C-125

BRIHANMUMBAI MUNICIPAL CORPORATION

Environment & Climate Change Department

MGC/F/6526 date 06/11/2025

Subject: Mandatory Installation of Sensor-Based Air Quality Monitors and LED Displays at all Construction Sites within BMC Jurisdiction

Reference:
1) 28 Point Guidelines for air pollution mitigation measures u/no. MGC/A/6976 dtd. 15.10.2024 issued by Hon. Municipal Commissioner.
2) Hon. High Court of Bombay order dtd. 09.01.2025 in SMPIL/03/2023 with regards to Air Pollution in MMR.
3) Direction issued by Development Planning Department through AutoDCR dtd. 07.02.2025.
4) MGC/F/6256 dtd. 13.05.2025 and 27.05.2025

CIRCULAR

All the project proponents / developers / contractors involved in building construction or infrastructure development activities of private and government works within Brihanmumbai Municipal Corporation (BMC) are hereby directed to comply with the mandatory installation of sensor-based air quality monitors and LED display boards at all ongoing and new construction sites. This directive is issued in continuation of the Hon'ble Municipal Commissioner's 28-point guidelines for air pollution mitigation dated 25.10.2023, the directions issued by the Hon'ble High Court of Bombay in SMPIL/03/2023 dtd. 09.01.2025, and instructions issued from time to time by the Development Planning & Environment & Climate Change Department. D.P department through AutoDCR has already given instructions on 07.02.2025 to deploy sensor based air pollution monitors.

As on date, not all construction sites have installed the same. In order to have a standard specifications, BMC had invited an EoI for Shortlisting of technology and make & model for sensor-based air pollutants measuring units/devices (PM 2.5 & PM 10) and has shortlisted 13 sensor makes and models as listed in Annexure B.

All construction projects with an estimated cost below ₹1000 Crores are required to install sensor-based air quality monitor for measuring PM2.5 and PM10 and display real-time AQI data through an LED display board at the construction site. The sensor should comply with the technical specifications in Annexure A and must be chosen from the make and models listed in Annexure B. Additional makes/models will be added/

deleted subject to successful validation through co-location study. If any listed sensor is found non-compliant during the co-location study, it will be removed from the list. The air quality data must be accessible at the site and made available for inspection by BMC officials and same will have to be integrated with BMC's Command & Control center.

Any alternate make/model of sensor that is not listed in Annexure B may only be installed upon prior approval from the Environment & Climate Change Department, provided the device complies fully with the technical specifications laid out in Annexure A.

As directed by Expert Committee appointed by Hon. High Court of Bombay, for projects cost more than ₹1000 Crores, the installation of a reference-grade air quality monitor (cost approximately ₹7 lakh) is required as per the technical specifications given in Annexure C, along with the display of AQI data via LED boards as per Annexure A.

Installation of both the sensor and LED display must be completed within 30 days of issuance of this circular. For new projects, installation must be completed within 15 days of receiving the work order or commencement of work.

Non-compliance with these directions within the stipulated timeline will result in Show Cause /Stop Work Notices and other penal action as per applicable legal provisions and the orders of the Hon'ble High Court of Bombay by Competent Authority.

Enclosure:

Annexure A: Technical Specifications of Sensor-based Air Quality Monitors at Construction sites (For Project Cost less than 1000 cr.)

Annexure B: List of 13 of shortlisted make & model of sensor-based Air Quality Monitors.

Annexure C: Technical Specifications of Reference Grade Air Quality Monitors at Construction sites (For Project Cost more than 1000 cr.)

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Annexure - A

Technical specifications for Sensor based Air Quality Monitor at Construction Sites

(For Project cost less than 1000 cr.)

1. Introduction

The pollution in Mumbai Metropolitan Region (MMR) is emitted from multiple sources, including vehicular emissions, industrial activity, infrastructure development, construction, solid waste management, burning of fossil fuels, bakeries, crematoria, etc. As per the CSIR-NEERI study of 2023 for "Air Quality Monitoring, Emission Inventory and Source Apportionment Studies for Mumbai City", construction dust is one of the major source of PM10 and PM2.5 in Mumbai.

