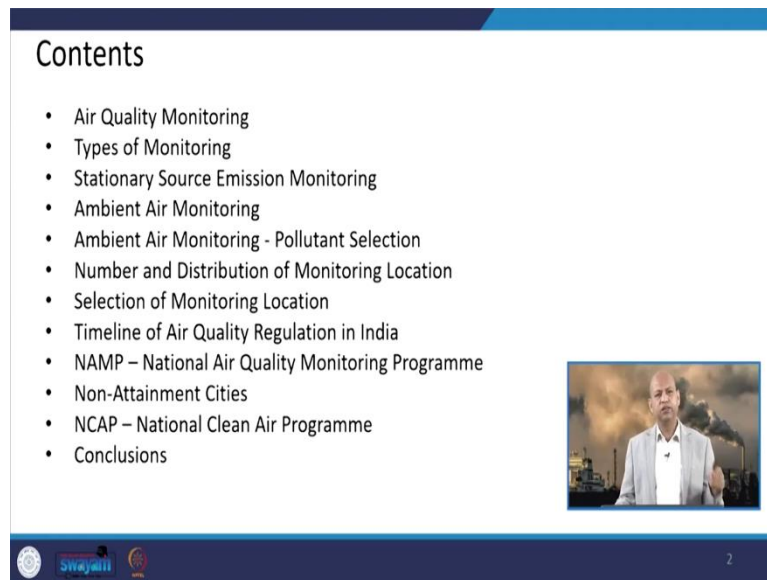


**Air Pollution and Control**  
**Professor. Bola Ram Gurjar**  
**Department of Civil Engineering**  
**Indian Institute of Technology, Roorkee**  
**Lecture - 13**  
**Status of Air Quality Monitoring in India**

Hello friends, today we will discuss about status of air quality monitoring in India. Basically, we will look into how air quality monitoring is carried out? What is its importance? What is its significance? What are the thumb rules or the processes which determines the locations, number of air quality monitoring stations, frequency all those kinds of things we will discuss.

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**Contents**

- Air Quality Monitoring
- Types of Monitoring
- Stationary Source Emission Monitoring
- Ambient Air Monitoring
- Ambient Air Monitoring - Pollutant Selection
- Number and Distribution of Monitoring Location
- Selection of Monitoring Location
- Timeline of Air Quality Regulation in India
- NAMP – National Air Quality Monitoring Programme
- Non-Attainment Cities
- NCAP – National Clean Air Programme
- Conclusions

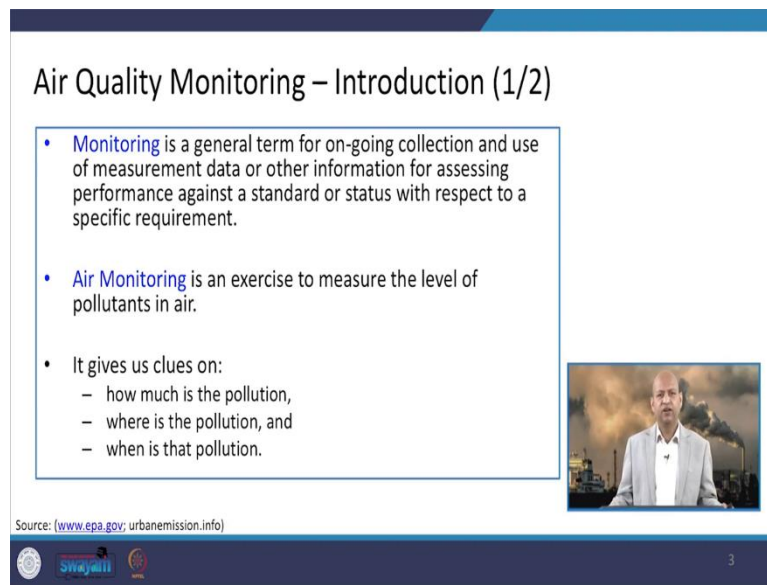
The slide also features a small video thumbnail of Professor Bola Ram Gurjar speaking, and logos for IIT Roorkee and Swayam at the bottom.

So, before going in detail, I can give you this contents list for this lecture, like we will look into very basic, very brief information of air quality monitoring. Then different kinds of types of monitoring, what are those types of monitoring or the way we carry out the monitoring, air quality monitoring in different ways. So, we will discuss about them. Then stationary source emission monitoring, we will look into because air quality monitoring and emission monitoring two different things are there, but they are both important.

Then we will look into ambient air monitoring, like different kinds of pollutants which we focus on when we go for air quality monitoring, ambient air quality monitoring. Then the number and distribution of monitoring locations, selection of monitoring locations, those kind of principles, basic rules and the timeline of air quality related regulations which have been implemented over the period of time in India so, that we will look into.

Then national air quality monitoring program. We will discuss briefly and the non-attainment cities that is exceeding air quality standard. So, about those cities we will discuss. Then we will focus on National Clean Air Program which is very important program which has been sponsored by central government of India. National Clean Air Program or NCAP and after that we will conclude.

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**Air Quality Monitoring – Introduction (1/2)**

- **Monitoring** is a general term for on-going collection and use of measurement data or other information for assessing performance against a standard or status with respect to a specific requirement.
- **Air Monitoring** is an exercise to measure the level of pollutants in air.
- It gives us clues on:
  - how much is the pollution,
  - where is the pollution, and
  - when is that pollution.

Source: ([www.epa.gov/urbanemission.info](http://www.epa.gov/urbanemission.info))

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So, when we talk about basics or brief information on air quality monitoring, so you can see that monitoring is nothing but a general term which relates to collection of data or measurement of the data and the information assessing, processing after the collection of those air quality related data. And the monitoring is an exercise of measurements of different levels of air pollutants, basically.

And it gives us some information which is related to, like how much is the level of the air pollution of a particular pollutant at a given location, where this pollution is there and what is the time series or when this pollution has occurred. Those kinds of things are determined with the help of air quality monitoring.

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## Air Quality Monitoring – Introduction (2/2)

The data, over a long term, allows us to draw patterns like:

- i. **spatial differences** in pollution (which areas of the city/country are more polluted or clean)
- ii. **temporal differences** (is there a pattern of pollution levels during the day and/or over the seasons, years).

YEAR 1998      YEAR 2010      YEAR 2015

Source: (urbanemission.info)    Image Source: (Guttikunda et al., 2019)

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When we look into like special differences or temporal differences or trends. So, with respect to the space or place, you can see the variation may be there from state to state within the state, city to city within the city from location to location there may be differences in the levels of air pollutants. Similarly, over the period of time if we monitor from one year to another, there is variation in different months.

So, average concentration, air quality concentration in different months may be different because of several factors like emissions may be different, plus metrological factors which also kind of govern the pollution levels because sometimes wind is more than it can take away the pollutants and then when precipitation is there, then again cleansing of air becomes very easy. So, those kinds of metrological parameters also influence the air quality.

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### Air Quality Monitoring - Objectives

- 01** To provide a sound scientific basis for the development of cost-effective control policies and solutions to abate air pollution.
- 02** To evaluate potential impacts of air pollution on population health and welfare
- 03** To provide the public with reliable and up-to-date information on air pollution
- 04** To assess how far air quality standards, limit values, and objectives are being met
- 05** To determine the impact of air pollution on ecosystems and our natural environment



Source: (Gurjar, B. R., Molina, L. T., Ojha, C. S. P., 2010)

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So, the temporal variation is there, special variation is there. When we look into the objectives or aims. So, most of the air pollution monitoring or air quality monitoring, then what is the purpose itself basically? There are numerous purposes basically, like it can provide a very sound and scientific basis for development of cost-effective control policies and programs or technological interventions which are needed to control the pollution discharges or emissions and to improve the air quality, you can say.

And it also helps in evaluation of potential impacts of air pollution on population, health and environmental health or welfare of the public because the air quality determines the public health related issues also. Then it also provides information about reliable information and up to date information on air pollution levels related to particular location or related to particular source.

So, that way we can control that particular source which is emitting more of the air pollutants. Then it also helps in assessing the air quality standards, whether those air quality standards are being met or not. If it is exceeding at a particular place, then what are the responsible factors for that. Is it because of some topographical factors or because of some source emission?




Then it also helps us in determining the impact of air pollution on the ecosystem and our natural environment and also assessing different policy measures which we have taken to improve the air quality. So, how much impact is there of that policy or technological intervention. So, that way air quality monitoring gives us a lot of information from that perspective.

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## Air Quality Monitoring (1/2)

**Area for monitoring is determined based on:**

- 1) Emissions sources (e.g., domestic, industrial, transport, agricultural, and natural) and contaminants emitted, and location and magnitude
- 2) Meteorology (areas prone to temperature inversions, etc.)
- 3) Topography
- 4) Geography
- 5) Population centers (especially where domestic fires and traffic emissions occur)
- 6) Historical monitoring data (if available)
- 7) Areas with high natural environmental value (e.g., in and around natural parks, forests, wilderness, and wetlands)



Source: (Gurjar, B. R., Molina, L. T., Ojha, C. S. P., 2010)

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Well, area for monitoring determined on the basis of emission sources, whether it is domestic or industrial transportation or agriculture related, natural and then those pollutants which are being emitted, what are the nature of those pollutants? Then the location and magnitude of the pollution intensity, all those things govern where we need to monitor.

Then metrological factors are also important because some areas are prone to temperature inversion, which can enhance the pollution levels. So, those kinds of things, then, topographical issues and undulation is there or flat terrain is there, geographical issues, population centres where a lot of population is there. So, receptor maybe more. So, it may be needed to monitor the quality because they will be impacted, their health will be impacted if a large number of populations is there.


