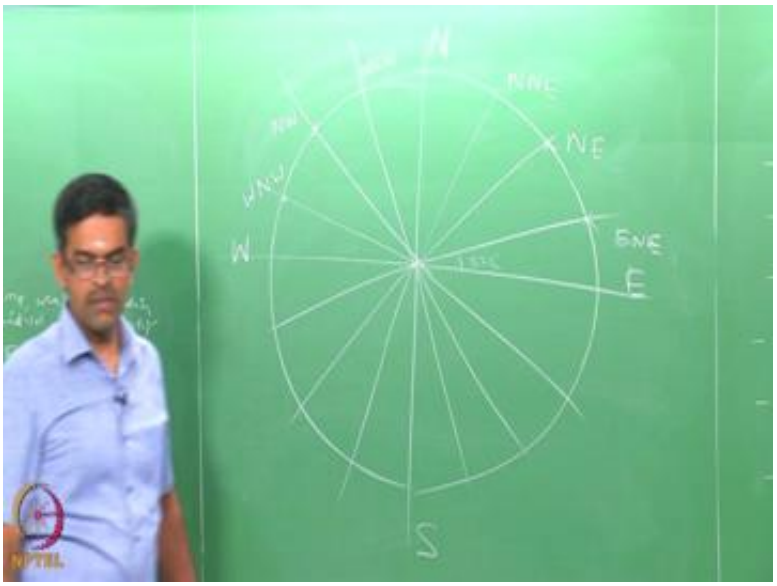

North, East, South, West; each is divided into 3 parts. So, 1, 2, 3, four-quarter. So, 16 wedge four-quarters. So, 16 wedge each about 22 and half degrees. So, I want to name this specific case. Now I can say this is north this is west therefore, this can be North West. So, I want to name this this is more towards north. So, I should say North West because that is the quadrant towards north I should have to name this. So, it is again in the North West quadrant, but towards west; obviously, if I want to name let us say this, this is going to be north east this is more towards north. So, north, north east this is more towards East, so east-north-east.

Similarly, you can also name the remaining parts in the same fashion as we can understand. So, wind rose diagram has got 16 segments each one of them equally divided by 22 and half degrees. If I look at the screen back now, where a wind rose diagram is projected on the screen you can see here the wind rose diagram seen on the screen. Now has got different colour index which shows the various wind speed that is the red colour shows more than 10 meter per second, recorded at that particular interval and the other colors are shown, where as the mean speed at that physical location calculated is 2.59 meter per second the peak direction is north-north west, why because the red is the maximum wind speed and the red is seen predominantly in north-north-west. There are no reds otherwise seen anywhere. Therefore, the predominant wind direction or the peak direction for this specific location is north-north-west.

Similarly, the percentage calm or the calm wind speed is considered to be 0.5 meter per second for the specific location, and if you look at the frequencies in terms of percentage. Let us say I want to know this particular value projected on the y axis, which is about let us say 18. So, we say that the peak frequency, which is on the predominant direction of north-north-west, is about 18.64 percentages. So, it means in this location predominantly wind blew or wind came from north-north-west direction at the velocity of 10 meter per second and in a given percentage specific locations in a period of interest. This was about 18 percent.

So, wind rose diagram helps you to understand the wind speed, the wind predominant direction and of course, the relative frequency of that particular wind speed of your choice at a specific geographic location at a specific time of interest because you want to know, what is a variation during the day. So, you cannot the plot a variation entirely on a single scale you can take any period of interest keep on plotting intermittently then you can take a mean value of a variation of wind speed and of course, the variation of wind direction as well. So, wind rose diagram is a very useful graphical tool which helps you to actually find out the qualitative and quantitative information about the wind speed the wind direction and the relative frequency, with which the wind is blowing in a specific geographic location at any specific time of interest.

Now, the wind speed and the direction of wind speed are influenced by the release which is happening and this influence is very significant. Now we would like to know what that wind speed which can be computed analytically is.

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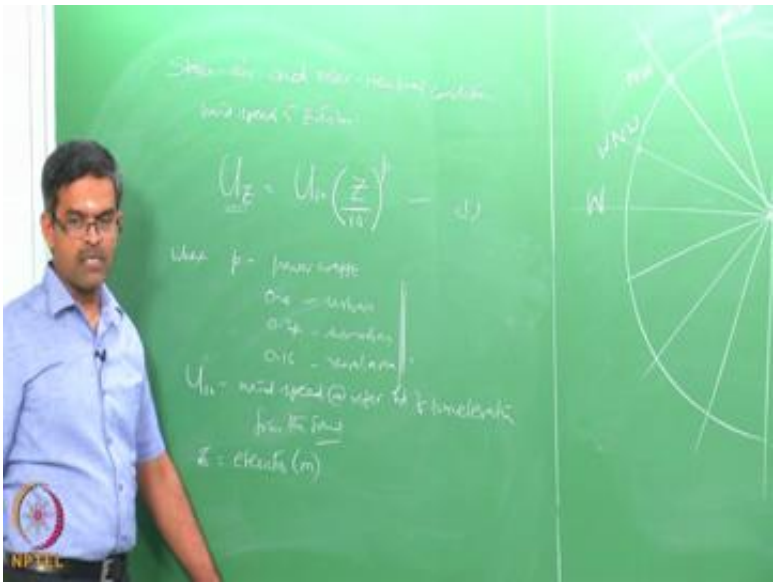

So, for a stable air condition and here near neutral condition wind speed is given by u z is equal to u 10 of z by 10. Where to the power p, where p is called power coefficient this value is taken as 0.4, 0.28 and 0.16 respectively for urban area for sub urban area and for rural areas u 10 is the wind speed at the reference height of 10 meter elevation from the ground and z of course, is elevation plotted or taken in meters. So; obviously, if I substitute 10 here you will see that the z variation up to 10 will be exactly a constant value.

So, how does it vary is what we can see from the screen, I will show you a different figure later. So, the second issue which is going to talking about or which is going to affect the dispersion release models is going to be the terrain effect the terrain effect will also influence the wind dispersion models very seriously.

We will talk about this in detail in the next lecture. We will also talk about the stability class and the humidity and temperature variation respect to the dispersion release models in the next lecture. So, in this lecture we have tried to introduce you the important issues related to the dispersion models which, can be discussed and seen in the presentation in this lecture. So, we would like to request you to go through the reference literature given in NPTEL website for parallel reading. So, that any doubts or any difficulties you have in understanding these lectures can be posted back to me at NPTEL website which can be clarified subsequently.

Thank you very much.