Dated: 26th Feb., 2020

To,
The Dean,
IIMS & R,
Lucknow.

Subject: Request for permission to monitor air quality of the hospital building.

Respected Sir,

This is to bring to your kind knowledge that Department of Chemistry has been assigned the responsibility to quantitatively assess the air quality of the university and hospital building, as an essential requirement of NAAC accreditation. Therefore, I seek your permission to set up the instruments to monitor particulate and gaseous contaminants for the assessment of indoor and outdoor air quality in the hospital building at 1) Reception area, 2) Emergency ward and 3) OPD from 10:00 am-4:00 pm on week days.

I shall be grateful for your kind cooperation.

Thanking You.

Yours Sincerely,

27.2.2020

Prof. A. R. Khan,
Dean, Faculty of Science,
Integral University,
Lucknow.

Permitted

3/3/2020

INTEGRAL UNIVERSITY इंटीग्रल विश्वविद्यालय लखनऊ-भारत LUCKNOW-INDIA

To,
Dean Faculty of Science/
Head Department of Chemistry
Integral University, Lucknow.

Dated: 29/01/2020

Sub.: **To monitor Indoor/ Out door Air Pollution within the University Campus. (Desired parameters : PM2.5, PM10, SOX, NOX and COX)**

Sir,

As desired by NAAC (Criterion-7) Faculty of Architecture and Planning had been interested upon the task of Environmental Audit of the university to provide IAQ data at the following destinations of the campus.

A) Indoor IAQ

1. Admin Block 2. BNLT Block 3. Hospital Block

B) Out door AQ

Main approach road of University Hospital (IIMSR)

Request to provide above monitoring data at priority basis.

Thanking you for your kind co-op ration in advance.

(Dr. Indrani Chakraborty)
Dean
Faculty of Architecture and Planning

VC Sir
May kindly approve the above for collecting the data by our research scholars/trainees.
30.1.2020

'A' Approved
30.1.2020

Dr Tahmeena
Kindly collect the data as per above requirement and submit the report within 15 days.
30.1.2020

INTEGRAL UNIVERSITY इंटीग्रल विश्वविद्यालय लखनऊ-भारत LUCKNOW-INDIA

Integral University, Lucknow
From: Head, Department of Chemistry

Report on Particulate Contamination Assessment

1.0 Particulate Matter (PM) and its origin

Particulate matter is a widespread air pollutant, consisting of a mixture of solid and liquid particles suspended in the air. Commonly used indicators describing PM that are relevant to health refer to the mass concentration of particles with a diameter of less than 10 µm (PM_{10}) and of particles with a diameter of less than 2.5 µm ($PM_{2.5}$). $PM_{2.5}$, often called fine PM, also comprises ultrafine particles having a diameter of less than 0.1 µm. In most locations in Europe, $PM_{2.5}$ constitutes 50–70% of PM_{10}. PM is a mixture with physical and chemical characteristics varying by location. Common chemical constituents of PM include sulfates, nitrates, ammonium, other inorganic ions such as ions of sodium, potassium, calcium, magnesium and chloride, organic and elemental carbon, crustal material, particle-bound water, metals (including cadmium, copper, nickel, vanadium and zinc) and polycyclic aromatic hydrocarbons (PAH). In addition, biological components such as allergens and microbial compounds are found in PM. Particles can either be directly emitted into the air (primary PM) or be formed in the atmosphere from gaseous precursors such as sulfur dioxide, oxides of nitrogen, ammonia and non-methane volatile organic compounds (secondary particles). Primary PM and the precursor gases can have both man-made (anthropogenic) and natural (non-anthropogenic) sources.

1.1 Health hazards associated with particulate contamination

According to WHO air quality guidelines, a reduction in yearly average $PM_{2.5}$ concentrations up to10 µg/m^3 could lead to reduced air pollution related deaths by 15% in developing countries [1]. The low and middle group countries have faced a lot of exposure to particulate matter usually originating from the household combustion of inferior fuel in traditional inefficient stoves, thereby increasing the risk for respiratory and cardiovascular diseases including acute lower respiratory infections, chronic obstructive pulmonary disease (COPD) and lung cancer [1]. An estimation done by WHO's International Agency for Research on Cancer (IARC) in 2013 revealed that particulate matter is the vital factor for increased vulnerabilityfor cancer, especially pertaining to lungs. A relationship has been established between ambient pollution and risk of urinary tract/bladder cancer [30]. The particulate matter has bad effect on human health as well as on environment in the form of reduced visibility which results due to absorption and scattering of sunlight. In India, if the particulate level remains at its current status, per-capita mortality rate would increase by 21% by the year 2030. The average particulate emission should be reduced by 20-30% in the coming fifteen years to reduce the mortality rates. A large number of epidemiologic studies have demonstrated a correlation between enhanced ambient particulate levels and hospital admissions for respiratory diseases [2-6].