Then historical monuments are also important because they can be affected by the air quality. So, we need to monitor the air quality in and around those places. Then also some very sensitive zones like natural parks for us, and wetland. So, pollutants can really change their particular ecosystem. So, we need to know how much pollution is there in and around those particular areas. Next is like, if some areas are vulnerable to pollution plumes, then again it is needed to monitor so that we can learn which particular pollutant is problematic.

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### Air Quality Monitoring (2/2)

**Area for monitoring is determined based on:**

- 8) Areas **vulnerable to air pollution plumes** from other areas
- 9) Areas **planned for development** (e.g., to get a picture of background concentrations)
- 10) Any **public complaints or issues of concern relating to air pollution**
- 11) Any **epidemiological studies on air quality effects on health** already carried out



Source: (Gurjar, B. R., Molina, L. T., Ojha, C. S. P., 2010)

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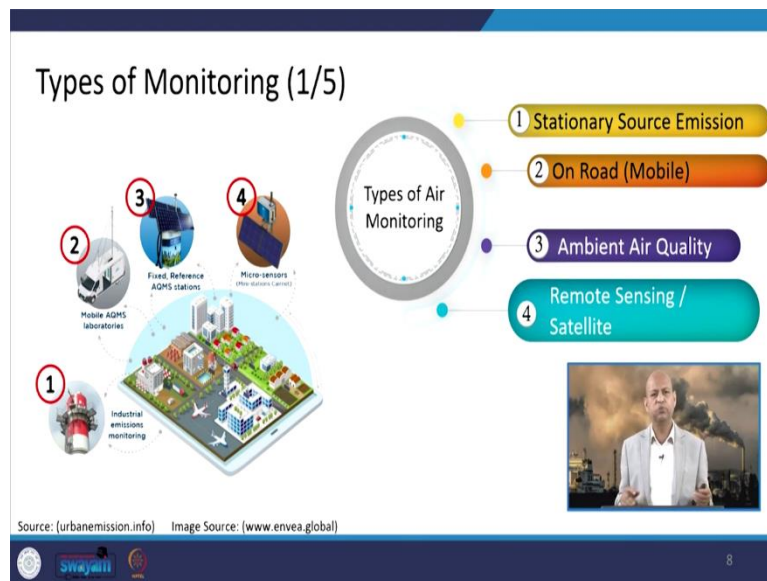
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Then the plan for the development, like if we are planning some particular industrial cluster or some new city something like that, then also we need to know the background concentration so that we can foresee that after implementation of our execution of this plan, what will be the air quality at that location.

Then, if there is complaint from the public or some person that at a particular place some pollutant concentration is increasing because of some source or because of some industry and the industry is not taking care of that, then again air quality monitoring is required to see whether it is true or not.

And then, any epidemiological studies on air quality affect the health already carried out. So, relationship between the epidemiological studies or the public health or the health on particular group of the public like children or old people and its relationship with the pollutants. So, those kinds of relationships can also be established by virtue of this data which is obtained from air quality monitoring.

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When we talk about what kind of monitoring techniques are there, then you can see, a stationary source emission monitoring can be there when some stack is there and you can monitor the emissions which is coming out of that stack. On road mobile when related monitoring instruments can be in that mobile and you can travel and you can also monitor the air. So, you can have a kind of trajectory of the air quality from one place to another. So, that kind of profile you can generate, a special profile, temporal profile.

Then ambient air quality can also be monitored by virtue of manual instruments or automatic instruments. Then remote sensing related instruments are also available nowadays or satellite observations can also be done. So, you can have this column of the air, you can see how much pollution is there of a particular pollutant, whether particulate matter or ozone or those kinds of pollutants you can easily monitor from the satellite also. There are certain sensors and they can give the reading of those concentration in that column.

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### Types of Monitoring (2/5)

- **Ambient Air Quality Monitoring**
- It collects and measures samples of ambient air pollutants to evaluate the status of the atmosphere as compared to clean air standards and historical information; and
- It is required to determine whether a geographical region or area is meeting the National Ambient Air Quality Standards (NAAQS) for criteria pollutants namely Carbon Monoxide (CO), Oxides of Nitrogen ( $\text{NO}_2$  and  $\text{NO}_3$ ), Ozone ( $\text{O}_3$ ), Lead (Pb), Particulate Matter (PM) both  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$ , Sulfur Dioxide ( $\text{SO}_2$ ), and Volatile Organic Compounds (VOC), etc.



Source: ([www.epa.gov](http://www.epa.gov)) Image Source: ([www.flickr.com](http://www.flickr.com))



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Then when we talk about ambient air quality monitoring, so, we have to see what is the purpose of that because in ambient air different pollutants are there. So, we have to monitor different pollutants. So, accordingly we need to install the instruments and we can assess the concentration of criteria pollutants for example CO or nitrogen dioxide or oxides of nitrogen like and  $\text{NO}$ ,  $\text{NO}_2$ ,  $\text{NO}_3$ , those kinds of things. Then ozone or heavy metals, etc, VOCs all kinds of these pollutants can be monitored by some technique, some instruments or especially instruments.

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### Types of Monitoring (3/5)

- **Stationary Source Emissions Monitoring**
- It collects and uses measurement data (or other information) at individual stationary sources of emissions (i.e., facilities, manufacturing plants, processes, emissions control device performance, or to verify work practices).
- Stationary source emissions monitoring is required to demonstrate that a source is meeting the emission requirements as per the set standards of the regulating authority or not.
- It also gives performance information to the facility operator so that corrective action can be taken, if necessary.



Source: ([www.epa.gov](http://www.epa.gov)) Image Source: ([pixfuel.com](http://pixfuel.com))

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Then the stationary source emission monitoring is done when the stack emissions are there. We want to know how much emission is going out of that stack and what is the concentration




in the exhaust gases which will be diluted afterwards in the air. So, those kinds of things because we need to know the performance of this air pollution control equipment.


For example, you want to see some ESPs there Electrostatic Precipitator at coal based thermal power plant etc. So, you need to know how much performance intensities they are or what is the efficiency of that instrument. So, unless you know how much is the input and how much is the output. So, those kind of stationary in the stack emissions you can see and know about those emissions.

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Types of Monitoring (4/5)



- **On-road (mobile) Monitoring**
- It collects and measures samples confined to roads and their immediate vicinity.
- Data is used for understanding pollution exposure during commute; specially to understand the acute health impacts of being exposed to augmented pollution levels on the roads.



Source: (urbanemission.info) Image Source: (www.aeroqual.com)

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Then you can see On-road mobile monitoring which can be done as I said, you can have different kinds of instruments in the mobile van and then you can suck the air through those inlet pipes. And there are sensor-based instruments also, they can give the readings of those pollutants and you can see the profile of the pollutants with respect to the time and the space.

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### Types of Monitoring (5/5)

- **Remote Sensing / Satellite Monitoring**
- It **collects and measures** samples of the whole city or state or country.
- Data is used mostly for annual scale pollution trend analysis.

Source: (urbanemission.info) Image Source: ([www.ceew.in](http://www.ceew.in); Holloway, T. et al., 2021)

Well, when we talk about remote sensing, satellite-based monitoring, then also depending upon the pollutants and depending upon the location, weather city, you want to focus, you want to focus the whole State. So, accordingly you can have this air quality monitoring and readings can be taken.

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### Stationary Source Emission Monitoring (1/5)

Stationary source emissions monitoring is composed of four elements:

- 1) Indicator(s) of performance
- 2) Measurement techniques
- 3) Monitoring frequency
- 4) Averaging time



Source: ([www.epa.gov](http://www.epa.gov)); Image: <http://www.industrialboiler.com>

Well, when we talk about a stationary source emission monitoring, so, as I said, there are different components of that particular process like indicators of the performance, then measurement techniques, different measurement techniques, monitoring frequency, averaging time, all these things are important when we carry out the emission monitoring of the stationary sources.

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### Stationary Source Emission Monitoring (2/5)

- **Indicator(s) of performance**
- The parameter(s) measured or observed for demonstrating:
  - Proper operation of the air pollution control measures, or
  - Compliance with the applicable emissions limitation or standard



Source: (www.epa.gov)



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So, when we talk about indicators performance, like proper operation, this is done for demonstrating the proper operation of the air pollution control measures which has been implemented. Then compliance of the applicable emission limitations or standards. Because when we will have some reading, only then we will be able to compare what are the norms and how much emissions are coming out. So, that indicator performance is done by this stationary source emission monitoring.

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### Stationary Source Emission Monitoring (3/5)

- **Measurement Techniques**
- It is the means by which information from or about the indicators of performance is gathered and recorded. It includes;
  - Continuous Emission Monitoring Systems (CEMS),
  - Continuous Opacity Monitoring Systems (COMS),
  - Continuous Parametric Monitoring Systems (CPMS), and
  - Manual inspections that include making records of process conditions or work practices.



