Air Pollution and Control
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Lecture 11
Atmospheric Stability and Plume Behaviour

Hello friends, you may recall last time we discussed about adiabatic lapse rate of the vertical temperature profile in the troposphere and its relationship with the atmospheric stability.

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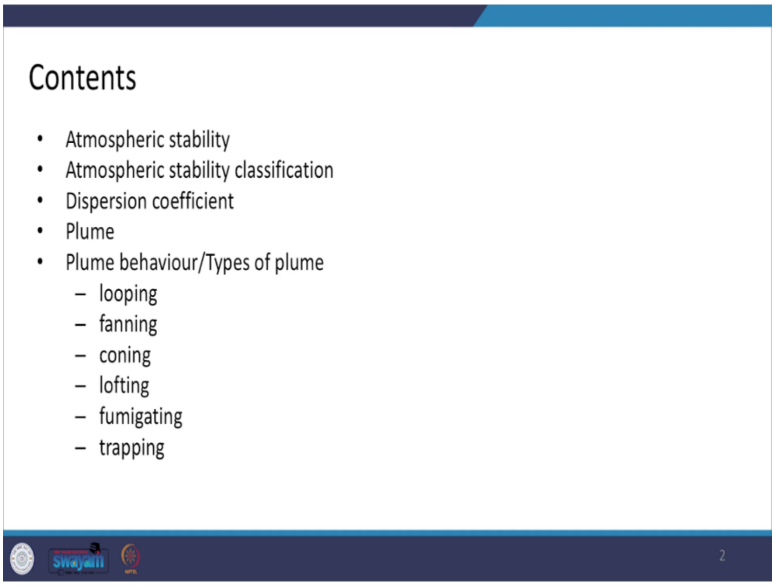

Today we will discuss how atmospheric stability influences the plume behaviour because plume which is emitted from the stack or some source. So, how does it disperse in the atmosphere, how it is shapes are defined by atmospheric stability and their relationship.

So, the contents that will include like atmospheric stability we will discuss very briefly again to revise and its classification based on different concepts, then some dispersion coefficients and then the plume what is plume and how different types of plumes are related with different kind of stability classes.

Well, so when we talk about atmospheric instability basically, it is associated with the atmospheric temperature profile, vertical temperature profile and it refers to vertical movement of the air that is the tendency of air to rise or to resist vertical motion, it can go up or it can come down or it can be on the same place where this air parcel has been released.

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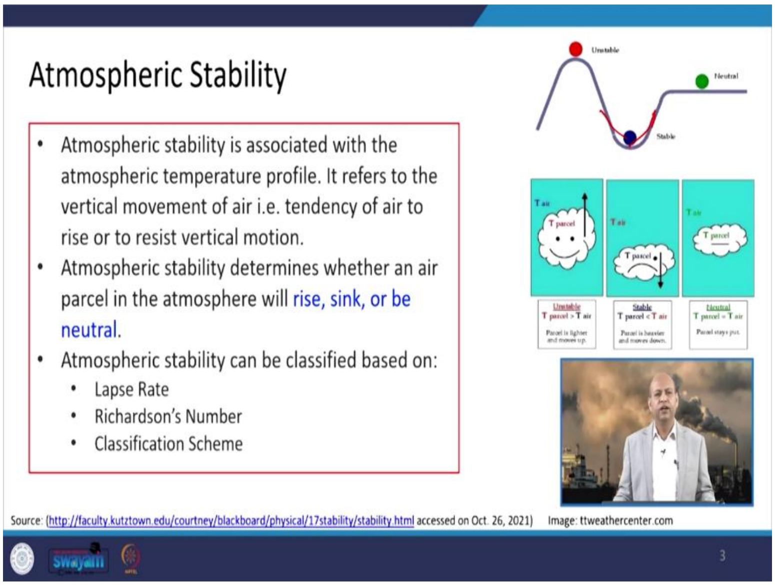

So, you will recall this kind of inner example, we showed you that something which is in this position it is stable because you take this ball to here or here it will come down to this position. Neutral means unless you provide some external force, it will remain wherever it is, but in this position even in small force, it will destabilise it, it will not be stable. So, it is unstable kind of situation.

So, in atmosphere also, depending upon the atmospheric temperature profile, the vertical movement of air parcel is influenced, whether it will go up or it will come down or it will hang on the same place where the air parcel is released. So, the atmospheric stability basically determines whether an air parcel in the atmosphere will rise, sink or be neutral. Well, atmospheric stability can be classified based on three major criteria like depending upon the lapse rate that is vertical temperature again, then some Richardson's number and classification schemes.

So, when we look at the stability classified or classification of the stability based on lapse rate, you have this kind of tabulation form which depends upon the dry adiabatic lapse rate, saturated adiabatic lapse rate and environmental lapse rate. Environmental lapse rate is the actual lapse rate within the atmosphere and dry adiabatic lapse rate and SALR are theoretical, DALR means Dry Adiabatic Lapse Rate that is 1 °C per 100 metre that kind of thing.

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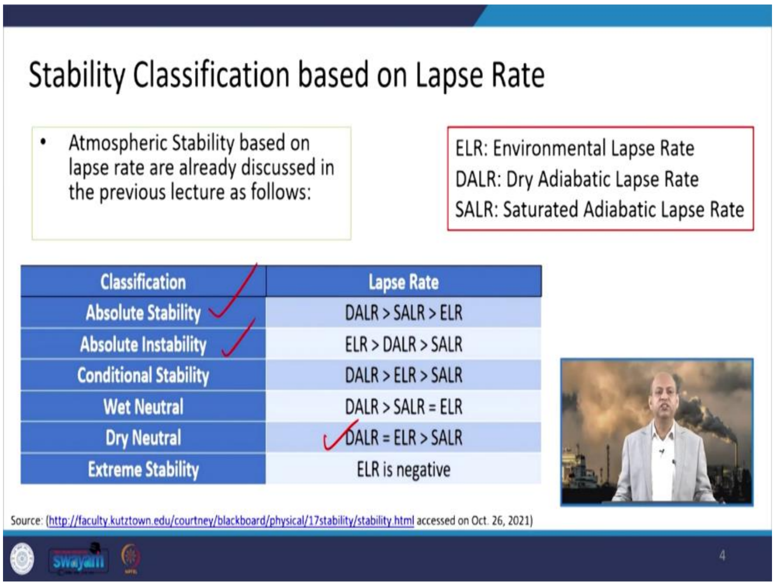

So, when this ELR is less than both DALR and SALR or you can say DALR is greater than SALR, which is always there and SALR is also greater than ELR in that case, the atmosphere is absolutely stable basically, when this environmental lapse rate is greater than DALR means the actual temperature gradient is faster, means temperature is decreasing faster than the theoretical lapse rate of the DALR , then this is absolutely unstable or instable.

Then conditionally stability like DALR is greater than ELR min ELR lying between SALR and DALR . So, that conditionally stability maybe depending upon whether we are considering in comparison of DALR or SALR. As you know DALR is Dry Adiabatic Lapse Rate, SALR is Saturated Adiabatic Lapse Rate, and ELR Environmental Lapse Rate. That is the actual lapse rate, which we observe and DALR and SALR we derive theoretically.

Then, wet neutral means, this DALR that is the Dry Adiabatic Lapse Rate, is greater than SALR and SALR and ELR are in parallel means both are same with the same gradient the temperature is decreasing in actual which is equal to SALR, then it is known as wet neutral, when the ELR is equal to SALR and then this kind of situation, DALR is equal to ELR and it is greater than SALR, then this is known as dry neutral.

And when ELR is negative means temperature instead of decreasing temperature is increasing with the height that is the negative gradient and that is known as inversion or extremely stable condition.

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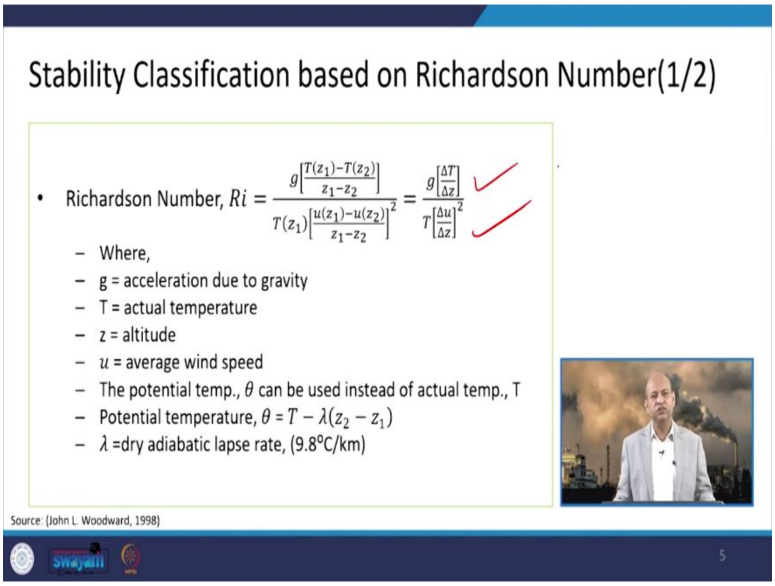

When we consider the Richardson number, this is defined as with this equation, we are you can see these are the parameters this g acceleration due to gravity, then $T(z_1)$, $T(z_2)$at different heights temperature, and actual temperature at z_1 and z_2 height, z_1 minus z_2 means difference between the height or the elevation, and this formula is used to calculate this particular relationship and this gives the R_i your Richardson number.

$$Ri = \frac{g\left[\frac{T(z_1) - T(z_2)}{z_1 - z_2}\right]}{T(z_1)\left[\frac{u(z_1) - u(z_2)}{z_1 - z_2}\right]^2} = \frac{g\left[\frac{\Delta T}{\Delta z}\right]}{T\left[\frac{\Delta u}{\Delta z}\right]^2}$$

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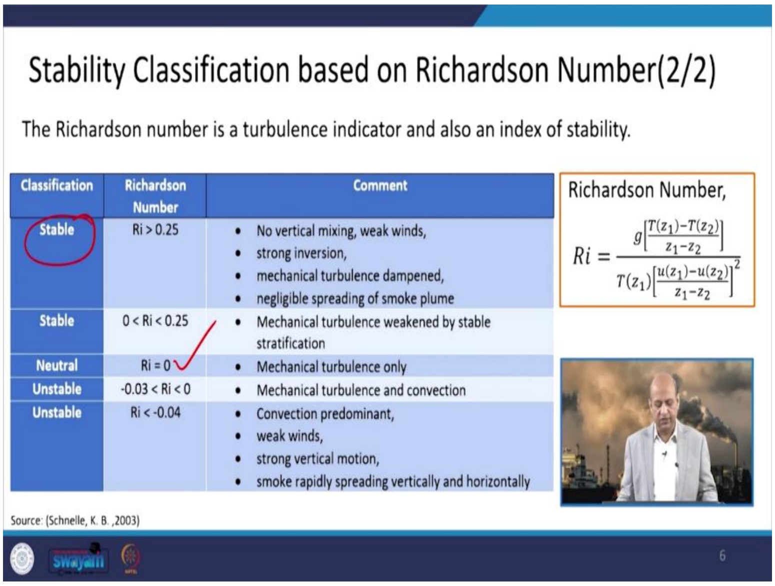

So, according to the Richardson number we can again define the stability classification of that atmosphere for example, if R_i is greater than 0.25, then it is the atmosphere is stable and in stable atmosphere no vertical mixing. Weak winds and then strong inversion may also happen. Mechanical turbulence is dampened, negligible spreading of smoke plume is there in a stable atmosphere.

