Fundamentals of Environmental Pollution and Control
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Lecture No. # 30
Health Effects of Air Pollutants (Contd.)

We were discussing about the effects of gaseous pollutants on human health. Today, you know we have to discuss on the aspect of particulate matters more importantly or most specifically the mechanism of, the mechanism, the mechanism of, the mechanism of lung injury, lung injury caused by PM 10.

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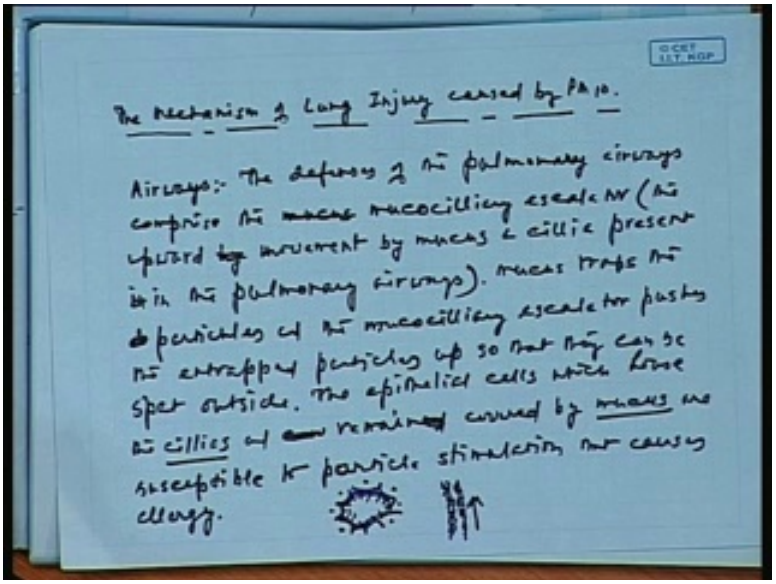

As I said you know is no, no longer necessary nowadays, it's no longer it is told as silica 5 micron or something like that, we generally consider this to be PM 10 you know this is the standard nomenclature now, nobody talks about you know silica 5 micron silica or things like that that are usually popular you know, you know various terminologies like in mining. So, here as I think I have discussed about this PM 10, how you explained the PM 10.

Now, having said this you know just let me explain you this you know how this effects take place. This is say first of all in the air ways there are three mechanisms actually by which this the PM 10 influences the human health. First is air ways, air ways. This is you know as we know this you know particularly as I was discussing the defenses, the defenses of, defenses of pulmonary, pulmonary airways ways comprise the mucus, mucos, mucociliary which is mucociliary escalator that means you know the upward movement, upward movement, upward movement, upward movement, by upward movement by the mucus, mucus and cilia present, present in say present in the pulmonary airways, pulmonary airways. So, here this mucus, mucus traps, traps the dust, traps the particulates, particulates and this mucociliary escalator, mucociliary,

mucociliary escalator pushes that, pushes the entrapped particles, particles up so that, so that they can be spat, they can be spat outside this, they can be spat outside.

This the epithelial cell, epithelial cells which house the cilias, which house the cilias and which house which I mean which keeps the cilias and cover them and remained covered, remain covered by mucus, remain covered by mucus which are house the cilias and remain cover and remain cover sorry remain covered by the mucus are susceptible to, susceptible to say this say particle stimulation, particle stimulation that causes allergy, that causes allergy. So, just you know what I have said essentially as I was discussing yesterday the same phenomena this particles, the air particles what they happen is as I have said in this you know this bronchial trough that is through which is this you know a part of that is the pulmonary system, pulmonary you say airways, so all that linked with the airways lung and all these thing, these are related to pulmonary airways, this pulmonary airways have epithelial cells.

