

Bird's Eye View on Pollution Using AQ Audit

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Abstract:- Good air quality is as critical to all life forms as human soul is to organisms structural presence. Industrial revolution and ceaseless rivalry amongst nations looking out for ranking higher above another is making this world devoid of this requisite component. Research aims to discern solutions through Air Quality Audit for sustainable wellbeing of fauna, flora and life systems, through identification of the problems and desired actions. AQ Audit with technologically driven measures has been recognized as last possible effort towards goal of attaining uncompromised air. It has been signaled remarkably by the research that regular examination and inspection in this direction can yield positive results. As indoor and outdoor air quality index has deteriorated to extreme levels by end of each day, it has become highly indispensable for intellectuals to engage in brainstorming sittings to overcome this complication.

I. INTRODUCTION

Deterioration in Air Quality levels has been one of the most debated issue of 21st century. World health Organization (WHO) and Environment Protection Agency's (EPA) have been pondering day and nights to find solutions to keep air pollution levels to its bare minimum and to improve air quality through monitoring measures.

As per one research and data collection agency more than 450 international treaties have taken place since 1820 to till date for protection of environment. Some of the major treaties include Convention on Long Range Trans Boundary Air Pollution (LRTAP), Geneva, 1979, Kyoto Protocol, 1992, Paris Agreement 2015 etc. All these treaties and conventions have somehow missed their goals due to which yet issues of Environment protection and Air pollution control are pending to be resolved.

Nations have long tried to develop internal measures, courses of actions, tools and programs to overcome the issues of Air Quality monitoring, related controls and improvements. AQ Audit is one of such resolve in direction to iron out loopholes and flaws in achievement of objectives.

Air Quality Audit involves assessment of regions or an organizational air quality with the motive to identify diversions and to ensure compliances with the accepted air pollution levels. It not only calls for evaluation of air quality but also to identify non allegiance towards environmental laws. It comprise of steps undertaken by professionally

enriched AQ Team to ensure safety of the area under inspection by identifying possible dangers and implementing corrective courses of action to control the situation. Information collected through audit is used to investigate particular air quality issue and develop a plan of action.

AQ Audits have gained enough significance in the present times as they support continuation of sustainable business operations in safe and protected environments. Way the world is evolving day by day, villages are shaping into towns, towns in mega cities and so on, and this development bandwagon has made everyone to aspire for quality life. However, this innocent desire is creating environmental and lifestyle issues. Serious deterioration has been reported in recent times in not just outdoor air quality levels but indoor pollutants level too. As per Environment Protection Agency (EPA) and National Institute for occupational safety and health (NIOSH), indoor pollutant level at some places has been recorded 100 times more than outdoors in United States of America. In India Central Pollution Control Board (CPCB), National Green Tribunal (NGT), State Pollution Control Boards (SPCB), Pollution Control Committee (PCCs), National Environmental Engineering Research Institute (NEERI) are collectively responsible for monitoring air quality in cities and towns. As per latest reports Air quality index in nation's capital city is at 450, just 50 down from the highest pollution level of 500AQI.

As per research and pollution data reporting agency IQAIR more than 15 Indian cities share rankings in worlds TOP 20 most polluted city list and this is based on data aggregated from more than 80000 data points. This is a matter of grave concern and demands immediate attention.

II. TYPES OF AQ AUDIT

➤ *Outdoor Air Quality Audit*

Outdoor air quality is derived by computing levels of eight atmospheric pollutants in air namely, Sulfur dioxide (SO₂), Nitrogen Dioxide (NO₂), Carbon Monoxide (CO), Ammonia, lead, Ozone (O₃), Suspended particulates smaller than 10µm in aero dynamic diameter (PM₁₀) and suspended particulates smaller than 2.5µm in aero dynamic diameter (PM_{2.5}). Individual AQI is assigned to each of these pollutants and final AQI is highest of these eight scores. The data derived across cities is then compared and possible reason for AQI categories of each of the city is then studied for identifying possible course of action. NGT and National Air Monitoring Program (NAMP) perform this assessment on continuous basis and share data with Expert group

comprising of air quality experts, Medical professionals, Environmentalist, government agencies for real time studies.

➤ *Indoor Air Quality Audit*

Indoor Air Quality is quality of air within and around building and structures. Quality of air inside and around affects health, comfort and survival of occupants of the building. Substandard Air Quality affects individual productivity, results in sick building syndrome, impairs the overall functioning at the premises. Indoor Air Quality Audit ensures that new developments, projects are safe and internal structural environment in an organization is protected for the people working within. Assessment of Internal air quality is indispensable for continuation of satisfactory operations in an organization and for prevention of occupation related hazards. AQ Professionals survey the audit location and project at hand in comprehensive manner to identify deficiencies.