2.0 Air pollution status in Lucknow

During the recent years air quality in Lucknow has witnessed a down fall. Studies have correlated air pollution status with environmental, human and plant health impacts. The metallic concentration associated with particulate matter has been found to fluctuate with meteorological conditions in the region. A survey based study done in early 2000 showed that particulate concentration exceeded the NAAQS limits. Particulate fraction

PM_{10} analyzed forheavy metals showed the presence of heavy metals in all the seasons [7]. The study revealed significant variation in the metal concentrations at different locations. The high PM_{10} concentration was attributed to diesel driven vehicles. In another study in Trans-Gomti area, during peak traffic hours (11.00AM-1.00PM) the recorded PM_{10} level was 499µg/m³. Thehighest PM_{10} level (990µg/m³) was observedat the most crowdedcrossing with most trafficdensity (6723 vehicle/h) and least (150 µg/m³)at low traffic density crossing with leastvehicular load (52 vehicle/h). This investigation revealed that the Trans-Gomti area is mainly polluted with PM_{10} and advised to ban diesel driven vehicles in the city areas to cut the PM_{10} level within the permissible limit[8]. Vehicular exhaust is one of the major reasons of particulate contamination, which affects the air quality and the health. Uttar Pradesh State Road Transport Corporation (UPSRTC) introduced bus services under the banner "Lucknow Mahanagar Parivahan Sewa" on different routes of Lucknow city. The Green Peace Report in 2016 has highlighted that in 20 cities of Uttar Pradesh, from where the data was collected by Pollution Control Board, the PM_{10} concentration was higher than the annual average of 60µg/m³ as suggested under NAAQS. PM_{10} concentrations in Gaziabad, Barielly, Allahabad, Kanpur, Agra, Lucknow, Varanasi and Sonebhadra were respectively 258, 240, 250, 201, 186, 169, 145 and 132µg/m³ for year 2015. A comprehensive observation of the data suggests that the PM_{10} levels has been dangerously high throughout the year for from October 2015 to September 2016, with October to February being the most polluted months when the PM_{10}levels reached to 400 µg/m³. Some of the recent episodes in Lucknow are as follows-

1. In December, 2015 AQI of the city reached to 489. The AQI between 401 and 500 has been categorized as severe for the exposed population.

2. Lucknow recorded a "very poor" air quality conditionon Diwali night, 2018 with $PM_{2.5}$- the presence of particles in the air with a diameter less than 2.5 micrometres- at 360 (International Business Times).

3. With an average $PM_{2.5}$ concentrations of 138, Lucknow was placed at 7th position out of ten most polluted cities of the world, according to WHO's latest report in 2018.

4. Lucknow climbed up to the position of second most polluted city in the country on November 28, 2018 with the AQI 'very poor (Times of India). As per the data released by the Central Pollution Control Board, The AQI of the city was 363.

3.0 Objectives of the study

To assess the outdoor and indoor particulate contamination level at the selected sites viz.Admin block, BNLT block, NLT block, LT block and main approach road of University hospital (IIMSR).

3.1 Sampling and analytical method

Particulate matter was measured through 5-6 h continuous monitoring at the selected sites. During this time the activity pattern and human occupancy was also recorded. PM_{10} and $PM_{2.5}$ samples for chemical analysis were collected with fine particulate dust sampler (APM 550M, Envirotech). The air inlet has a circular symmetrical hood designed to keep out rain, insects and very large particles. Inlet section leads to an Impact stage with trap particles larger than 10 microns. For the sampling of $PM_{2.5}$ a well-shaped (WINS) Impactor can be attached to the down tube. It is designed to trap medium size (between 2.5 and 10 micron) particles. To avoid sampling error due to bouncing of small size particulate from impaction surface, a 37 mm diameter GF/A (Glass Fibre) paper immersed in silicon oil is used. The air stream now leaving the WINS Impactor consists of only fine particles with aerodynamic diameter smaller than 2.5 microns [9]. APM 550 used oil-less rotary pump to produce the suction pressure and critical flow control or office (as recommended by USEPA) for maintaining a constant air-flow rate of $1m^3$/hr or 16.7 L/min. The particles were collected on 46.2 mm diameter, 2 μm pore size polytetrafluoroethylene (PTFE) Whatmann filters. Glass fiber filters are cheap and have been used in many studies previously for determination of metals in coarse particle. Sampling was done at a height of 1 meter from ground level. The air inlet hood of collection sampler was kept at a height of 1-1.5 m above the ground level to simulate the human breathing zone. The instrument was set at least 1 maway from any significant pollution sources [9].