Similarly, 0 greater than less than R_i and R_i is less than 0.25, then again no slightly stable kind of condition happens neutral happens. Neutral condition of this stability classification is when R_i is 0 when Richardson number is 0, similarly, unstable conditions may be as per different values of the R_i.

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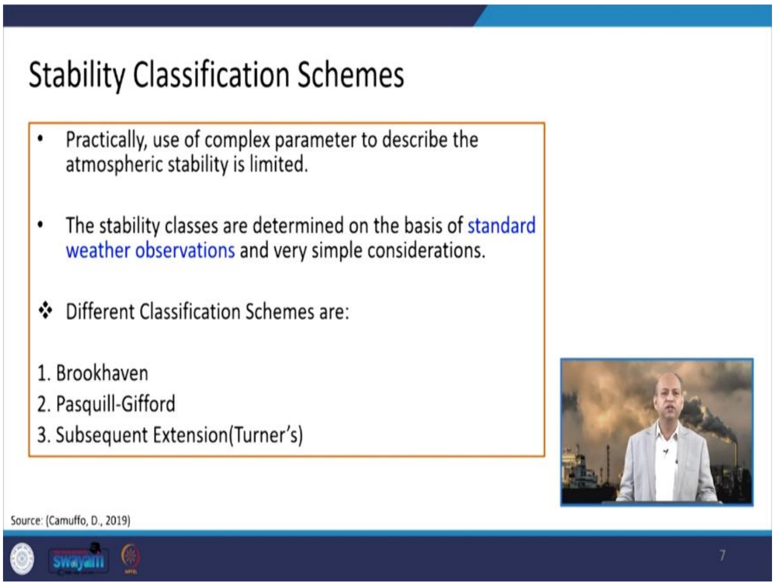

Well, so you can say that practically the use of these complex parameters of the gradient of the temperature or these Ri that is Richardson numbers we normally do not follow rather, we go for very simplistic things like visual inspections of plume and their shapes and, types or behaviour. So, different classification of schemes may also be there depending upon which has been proposed like name of the place or name of the scientist.

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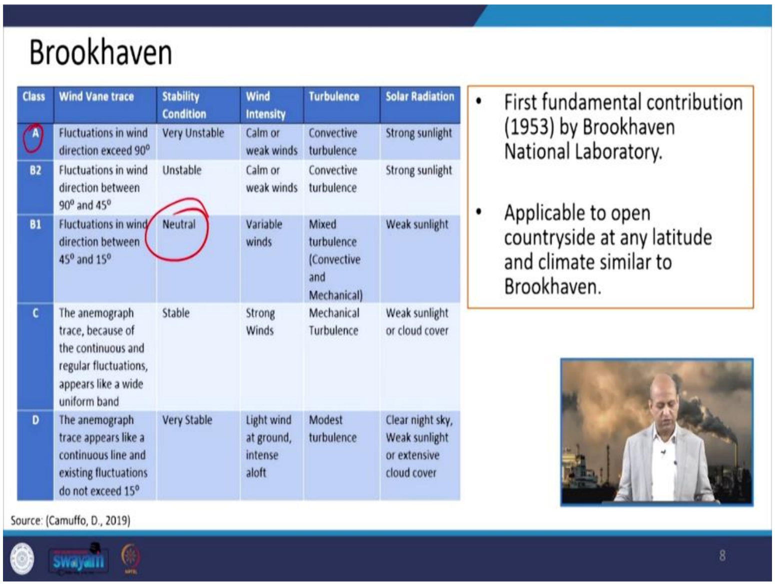

So, this is the Brookhaven a scheme which was given by the researcher at the Brookhaven National Laboratory and these are the classes A, B2, B1, C, D etc . So, very unstable, unstable, neutral all these kinds of are their relationship. Then, wind intensity, turbulence, solar radiation. Solar radiation is very strong, then this chances are this is very unstable, because when solar insulation is very strong then the Earth's surface becomes hot and the temperature gradient means decreasing of the temperature profile becomes more sharper means rapidly temperature decreases with the height, when insulation very strong.

Then weak sunlight, then it is neutral kind of thing means, maybe it is decreasing with the same rate as adiabatic lapse rate or so, that kind of thing. When solar installation is very weak or clear night so, that the temperature dissipation or when temperature of the earth is lost very quickly, then this temperature gradient becomes some sometimes a negative like inversion kind of condition may happen. So, those are the basically very stable kind of conditions

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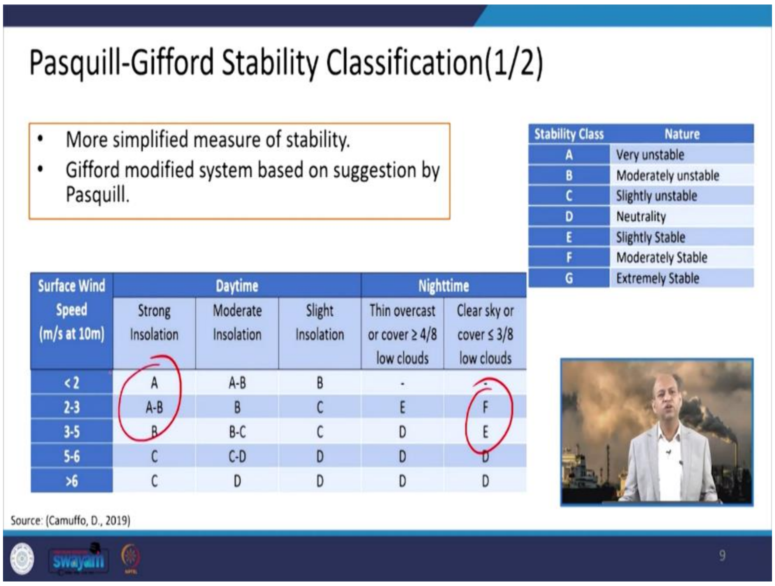

Well, when we talk about Pasquill-Gifford stability classification, then they give very good relationship between the surface wind velocity, surface wind velocity means the velocity which we have measured at the 10 metre height from the ground, that we call the surface wind velocity. Then the strong insulation or moderate insulation or slight insulation that is in the daytime. In night-time, they have two categories depending upon the cloud cover.

So, that thin overcast low clouds cover is more than 4 by 8, clear sky or cover is less than 3 by 8, if you divide the sky in the 8 parts and how much cloud cover is there accordingly you can call it clear sky or the thin overcast those kind of thing. So, accordingly, classification of this atmospheric instability is there in terms of A, B, C, D, like, E, F, and G. A is very unstable, B is moderately unstable and C is slightly unstable then D is neutral.

Again neutral whenever neutral is there, means the temperature is decreasing with the rate of dry adiabatic lapse rate 1 °C per 100 metre or 10 °C per kilometre you please remember this, slightly stable E and F is moderately stable, G is extremely stable or inversion you can call, so those kind of things maybe they are depending upon when clear sky is there.

So, the you can see this stability is increasing F, E, those kinds of thing, because the temperature losing mechanism is very prominent in that case Earth surface loses temperature. So, there are chances that temperature instead of decreasing it sometimes increased means temperature is lower at the surface and higher in the our upper layers of the atmosphere, those kinds of situations may there.

Well, when a strong insulation there, then the chances of this high temperature gradient or the decrease of the temperature faster than DALR, the chances are there that is why these unstable conditions occur A or B.

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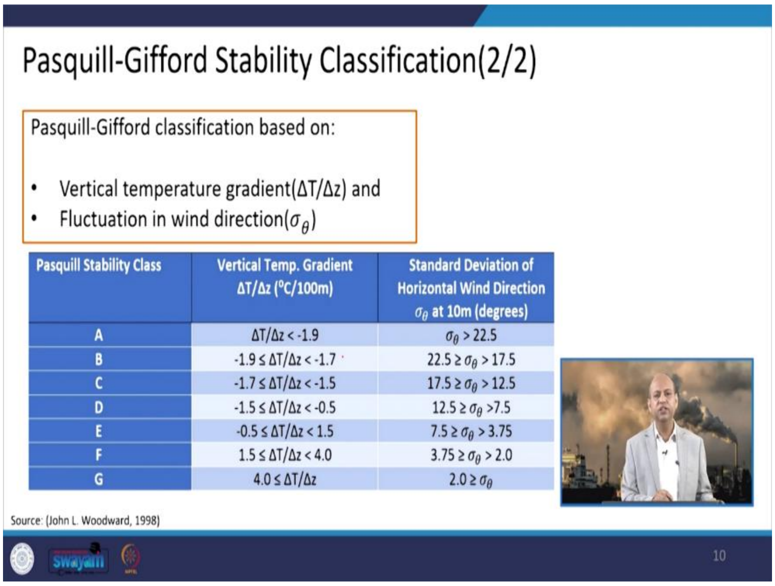

When we see these in terms of vertical temperature gradient and this is standard deviation horizontal wind direction, again some classification has been given according to their values this can be seen in this table.

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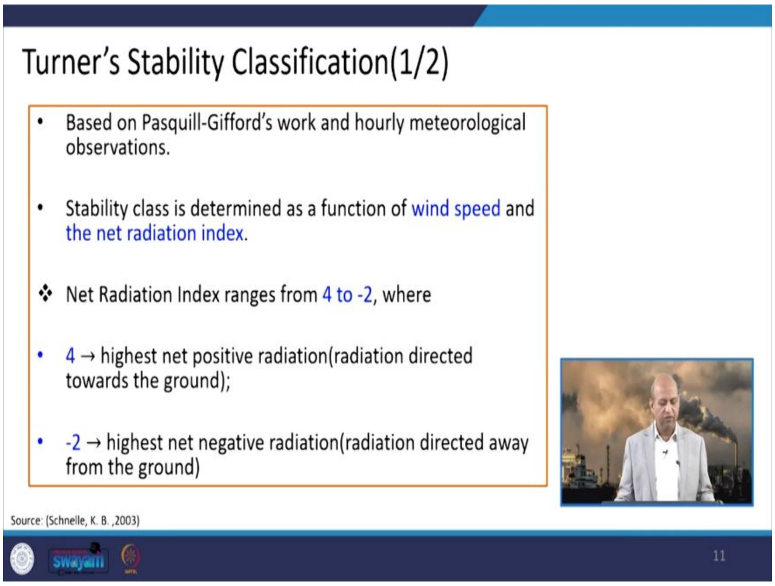

Well, the Turner's stability classification with which you can determine upon the basis of Pasquill-Gifford work and hourly meteorological observations and the stability class is determine as a this function of wind speed and the net radiation index. A net radiation index may range from 4 to minus 2 where, 4 is highest net positive radiation, radiation directed towards the ground and minus 2 highest net negative radiation, radiation directed away from the ground.