III. PROCESS OF OUTDOOR AIR QUALITY AUDIT

- **Determination of Audit Objective:** General audit objective of Outdoor AQ audit is to measure pollutant levels in the air and relative actions to be applied to bring the situation under control, if required for the subject matter of the audit.
- **Audit Criteria:** Audit team decides about the standard against which subject matter is evaluated. Standard is the acceptable AQI Levels and PM levels for the various pollutants in the air. Air (Prevention and control of pollution) Act, 1981, Environment Protection Act, 1986, Motor vehicle Rules Act, 1989 and several other notifications, circulars and orders are taken in consideration at the time of determination of audit criteria.
- **Audit Coverage and Methodology:** AQ team determines locations, regions and places to be covered under assessment. Besides this industrial clusters, Monitoring stations, PUC units to be surveyed are listed. Methodology to be used for conducting the assessment is documented. Various scientific tools, equipment's and machinery for collection of data and generation of output is acquired. Emission monitor Em919, Screw Sampler, Bag Filters, Electrostatic Precipitators, RCM10, CMM10, PM2.5 Detectors, VOC1 Meter, Air Quality Gauge, Aerosol Monitors, CO2 Meter, etc are some of equipment's used for collection of pollutants data in the air.
- **Audit Planning:** It is one of the most critical aspect for seamless execution of audit. It includes sequence of activities, plans, programs, action to be undertaken for achievement of objectives of the audit. It involves devising strategies for measuring air pollutants, collection of data of PM10, PM2.5, CO, CO2, SO2, NO2, ammonia and benzene levels in the air by use of various monitoring tools. AQ teams are formulated and duties are assigned for satisfactory execution of audit.
- **Execution and fieldwork:** Industrial pollution range, sensitivity and sources in and around the area under

assessment is documented. Levels of Eight pollutants in air are measured. Based on measured concentration level, corresponding standard and likely health impact, a sub-index is calculated for each of these pollutants. The worst sub-index reflects overall Air quality index of the region under evaluation.

- **Reporting:** One of the most critical stages of AQ audit is reporting of the audit findings to the stakeholders who generally include state and central government authorities, medical practitioners, panel environmentalist, expert group members etc. Issues which are critical and require immediate resolution are summarized. Report is abridged in such a manner that all the pressing issues that require feedback must have defined action plan. All deficiencies, findings, conclusion and recommendations are reported through final report.
- **Follow-up Audits:** Outdoor Air Quality team conducts a follow up audit as per audit engagement terms and conditions after the completion of audit. For status of agreed to corrective actions, present and historical levels of AQI are compared and further suggestions for improvement are communicated.

IV. PROCESS OF INDOOR AIR QUALITY AUDIT

Indoor Air Quality audit is a function undertaken to ensure that the air in and around the building structure is of optimum quality and meets the regulatory and environmental guidelines. IAQ teams measure pollutants in air, whole process is undertaken to identify deficiencies, meet environmental standard, attain certification and to rectify issues related to contamination in air. IAQ Certification Standards like WELL, ISO 4225:2020(en) and BREEAM are providing independent third party attestations for sustainable performance of individual building, communities and infrastructure projects. In India AAR Consulting, SGS India, NABL, CIEC are performing IAQ audits of projects, buildings, communities for identifying and measuring pollutants, their sources, health risks and course of action required. IAQ Audit involves under mentioned process:-

- **Audit Engagement:** Prospective Auditee is required to register online for making application for indoor quality audit with the auditor. At the time of registration basic information about project and its scope is defined. Arrangement is agreed upon between client and auditor for services to be provided, period of audit and other conditions for performance of the assignment. Well defined audit engagement helps client and IAQ Auditor to get on the same page.
- **Scope Finalization and requisite documentation:** Scope of audit is agreed upon. Boundaries of the region, area under audit, structural periphery is clearly earmarked. A single IAQ Audit project may include multiple distinct structures that are not physically connected to each other. Exclusions and inclusions of structure under audit must be clearly documented so as to avoid any misunderstanding in future.
- **Audit Planning:** Once scope is agreed upon between the auditee management and the IQ Audit team, plans,

programs, strategies and check list are devised for timely and successful execution of audit. Audit teams and their roles are clearly documented. Roles and responsibilities of reviewers, performance testing agents, project administrator, and other team members are formulated and handed down. Technological equipment's to be handed down to respective IAQ teams are ascertained and kept on standby mode for their use. Documentation required for review is check listed like Annotated Map, Blue Prints, Architectural drawings, Design specifications of equipment, machinery and other installations at project site, Commissioning reports, Past survey's, audit reports and so on