If I remember if you just say you know I said that the cells are like this you know they are connecting like this, you have the nucleus in the cells like this large cells, large singular or a combination of cells like this, these are the epithelial cells. Within these epithelial cells, you have this the cilias, the cilias, the cilias within the cilias as I have said within the cilias and of this cilias you know this part is where should be covered by the mucus, so is a covered by the mucus, so covered by the mucus. So, this, this particularly as you can see this tract like this, this tract like this when the particles when this, when the particles are trapped in it, when the particles are trapped in this, this the typical, the typical say muscular movement, typical muscular movement, the muscular movement forces the particle and the mucus, the particles and the mucus particles and the mucus, this particles and the mucus here the particles and the mucus here to move up, so that they can be spat outside.

So, wherever they are trapped, these epithelial cells which house the cilias and covered by, covered by the mucus they when after it is trapped by the voluntary action itself you know this they can, they can move up and move up and come to the saliva and that can be spat out. You know this typical thing you know what happens when the dust enters in your throat, the kind of things that you generally do. So, this is what is this the particle stimulation that causes allergy I mean so you know sometimes this particle causes you know depending on the subject, depending on the whether there is a, there is a person having some bronchial, bronchial disorder records or you know their type of exposure, the people would be, the effect would be that way I mean a prominent say you know some people would be extremely sensitive to this allergens, the particles should be immediately act as allergen. Say people like me you know people like you and me may be you know even if we have a good amount of dust in the mine, mines or anywhere where wherever there is a lot of dust, we generally are not very sensitive, you know our system may be somewhat more immune but there are many people who cannot tolerate a small flakes of dust also, for them it becomes extremely difficult to survive in such situations. So, this is what I said it this is the typical mechanism that that the mechanism, the mechanisms that by which this the particularly the dust particles should be arrested in the airways and will be moved up.

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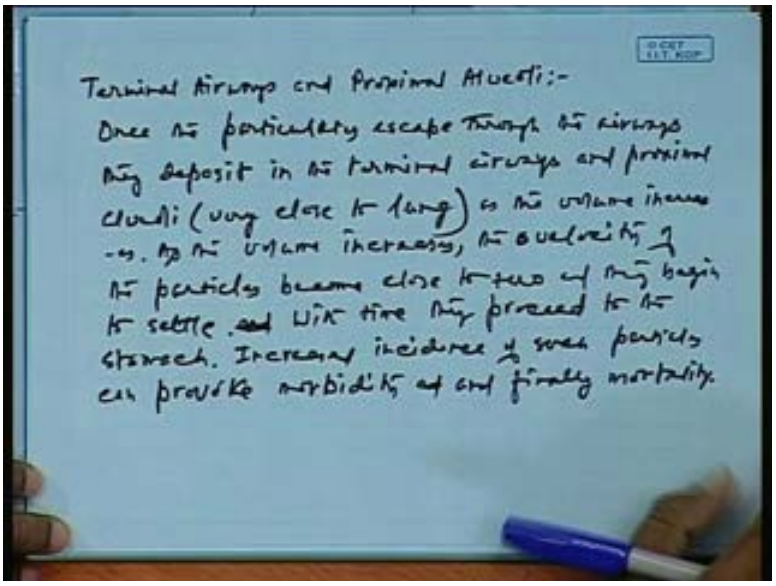

So, there are few more you know this is, this is if we can just observe now there would be terminal airways you know this is if it has spilt say if the dust particles have moved further from the airways, it would move to the terminal airways, terminal airways, terminal ways and proximal alveoli, proximal alveoli where what happens here is once this, once the particles, particulates small particles are called particulates, so you know it's just remember this only the small particles. Once the, once the particulates escape, escape through the airways, escape through the airways they deposit, they deposit in the terminal airways, terminal airways and terminal airways and proximal alveoli. Proximal alveoli is the proximal, the word proximal is very close to, very close to, very close to lung, as the, as the volume increases. See, as the volume increases, as the volume increases what happens is as the volume increases, as the volume increases, as the volume increases, as the volume increases, as the volume increases the speed, the velocity of, velocity of the particles become close to zero and they begin to settle, they began, begin to, they begin to settle and they begin to settle and proceed and with time, with time, they proceed to the, proceed to the stomach, proceed to the stomach, proceed to the stomach. Increased incidence of such particles, increase of such particles can provoke, can provoke morbidity and finally mortality, finally mortality.