4.0 Results and Discussion

The concentrations were compared with the CPCB 2009 guidelines. Monitoring was done during working hours between 10:00 a.m.- 4:00 p.m. In indoor environment ventilation was mainly natural. The site description is given in Table 1. The average concentrations of PM_{10} and $PM_{2.5}$ are given in Table(s) 2-5. As compared with the CPCB limits (Table 6), the PM concentrations were either within the limit or slightly exceeded which was not very alarming.

Table 1. Site Description

Site	Description
NLT Floor 2(Outdoor)	The sampler was kept near the staircase on the second floor.Throughout the day, students used the staircase so there was adequate movement during the university hours.
NLT Building Floor 3 (outdoor)	The sampler was kept near the staircase on the third floor.Throughout the day, students used the staircase frequently leading to adequate activity.
NLT B.Tech. Chemistry Lab (Indoor)	The sampler was positioned at the back of a lab where there were 2 windows (which were closed). During the monitoring time students performed their experiments hence there was ample activity during college hours.
BNLT Studio First floor (Indoor)	The sampler was kept approximately 6 feet away from the blackboard. The studio had several windows. Classes were held in the studio during monitoring hours.
BNLT entrance (Ground floor outdoor)	The sampler was positioned outside the BNLT building opposite to the administrative section. Parking space was situated 10 feet away from the monitoring spot.
Gate 2 (Outdoor)	The sampler was placed on the sidewalk next to the road. Vehicles passed the sampler during the day. The sampler was completely exposed to the surroundings.
LT Building (ground floor outdoor)	The sampler was kept next to the cooler where there was a door to the right. There were several entry points and people approached the sampler throughout the day to drink and wash hands to the cooler.
LT Building Chemistry Lab (Indoor)	The sampler was positioned at the back of a lab where there were 2 windows. During the day students performed experiments hence there was ample activity during college hours.

Table 2. Particulate concentration at NLT building

S.No.	Site	Floor	Environment	PM 10 (µg/m^{3})	PM 2.5 (µg/m^{3})
1.	NLT Staircase	Second	Outdoor	101	106.6
2.	NLT Staircase	Third	Outdoor	37.4	68.3
3.	NLT B.Tech. lab	First	Indoor	104.43	173.64

Table 3. Particulate concentration at BNLT building

S.No.	Site	Floor	Environment	PM 10 (µg/m^{3})	PM 2.5 (µg/m^{3})
1.	BNLT Studio 4A	One	Indoor	246.2	75.64
2.	BNLT Entrance	Ground	Outdoor	148.17	55.46

Table 4. Particulate concentration at Gate No. 2

S.No.	Site	Floor	Environment	PM 10 (µg/m^{3})	PM 2.5 (µg/m^{3})
1.	Gate 2	Ground	Outdoor	54.3	54.45

Table 5. Particulate concentration at LT building

S.No.	Site	Floor	Environment	PM_{10} (µg/m^{3})	$PM_{2.5}$ (µg/m^{3})
1.	Near Cooler	Ground	Outdoor	94.64	75.71
2.	Chemistry lab	Ground	Indoor	102	84.83

Table 6.CPCB 2009 limits (Ambient)

Particulate Matter	Annual Mean	24-hour mean
Fine Particulate Matter (PM2.5)	40 µg/m3	60µg/m3
Coarse Particulate Matter (PM10)	60µg/m3	100 µg/m3

BNLT: Academic Block III

NLT: Academic Block IV

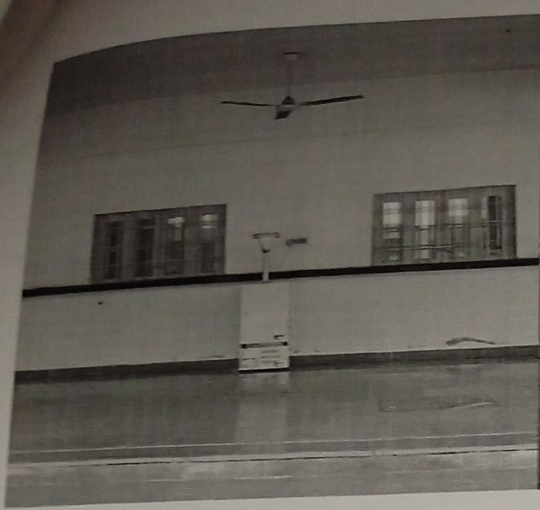
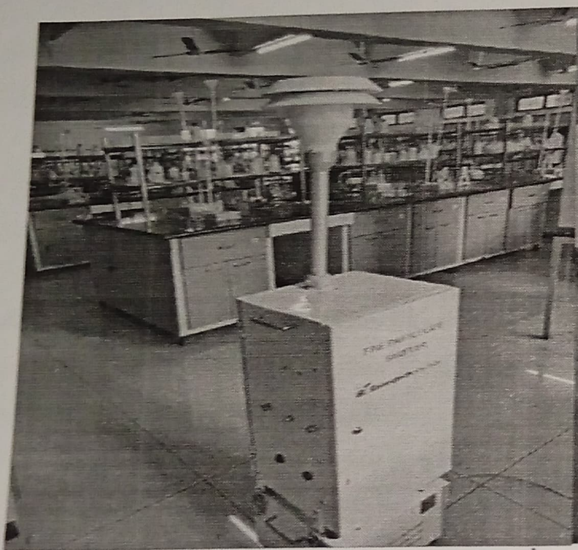