Source: (www.epa.gov); image: <https://essvietnamblog.wordpress.com/>

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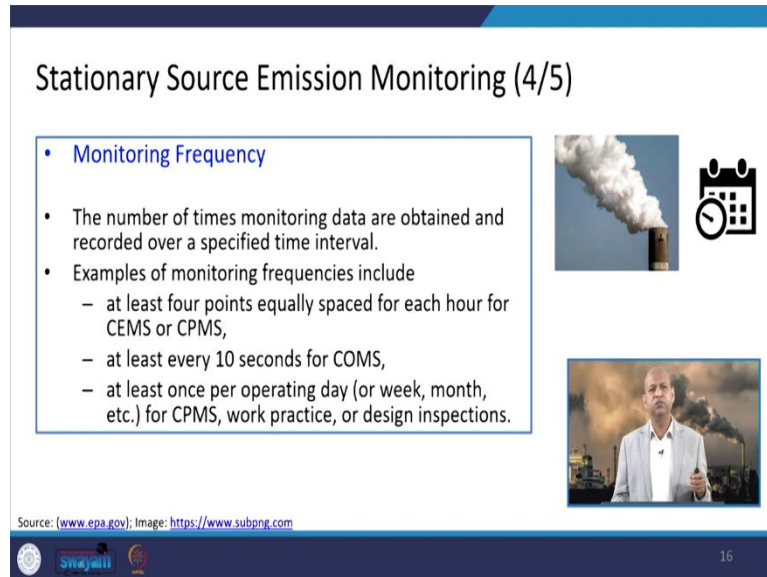
Then there are different techniques like Continuous Emission Monitoring System can be there CEMS, Continuous Opacity Monitoring System can be there. Continuous Parametric Monitoring System can be there or Manual inspections that include like records and

processes, different kinds of different conditions, work practices, all those things can be combined and then you can evaluate those things to see what is the emission. Basically, what is the intensity of the emission and what is the air quality impact of that emission in that surrounding.

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### Stationary Source Emission Monitoring (4/5)

- **Monitoring Frequency**
  - The number of times monitoring data are obtained and recorded over a specified time interval.
  - Examples of monitoring frequencies include
    - at least four points equally spaced for each hour for CEMS or CPMS,
    - at least every 10 seconds for COMS,
    - at least once per operating day (or week, month, etc.) for CPMS, work practice, or design inspections.



Source: ([www.epa.gov](http://www.epa.gov)); image: (<https://www.subpng.com>)

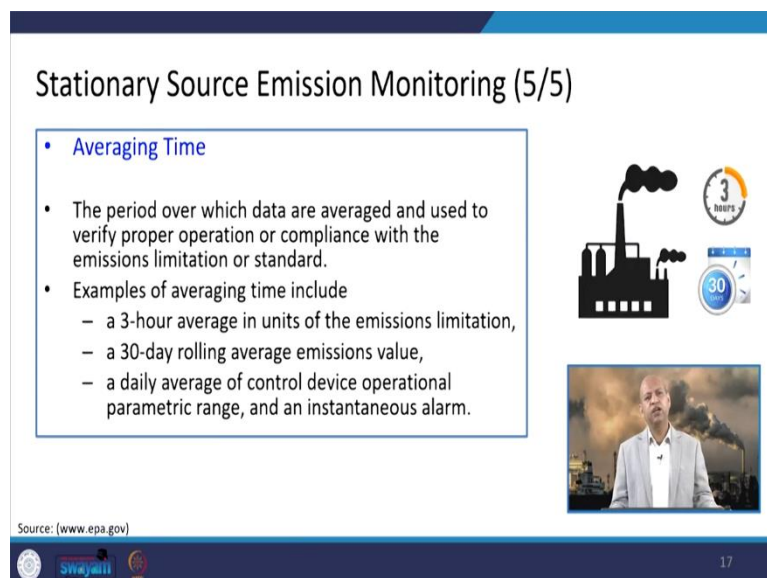
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Then the frequency means like hourly or weekly, depending upon the purpose you can decide the frequency basically and then even if you are having hourly, then you can convert it into weekly or monthly depending upon what kind of purpose is there for this monitoring?

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### Stationary Source Emission Monitoring (5/5)

- **Averaging Time**
  - The period over which data are averaged and used to verify proper operation or compliance with the emissions limitation or standard.
  - Examples of averaging time include
    - a 3-hour average in units of the emissions limitation,
    - a 30-day rolling average emissions value,
    - a daily average of control device operational parametric range, and an instantaneous alarm.



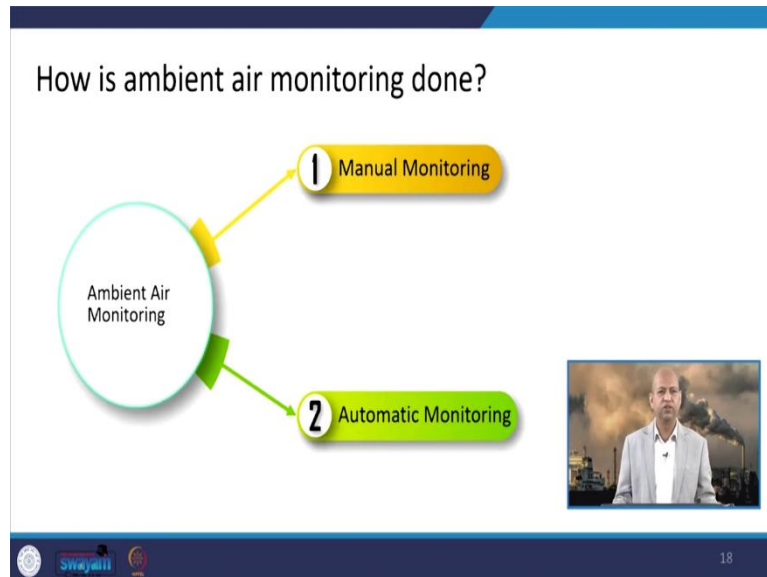
Source: ([www.epa.gov](http://www.epa.gov))

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Well, averaging time again you can do because instruments are there which can give you per minute data, per second, data per hour. So, then you can process, what is the average in time

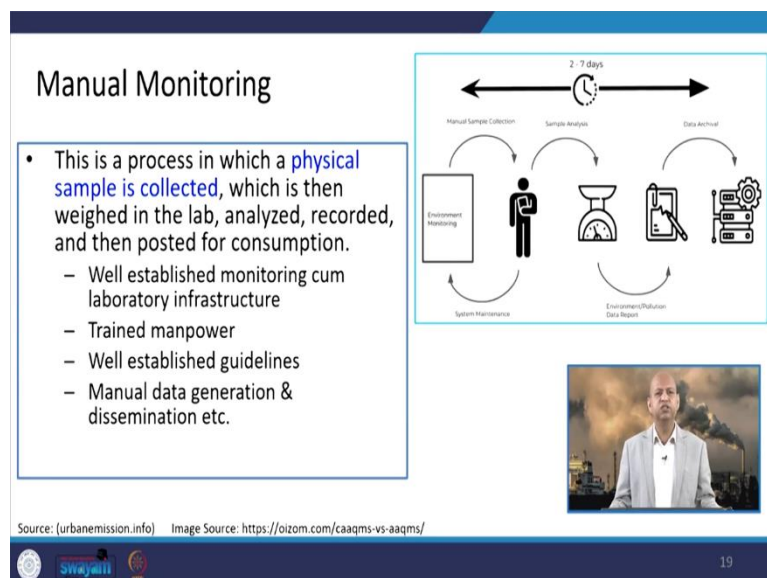
depending upon, you want to compare with 24 hourly emissions or hourly emissions. Accordingly, you have to do the averaging time. So, that comparison can be of the same unit.

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When we talk about ambient air monitoring. Then again, it can be done like through manual monitoring, by hand instruments and then automatic monitoring.

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So, manual monitoring is basically like some instruments are there and you do like physical activity when for example, you are monitoring particulate matters so, you have to weigh the filter paper, you have to install it and then you have to run, you have to check the reading. So, that means a lot of involvement is there of the expert or the skilled person who knows how to carry out the air quality monitoring using that particular instrument.

So, there are well established guidelines which needed to be followed and the manpower must be skilled and the manual data generation and dissemination is possible by this particular methodology.


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### Methods of Ambient Air Monitoring (Manual)

Manual Monitoring

- 1 Improved West & Geake Method
- 2 Modified Jacob and Hochheiser Method
- 3 Chemical Method (Buffered Potassium Iodide (KI))
- 4 Indo-phenol Blue Method
- 5 Gravimetric Method
- 6 Adsorption Desorption followed by GC
- 7 Solvent Extraction followed by HPLC / GC
- 8 AAS after sampling using EPM 2000 ED-XRF using Teflon Filter
- 9 AAS after sampling using EPM 2000 Method

Source: (CPCB Manual, Vol.-I)



So, there are several instruments which are used for manual monitoring like Improved West and Gaeke Method, Modified Jacob and Hochheiser Method, then Chemical Method can be there, Garvimetric Method can be there for particulate matter. So, these are the listed different kinds of instruments which can be used.

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### 1. Improved West & Geake Method

- For sampling and Analysis of Sulphur Dioxide (SO<sub>2</sub>)
- National Ambient Air Quality Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other Areas	Ecologically Sensitive Area (Notified by Central Govt.)
Sulphur Dioxide (SO <sub>2</sub> ), µg/m <sup>3</sup>	Annual*	50	20
	24 Hours**	80	80

\* Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.  
 \*\* 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with a 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Source: (CPCB Manual, Vol.-I) Image Source: www.americanscientist.org



So, if we go one by one then this particular method which is known as Improved West and Gaeke Method, this is used for monitoring the sulphur dioxide and there are these annual

standards 50 and 20 for industrial, residential and ecologically sensitive areas. Then 24 hours these guidelines or concentrations are also there, which are 80 micrograms per cubic meter. So, accordingly monitor data can be compared with these guideline concentrations.