So, here this is the finally mortality a, such you know it is, so it can, it very simply can be said as to increase to this mortality. So, you can see here so essentially all these you know finally they can some of them would be, a some of them would be depositing in the terminal airways and as a result of this terminal airways it would you know reduce the capacity of the lung, it would reduce the capacity of the lung. If it is of it is continuously exposed like that a person say you know a person having say child going to school, every day he is getting exposed to particularly those child, children who are travelling by bus say a long distance they are through a dusty road, they are getting exposed to the dust continuously over time, right. This, this particular you know kind of incidences where there are some periods when they will have a heavy dose of these particles, these particles over time continuous exposure to this kind of situation might lead to the morbidity of some of the, some of the, some of the, some of the intestinal as well as bronchial parts okay,

intestinal and bronchial parts. So, you know this can result into this kind of disturbances which can finally lead to death. Let me explain you know how this you know in a particularly in a, in a, in a pictorial form, let us explain now how this things takes place.

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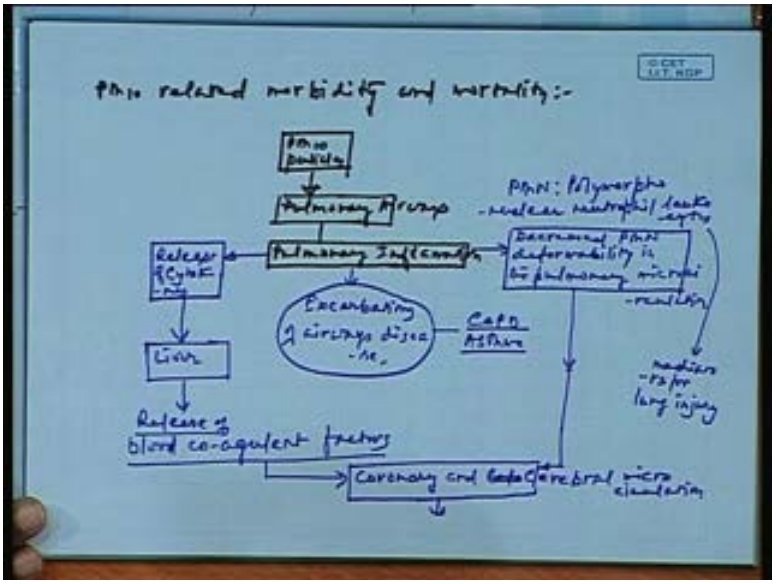

See, this is a PM 10 related mortality, PM 10 related, related morbidity and mortality. This is PM 10 you know PM 10 this is you know PM 10 particles, PM 10 particles, this arrow meaning that is entering to this, entering through the pulmonary airways. This is you say is a pulmonary airways, pulmonary airways, so would lead to say you know finally would lead to this, it can lead to pulmonary inflammation pulmonary, pulmonary inflammation. This pulmonary inflammation from this you know if you can just see this is okay. If you come to this side, release of, release of, release of cytokines, release of cytokines, this release of cytokines I am coming back to that, on the other side this would be on the other side, this one is decreased, decreased PMN deformability in the pulmonary, pulmonary microcirculation, pulmonary micro circulation.