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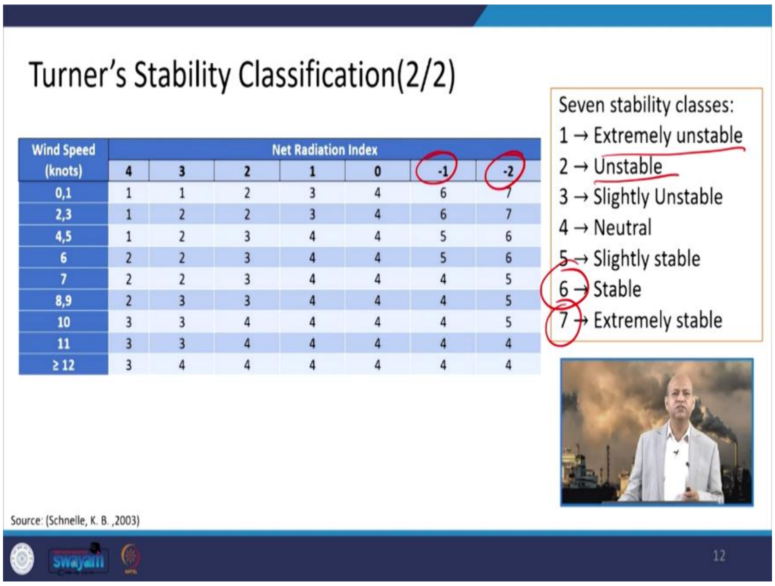

Wind Speed (knots)	Net Radiation Index						
	4	3	2	1	0	-1	-2
0,1	1	1	2	3	4	6	7
2,3	1	2	2	3	4	6	7
4,5	1	2	3	4	4	5	6
6	2	2	3	4	4	5	6
7	2	2	3	4	4	4	5
8,9	2	3	3	4	4	4	5
10	3	3	4	4	4	4	5
11	3	3	4	4	4	4	4
≥ 12	3	4	4	4	4	4	4

So, accordingly you can see the stability more stable classifications are there minus 1 and minus 2, net radiation index inferences, because this 7 is extremely stable, 6 is stable. So, those kinds of things are visible in this particular index number you can see this radiation index otherwise, you can have, this wind speed and the net radiation index when it is 1, 2 those kind of these are extremely unstable.

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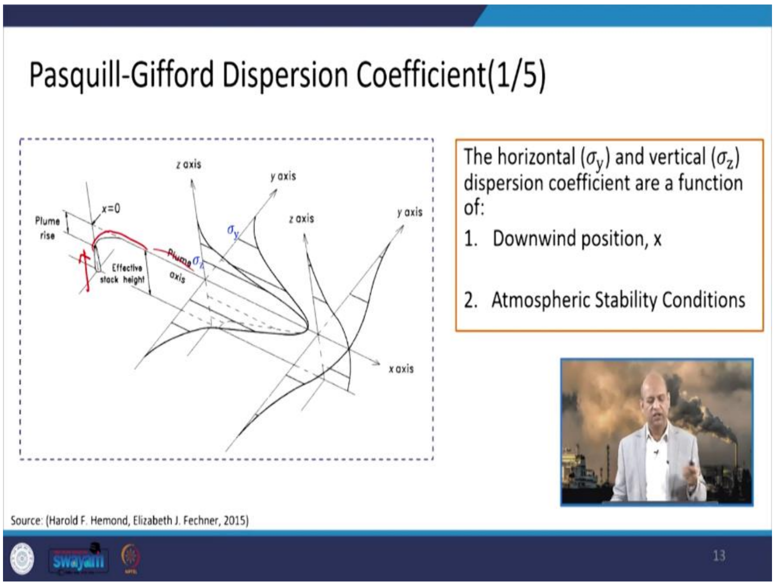

So, several kind of classification schemes are there, but mostly this Pasquill-Gifford scheme is very much used by researchers and in dispersion modelling efforts also that is very easy to follow and understand. Well, when you see this particular coefficient Pasquill-Gifford dispersion coefficient means how the pollutants dispersed from the central line.

So, for example, this is, this stack and from stack this plume comes and then it starts dispersion, it goes into downwind direction, x_0 means x increases when we go away from this stack. So, the plume, disperses away from the centreline in horizontal direction as well as in vertical direction, that is why it kind of funnel shape you can see in the plume and it widens when you go away from the stack.

And this deviation from the centre in horizontal direction is sigma y, which is known as horizontal dispersion coefficient sigma y, and the vertical dispersion coefficient is sigma z in the y direction. So, these values really help us when we do modelling for estimating ground level concentrations depending upon many metrological parameters and each stack parameters.

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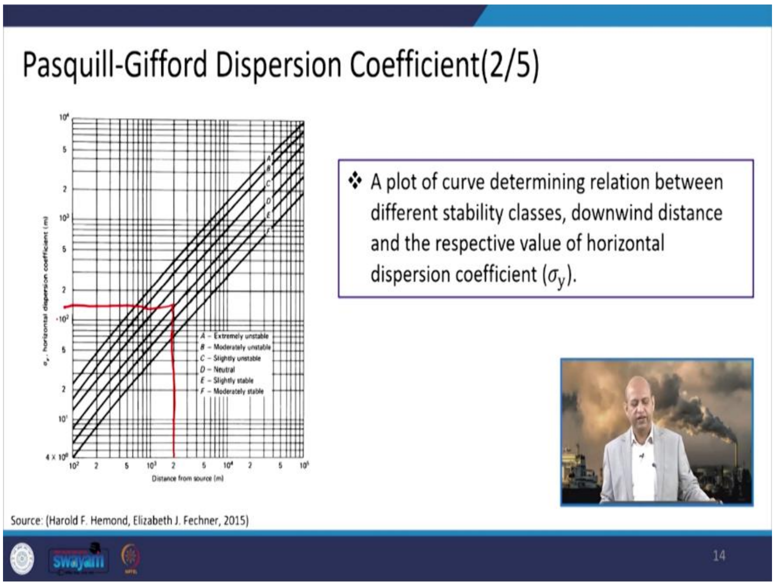

Well, so the coefficient like based on a steadies empirical observations, they have prepared this kind of chart where you can, see the downwind distance from the source and here the value of sigma y and these A, B, C, D, E, F these lines show the variation of this horizontal, this coefficient dispersion coefficient and distance from the source horizontal distance.

So, for example, you want to know what is the value of sigma y at 200 metre. So, you go at these 200 metres or 2 kilometre, then here this is 2000 metre you go up, if you know that you want to calculate sigma y four, let us say D. So, where is the D neutral condition you go up to D, then you go this. So, this value will be the sigma y very simple way of estimating sigma y.

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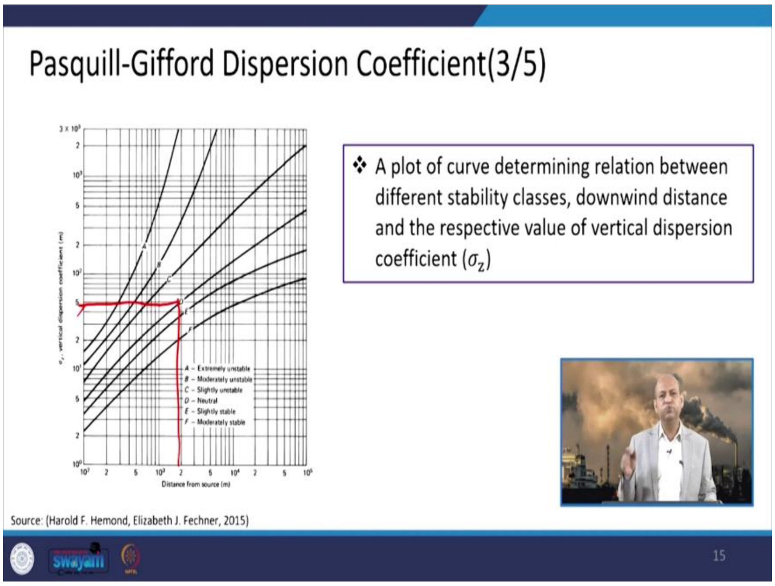

Similarly, sigma z So, these are the plots which show the variation of vertical dispersion coefficient and the distance from the source horizontal distance. So, again if you take the 2 kilometre or 2000 metre and go up to D, then you can get this value of sigma z. So, that is the very simple way of getting sigma y and sigma z which will be used for estimating concentrations in Gaussian dispersion models.