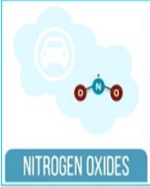

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## 2. Modified Jacob and Hochheiser Method

- For sampling and Analysis of Nitrogen Dioxide (NO<sub>2</sub>)
- National Ambient Air Quality Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other Areas	Ecologically Sensitive Area (Notified by Central Govt.)
Nitrogen Dioxide (NO <sub>2</sub> ), µg/m <sup>3</sup>	Annual*	40	30
	24 Hours**	80	80

\* Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.  
 \*\* 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with a 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Source: (CPCB Manual, Vol.-I) Image Source: www.americanscientist.org

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Similarly, if we talk about modified Jacob and Hochheiser Method, then this is done for measurements of NO<sub>2</sub>, nitrogen dioxide. And we can compare with again this table gives the air quality standard, National Ambient Air Quality Standards for 24 hours and for annual standards. So, whatever data you are processing you can compare accordingly.



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## 3. Chemical Method [Buffered KI(Potassium Iodide)]

- For sampling and Analysis of Ozone (O<sub>3</sub>)
- National Ambient Air Quality Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other Areas	Ecologically Sensitive Area (Notified by Central Govt.)
Ozone (O <sub>3</sub> ), µg/m <sup>3</sup>	8 Hours*	100	100
	1 Hour**	180	180

\* Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.  
 \*\* 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with a 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Source: (CPCB Manual, Vol.-I) Image Source: www.americanscientist.org

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## 4. Indo-phenol Blue Method

- For sampling and Analysis of Ammonia (NH<sub>3</sub>)
- National Ambient Air Quality Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other Areas	Ecologically Sensitive Area (Notified by Central Govt.)
Ammonia (NH <sub>3</sub> ), µg/m <sup>3</sup>	Annual*	100	100
	24 Hours**	400	400

\* Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals

\*\* 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with a 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.



Source: (CPCB Manual, Vol.-1) Image Source: www.americanscientist.org



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When we talk about ozone monitoring or sampling, then this chemical method which is also known as buffered potassium iodide method, this is used. We will look into these methods in detail later on. I am just giving you a brief introduction about different instruments or methods which are used for air quality monitoring. For ammonia, we need to use this Indo-phenol Blue method.

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## 5. Gravimetric Method (PM<sub>10</sub>) (1/2)

- For sampling and Analysis of Particulate Matter PM<sub>10</sub>
- National Ambient Air Quality Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other Areas	Ecologically Sensitive Area (Notified by Central Govt.)
Particulate Matter, PM <sub>10</sub> , µg/m <sup>3</sup>	Annual*	60	60
	24 Hours**	100	100

\* Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals

\*\* 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with a 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.



Source: (CPCB Manual, Vol.-1) Image Source: www.americanscientist.org



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## 5. Gravimetric Method (PM<sub>2.5</sub>) (2/2)

- For sampling and Analysis of **Particulate Matter PM<sub>2.5</sub>**
- **National Ambient Air Quality Standard**

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other Areas	Ecologically Sensitive Area (Notified by Central Govt.)
Particulate Matter, PM <sub>2.5</sub> , µg/m <sup>3</sup>	Annual*	40	40
	24 Hours**	60	60

\* Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.  
 \*\* 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with a 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.



Source: (CPCB Manual, Vol.-1) Image Source: [www.americanscientist.org](http://www.americanscientist.org)



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For Gravimetric Method like for PM<sub>10</sub>, particulate matter of 10 micrometre size or less than that RSPM, it is also known as like respiratory, the suspended part plate matter. So, the same Gravimetric method can be used for PM<sub>2.5</sub> also and you can see these ambient air quality standards which need to be met.

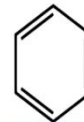
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## 6. Adsorption Desorption followed by Gas Chromatography (GC)

- For sampling and Analysis of **Benzene (C<sub>6</sub>H<sub>6</sub>)**
- **National Ambient Air Quality Standard**

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other Areas	Ecologically Sensitive Area (Notified by Central Govt.)
Benzene, C <sub>6</sub> H <sub>6</sub> , µg/m <sup>3</sup>	Annual*	5	5

\* Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.  
 \*\* 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with a 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.



BENZENE



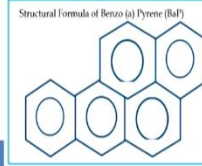
Source: (CPCB Manual, Vol.-1) Image Source: <https://freessvg.org/benzene-ring>



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## 7. Solvent Extraction followed by HPLC (High Performance Liquid Chromatography) / GC

- For sampling and Analysis of **Benzo(a)Pyrene** & other PAHs (Polycyclic Aromatic Hydrocarbons)
- National Ambient Air Quality Standard



Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other Areas	Ecologically Sensitive Area (Notified by Central Govt.)

Benzo(a)Pyrene, ng/m <sup>3</sup>	Annual*	01	01
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\* Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.

\*\* 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with a 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.



Source: (CPCB Manual, Vol.-I)



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Well, like gas chromatography method is there, adsorption desorption followed by gas chromatography which can be used for benzene measurements or sampling. And, if you want to monitor this Benzo Pyrene then solvent extraction followed by HPLC. HPLC is High Performance Liquid Chromatography and gas chromatography can also be used. So, these methods are necessary for measurement of Benzo Pyrene.

(Refer Slide Time: 18:09)

## 8. Atomic Absorption Spectrophotometer(AAS) after sampling using EPM 2000 ED-XRF using Teflon Filter Method

- For sampling and Analysis of **Lead and Nickel**
- National Ambient Air Quality Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other Areas	Ecologically Sensitive Area (Notified by Central Govt.)

Lead (Pb), µg/m <sup>3</sup>	Annual*	0.50	0.50
	24 Hours**	1.0	1.0
Nickel (Ni), ng/m <sup>3</sup>	Annual*	20	20

\* Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.

\*\* 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with a 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.



Source: (CPCB Manual, Vol.-I)



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## 9. Atomic Absorption Spectrophotometer(AAS) after sampling using EPM 2000 Method

- For sampling and Analysis of **Arsenic**
- National Ambient Air Quality Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other Areas	Ecologically Sensitive Area (Notified by Central Govt.)
Arsenic (As), ng/m <sup>3</sup>	Annual*	06	06

\* Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.  
 \*\* 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with a 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Source: (CPCB Manual, Vol.-I)

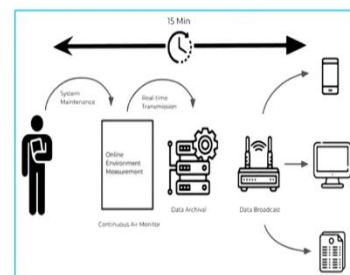


Similarly, if you go for heavy metals like lead or nickel then, you need to go for Atomic Absorption Spectrophotometer (AAS), there are different mix, different companies make it but this is the methodology which is used for this particular, these particular pollutants. If you go for Arsenic sampling and monitoring, then Atomic Absorption Spectrophotometer AAS, is there and using EPM 2000 method can be used for these Arsenic monitoring.

(Refer Slide Time: 18:39)

## Automatic Monitoring

- This is a process in which except for periodically taking care of the monitoring equipment, **all the steps** (sampling, weighing, analyzing, recording, and posting of the data) **are automated**.
  - Sophisticated analyzer
  - Quality Assurance/Quality Check
  - Instant Data Generation
  - Online data disseminations
  - Air Quality Index
  - Early warning System
  - Forecasting, Modeling, etc.



Source: (urbanemission.info) Image Source: <https://oizom.com/caaqms-vs-aaqms/>

When we go for automatic monitoring, then there are sophisticated analyzers which are sensor based and different techniques are there and the quality assurance, quality check is to be done. Air Quality Index Development all these things can be done by automatic monitor because in this case, intervention of human needs very less. Automatically measurements happen sensor-based calculations happen.


So, computer-based calculations are also there, it can help us in calculating Air Quality Index or early warning systems forecasting modelling, all those things are basically done by these Automatic Monitoring Systems because they give the real time observations, real time measurements.

(Refer Slide Time: 19:24)

### Methods of Ambient Air Monitoring (Automatic) (1/3)

Automatic Monitoring

- 1 UV Fluorescence Method
- 2 Chemiluminescence Method
- 3 UV Photometric Method, Chemiluminescence
- 4 Non-Dispersive Infrared Spectroscopy Method
- 5 Tapered Element Oscillating Microbalance, Beta Attenuation Method
- 6 Gas Chromatography based Continuous Method




Source: (CPCB Manual, Vol.-II)

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### Methods of Ambient Air Monitoring (Automatic) (2/3)

1. UV Fluorescence Method
  - For sampling and Analysis of Sulphur Dioxide
2. Chemiluminescence Method
  - For sampling and analysis of Oxides of Nitrogen (NO – NO<sub>2</sub> - NO<sub>x</sub>) and Ammonia(NH<sub>3</sub>)
3. UV Photometric Method, Chemiluminescence
  - For sampling and analysis of Ozone



Source: (CPCB Manual, Vol.-II)

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And different methods of the ambient air monitoring of the automatic nature, we go for ultraviolet, this fluorescence method or this photometric method is also there. So, these are listed you can see like ultraviolet fluorescence method is for sulphur dioxide, then for oxides of nitrogen or ammonia, you can use this Chemiluminescence Method and Ultraviolet Photometric Method can be used for ozone.