PMN stands for, PMN stands for polymorpho nuclear, polymorpho nuclear neutrophil, neutrophil leukocytes, leukocytes you know this is these are mostly this leukocytes, this is a purpose is they are important mediators, mediators for lung injury, mediators for lung injury. What happens is this pulmonary inflammation at this taking place as I have said say increased incidence of say increased incidence of this dust particles would lead to decreased PMN deformability in the pulmonary microcirculation, pulmonary microcirculation. What happens here is this PMN is the polymorpho nuclear neutrophil leukocytes. These are the, these are the components of the blood leukocytes, it's a typical leukocytes. These leukocytes what happens is they generally work as a mediators for lung injury that means they resist, they resist the lung injury you know whatever the dust particles are there you know they would immediately they are, they are, they are a tuned, they are tuned to resist the, the dust being in dust entering the blood stream.

So, what happens is consistent exposure of dust, consistent exposure of dust makes them ineffective. Their, their deformability, decreased PMN deformability in the pulmonary microcirculation that is continuously this is one effect that relates to the decreased deformability, decreased PMN deformability of the microcirculation. Here this one finally what happening is there as a result of that, as a result of that continuously is you can see this continuously from this you know this would lead to the deformation change, this would lead to the changes which I'll coming back you know I will come back to this again. This one is here this particularly pulmonary inflation would release, would reveal you know a particularly is you know this part this exacerbation, exacerbation of airway, airways disease.

What happens here is just try to understand suppose you know you have already, already a patient suffering from COPD or say asthma, COPD or asthma this would increase. Exacerbations means you know this would be, they a particularly asthmatic patient should be having more higher say you know this the rhythms of heart and the rhythms of lung you know where it would be, it would continuously vibrate at a highest speed or at a higher frequency that's how this is, this kind of exacerbations increase. This is pulmonary means you know increased effect on this pulmonary inflammation would finally lead to exacerbations of airways disease, a particularly related to COPD and asthma patients. This release of cytokines, these release of cytokines, these at the release of cytokines you know these are body antigens, these are body antigens which would directly impact, this is directly impact the liver.

This is, this as this release of this cytokines, this cytokines are body antigens, this body antigens, this body antigens would essentially impact the liver. So, these liver from this these liver as you can observe it release of, release of blood coagulant you know no dash actually, blood coagulant factors. See, what is happening here, see pulmonary inflation, increased pulmonary inflation this is the release of cytokines, the release of cytokines in the liver would be in the, in the liver would essentially mean that the blood would begin to coagulate. What happens to the blood beginning to coagulate? As I was discussing you know it's a blood is essentially a, is essentially an emulsion, any emulsion, any emulsion is not a perfect mixture if you know that emulsion is, emulsion is you know is remain as a in a particular, at a particular temperature, at particular potential they remain within the, within the solution it's not a mixture.

So, what happens is they are extremely sensitive to impurities. See, the, that is why you know this most of the cases the milk is a particularly a good example of emulsion. If you just drop a drop of a lemon it immediately it coagulates, the particulates coagulates. So, you know in the emulsion structure breaks and it begins to coagulate, it begins to stick together okay that is what you know of you know mostly the substance you know this, this is particularly begins to take place. The release of blood coagulants you know this would lead to the blood forming to say this coagulate. Now, if the exposure is limited, exposure is limited for a say for small time say a not for a very critical time then the person can survive because you know after some time again when this is bring, brought back to a normal air environment if he begins to breathe, again the oxygen level rises, again the clot dissociates and begin to take place you know in situation he can again survive but if it continues, if it continues like this all these you know finally all these finally would lead to all these would finally these two things would lead to, these two things would lead to, this is all the these two things would lead to, would lead to coronary, coronary and cerebral, cerebral micro circulation, coronary and cerebral micro circulation.

You can see this, what started in the lung is finally travelling to the heart okay, what started in the lung is essentially travelling to the heart and finally to the head, cerebral microcirculation. This would finally, this is from here if you just see from here, the increased effect of the dust PM 10 here would means would be this particulates here would be, this would lead to, this would lead to hemostasis and clot formation.