The 28-point guidelines for Air pollution mitigation measure dated 15.10.2024 issued by the Hon'ble Municipal Commissioner has mandated the deployment of sensor-based air pollution monitors at construction sites at "*Sr. no. 09 - All construction sites to deploy sensor-based air pollution monitors at work sites and act immediately on observing pollution levels exceeding the limit.*"

2. The Hon'ble High Court of Bombay order dated 09.01.2025 in SOU MOTO PIL Case No. 03/2023, has directed that *"Para. 20: The Municipal Corporation as also the MPCB has already taken steps in seeking compliance of the installation of pollution indicators, insofar as the industries are concerned. Such devices be also installed on all the construction sites in which construction is in progress. All these devices / monitors be centrally connected and an appropriate surveillance in regard to the pollution generated by such construction sites and industries be rigorously observed by the Maharashtra Pollution Control Board. In regard to the construction units, if such devices are not installed within a period of one month from today, action be taken against such units including to close down such constructions, till the compliances are achieved."*

3. The Development Planning Department had also issued directions via AutoDCR dated 07.02.2025 mandating that sensor based air quality monitors must be maintained at site and data to be made available for inspection by the Competent Authority.

Accordingly, it is mandatory for the project proponents / developers / contractors of private and government works to install these sensor-based air quality monitors along with LED display for public at their construction sites within one month of receipt of this circular. The installation of these sensor-based air quality monitors and their integration with the Central Command Centre will enable BMC to track real-time pollution levels at the source and take necessary action.

The construction site shall also display real-time pollution measurement data visibly at the site on LED screen for public. This sensor-based air quality monitors should feature a satisfactory protocol to transmit the data to the Central Command Centre of BMC for regular monitoring and supervisory control.

Ambient Air Quality Sensor Monitor are Internet of Thing (IoT) based air pollution monitoring system that can collect real-time data from multiple locations, which then analyzed to identify the sources of pollution. The system can provide valuable data to government agencies, researchers, and the public to make informed decisions about air pollution.

The Ambient Air Quality Sensor Monitor sensors shall provide real-time measurements of PM concentration (µg/m^3), Relative Humidity (RH) (%) and Temperature (°C). This robust device shall have ability to provide the real-time data at 1 minute interval with wide range of measurements.

Sensor must possesses certification such as mCERTS TUV, NIST, or AirParif, or have undergone performance evaluations by institutions like IIT Kanpur, IIT Bombay, IIT Delhi, IIT Madras, IIT Kharagpur, or CSTEP Bangalore.

2. Component & Selection of Air Quality Sensors

Ambient Air Quality Sensor Monitor shall comprise of several components that work together to collect and analyze air quality data. The components will include -

i. **Sensors:** The main pollutant at construction site is PM10 and PM2.5. The sensor installed should monitor PM2.5, PM10, temperature and relative humidity.

Parameter	Measurement range	Accuracy/Pearson co-orelation Coefficient	Response Time (sec)	Lifetime (months)	Operating conditions
PM2.5	0 to 1000 µg/m^3	R^2>0.7	<10	~24 to 30	T=-30°C to ~70°C RH=0 to 95%
PM10	0 to 1000 µg/m^3	R^2>0.7	<10	~24 to 30	T=-30°C to ~70°C RH=0 to 95%
Temperature	-40°C to 85°C	+/- 0.5 C for range 0 – 65 C, +/- 1.25 C for range –20 to 0 C	1	~24 to 30, validated from field deployments	NA
Humidity	5% to 95%	+/- 3%	1	~24 to 30, validated from field deployments	NA

Working principle:

Optical Particle Counter (OPC) sensor shall detect PM2.5 and PM10 by directing a laser through an air sample and measuring the intensity of light scattered by

individual particles using a photodetector. The scattered light signal is processed to estimate particle size and concentration, enabling calculation of mass concentrations (µg/m³) based on assumed particle properties.

ii. **Micro-controller:** It shall receives data from the sensors, processes it, and send it to the cloud server or any other data storage hardware. The microcontroller is usually a microprocessor such as Arduino, Raspberry Pi, or similar devices.

Communication Module: The communication module is responsible for transmitting data from the microcontroller to the central cloud server. Communication modules can use various wireless technologies such as Wi-Fi, Bluetooth, GSM, LoRa, Ethernet Sigfox and NB IoT to transmit the data real time or cellular networks.

iii. **Cloud Server:** The cloud server is a centralized platform for storing, analyzing, and sharing air quality data. It shall collect data from the communication module of Ambient Air Quality Sensor Monitor and store it in a database. The cloud server also shall provide web and mobile applications for users to access the data. The cloud server will not be in scope of the project proponent of construction site.

iv. **Third party software support:** Data should be accessible through APIs to facilitate Integration into third party software, process automation and central centre.

v. **Power Supply:** The devices shall operate on AC mains supply. In case of power failure, provisions for alternate power supply, such as solar panels or UPS with a backup of 10 to 12 hours, should be in place.