(Refer Slide Time: 19:56)

### Methods of Ambient Air Monitoring (Automatic) (3/3)

4. Non-Dispersive Infrared Spectroscopy Method  
– For sampling and analysis of **Carbon Monoxide (CO)**

5. Tapered Element Oscillating Microbalance (TEOM), Beta Attenuation Method  
– For sampling and analysis of **PM<sub>2.5</sub>** and **PM<sub>10</sub>**

6. Gas Chromatography based Continuous Method  
– For sampling and analysis of **Benzene (BTX)** (Benzene, Toluene, Ethyl benzene M+P Xylene and O-Xylene)



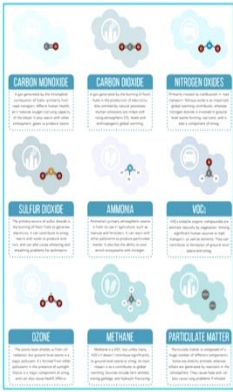
Source: (CPCB Manual, Vol-II)

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Similarly, other methods are also there for carbon mono-oxide and PM<sub>2.5</sub>, PM<sub>10</sub>. All those different pollutants can be measured by these automatic sensor-based equipment. And Gas Chromatography is quite expensive, but this can help in measurements of benzene and there are some sensors also which are used for measurements in automatic fashion.


(Refer Slide Time: 20:24)

### Air Monitoring - Pollutant Selection (1/2)



**Pollutants are selected based on:**

- They cause significant adverse **health or environmental effects**
- They are **commonly discharged** from known or suspected sources within the area
- They provide a good indication of the overall **quality of air**.



Source: (Gurjar, B. R., Molina, L. T., Ojha, C. S. P., 2010) Image Source: [www.americanscientist.org](http://www.americanscientist.org)

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## Air Monitoring - Pollutant Selection (2/2)

- **For example,**
- If **vehicles** are the primary source of pollutants, Possible contaminants: Nitrogen Dioxide ( $\text{NO}_2$ ), CO, Benzene and Fine Particulate Matter ( $\text{PM}_{2.5}$ )
- If the area is affected by **domestic fire emissions from wood burning**, Possible contaminants: Particulate Matter, CO and Polycyclic Aromatic Hydrocarbons (PAHs)
- Where **coal** is commonly used as domestic fuel or by industry, Possible contaminants: Particulate Matter, CO,  $\text{SO}_2$  and Polycyclic Aromatic Hydrocarbons (PAHs)
- In **urban areas**, Possible contaminants: Carbon Monoxide (CO),  $\text{SO}_2$ ,  $\text{NO}_2$ ,  $\text{PM}_{2.5}$ ,  $\text{PM}_{10}$



Source: (Gurjar, B. R., Molina, L. T., Ojha, C. S. P., 2010); Image: <https://www.shutterstock.com>



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Well, so, when we go for selection of pollutants, which pollutants are important. So, this depends upon what kind of health impacts we are going to assess or evaluate. So, accordingly we need to go for that particular pollutant. Also, it depends on what kind of major pollutant sources can be there.

So, accordingly you can choose the pollutants, like if you want to major near highways or vehicular air pollutions, then basically carbon monoxide or nitrogen dioxide, benzene, fine particulate matters like  $\text{PM}_{2.5}$ . They are the important because they are emitted in large quantity from these particular sources.



When you go for like coal-based power plant then  $\text{SO}_2$  particulate matter are more important. Urban areas, you can go carbon monoxide  $\text{SO}_2$ ,  $\text{NO}_2$ ,  $\text{PM}_{2.5}$ ,  $\text{PM}_{10}$ . So, depending upon nature of the pollution sources and other issues you can choose which particular pollutant we need to monitor.

(Refer Slide Time: 21:22)

### Air Monitoring – Number and Distribution of Monitoring Location (1/3)

➤ Number of Sampling Sites depends on:

- Size of the area to be covered
- The variability of pollutant concentration over the area to be covered
- The data requirements, which are related to the monitoring
- Pollutant to be monitored and
- Population figures which can be used as indicators of criticality both from view of likely air quality deterioration and health implications.




Source: (Guidelines for Ambient Air Quality Monitoring, 2003)

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### Air Monitoring – Number and Distribution of Monitoring Location (2/3)

Pollutant	Population of Evaluation Area	Minimum No. of AAQ Monitoring Station
SPM (Hi-Vol.)	<100 000	4
	100 000- 1000 000	4+0.6 per 100 000 population
	1000 000 – 5000 000	7.5 + 0.25 per 100 000 population
	>5000 000	12 + 0.16 per 100 000 population
SO <sub>2</sub> (Bubbler)	<100 000	3
	100 000- 1 000 000	2.5+0.5 per 100 000 population
	1000 000 - 10 000 000	6+0.15 per 100 000 population
	>10 000 000	20
NO <sub>2</sub> (Bubbler)	<100 000	4
	100 000- 1000 000	4+0.6 per 100 000 population
	>1000 000	10
CO	<100 000	1
	100 000- 5 000 000	1+0.15 per 100 000 population
	>5 000 000	6+0.05 per 100 000 population
Oxidants	-do-	-do-



Source: (Guidelines for Ambient Air Quality Monitoring, 2003)

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Then we come to how many numbers and distribution of monitoring locations can be there. How many samples, sampling stations we should install? So, that depends on various factors like size of the area, how many people are living in that particular area, frequency of the data which we need. So, all those factors influence the number of these locations or sampling stations.


For example, if you go for like SPM monitoring and this is the population data, so it gives the number of, these monitoring stations which are required. So up to one lakh population 100,000 population, minimum 4 stations are recommended. Then population increases, so, there is some relationship empirical relationship which can be used to decide the, to determine the number of stations.

So, similarly, for all different pollutants, we can get the number of these stations, air quality monitoring stations like carbon monoxide, you can have only 1 station is enough 400,000 people whereas for SPM you need 4, for NO<sub>2</sub> you need 4, for SO<sub>2</sub> you need 3. So, depending upon pollutants, number of stations also vary.

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**Air Monitoring – Number and Distribution of Monitoring Location (3/3)**

- Generally **three monitoring stations** are chosen as one each in residential (or commercial), sensitive and industrial area.
- **Distribution of monitoring station** in a city **depend on** the distribution of **pollution sources** and **population** in a city.
- More stations should be located in areas where **population density is high**, **number of industries** are more and **vehicular density is high**



Source: (Guidelines for Ambient Air Quality Monitoring, 2003)

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Then there are, on the basis of the experience and expert opinion and a statistical parameter, three monitoring stations are chosen as one in each residential or commercial sensitive and industrial areas. So, that can give fair level of air pollution in different nature of the areas. And the distribution of monitoring stations can also depend upon pollution sources and population. So, in a particular location more population is there, then you can add additional these instruments. Depending upon the sources also.



(Refer Slide Time: 23:15)

## Air Monitoring – Selection of Monitoring Location (1/4)

Requirements to be fulfilled:

### 1. Representative Site

- The site should be selected such that it is **expected to remain** a representative site **over a long time** and no land use changes, rebuilding's etc. are foreseen in near future.
- The site should be **away from major pollution sources** depending upon its height and its emissions. The station should be at least 25 m away from domestic chimneys, with larger sources the distance should be greater (WHO,1977).
- The site should be **away from absorbing surfaces** (absorbing building material). The clearance normally be at least 1 m. (WHO, 1977).



Source: (Guidelines for Ambient Air Quality Monitoring, 2003)



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## Air Monitoring – Selection of Monitoring Location (2/4)

### 2. Comparability (IS 5182 (Part 14) 2000)

- **All four sides should be open**, the intake should not be within a confined space, in a corner, under or above a balcony.
- **For traffic pollution monitoring** the sampling intake should be **3 m above the street level**.
- Sampling in the vicinity of unpaved roads and streets results in entrainment of dust into the samplers from the movement of vehicles. Samplers are therefore to be kept at **200 m from unpaved roads and streets**.



Source: (Guidelines for Ambient Air Quality Monitoring, 2003)



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## Air Monitoring – Selection of Monitoring Location (3/4)

### 3. Physical requirement of the monitoring sites:

- The site should be available for a **long period of time**.
- **Easy access** to the site should be there anytime throughout the year.
- Site sheltering and facilities such as electricity of sufficient rating, water, telephone connection etc. should be available.
- It should be **vandal proof** and protected from extreme weather.



Source: (Guidelines for Ambient Air Quality Monitoring, 2003)



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## Air Monitoring – Selection of Monitoring Location (4/4)

### 4. Topographical and Meteorological Factors

- The topographical factors that must be considered are:
  - Mountains (may cause precipitation),
  - Valleys (may channel the local winds into a particular direction),
  - lakes, oceans and rivers (may cause a land-sea breeze wind pattern causing pollutant transport).
- These factors cause a meteorological phenomena that may affects air pollutants distribution.



Source: (Guidelines for Ambient Air Quality Monitoring, 2003)



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Then, if we go for selection of monitoring location. So, that location how to decide? Basically, that location should be representative means if you are having so many sources in industrial location, you choose that location which can be representative of that industrial area. And if you want to have the background concentration, then you should be locating that sampling station quite far away from those major sources.