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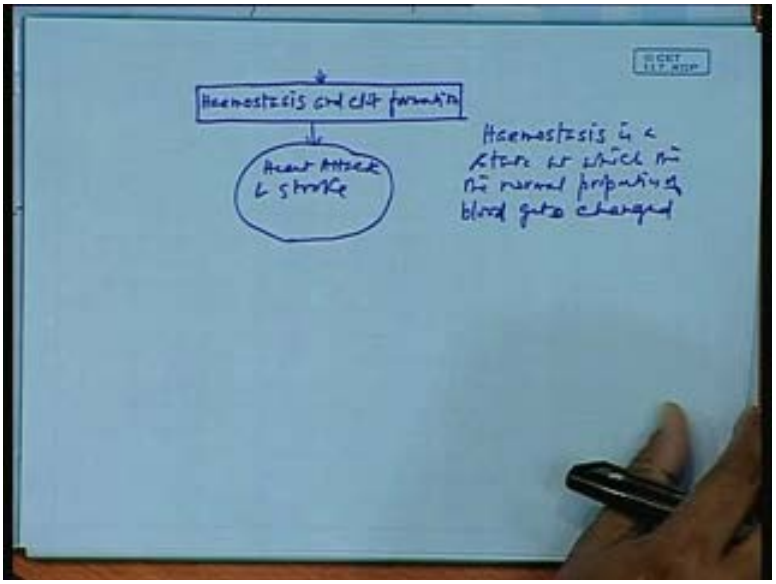

Hemostasis, hemostasis is a state at which the normal properties of blood, normal properties of blood get, gets, get changed, get changed and the blood begins to form clots. These clots, excessive of these clots, excess of these clots would result to heart attack, heart attack and stroke, heart attack and stroke, heart attack and stroke. So, you know this is heart attack and strokes you know you can see the excessive, excessive incidence, excessive incidence, excessive exposure to dust, excessive exposure to dust can finally relate to a heart attack and stroke but remember one thing till this point, till this point if you can see this still this points, if this is temporary I mean it's for a short duration the person can again get back to its usual position with certain meditation or certain physical helps you know certain say a forced say breathing and they person can be, the increased supply of oxygen can relief to the person to go back to effective normal position. But on the other hand if it does not remain like this, so this kind of situation takes place when, just to give you an simple example when this kind of things can take place, this kind of things can take place when suppose a person suddenly you know say a large quantity of dust is thrust into a somebody's mouth or you know a large amount of dust is you know in a very dusty environment he is working a very dusty environment and consistently being exposed to that.

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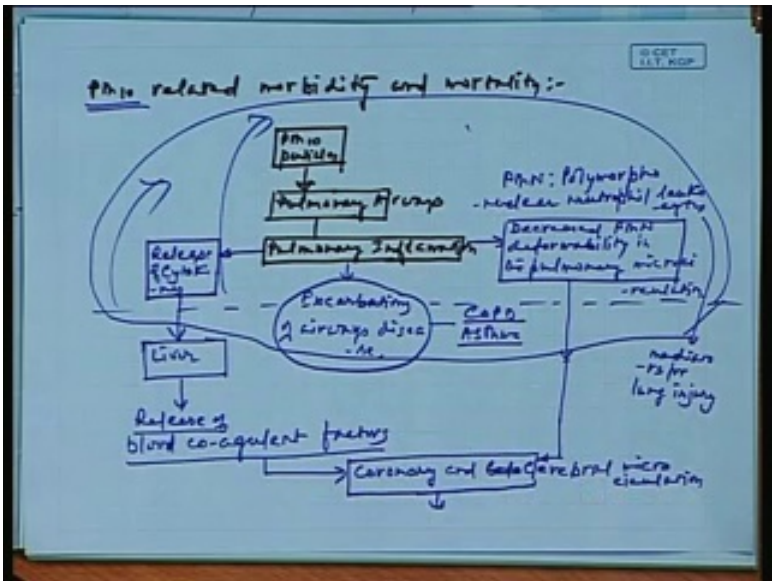