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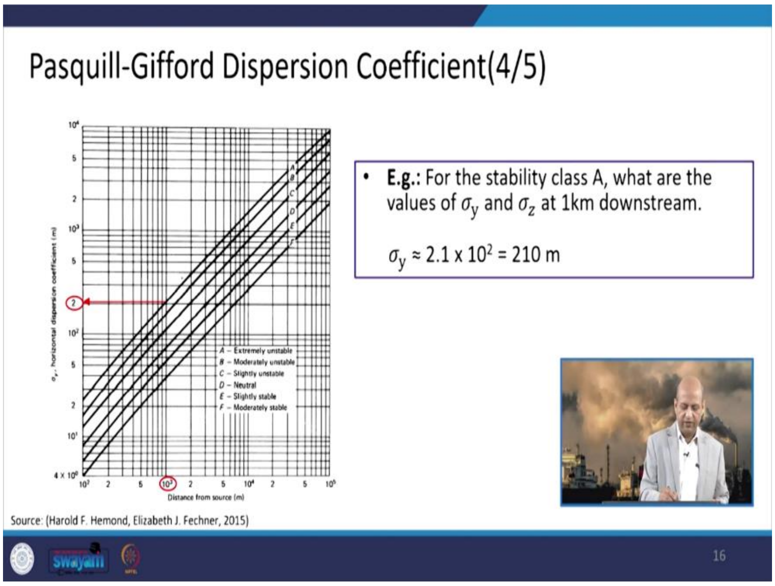

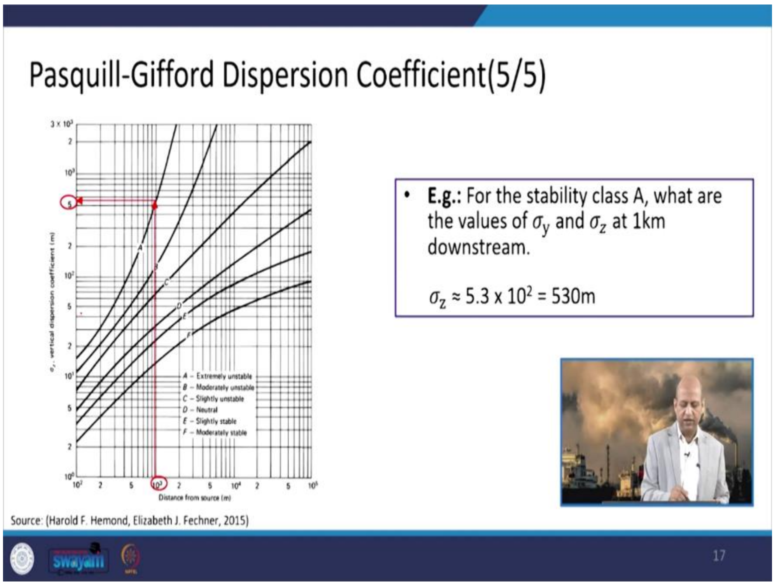

Well, for an example, like for if you are given the stability class A like I just show for stability class D, but if it is a stability class A and the values of sigma y and sigma z are determined at 1 kilometre, then 1 kilometre is nothing but 1000 metre. So, here you go up to this A, this is the A and you go this side, so, you get this value.

Similarly, sigma z from 1 kilometre you go to the A and go to the left side and get the value of sigma z and that is 530 metre around this is 210 metres sigma y and sigma z is 530. There are other relationships like sigma y sigma z empirical relationships are also there which we will discuss and we can compare and more or less they are similar little bit difference maybe they are depending upon other values.

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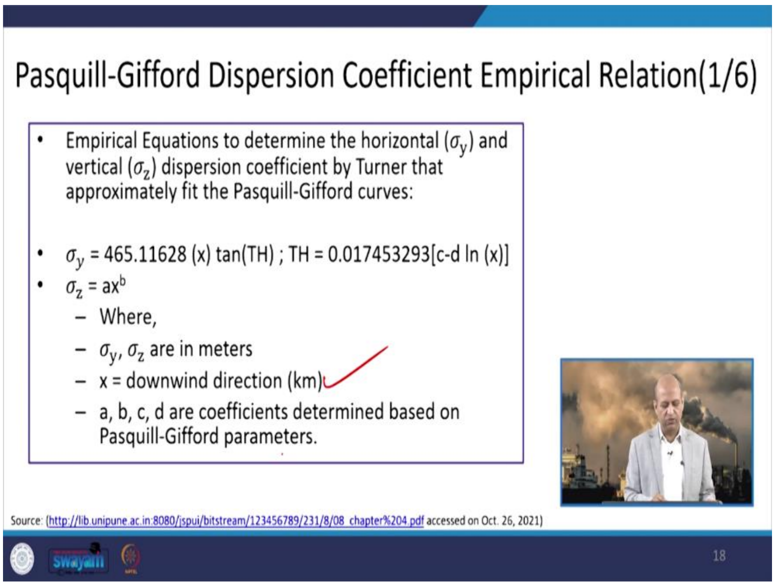

Like, this is one empirical relationship σ_y = 465.11628 (x) tan(TH) ; TH = 0.017453293[c-d ln (x)] and theta (TH) is given by this relationship where C D and A and B are some sort of coefficients, sigma y, sigma z are a metres, downwind distances are in kilometres. Whereas, in graph it was in metres distance was in metres please remember. A, B, C, D are coefficient determined based on Pasquill-Gifford parameters.

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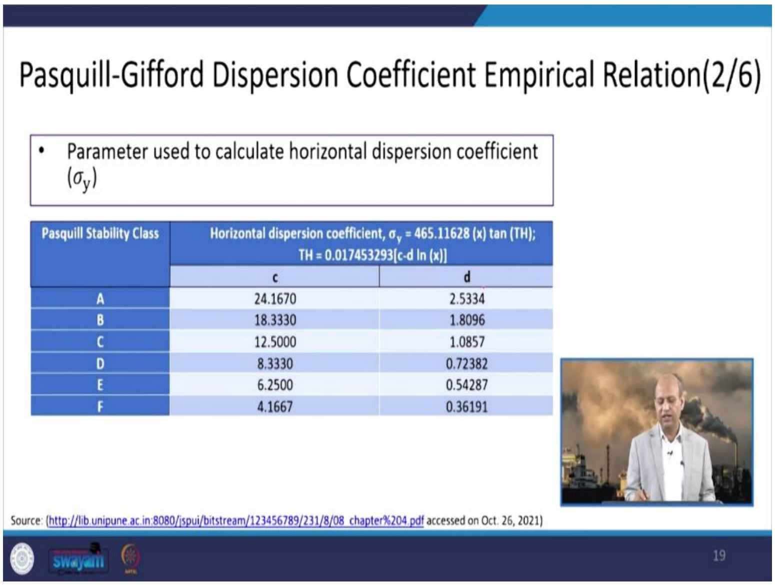

So, when if you see this particular table, we are Pasquill stability classification A, B, C, D, E, F are there and the values of C and D are there. So, you can use these values in that formula.

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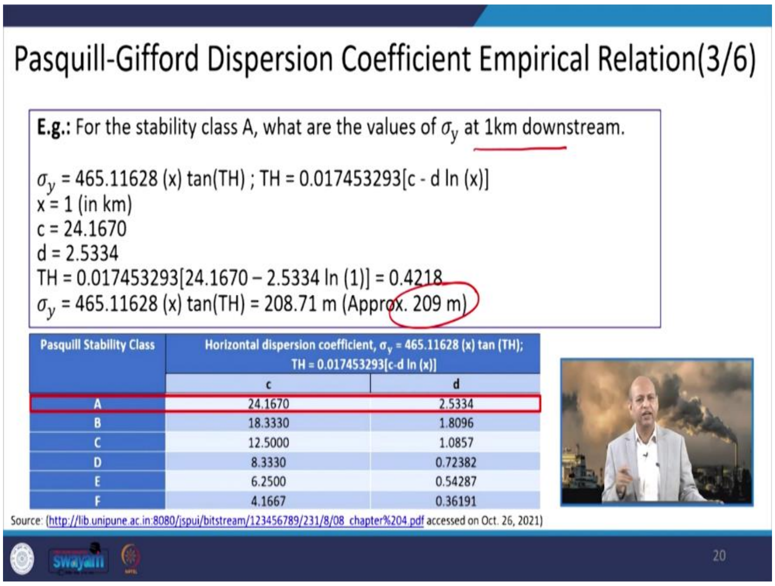

For example for the stability class A you want to again calculate sigma y for 1 kilometre downstream the same value which we used in the graph. So, you get this kind of calculation and around 209 metre, whereas from that graph we got 210 metre or so.

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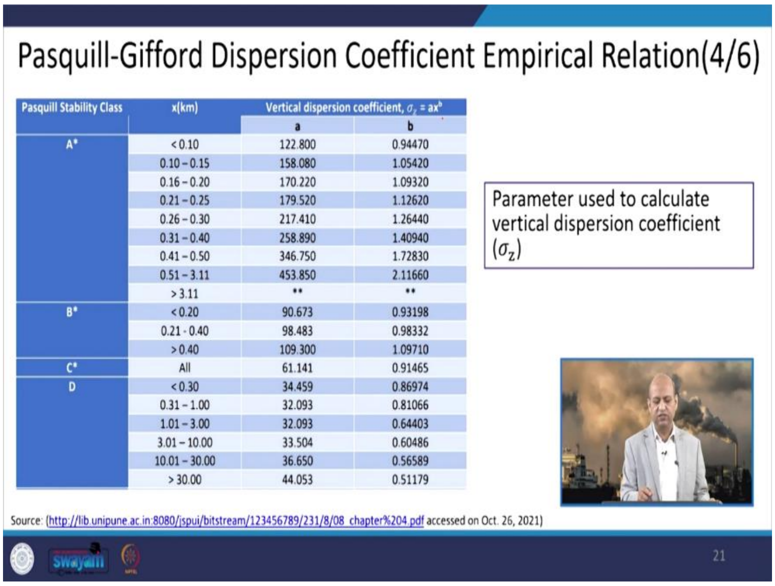

Pasquill-Gifford Dispersion Coefficient Empirical Relation(4/6)

Pasquill Stability Class	x(km)	Vertical dispersion coefficient, $\sigma_z = ax^b$	
		a	b
A*	< 0.10	122.800	0.94470
	0.10 – 0.15	158.080	1.05420
	0.16 – 0.20	170.220	1.09320
	0.21 – 0.25	179.520	1.12620
	0.26 – 0.30	217.410	1.26440
	0.31 – 0.40	258.890	1.40940
	0.41 – 0.50	346.750	1.72830
	0.51 – 3.11	453.850	2.11660
	> 3.11	**	**
B*	< 0.20	90.673	0.93198
	0.21 - 0.40	98.483	0.98332
	> 0.40	109.300	1.09710
C*	All	61.141	0.91465
D	< 0.30	34.459	0.86974
	0.31 – 1.00	32.093	0.81066
	1.01 – 3.00	32.093	0.64403
	3.01 – 10.00	33.504	0.60486
	10.01 – 30.00	36.650	0.56589
	> 30.00	44.053	0.51179

Parameter used to calculate vertical dispersion coefficient (σ_z)

Source: (http://lib.unipune.ac.in:8080/jspui/bitstream/123456789/231/8/08_chapter%204.pdf accessed on Oct. 26, 2021)

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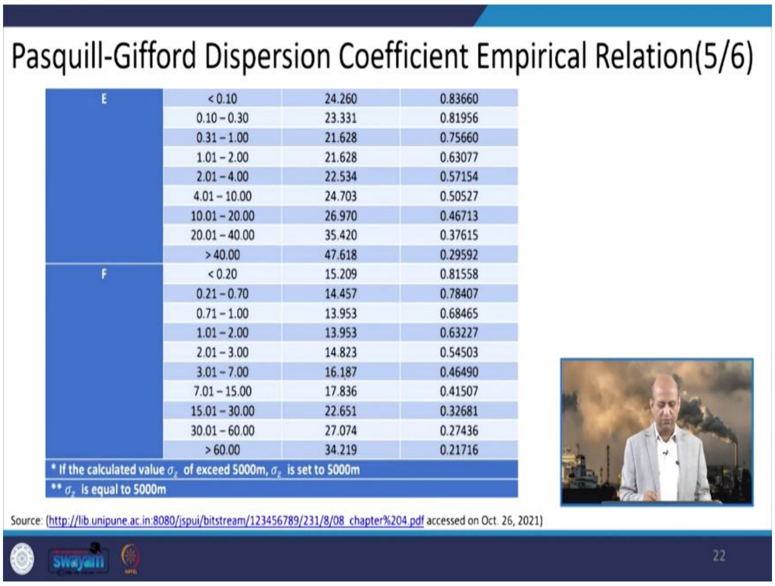