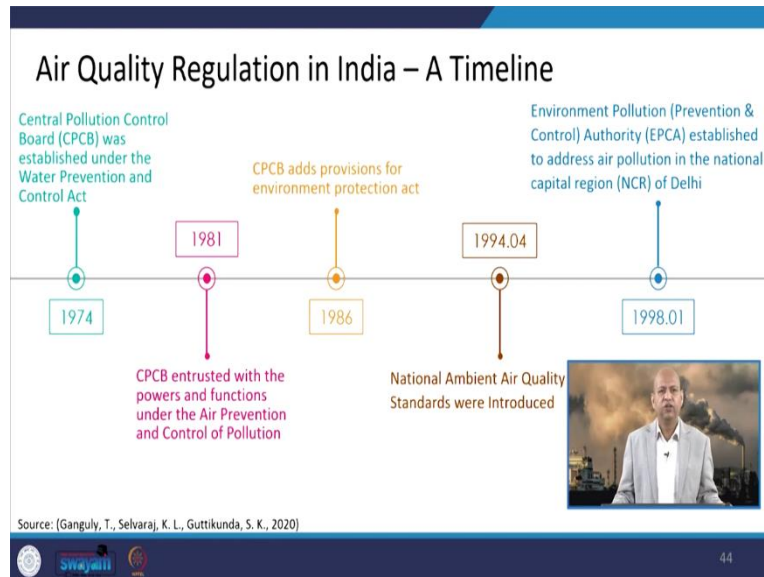
So, that way the representative site this concept must be kept in mind when we are choosing the monitoring station. Then there are other rules and regulations also like it should be at least 25 meters away from the domestic chimney's, those kind of thing, guidelines are there. It should be one meter clearance from those absorbing surfaces like buildings, walls etc. So, all these things need to be kept in practice.

Then those locations must also follow the law of comparability. So, all four sides should be quite open. Otherwise, not only it will not be representative, it will not be comparable with that particular site or location. Then it should be away from the balcony and this traffic pollution, if you want to have then also it should be away by 3 meter above the street level and it should be 200 metres from the unpaved roads because then resuspension of dust etc, can influence the readings. It will give quite biased reading. So, we have to avoid those biased reading, disproportionate reading.

Then, for longer period or easy access all those power supply, all those things are the factors which can influence the location. If there is no power then it is very difficult, if you are having a diesel generator, then it can also add to the pollution. So, those kinds of things we need to keep in mind that this location should not be destroyed by some external sources. Topography and metrological factors also influence. If it is a mountainous region or valley,

then how to keep this? Land sea breeze, all those things should not again influence this monitoring exercise.

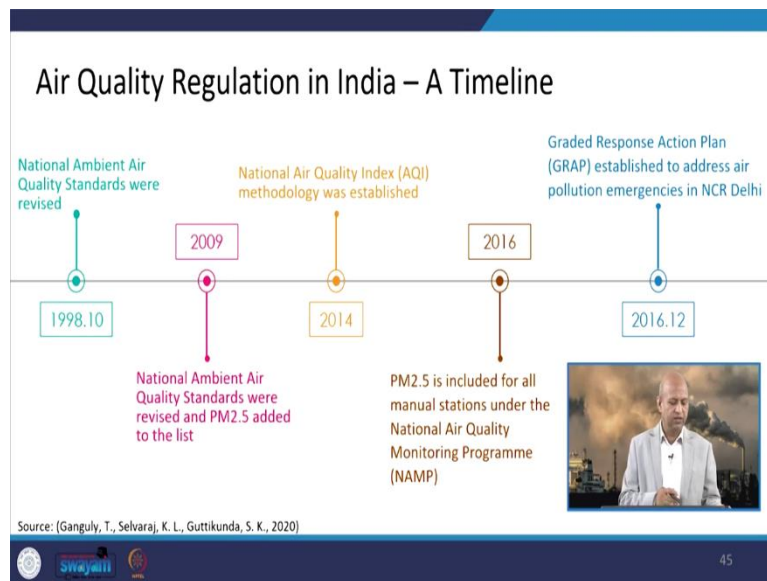
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Well, when we look into different regulations which emerged or which were framed by the different government agencies especially like CPCB, MoEFCC (Ministry of Environment and Forests and Climate Change). So, you can see in 1974 from Indian context we are talking about. Air quality regulations which emerged in India, so, timeline can be seen like in 1974 the central pollution control board was established. In 1981, then it was entrusted the CPCB was entrusted with the powers and functions under the Air Prevention and Control of the Pollution Act. In 1986 this added like provisions of Environment Protection Act.

So, evolution has happened over the years. In April 1994 National Ambient Air Quality Standards were introduced NAAQS and then in 1998, January this Environment Pollution Authority PCA, Prevention and Control, this was established to address air pollution related issues in NCR (National Capital Region of Delhi). So, especially because this was affected by several regional sources etc.

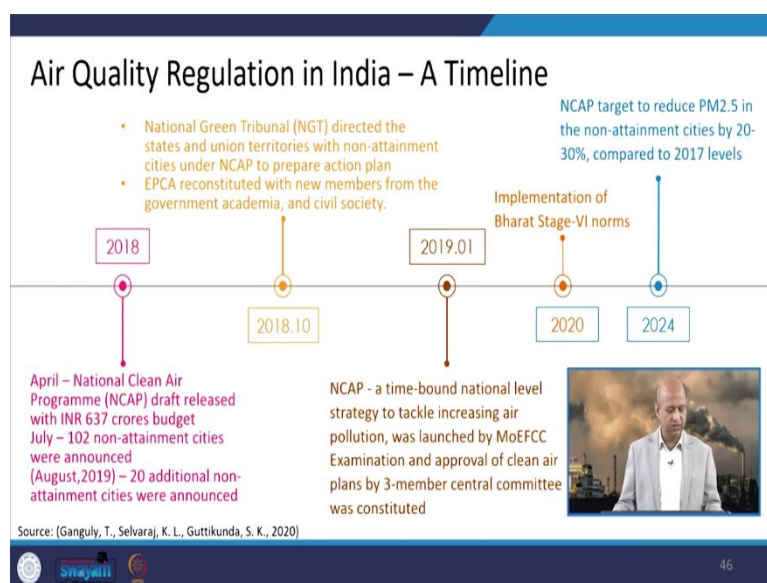
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Then again in 1998, National Ambient Air Quality Standards were revised. In 2009, the PM<sub>2.5</sub> were added, these air quality standards. In 2014, again this National Air Quality Index Methodology was established. So, how to calculate the AQI? In 2016 PM<sub>2.5</sub> included for all the manual stations under this National Air Quality Monitoring Program otherwise, in 2009, it was added in the air quality standards.

But the monitoring was not happening across the country. But later on it was added in air quality monitoring stations also. Then in 2016, December this Graded Response Action Plan GRAP established to address air pollution emergencies in NCR Delhi.

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And then in 2018, this National Clean Air Program NCAP, this draft of this particular program, which is very ambitious program was released with 637 crores of the budget and the 102 non-attainment cities were identified later on, 20 more additional cities were added into it. In 2018 October, this NGT (National Green Tribunal) directed the states and union territories with non-attainment cities under NCAP to prepare action plan. How to improve their quality? How to reduce their pollution in those particular cities which are non-attainment in that particular criteria or framework.


So, then in 2019 this NCAP, time bound national level strategy to tackle the increasing air pollution in those cities with the help of this MoEFCC (Ministry of Environment and Forests and Climate Change). So, that really launched this ambitious program and there was this central committee to monitor was also constituted. In 2020, the implementation of Bharat Stage, 6 norms were done because we were having this Bharat Stage 4 like Euro 4. Similar to Euro 4 so, rather than Euro 5 we went directly to Euro 6. So, that is known as Bharat Stage 6.

Then in 2024, we will see because this NCAP is having the target to reduce the PM<sub>2.5</sub> concentrations in the ambient air in non-attainment cities by 20 percent to 30 percent with respect to 2017 levels, 2017 levels. So, that is the target in 2024 we will see. So, those kinds of activities are going on in that way.

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**National Air Quality Monitoring Programme (NAMP) (1/4)**

- NAMP was started in 1984 by CPCB with 7 stations at Agra and Anpara.
- The network consists of **804 operating stations covering 344 cities/towns in 28 states and 6 Union Territories** of the country. The **objectives** of the NAMP are:
- To determine status and trends of ambient air quality;
- To ascertain whether the prescribed ambient air quality standards are violated;
- To Identify Non-attainment Cities;
- To obtain the knowledge and understanding necessary for developing preventive and corrective measures, and
- To understand the natural cleansing process undergoing in the environment through pollution dilution, dispersion, wind-based movement, dry deposition, precipitation and chemical transformation of pollutants generated.



Source: (NAMP, cpcb.nic.in)

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## National Air Quality Monitoring Programme (NAMP) (2/4)

- Parameters Monitored are:

- Under N.A.M.P., four air pollutants, Sulphur Dioxide ( $\text{SO}_2$ ), Oxides of Nitrogen as ( $\text{NO}_x$ ), Respirable Suspended Particulate Matter (RSPM /  $\text{PM}_{10}$ ) and Fine Particulate Matter ( $\text{PM}_{2.5}$ ) have been identified for regular monitoring at all the locations.
- The monitoring of meteorological parameters such as wind speed and wind direction, relative humidity (RH) and temperature were also integrated with the monitoring of air quality.



Source: (NAMP, cpcb.nic.in)



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## National Air Quality Monitoring Programme (NAMP) (3/4)

- Frequency of Monitoring:

- The monitoring of pollutants is carried out for 24 hours (4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter) with a frequency of twice a week, to have 104 observations in a year.



Source: (NAMP, cpcb.nic.in)



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## National Air Quality Monitoring Programme (NAMP) (4/4)

- Monitoring Agencies:

The monitoring is being carried out with the help of

- Central Pollution Control Board;
- State Pollution Control Boards;
- Pollution Control Committees;
- National Environmental Engineering Research Institute (NEERI), Nagpur.