Say if he is in the dusty environment he cannot stop breathing, it has to stop, he has to breath and if he breaths these are the excessive, these are the, these are the reactions that are likely to take place. This these reactions when they continue over a long time, over a reasonably long time depending on the concentration of dust can lead to death. So, this is what is this is says the role of PM 10 which is you know in many cases in mining situations or in kind of workers related this, this, this thing. See, here as you can see if it is, if it is in this place if you just observe this can say what is what we have known of say pneumoconiosis or silicosis kind of diseases which are now differently known, these are essentially creating morbidity, a certain dysfunction or dysfunction or no function at all of a certain body part, body organs. Say the lung one lung may be completely damaged or the lung capacity has been completely you know derated, lung capacity has been derated for the whole life nothing can change it.

So, when the process is you know the effect is permanent we would call them morbidity but this morbidity can overall a gradual the, this morbidity can result in two functions like in the mortality as well. If you know mostly you know there are very critical and very solid examples are you know those people who are miners who work in particularly say a marble mines, slate mines, mica mines this, this people you know when they, they start with morbidity but finally they die with you know a mortality at a very young age. Say, it's a particularly if you go to Rajasthan side you know there are about thousand marble mines and in those thousand marble mines, the life of the worker at best would be about 40 years. So, they might be joining the work force at 12 years or 13 years by 31, 32 they may be prematurely aged and they would be say by 40 all of them are dead. These happens you know these happens you know in one more different situation also like you know if you see the rickshaw pullers, try to see some time that the rickshaw pullers if you observe the rickshaw pullers, most of them those who are, whom you see in IIT Kharagpur or any areas like that their age would be mostly about say within 40, very few rickshaw pullers you would say you would survive say the age of 50 years or 55 years or 60 years, they don't survive.

So, the condition is this is what I am saying it's that you know consistent exposure, episodial exposures when there are, there are from a large exposure for small time but over a long duration, over a long period of time, they can generate morbidity in the first place and from the morbidity itself they can generate mortality. Suddenly the, that you can see the other habits are also important say you know if he is, if he is a smoker or if he, if he drinks or you know he uses some other say the substances like tambaku and all other kind of stuff that he can take, all these situation they together can be aggravate the situation, the situation can even go worse okay. So, these kind of things you know these are the likely situation that takes place, the related kind of diseases and the typical say the exposure related problems of most of this gas and gaseous particulates and the, and the particulates, okay. So, I have mostly discussed if the, this health effects, you know I will see is generally you will have a some idea about what kind of health effects are usually take place. Apart from that you know there are few things you know I would like to just this is, these are the things say air quality standards.

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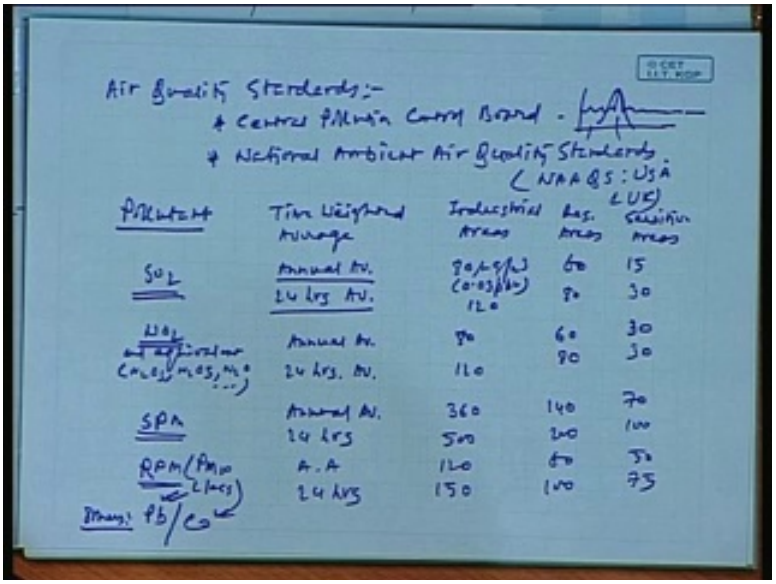