- Audit Execution: Systematic approach is followed at the time of execution of audit. IQ Audit team conducts walkthrough interview, it helps team to gain insights about the study areas and monitoring locations of interest. Map, Blue Prints and annotations help team to gather data about possible pollutant sources and concentrate upon probable risk creating factors. Interviews with occupants also help team to gauge the extent of issues with the air quality and structural formations. On the basis of information attained grey areas and possible threats are pin pointed for further study and evaluation. This forms basis for pollutant level measurement and hazardous substance assessments. Team performs Chemical measurements for CO, CO₂, SO₂, NO₂, PM₁₀, PM_{2.5} presence in indoor air levels is calculated and recorded using detectors and air monitors. Air Transfer and exchange rates from one area to another area is noted down through use of tracer gas technique and gas analyzer. Katharometer is used to detect the concentration levels of tracer gases. Generally deployed tracer gases include hydrogen, helium, ammonia, carbon monoxide, methane etc. IAQ Team uses DC Pressurization equipment also known as blower door to measure air tightness in the area under audit. Several other data regarding thermal comfort, particulate concentration, biological culture like bacteria, fungi accumulations in air is measured using specific monitors. Data collected is then evaluated applying formulae's and computations to arrive at audit conclusions.
- Reporting findings and recommendations: Final step takes place in the form of drafting of report which consist of exhaustive details about findings on pollutant levels, AQI index, Functioning of HVAC Systems, Structural defects aggravating air quality issues, Gaseous formations and reasons thereon and so on. All these identifications are reported comprehensively with the recommendations to bring the alarming situation under control. If IAQ Team finds that levels of pollutants and chemical substances is within the acceptable standards and threshold limits a certificate in this regards is issued to the auditee management along with concluding report. Building walkthrough, objective pollutant measurements, and subjective analysis helps the team to reach to conclusion and make recommendations considering the gravity of the situation.

V. METHODOLOGIES, TOOLS AND TECHNIQUES FOR AIR QUALITY AUDIT

- i) METHODOLOGIES: Several methods, rules and postulates are employed to attain data, explanations and relevant information for IAQ Audit. These include:
 - Walkthrough Assessment: Walkthrough test or assessment is done by IAQ Team during audit to identify loopholes, presence of controls and gauge reliability of present structural systems. It helps the team to develop formal plan of action for execution stages of audit. Indoor Air quality walkthrough are cradle to grave assessment of strengths, deficiencies, inadequacies within building structure under review. Walkthrough includes exhaustive observation of premise, inspection of blue print, documents, NOC certifications, interviews and inquiries with the occupants. Every audit requires assessment of risk for identification of grey areas to be covered for detailed review; walkthrough exercise helps in fulfilling this requirement.
 - Objective Measurement: In IAQ audit objective measurement involves use of technological equipment's for collecting and recording of data related to objects under study. As pollutant contamination level in air is to be gauged and proper remedies are to be reported to the auditee though audit, it is highly indispensable to collect data of their chemical concentration in the air. Audit team uses air analyzers, barometer, katharometers, Hygrometer and similar devices to obtain measurements of CO, CO₂, SO₂, No₂, PM₁₀, PM_{2.5}, Ammonia, Lead and other hazardous substance presence in air.
 - Subjective Analysis: This involves proper analysis of data collected through walkthrough exercise, interviews, chemical measurements, documentation and structural reviews. Actual data about contaminants is compared to the standard levels of pollutants allowed as per rules, regulations and guidelines of EPA and other regulatory agencies. Deviations are identified, grouped, categorized and indexed for further reporting. Reasons for deviations are identified and solutions in the form of remedial steps desired to overcome anomalies are communicated to the auditee.
- ii) TOOLS: Innumerable tools and equipment are available for collection of data for IAQ Audits. Some of the tools which are widely used include:
 - Flu Gas Analyzer: These are used when IAQ Audit of Factory premises or Boiler furnace installation is done. It helps in measuring oxygen and CO levels and ultimately helps in optimizing combustion efficiency.
 - Electronic thermometer: It monitors air temperature for efficient HVAC, heater or furnace system operation assessment. Its measuring range is -50 to 1300°C.
 - Air Quality Meter/Gauge: It detects pollutants in air and their concentration levels on real time basis. It also records data about PM₁₀, PM_{2.5}, volatile organic compounds and formaldehyde. It also quantifies and reports presence of solid, liquid and gaseous substances in air.