CPCB co-ordinates with these agencies to ensure the uniformity, consistency of air quality data and provides technical and financial support to them for operating the monitoring stations.



Source: (NAMP, cpcb.nic.in)



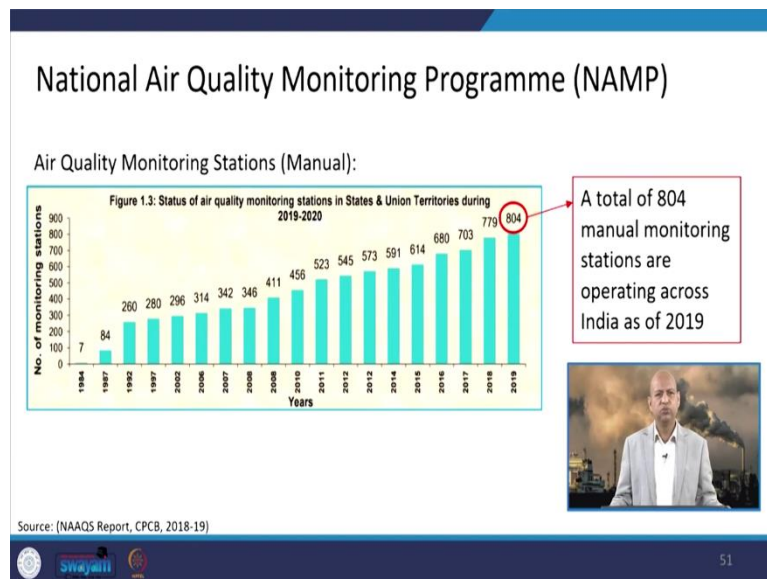
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Well, National Ambient Air Quality Monitoring Program is a Pan-India program, and it was launched in stages manner like large cities, then in rural areas also. Now, 344 cities are having, 804 operating stations for this particular program. This is very large program and it gives Air Quality Profile for all the cities and countryside for different pollutants, criteria pollutants particularly.

So, these are the parameters which are monitored under this program. And the frequency is like four hourly sampling for gaseous pollutants and eight hourly sampling for particulate matter with a frequency of twice a week and 104 observations in a year, that is minimum as per these standards, NAAQS.

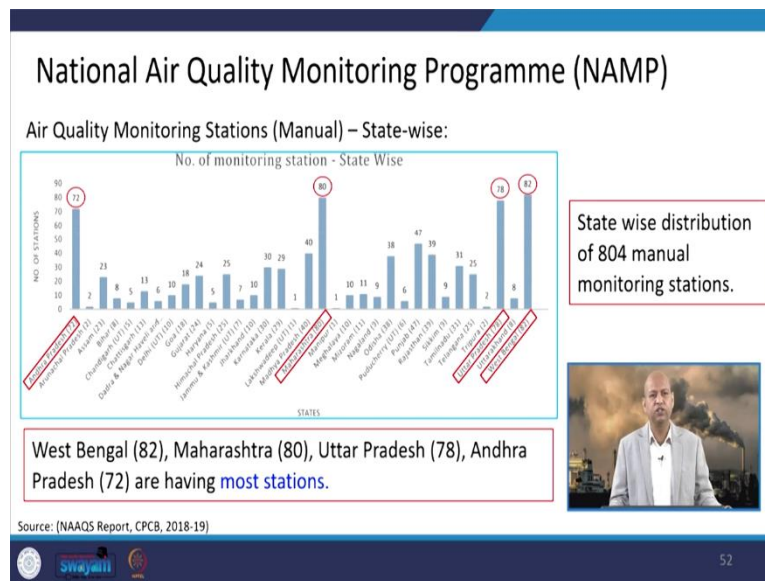
And monitoring agencies are Central Pollution Control Board, then there are State Pollution Control boards. Then pollution control committees in different cities, local bodies, National Environmental Engineering Research Institute nearly all these are in integrated manner monitoring happens and all the data is collected and analysed.

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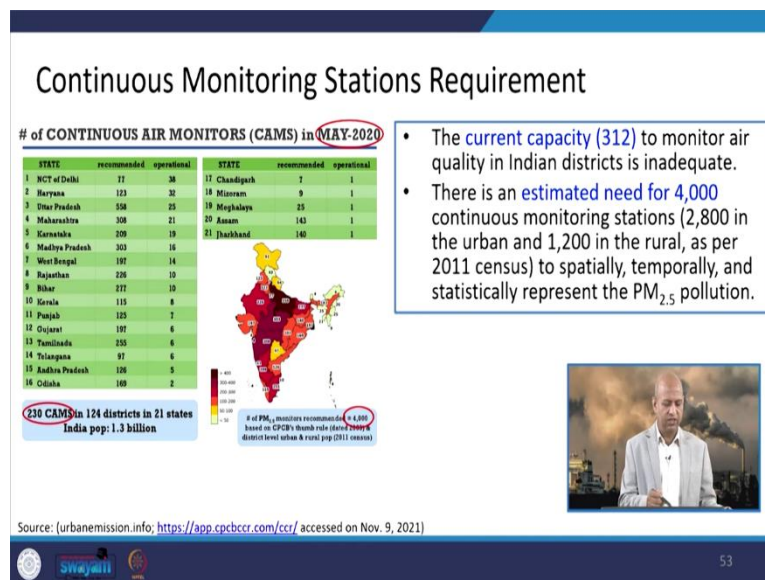
So, you can see, the development and increasing in the number of monitoring stations from 1984 where only 7 stations were there and now it is 804 stations. So, that way, we are expanding in number of stations. So, that gives better profile, special distribution of the air pollution and all those things are better now a days. And it is still increase basically. Different agencies are coming for installing their stations also in addition of these government agencies.

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Well, different states have different air quality monitoring stations. So, the highest number are in like West Bengal, Maharashtra, Uttar Pradesh and Andhra Pradesh. They are having large number of Air Quality Monitoring Stations. So, they can have better profile of air quality across the air, regions or different cities.

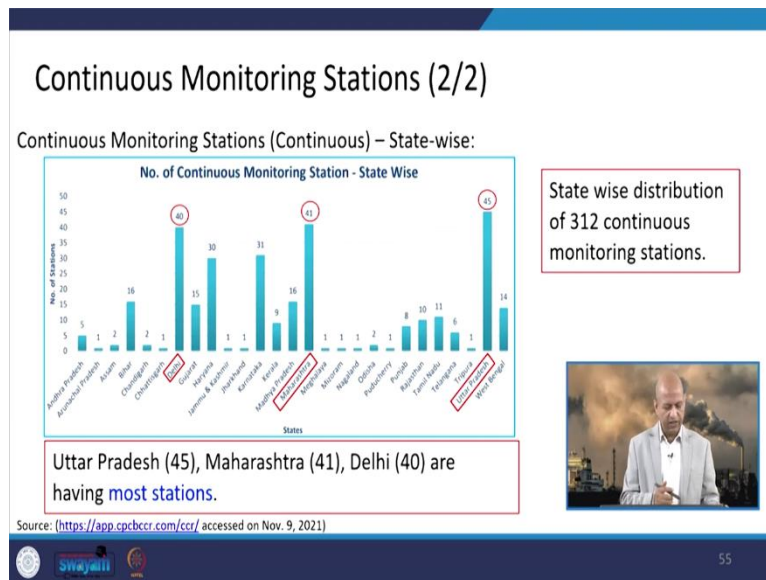
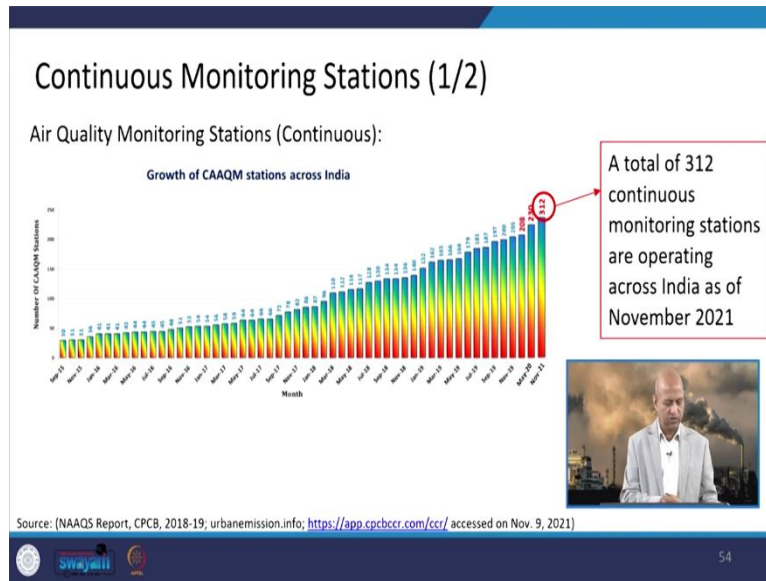
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So, this is again given in May 2020, this was only 230 continues monitoring stations, now it is 312. So, continuous monitoring stations are also increasing in number so that really helps in forecasting of the air quality, for near future forecasting or comparison of air quality indices, all those things are possible because of these continuous monitoring stations.



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Well, again, you can see these number is continuous. From September 2015, when it was 30, now in November 2021 it is 312 and continuously they are growing in number. So, again, there number is also varying according to States so the pioneer states are Delhi, Maharashtra, Uttar Pradesh are having large number of continuous monitoring stations.