I would say you know mostly this you know you find this nowadays in the websites and any other places, this is for our country, the central pollution control board. This is standards which are generally famous is another is national ambient air quality standards NAAQS, this is which is this is USA and UK. Mostly, these there are some other permitted industrial concentration anyway. So, these two are, these two please try to see you know in all many websites are there already, you just site see right CPCB central pollution control board, you will find many of these websites even most of the cases this, this standards are given but just to give you some idea about how, what are their there is, their standard values pollutants, pollutant time weighted average industrial areas, residential areas, sensitive areas, sensitive areas, sensitive areas. So, you know this is a pollutants SO 2, SO 2 annual average, annual average, annual average or 24 hours average, mostly the values are 80 microgram per meter cube. This is essentially 80 micro gram is about say 0.03 PPM, residential area is 60, 60 microgram per meter cube, this one is 15 microgram per meter cube 15.

This is SO 2, NO 2 oxides, NO 2 and oxides of nitrogen equivalent, NO 2 and equivalent, equivalent are say N 2 O 3, N 2 O 5, N 2 O all these. These are annual, annual average 24 hours, 24 hours average, these are say 80 120, this is 24 hour, this is 120 here, this is 80, this is 30. So, here it's okay let me explain this. This is why one 120, 80 and 120, 60, 80 these are similar, 60 80 and 30, 30 okay. What it means? Why these things you know these things annual average and 24 hours average? What it generally says is that you know is can be in times is this annual average you can see this are generally less than the 24 hours average is always less than 24 hours average. It is to suggest there you know there can be, there can be some peaks, there can be some peaks of this air pollutants at the time of the day, at time day but here generally mostly this the curve should be like this you know sometimes it can peak but it should remain like this.

So, over a long time it should have a, it should have a generally a lower value than the incidental peaks that there may be some peaks during some time which can increase say you know even in this 24 hours average say you know day and night included, it should be not, it should not be more than 120 microgram per meter cube. So, here on the other hand the annual average is only about 80 micro gram per meter cube, so the annual value should be less than the episodial I mean the typical standard values like this, okay. SPM, SPM annual average 24 hours 360, 500, this is 360, 140, 200, 140, 200 and this is 70, 70 and 70 and 100 microgram per meter cube and this is respirable RPM, RPM all these RPM is you know PM 10 and less, remember this. This is PM 10 and less, PM 10 and less, say PM 1.25 this say generally comes out with the exile breath, so about between PM 10 and PM say 1.25 anything less than 1.25, 1.25 actually comes out with the exile breath. So, even if it is a dust it would come out.

So, here RPM, RPM would be, RPM as you can see this is annual, annual average and 24 hours, annual average and 24 hours, it is about say annual average and this is, this is 120, 120 and 150, 150 and then 120 and 150, 60, 100, 60, 100, 60, 100 then it is 50, 75, 50, 75. So, you can see about, about 30% of this SPM, about in any SPM suspected particulate matter about 30% would be RPM, about 30% would be RPM so that the finally which one is respirable. Since, there are few more led and carbon monoxide, I would just ask you to lead that led and you see carbon monoxide, led and carbon monoxide these are there. So, this can be say you know particularly led and CO and CO. please, see them or otherwise I will sometime give you. So, this is mostly these are other, other serve, other serve led and CO which are of importance. So, we just generally have a quite a good understanding of what are the values like for the, for generally you know these are the things which are generally asked and which we should know also this gives us the standard values for which this you know in a, any, any kind of exposure related, related pollutants what are the typical values for their that they should have in the air suspended in the air is given by this standards. So, this standards finally have come through the different experiments. If I find time you know I have, I have a material which to suggested you know how this standards are come about but that would be a different story, a long story. So, it's okay I mean we complete this, so in today's class this, this much.