Fig. 1 Monitoring at BNLT

Fig. 2 Monitoring at Gate No. 2



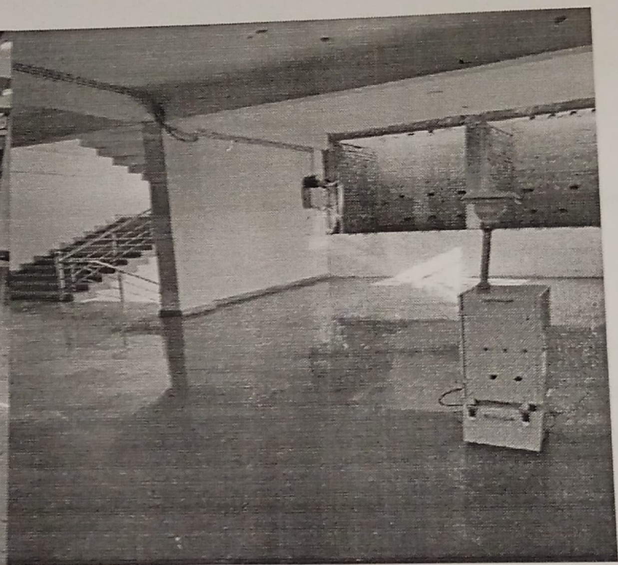


Fig. 3 Monitoring at NLT indoors

Fig. 4 Monitoring at NLT outdoor

5.0 Conclusion

Good air quality has been associated with improved concentration and performance level. The present study was conducted to find out the outdoor and indoor air quality at the selected sites in terms of measuring particulate contamination. The results revealed appreciable air quality in the university campus.

References

1. Ambient (outdoor) air quality and health WHO, 2nd May, 2018

2. Fusco D, Forastiere F, Michelozzi P, Spadea T, Ostro B, Arca M, et al. (2001) Air pollution and hospital admissions for respiratory conditions in Rome, Italy. EurRespir J 17:1143-1150.

3. Spix C, Anderson HR, Schwartz J, Vigotti MA, LeTertre A, Vonk JM, et al. (1998) Short-term effects of air pollution on hospital admissions of respiratory diseases in Europe: a quantitative summary of APHEA study results. Air pollution and health: a European approach. Arch Environ Health 53:54-64.

4. Atkinson RW, Anderson HR, Sunyer J, Ayres J, Baccini M, Vonk JM, et al. (2001) Acute effects of particulate air pollution on respiratory admissions: results from APHEA 2 project. Air pollution and health: a European approach. Am J RespirCrit Care Med 164:1860-1866.

5. Migliaretti G, Cadum E, Migliore E, Cavallo F (2005) Traffic air pollution and hospital admission for asthma: a case-control approach in a Turin (Italy) population. Int Arch Occup Environ Health. 2005;78:164-169.

6. Sun HL, Chou MC, Lue KH (2006) The relationship of air pollution to ED visits for asthma differ between children and adults. Am J Emerg Med 24:709-713.

7. Pradhan A, Waseem M, Dogra S, Khanna AK, Kaw JL (2004) Trends of metals in the respirable particulates: a comparative seasonal study in Lucknow city. Poll Res 23(3):445-450.

8. Verma A, Singh SN, Shukla MK (2003) Air quality of transgomti area of Lucknow city. India, Bull Environ ContamToxicol70(1):166-173.

9. Lawrence AJ, Khan T. (2020) Quantification of Airborne Particulate and Associated Toxic Heavy Metals in Urban Indoor Environment and Allied Health Effects. In: Gupta T., Singh S., Rajput P., Agarwal A. (eds) Measurement, Analysis and Remediation of Environment, and Sustainability. Springer, Singapore.DOI http://doi.org/10.1007/978-981-15-0540-9_2.

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25.2.2020
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