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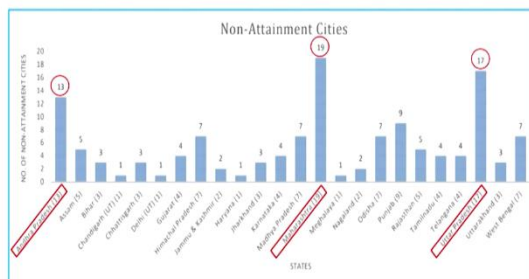
## Non-Attainment Cities (1/3)

- Cities that have crossed the National Ambient Air Quality Standards (NAAQS) for over 5 years are called **Non-attainment cities**.
- CPCB has identified list of polluted cities in which the prescribed NAAQS are violated.
- 122 cities have been identified based on the ambient air quality data obtained (2014–2018) under NAMP which now stands at **132** including million plus cities.
- Action plans are being formulated and implemented to control air pollution in non-attainment cities.



Source: (NAAQS Report (2018-19); <https://cpcb.nic.in/list-of-non-attainment-cities/>; accessed on Nov. 9, 2021)

## Non-Attainment Cities (2/3)



Total of 132 Non-Attainment Cities including million plus cities (8) in different States

Out of all the cities in India, cities having population of one million and above are called **million plus cities**.

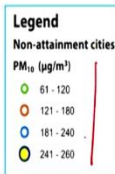


Source: (<https://cpcb.nic.in/list-of-non-attainment-cities/>; accessed on Nov. 9, 2021)

## Non-Attainment Cities (3/3)



Non-Attainment cities with  $PM_{10}$  concentration exceeding Annual NAAQS Standards of  $60 \mu\text{g}/\text{m}^3$

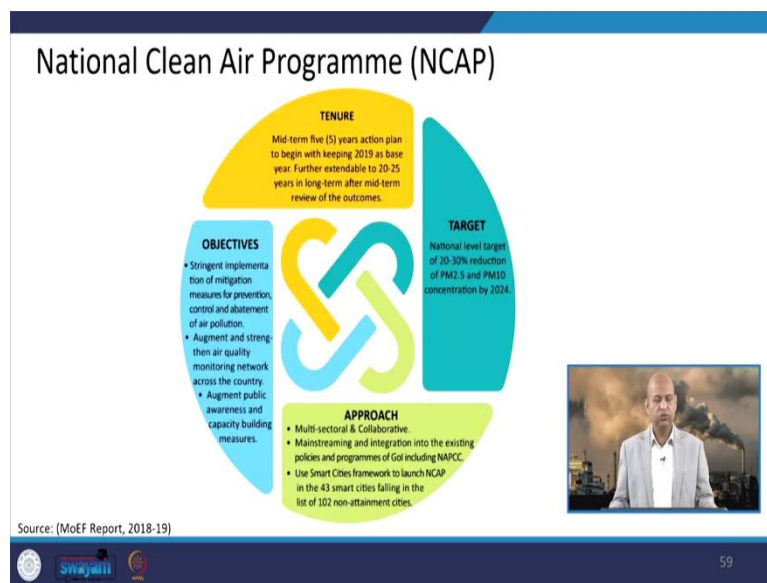


Source: (MoEF Report, 2018-19)

Non-attainment cities, those cities which are exceeding the air quality standards, so those are the non-attainment cities, as I said, it was 102 initially and then more added and now it is 122 and some millions of cities were also added and it is now 132 basically. So, you can see the non-attainment cities in different states.

So, highest number are in Andhra Pradesh, Maharashtra and Uttar Pradesh, basically. So, they are the focused area and you can see the distribution of these cities across the country. And they are having different levels of air pollutants and they are also shown in this.

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So, the NCAP program (National Clean Air Program) this is very ambitious program and this will really a game changer kind of thing. This will improve air quality in a big way because very focused and targeted efforts are being made in an integrated manner, where central government, state government, local bodies, all are involved.


Educational institutes are also involved so experts and everyone, those stake holders, their participation and all these approaches are well documented. So, uniformity is there, it is not like adhocism. Very systematic way this program is implemented, so I am sure that this will help in improving the air quality of different cities. Right now, non-attainment cities but they will be cleaner in near future.

(Refer Slide Time: 34:12)

### NCAP – Key Components



- Development and extension of air quality monitoring network.
- Extending source apportionment studies to all non-attainment cities.
- Focus on air pollution health and economic impact studies
- International cooperation including sharing of international best practices on air pollution
- Review of ambient air quality standards and emission standards



Source: (MoEF Report, 2018-19)


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And you can see the key components for this particular program are health, economic impact studies and source apportionment studies, all those kinds of studies are incorporated.

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### NCAP – Broad Strategies (1/2)

Level	Strategies	Implementing Agencies
Local (city level)	<ul style="list-style-type: none"> <li>• Control of local activities generating pollution: refuse burning, construction activities, unpaved/dusty roads</li> <li>• Congestion management at traffic junctions: intelligent transport system (ITS), congestion pricing, low-emission zones (LEZ), etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Municipal Corp.</li> <li>• RO (SPCB)</li> <li>• Traffic police</li> </ul>
City (city/state level)	<ul style="list-style-type: none"> <li>• Landuse planning: demand side management</li> <li>• Transport: enhancing public transport, plying restrictions, I&amp;M, and non-motorized transportation</li> <li>• Waste: Solid waste management, landfill gas recovery</li> <li>• Roads: Paving, maintenance and cleaning of roads</li> <li>• DG set: 24x7 power supply</li> <li>• Enforcement</li> </ul>	<ul style="list-style-type: none"> <li>• Dept. of Planning</li> <li>• Dept. of Transport,</li> <li>• Municipal Corp.</li> <li>• PWD</li> <li>• Dept. of Energy</li> <li>• SPCBs</li> </ul>




Source: (MoEF Report, 2018-19)


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## NCAP – Broad Strategies (2/2)

Level	Strategies	Implementing Agencies
Regional (India)	<ul style="list-style-type: none"> <li>Transport: Auto fuel policy for stringent norms for fuel and vehicles, road to rail/ waterways, fleet modernization, electric vehicle policies, clean fuels, bye-passes, taxation policies, etc.</li> <li>Industries: Stringent industrial standards, clean fuels, clean technology, emission trading schemes, and enforcement (continuous monitoring)</li> <li>Biomass: Enhanced LPG penetration, agricultural burning control, and management</li> </ul>	<ul style="list-style-type: none"> <li>MoRTH, MoPNG</li> <li>MoEF&amp;CC, CPCB</li> <li>MoPNG, MoA</li> </ul>
Trans-boundary	<p>Linking INDC's target of additional forest and tree cover of 2.5 to 3 billion tonnes of CO<sub>2</sub> equivalent by 2030 to the NCAP. There needs to be more focus on the western regions of India (Rajasthan and Gujarat) for an enhanced tree cover, which will reduce wind-blown dust within the country and will also act as barriers for transboundary dust.</p> <p>Air quality management at the South-Asia regional level</p>	<p>MoEF&amp;CC</p> <p>Intergovernmental task force.</p>



Source: (MoEF Report, 2018-19)



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And the broad strategies you can see, the local government as I said, city level, different departments are involved so their integrated approach or integrated efforts will bring light to the problem.

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## Conclusions

- Air Quality Monitoring is one of the important steps in combating air pollution.
- Continuous air monitoring is more reliable and faster than manual monitoring.
- National Air Quality Monitoring Programme (NAMP) is one of the first step by Indian Govt. towards tackling air pollution.
- National Clean Air Programme (NCAP) is more focused and target-based programme to tackle the air pollution situation in India.



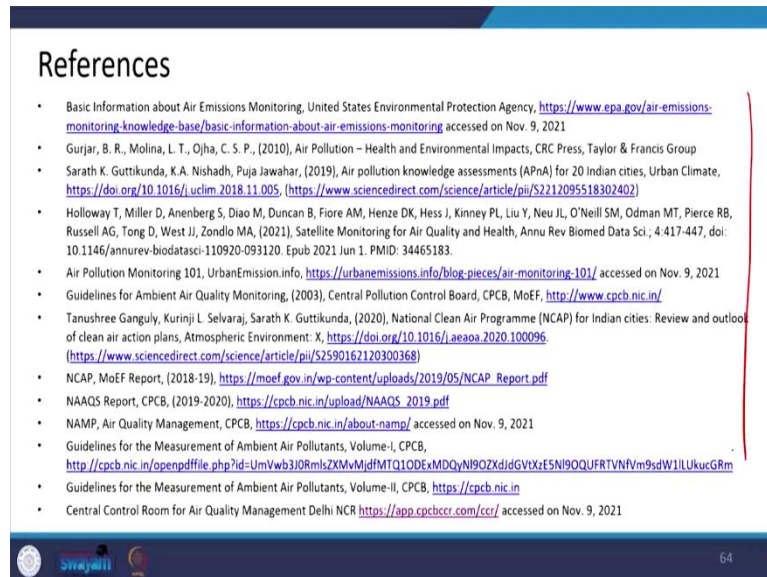

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Well, in conclusion we can say, that the air quality monitoring is one of the important steps in combating air pollution and continuous air pollution monitoring is more reliable and faster than the manual monitoring. If provided, calibration is proper because if you are just using the instruments without calibration, then reliable information may not be there.

And National Air Quality Monitoring Program is one of the first step by Indian Government which was taken up and towards tackling the air pollution problem. And NCAP program as I

said, is more focused and target-based program which will tackle this air pollution situation in India and air quality will be improved in a significant way.

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So, this is all for today, you can go through these references for additional information. Thank you for your kind attention, see you in the next lecture. Thanks again.