Pasquill-Gifford Dispersion Coefficient Empirical Relation(5/6)

E	< 0.10	24.260	0.83660
	0.10 – 0.30	23.331	0.81956
	0.31 – 1.00	21.628	0.75660
	1.01 – 2.00	21.628	0.63077
	2.01 – 4.00	22.534	0.57154
	4.01 – 10.00	24.703	0.50527
	10.01 – 20.00	26.970	0.46713
	20.01 – 40.00	35.420	0.37615
	> 40.00	47.618	0.29592
F	< 0.20	15.209	0.81558
	0.21 – 0.70	14.457	0.78407
	0.71 – 1.00	13.953	0.68465
	1.01 – 2.00	13.953	0.63227
	2.01 – 3.00	14.823	0.54503
	3.01 – 7.00	16.187	0.46490
	7.01 – 15.00	17.836	0.41507
	15.01 – 30.00	22.651	0.32681
	30.01 – 60.00	27.074	0.27436
	> 60.00	34.219	0.21716

* If the calculated value σ_z of exceed 5000m, σ_z is set to 5000m

** σ_z is equal to 5000m

Source: (http://lib.unipune.ac.in:8080/jspui/bitstream/123456789/231/8/08_chapter%204.pdf accessed on Oct. 26, 2021)

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Similarly, for sigma z you can use this A B values C D values was for sigma y, in sigma z this is ax^b. So, you calculate the sigma z.

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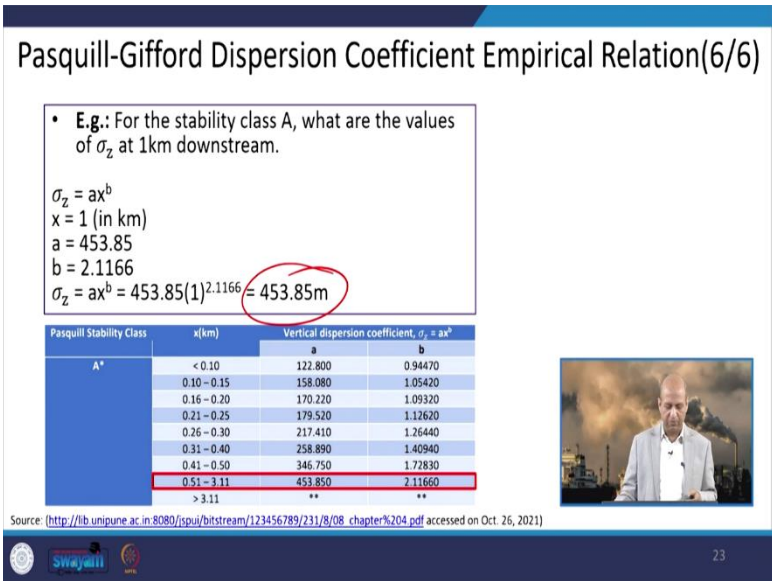

Here in this and you get value around 454 metre, where is it was 500 and I think 30 or so. So, a little bit difference, but it is not kind of that you are estimating 100 or 150 another one is 500-600 something like that. So, those kinds of differences may be fine in case of atmospheric dispersion modelling because atmospheric dispersion modelling is very rough estimation, it is not very precise and even 50-60 percent deviation sometimes called it is fine otherwise.

But there are other techniques which are becoming now robust, but in atmosphere so, many uncertainties are there like wind velocity, temperature gradient you can never measure in actual sense because its changes every minute or every hour and for calculation purposes you cannot go for so many no parameters. So, approximations are always there.

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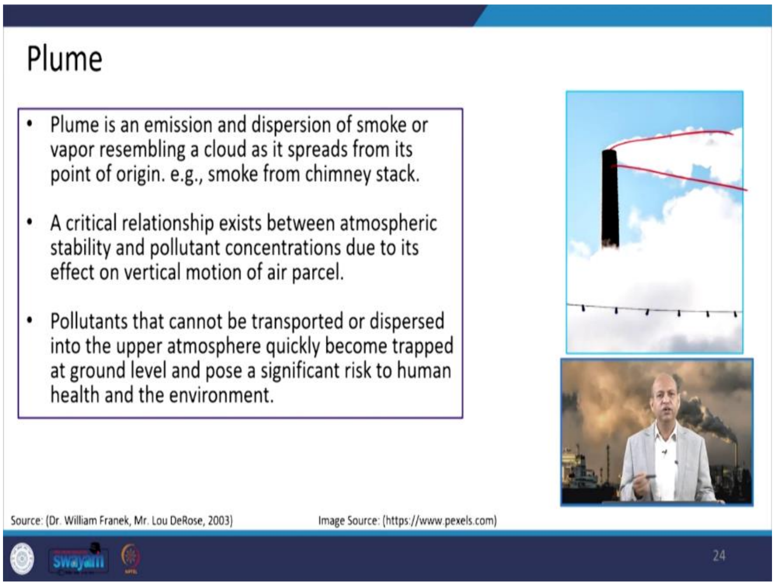

Well, when we talk about the plumes, the plume is nothing but, the emission of the these exhaust gases or particles and the dispersion of the smoke or vapour you can see and resembling as a cloud it goes down and spreads from a point of its origin. So, from like stack or wherever, something happens like this and it disperses according to the wind velocity according to the stability classification.

And the critical relationship exists between atmospheric stability and pollutant concentrations due to its effect on vertical motion of air parcel, because if this vertical motion is promoted or helped by this unstable atmosphere, then dilution will be quick, the concentration will be less and when it is stable, then concentration will be high, because dispersion will be less.

So, the pollutants, which cannot be transported or dispersed into the upper atmosphere, quickly become trapped at the ground level and it can cause significant risk to the human because of exposure and those instability conditions we have to see, which creates such situation. So, we should avoid those kind of conditions, we have to see what is the plume behaviour and the dispersion effect of the stability classification.

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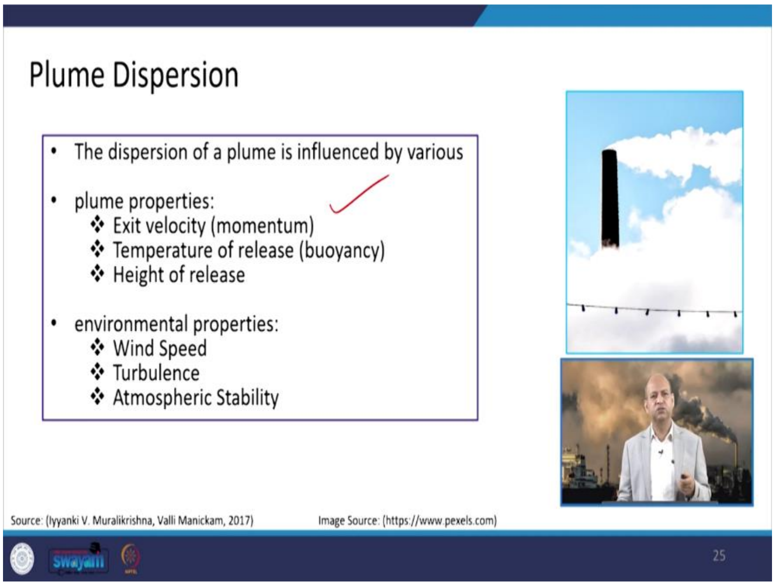

Well, so we can see the plume dispersion depending upon it is, influenced by several properties like exit velocity, stack velocity or there are plume properties you can call. Exit velocity from the stack, temperature of the release that buoyancy, exit velocities momentum, height of the release even diameter all those things are there.

Then environmental properties maybe like wind speed, turbulence and the atmospheric stability or vertical temperature profile, they will influence the dispersion from metrological point of view or environmental point of view. So, both these set of parameters or properties, they influence the dispersion of pollutants and plume.

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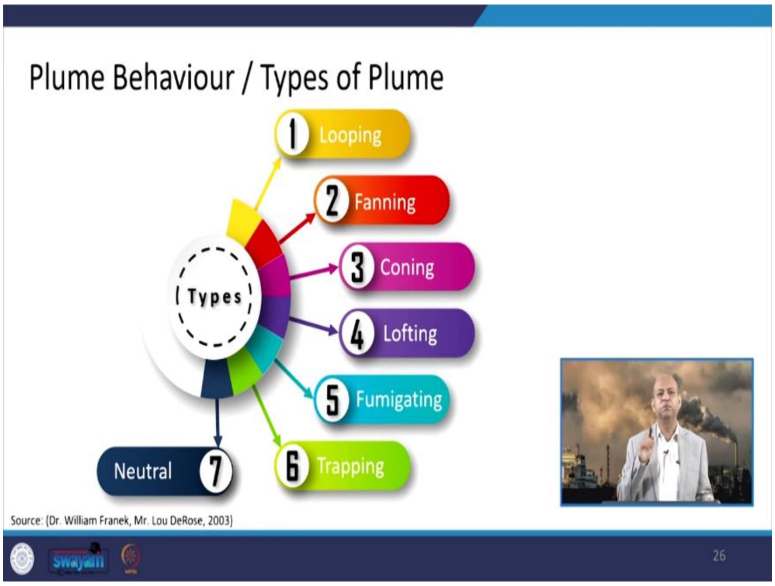

So, the types of plume or the plume behaviour is determined by you know can say the stability class, like a stability class can be extremely unstable, moderately stable, neutral, stable, extremely stable inversion those kinds of things. So, let us see accordingly like it will happen like looping or feigning or coning, lofting, fumigating, trapping neutral, those kinds of plume types can be there depending upon a particular instability class. So, let us see one by one.