CAUTION AND SAFETY FOR SENSORS

- Monitor shall use a regulated power supply to avoid fluctuations that could affect sensor performance. Voltage spikes or drops can lead to inaccurate readings or even damage the sensor.
- It shall use appropriate gauge wiring and secure connections to avoid issues related to poor connectivity or electrical noise.

vi. **Internal memory:** For short duration, storage of real-time data at instances of network connectivity issues shall be done locally for 60 days.

Module shall have Memory back up to ensure no data loss or network failure.
SD card for data storage. (In case of a network error, the data will be still stored on the SD card, preventing any loss of data).

vii. **Enclosure:** The enclosure is the outer covering that protects the components from environmental factors such as dust, rain and wind. The enclosure housing the sensors and electronic peripherals shall be lightweight and compact System with IP65 and above grade enclosure for endurance against harsh weather conditions.

viii. **Dehumidifiers (optional):** The dehumidifier is designed to prevent humidity in measuring ambient air during hot and humid or monsoon conditions. The dehumidifier includes a heating element that prevents excessive humid air from

being sampled for measurement of PM2.5/10 and as a result, improves the performance of particle sensors in outdoor conditions.

Considering humidity conditions in Mumbai, retrofitting of dehumidifier shall be considered with following specifications:

Component	Stabilization time (sec)	Operating voltage	Average Current	Lifetime (months)	Operating conditions	Storage conditions	Data refresh cycle (sec)
Dehumidifier	5	DC 12V +/- 0.5V	2.8A @12V DC	60	T=-30°C to ~70°C RH=0 to 95%	T=-40°C to ~85°C RH=0 to 95%	1

ix. **Real Time Measurement Data Display:**

The communication module shall be responsible for transmitting data from the microcontroller to the central cloud/server and to display the real time air quality information to the public. Digital LED display board shall be with following specifications*.

Led installation type	Wall mounted/Stand Alone
LED display Size	915 mm x 1220 mm H x W (Approx. 3 Ft. x 4 Ft.)
Screen resolution	320X192 pixels, 240 X 160 pixels, 192 x 128 pixels
View Angle – Horizontal/Vertical	140°/130°
Ingress Protection - Front/Back	IP65 or above grade
Visibility Range	25 metre
Brightness	8500 NIT
Display of Color Element	1 Red, 1 Green, 1 Blue Pixel
Minimum Life Span of the system LED	30000 Hrs.

**Suitable size modifications as per site condition with prior approval.*

3. Site Selection Criteria for Sensor Installation

SITE SELECTION & ITS CRITERIA FOR LOW COST SENSORS

Ambient Air Quality Sensor Monitor shall be installed in the field as a wall or a pole-mount, nearby a reliable power source. A suitable location with 180° air circulation shall be identified.

Minimum Checklist

- 24*7 Power Supply
- Unobstructed Airflow(270°)
- Wi-Fi/ Cellular Network
- Easily Accessible
- Site is selected for ambient measurement.

Sensor installation: For ambient monitoring, sensors should be installed in areas with free air movement, at a height of 3–5 meters from the ground level.

4. Sensor Calibration & Data Accuracy

Ambient Air Quality Sensor Monitor shall provide ambient PM2.5 and PM10 concentrations with notable accuracy. To ensure and improve accuracy, devices require calibration. Accuracy and precision should be tested against FRM/FEM regulatory monitors. Calibration should occur every two months. The Calibration Report for the unit/model/product shall be made available for inspection to BMC authorities as and when demanded.

Collocate sensors with reference monitors for deployment at construction sites:
All sensors must be collocated with reference monitors (e.g., CAAQMS BAMs) for a minimum of two weeks in dusty conditions and tested over varying relative humidity. Collocation (sampling with the sensor node within 10 meters of the reference monitor inlet) can improve data accuracy by developing correction models. The project proponents / developers / contractors involved in building construction or infrastructure development activities of private and government works within BMC jurisdiction for ongoing project shall deploy sensor based air quality monitor (with factory calibration certificate) and without above Co-location study. However, the Co-location/ Calibration for the unit shall done within 6 months and the report shall be made available for inspection to BMC authorities as and when demanded.
For new construction sites, 15-days co-location study shall be done prior to deployment of units at site.