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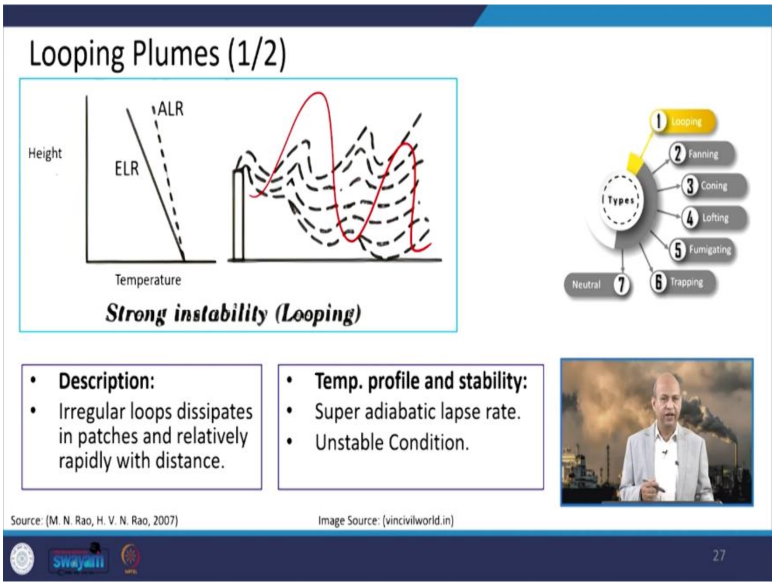

Looping plumes means the plume when it comes out then it goes up and down and dispersion happens very quickly and the reason is because the ELR that is the Environmental Lapse Rate actual lapse rate is higher than the adiabatic lapse rate. So, the atmosphere is unstable and turbulence is low and depending upon this turbulence this fluctuation will go like it will go up it will come down.

So, a lot of Eddies of the air this mixing is there and atmospheric Eddies plus turbulence they help in diffusion and dispersion of the pollutant and this wind also takes away. But, the what is the problem in unstable atmosphere sometimes because plume goes up and come down. So, it can come down and at the surface concentration may be higher near to the sources which is not so, good.

But ultimately, the dispersion happens quite quickly and dilution happens quite significantly, but at certain places at certain locations near to the source the concentration may be higher.

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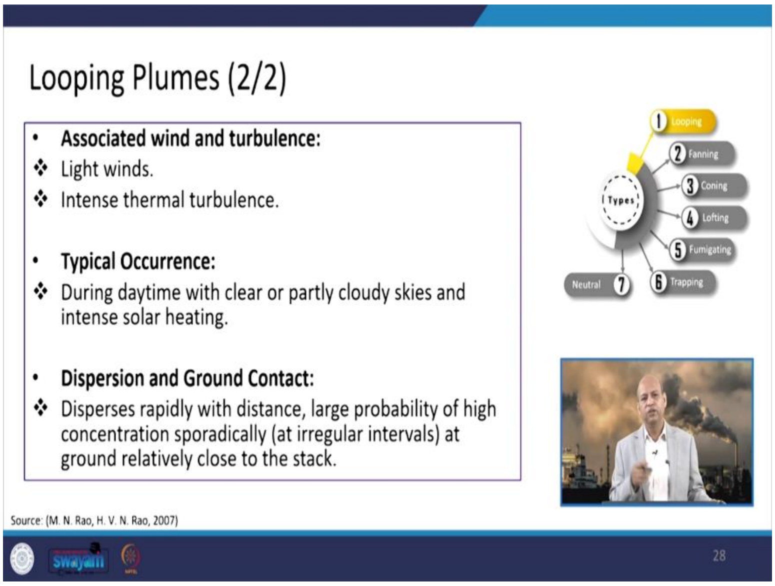

And you can see the associated wind and turbulence properties like light wind maybe there, then thermal turbulence are intense. And the occurrence may happen like daytime with clear or partly cloudy skies, intense solar heating must be there. So, that gradient of temperature is faster than or more than this ALR Adiabatic Lapse Rate.

Then dispersion and ground contact as I said rapidly with the distance this dispersion happens, but probability is quite high when concentration at some places irregular although, but at nearby places maybe higher than the required.

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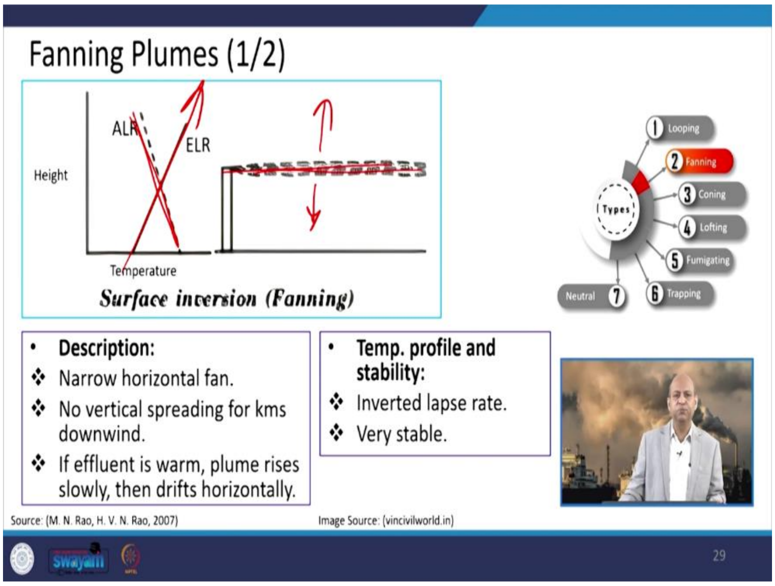

Well, fanning happens when this the plume neither goes up nor come downs rather it goes in a kind of thin layer with the downwind direction. So, that happens when the inversion condition is there. So, now neither it will go up nor it will come down, it will just stay thin line like a very sheet kind of thing. So, the narrow horizontal fan you can assume that is why it is known as fanning.

No vertical spreading for kilometres in the downwind direction and if effluent is warm, plume rises slowly depending upon the condition of the atmosphere and it drifts horizontally because that is possible horizontal drifting, dispersion is possible but vertical is restricted because of this inversion phenomena.

And the temperature as you see the inverted lapse rate is there because the temperature rather than decreasing with the height, it is increasing, this theoretical lapse rate is decreasing ALR Adiabatic Lapse Rate, the environmental upset actually is increasing with the height so, that is very dangerous thing, we should avoid and at the places where a lot of inversions occur, we should be very careful we should not go for higher emission related activities in those locations.

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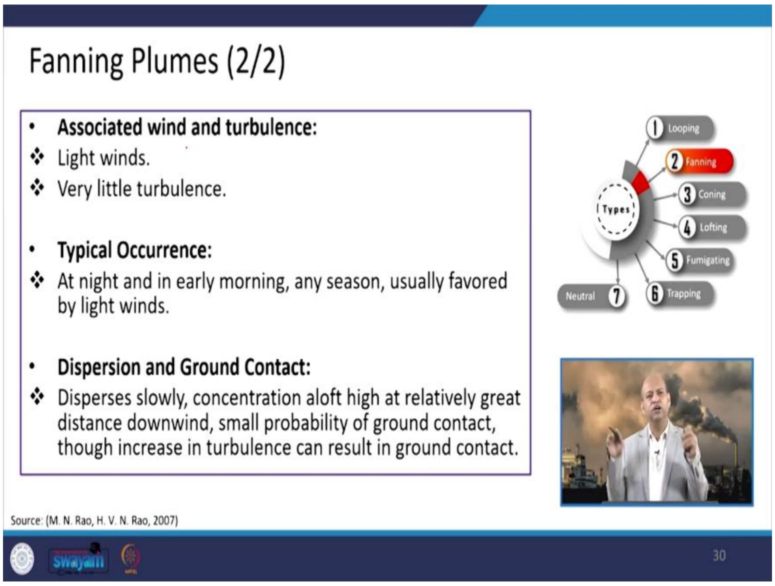

Well when we talk about, these wind turbulences etc. So, again light winds, or very little turbulence can be there, and it can happen at night or early morning, when the temperature of the surface is lower, and chances are there that the upper layers of atmosphere is warmer, that is why this inversion phenomena will be there. And those things like, the concentration is of course, it will not come to the ground, but it will hang on the atmosphere. So, at certain height, it will be higher, but it will be avoiding the ground level concentration.

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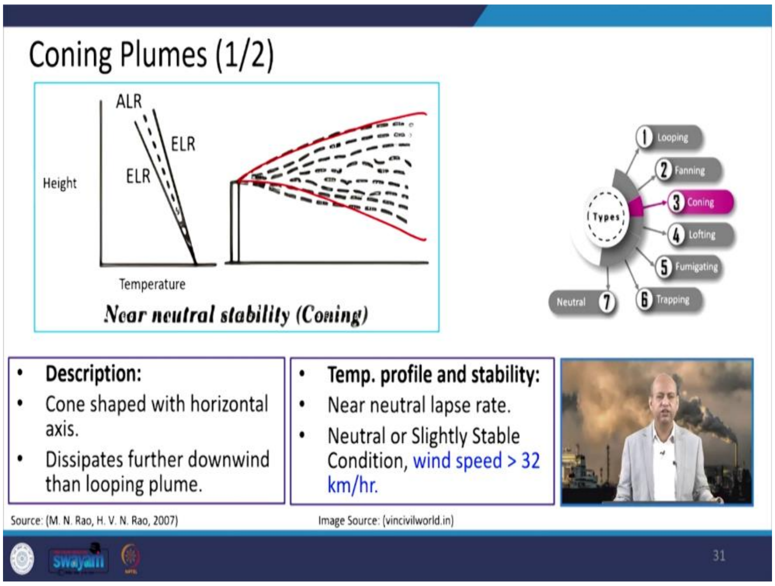

When we talk about coning it happens when like near neutral phenomena means, the actual environmental lapse rate is almost near to the ALR. It may be parallel or just a little bit, higher side lower side does not much matter. And this cone means, vertical movement can happen on both sides upper and lower and like a funnel or cone, the dispersion happens that is why it is known as coning.

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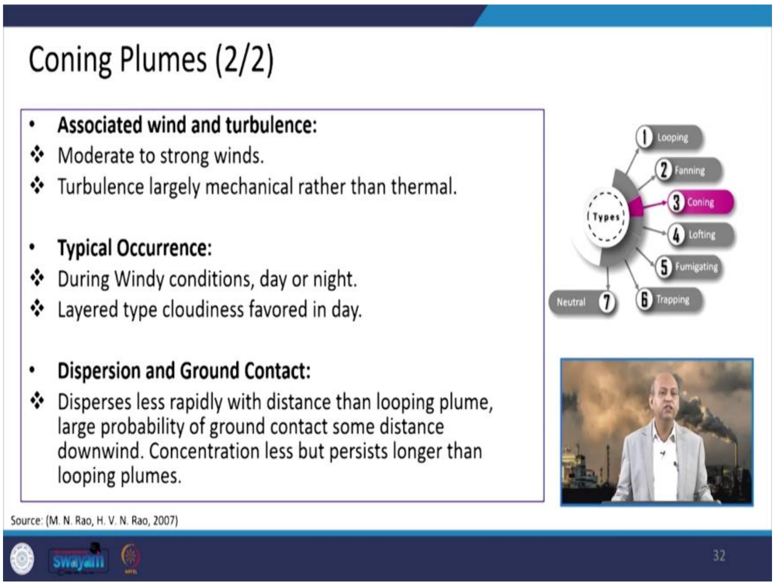

And you can see like, moderate or strong winds are the kind of properties which signify these particular phenomena, turbulence largely mechanical rather than thermal, and this during windy conditions, day or night it can occur and layer type cloudiness can be there which can favoured in the daytime.

And the dispersion less rapidly with the distance then looping in comparison to the looping. Looping, dispersion happens quite quickly. So, dilution will not be as good as like in looping, in the case of looping. But, it will not have the higher concentration at very near distances which may happen in case of looping.

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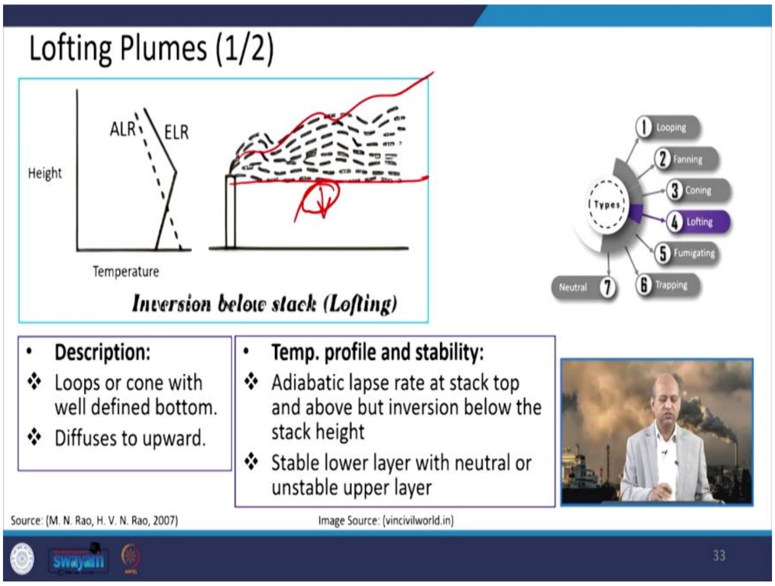

When we talk about lofting, which occurs when lower side like stack emission is there, the below the stack height inversion is there. So, the vertical movement of the plume is restricted or not encouraged it is you stopped. So, kind of this line is there at the site and if unstable atmosphere is upper then this stack height, then the dispersion will happen on upper side.

So, that is why it is called as lofting it is a very good thing for us, because it will not induce or it will not increase concentration to build up higher at the ground level. Because ground level there is no concentration only dispersion will happen on the vertical side and when lot of dilution will happen even if this inversion is broken, then the pollution will come to the ground level it will be very less. So, this kind of situation is very helpful for us.

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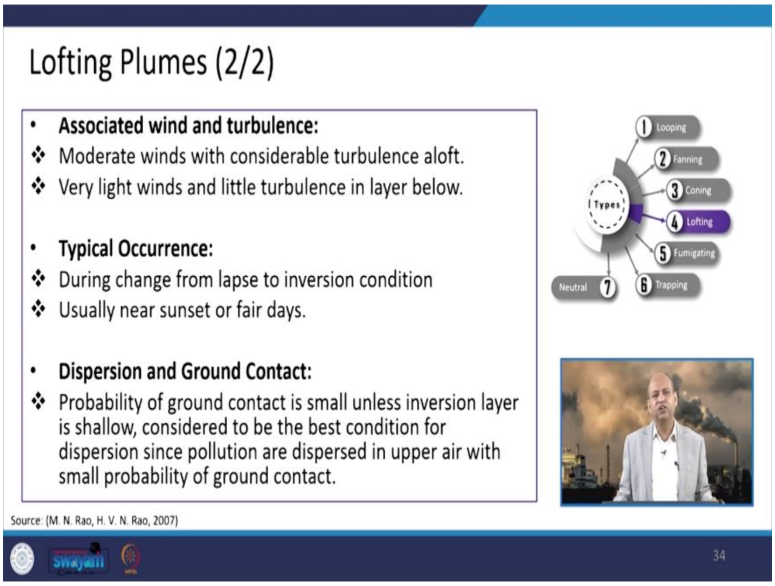

And the situations when it happens like moderate winds, considerable turbulence, very light winds or literal turbulence those kinds of situations may be there and probability of ground contact is very small, unless inversion layer is shallower it is broken very quickly and it is considered as the best condition as I said for dispersion purpose, because it will avoid the ground level contact of the pollutants.

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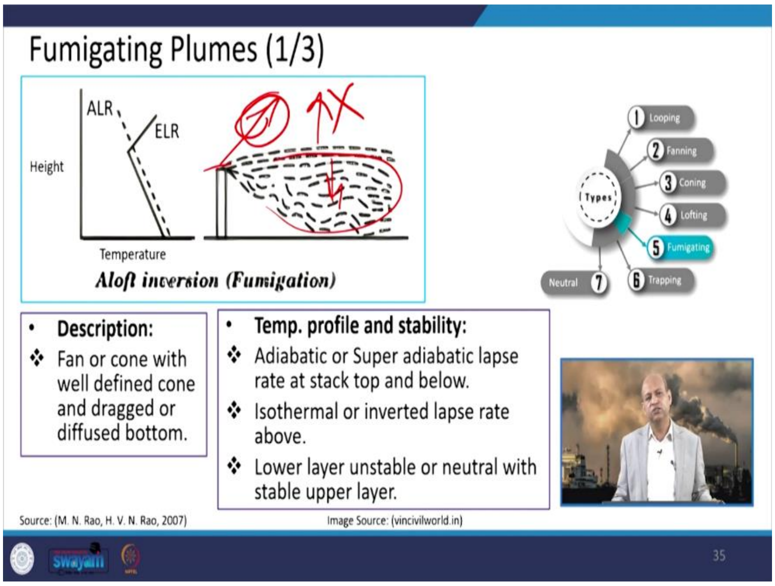

This is very dangerous, which is known as fumigating, when the inversion is above just above the stacks emission. So, this is the inversion and the vertical movement will not be there above the chimney height or stack height. But whether it is neutral or it is unstable below this stack height then lot of vertical movement will be there in this particular location.

So, the high concentration will be there because of this fumigation this is very very dangerous, because, very high concentration may occur at the ground level and those receptors whether it is people or animal or ecosystem, they will be severely affected because of this.

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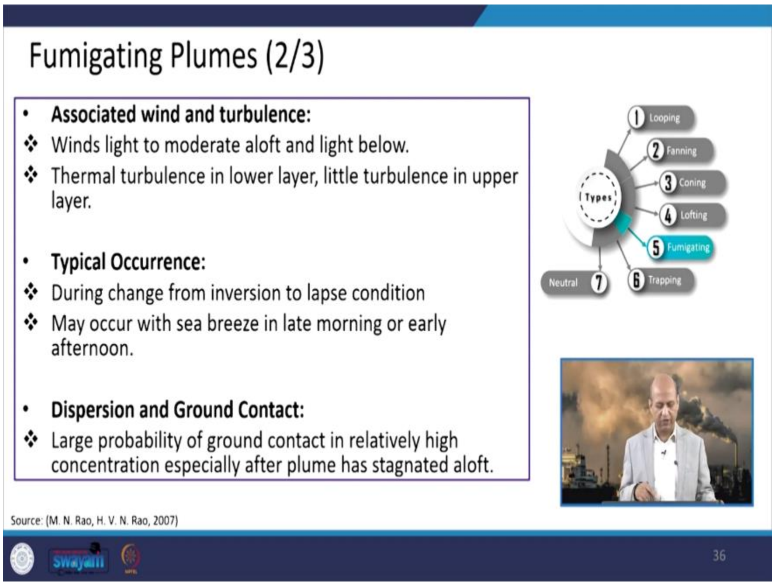

And these are the conditions when it occurs like during change from the inversion to the lapse conditions, it may occur also with the Seabreeze in the late morning or early afternoon, when upper layer maybe their inversion remains and the lower inversion breaks. So, a lot of turbulence and instability is there at the lower layer and the dispersion may happen very quickly.

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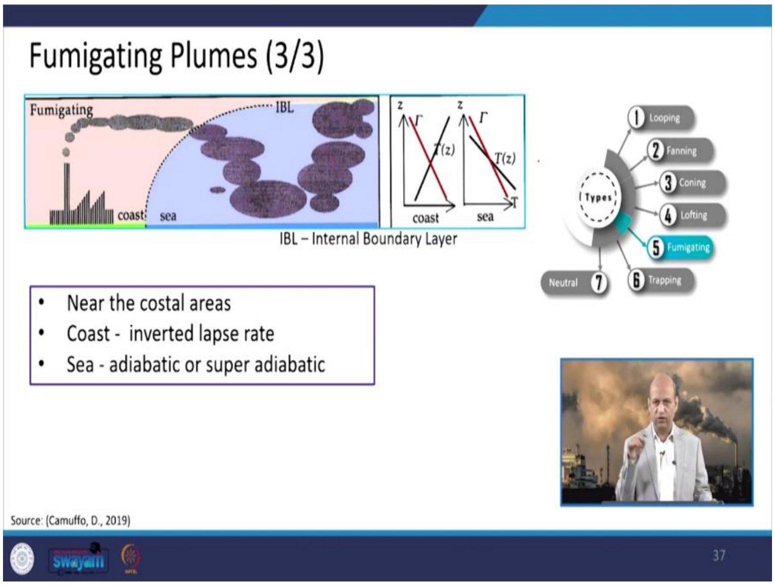

Well, the fumigating, plumes you can see here different kinds of conditions like near coast and Sea-adiabatic, super adiabatic those conditions may happen. So, coastal regions like this is the inversion then this kind of situation may happen because of the temperature changes. So, at the lower level inversion is not there, this inversion breaks. And then it can be the dispersion or the lower side of the atmosphere.

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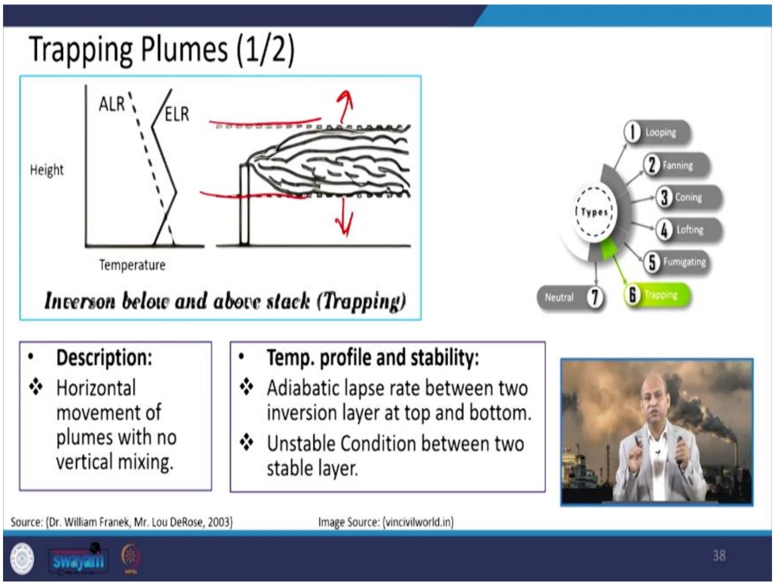

When we talk about trapping, this happens when below a certain height inversion is there and above certain height inversion is there and in between unstable condition occurs or neutral condition occurs. So, dispersion becomes only between these layers. So, the trapping because plume neither goes up or comes down from these particular heights. So, within a layer, this kind of sandwich kind of condition happens with the plume, unless this inversion breaks out, because of certain temperature gradient.