5. Data Collection, Transmission, and Validation

Data Accessibility:

Data should be accessible through APIs for integration into third-party software, process automation, and the Central Command Center at BMC.

Real-time data collection: Sensor nodes should report the data at 30-second or 1-minute resolution. The manufacturer should provide API-based data access every 15 minutes to the central command centre so that officials can be alerted and take quick action if pollution levels are too high.

Data standardisation: For using multiple integrators, the data should be standardised in near-real-time before analysing the data. General standardisation includes converting timestamps into IST, giving uniform names and units to the parameters (PM2.5 and PM10 reported in µg/m3), and averaging the measurements to uniform time intervals. Standard Reference PM Monitors like the Beta Attenuation Method (BAM) approved by CPCB used in Continuous Ambient Air Quality Monitoring Station (CAAQMS) generally report data as 1-hr averages. Hence, aggregating the sensor data on an hourly basis can assist in comparisons with the reference monitors. However, sensor data should be averaged at hourly basis only if 75% of data points are available for that particular hour. For routine monitoring and data visualisation, reporting at 1-minute or 15- minute basis is recommended.

Data processing

The dataset from Sensor Ambient Air Quality Monitor deployed should contains PM 10 and PM2.5 concentration and other meteorological parameters (such as Temperature and Relative Humidity) with a timestamp. All the collected datasets shall be merged based on timestamp and unique device ID.

6. Maintenance and Replacement Protocol

Evaluation & Accuracy of Ambient Air Quality Sensor Monitor

The Ambient Air Quality Sensor Monitor devices prior to installation in the field should be rigorously evaluated in the test sites in colocation with a reference monitor, for a period of 10-15 days against a carefully deliberated test matrix.

Ageing of sensors: PM sensors lose their accuracy over a period of time, e.g. as dust collects on the sensor optics leading to underreporting of PM, humidity interference etc. Indicators can report the same concentration for days, or reporting zeroes. Hence, periodic collocation (e.g. every three months) with a reference PM monitor should be ensured to ensure data reliability.

Life cycle of components used in Ambient Air Quality Sensor Monitor

The typical lifetime of the sensors is 30 months while that of the dehumidifier is 60 months. The sensors should be replaced at the end of 30 months cycle. The manufacturer/supplier shall ensure that the unit/mode/product offered is not at 'End of Life Cycle' and manufacturer shall support for spare parts/ maintenance services for next three to five years.

Installation & Maintenance of Ambient Air Quality Sensor Monitor

The device monitoring module should notify the status of any offline/faulty device at every 6 hours to central command centre. The field maintenance team of the construction site shall reach the identified faulty devices. The maintenance should be carried out in the field for issues that can be resolved on site. For issues not serviceable in the field, the device should be swapped with a replacement device till the issue is resolved. The schedule for replacement of hardware consumables will be as per the component lifetime. Any faults without component replacement should be addressed within the 6-hour maintenance window. Expected replacement timeline is 24 hours.

Zero break-down and fault detection

Strategy for fault-detection: The objective of fault detection is to identify sensors that either provide inaccurate measurements or have stopped working. These sensors need to be replaced with new sensors in the devices.

Checks to be performed on the data from the sensors every 6 hours

Check	Definition	Target value
Uptime	The operational time of the sensor is calculated by dividing the actual number of hourly data points received from the sensor over last 24-hours by the total number of hourly data points	>95%
Range violation	The count of out-of-bounds readings given by the sensor violating the upper limit or lower limit of sensor measurement range in last 24-hours	<1%

Any sensor recording less than the target uptime value for two consecutive months shall be replaced with a new sensor unit.

Cleaning: Periodic cleaning is important to ensure optimum device performance. Monthly or quarterly regular maintenance activity has to be carried out depending upon the surrounding. The activity includes cleaning the dome for the light sensor, air inlet, and outlet mesh & general cleaning of the exterior.

30/10/25

Chief Engineer
(Environment & Climate Change)

Annexure – B

List of 15 of shortlisted make & model of sensor-based Air Quality Monitors.