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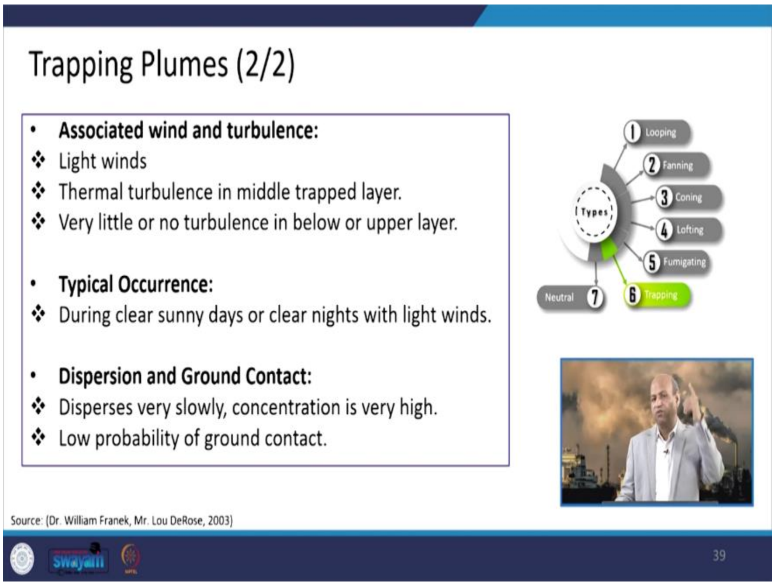

And this happens like light wind thermal turbulence or dispersion very slowly concentration is very high in that particular layer and low probability to come in contact with the ground because, this is as I said trapped and it can, move in the horizontal direction with the horizontal windward vertical distribution is restricted.

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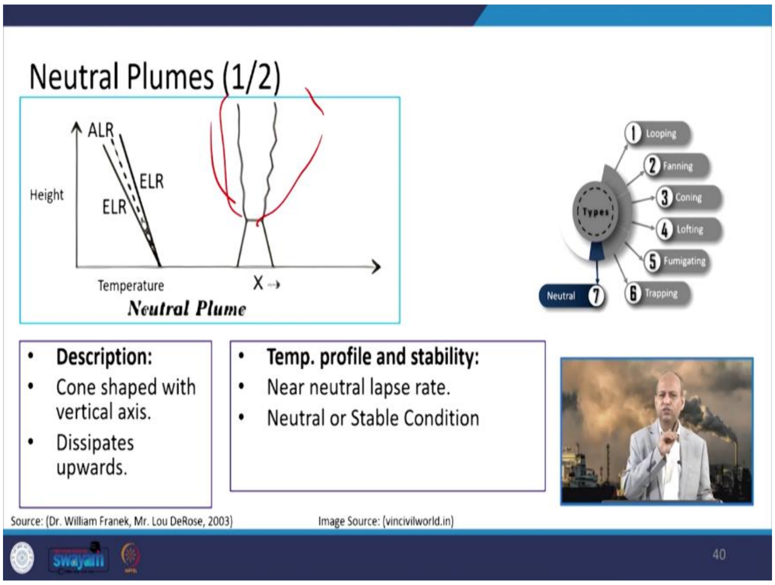

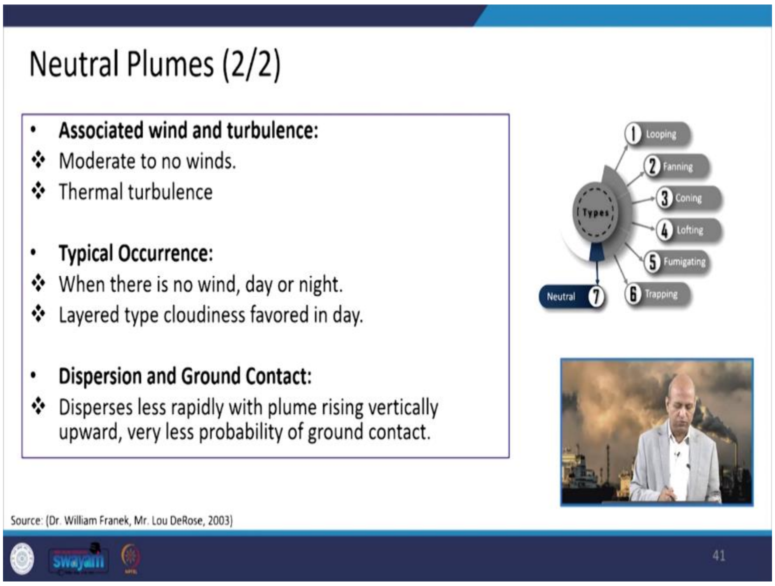

When we again talk about neutral plumes and if horizontal wind is not so much, calm conditions are there, then plume rather than going downwards as a coning or something like that, it will just go up. So, this kind of mushrooming kind of thing may happen, it may go like this, that kind of condition.

So, whenever you travel on the ground or in the train, if you see around and there are stacks, chimneys, and you see some sort of shape of the plume, you can easily relate with the atmospheric condition instability classification, because different testability classification shaped the plume differently you can, you have seen those kind of plume shapes or behaviour according to the stability classification.

So, in this new condition, but near neutral lapse rate, but a stable condition plus calm wind means there is no wind so that it does not disperse in horizontal direction this can happen in that particular situation no wind kind of thing, day or night anytime it can happen.

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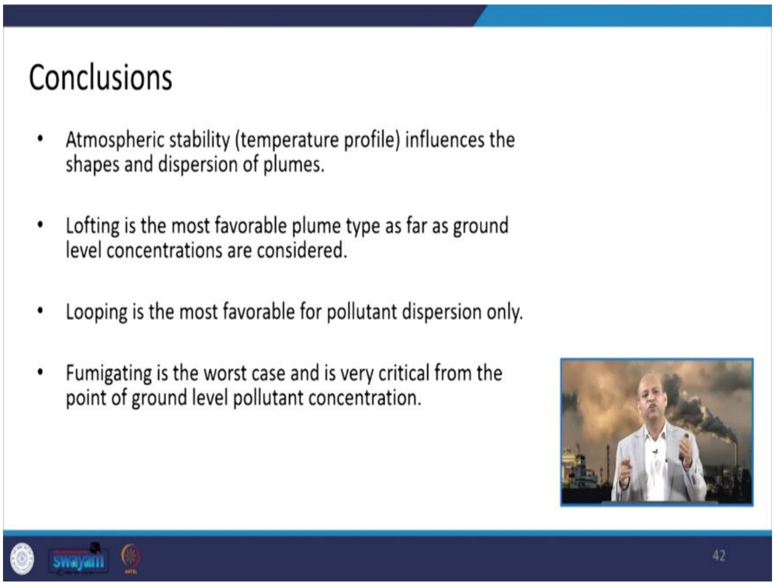

So, in conclusion, we can say that the atmospheric stability that is the temperature profile, this influences the shapes and the dispersion behaviour of the plumes. And the lofting is the most favourable plume tie for us because we always want that the pollutant concentrations should not build up on the ground level, the concentrations should not be high at the ground level it goes and dilutes in the atmosphere, that is fine for us.

So, lofting condition where the dispersion happens on the upper side of the stack. So, it is good for us because ultimately it will be diluted and it will be less than the prescribed limit like NAAQS (National Ambient Air Quality Standards). So, that will be meet very nicely. Looping is again most favourable for dispersion only means, it will dilute very quickly but sometimes as I said near to the source, at certain pockets or irregular distances concentration may be high, that is only the negative aspect of this otherwise, this is also good for diluting the pollutants.

Fumigation is very, very dangerous. So, that should be avoided from the stack above the stack, if inversion is there and below the stack, it is, in a stable condition that that fumigation can occur. So, that situation must be avoided, and with the help of metrological observations if you know a particular place if in winters or some other seasons, most of the time, if those kinds of conditions happen, that the surface layer is very unstable near to the ground and above certain it is inversion kind of thing. So, at that place, we should avoid having these kinds of emissions.

So, this kind of knowledge really help us where to locate industry, how much pollution can build up because of these metrological phenomena, and the emissions which are occurring because of industrial activity. So, this is all for today to give you idea about the role of stability classification and shaping the plume behaviour and the role of plumes in deciding the ground level concentration weather it will be high or low and how this plume will be help in dispersion of pollutants away from the ground or nearer to the ground. So, that is all for today for you, thank you very much for your kind attention.

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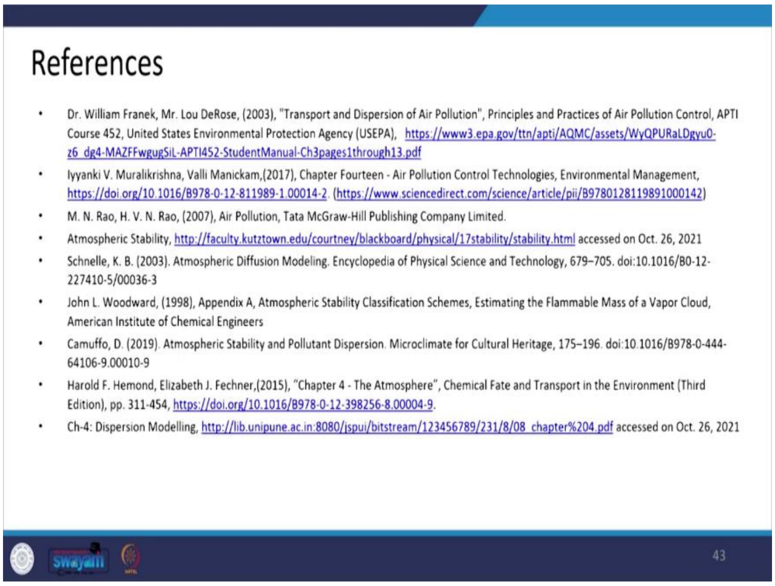

These are the references, which you can go at leisure and have more information about different aspects of stability classification. See you again in the next lecture, thank you.