Sr. No.	Name of the Company	Make of Sensor/ Unit	Model of Sensor Unit	Contact Person and Number
1	M/s. Respirer Living Sciences Private Limited	Re spirer	AtmosAQ-Pro	Mr. Ronak Sutaria 9619690020 rsutaria@respirer.in
2	M/s. Airveda Technologies Pvt. Ltd.	AIRVEDA	PM2510TH-GSM-EYE	Mrs. Namita Gupta 9818955539 namita@airveda.com
3	M/s. Technovalue Solution Pvt. Ltd.	OIZOM INSTRUMENTS	OIZOM AQBOT PM	Mr. Ajinkya Jiwane 8879330483 ajinkyajiwane@technovalue.in
4	M/s. Saksham Scientific Instruments Pvt,Ltd.	TSI Incorporated, USA	BlueSky™ AIR QUALITY MONITOR Model 8143	Mr. Rahul Yamgar 8828338357 sales@ssipl.net.in
5	M/s. Florosense Engineered Solutions Pvt. Ltd.	DUTON (Florosense Engineered Solutions Pvt. Ltd.)	FLO-NODE S	Mr. Adarsh K 7829553183/ 8073593961 info@florosense.com
6	M/S. Fortunexis Automation Private Limited	ENVIROZONE	EZ320	Mr. Dharmender Verma 8076751198 d.verma2004@gmail.com sales@fortunexis.in
7	M/s. Chemtrols Industries Pvt. Ltd	Chemtrols - Aurassure	Chemtrols – AirXpert	Ms. Neena Nair 9819508720 neena.nair@chemtrols.com
8	M/s. Opruss India Pvt Ltd	Opruss India Pvt Ltd	OPRUSS ADM-1000 System	Mrs.Shreshtha Lad 9175984817 accounts@opruss.com
9	M/s. PT Ecological Services Pvt. Ltd	PT ECOLOGICAL SERVICES PVT. LTD.	M-AAQM	Mrs. Sonal Mahyavanshi 7756979879 official@ptespl.com

Sr. No.	Name of the Company	Make of Sensor/ Unit	Model of Sensor Unit	Contact Person and Number
10	M/s. Traceengineering Solutions Pvt. Ltd.	Trace Engineering	AQM LOGGER	Mr. Shreedhar Pandya - 9833374812 projects@traceengineering.in
11	M/s. Steamlok Engineering Pvt. Ltd.	EARTHSENSE	ZEPHYR	Mr. Milind Kadam 9881566175 sales@steamlokengineering.com
12	M/s. Pollution Protection Systems Mumbai Pvt.Ltd.	SENSIT	RAMP	Mr. Sachin Chaudhary 9987522982 sachin@ppsmumbai.com
13	M/s. Safa Enterprises-(Kandivali – West)	Prana Air	Ambient PM	Mr. Aditya Sunil Godse 8208043297 safaenterprises22@gmail.com
14	Engineering & Environmental Solution Pvt. Ltd.	E&E	EE-AQMS-M01	Mohd. Hamza 9540990415 hamza@enggenv.com
15	M/s. Eco Ventures Pvt. Ltd.	AUG Signals Ltd., Toronto, Canada	AirSENCE DUST WATCH	Ankitkumar Dhanurkar 9702660756 evinfo21@gmail.com

NOTE: The above list of shortlisted make & models of sensor-based Air Quality Monitors is valid for next 3 years i.e till 30.05.2028 and will be updated time to time.

30/10/25

Chief Engineer
(Environment & Climate Change)

Annexure – C

Technical specifications for Sensor based Air Quality Monitor at Construction Sites

(For Project cost more than 1000 cr.)

As per the directions of Expert Committee appointed by Hon. High Court of Bombay, sites with project cost more than 1000 cr. shall install reference grade PM monitors (cost about 7 lakhs). The reference grade monitor to be installed shall conform to the technical specifications prescribed for Continuous Ambient Air Quality Monitoring Analysers (Particulates) as per CPCB guidelines under 'Technical Specifications for Continuous Ambient Air Quality Monitoring (CAAQM) Station – Real Time'.

Link - https://erc.mp.gov.in/Documents/doc/Guidelines/CAAQMS_Specs_new.pdf

Note: For the project costing less than 1000 Cr., but where substantial excavation or material movement is ongoing, shall also have to install reference grade PM monitors (cost about 7 lakhs). BMC may select such project sites based on cost and air pollution potential as suggested above.

30/10/25

Chief Engineer
(Environment & Climate Change)