- Formaldehyde detectors: It detects formaldehyde concentration level in air which is chemical composition of hydrogen, oxygen and carbon, though all life forms like fish, plants, animals, bacteria and humans naturally produce formaldehyde however it is found in research studies that excess formaldehyde level can cause Nasopharyngeal Cancer(NPC). It is important to regularly monitor its presence in air.
 - Thermo Hygrometer: It helps in measuring temperature and humidity levels in percentage of Site under Air Quality Audit. It works on principle of evaporative cooling. Some hygrometer also provide data about wind speed, dew point, wet bulb temperature and air volume.
 - Nephelometer: This instrument is used to measure concentration of aerosols in an atmosphere. It reports information about particular properties by using light scattering technique.
 - Barometer: This scientific instrument is widely used in indoor air quality audit by IAQ teams to measure atmospheric pressure. This data is used to make surface weather analysis and to identify pressure systems across locations within the structure under audit.
 - Controlled Atmosphere Analyzers: When IAQ Audit of Cold Storage or Warehouse facility is done these controlled atmosphere analyzers helps to measure temperature, Humidity, Background gas of facility and pollutant levels. Deficiencies identified are recorded and reported for further courses of action.
 - Air Quality Analyzers: These devices are generally installed by government agencies to monitor air pollutants levels at bigger areas, spaces and locations within a chosen periphery. They are part of air quality monitoring stations which obtain data about particulate, gaseous pollutants, humidity levels and environmental conditions through them.
- iii) TECHNIQUES: Several techniques are used in Air quality assessment. Some of the techniques are mentioned below:
- Laser Scattering Detection: This technique involves particle sizing through laser beams to detect types of microscopic air pollutants and to calculate their number. It helps in detecting pollutants as small as nanometer and millimeter in size.
 - Non Dispersive infrared radiation sensing: This technique is used for calculating carbon dioxide concentration in air. It uses non dispersive infrared radiation sensor to measure the attenuation of infrared radiation of particular wavelength in the air.
 - Electrochemical sensing: This air quality monitoring technique uses electrochemical cell with a solid electrolyte for detecting and measuring carbon dioxide concentration in air. Electrochemical sensor is integrated with auto calibration feature which gives stable and reliable outputs.
 - Beta Attenuation: This measures small particulate suspension in air. PM10 & PM2.5 pollutants and nano particles are identified by process of beta attenuation. When air is passed through an ultrafine filter cartridge, solid particles in air absorb beta radiation and Attenuation meter identifies and records its

concentration.

VI. BENEFITS FROM AIR QUALITY AUDIT

- AQ Audits helps in adequate monitoring of pollutant levels in air and thus assist in controlling pollution.
- Data measured from air quality monitoring enables teams to assess the effect of contaminated air quality on health of occupants.
- Actual data comparison with standards set by WHO, EPA, NIOSH, NGT, NEERI, ISO helps in identifying deflections on timely basis.
- It helps in monitoring places with poor air quality and take remedial steps for rectification.
- It enables regulatory authorities to form policies and guidelines to control any adverse situations on prompt manner.
- It helps researchers and government agencies to calculate mortalities in an area due to hazardous pollutants levels.
- Enables occupants to understand risks arising from Biological pollutants like mold dander, pollen, allergen, dust mites, bacteria, Volatile organic compounds (VOC's) like formaldehyde and lead etc and devise measures to control them.
- Improvement in air quality helps in reduction in energy consumptions and related cost as HVAC units, Humidifiers, exhaust units do not have to work as hard to cool or heat the air.
- Measures implemented to control air quality as suggested through IAQ Reports enable reduction in volume of allergens in air like dust, mites, pollens, mold etc.
- Data obtained from humidifiers and barometers helps in monitoring levels of humidity in air which allows AQ teams to suggest moisture control measures to auditee management. Control on moisture prevents growth of bacteria, fungi, and mold in the atmosphere.
- Entire exercise of AQ Audits enables stakeholders to identify sensitive ecosystem and estimate exposure of contaminants on human population.
- It allows auditee management to ensure that its indoor air quality measurements comply with the standards and norms which apply in the area and thus protect organization from any adverse action from regulators for non-compliances.
- It helps in preventing any untoward incident that may occur due to building structural defects, poor ventilation systems, and unreliable HVAC setup and so on.
- It helps in taking cognizance of the sources which are making contribution in pollution and on the basis of ranking and seriousness of the issues concerned may devise strategies to treat them.
- It helps AQ Teams to check efficiency and effectiveness of emission control programs.
- AQ teams extrapolate the pollutants and contaminants for upcoming periods on the basis of present measurements and controls implemented.
- Air Quality audit be it indoor or outdoor serves as warning system for occupants about future level of contaminants in air.
- It aware the systems, occupants and societies about the

cause for clean and uncontaminated environment surroundings.

- It enables Audit team to accumulate information's about sources of pollutants and form measures to its control its generation, removal and transportation.
- Findings of Air quality audit not just help auditee management in regulatory compliances. It also helps architects, infrastructure developers in their efforts to develop green and sustainable infra products and scientist, medical professionals, vaccine developers in their efforts to create healthcare remedies for allergens and pollutants present in the atmosphere.
- Audit discoveries will lead to assessment of pattern and trends in air pollutant exposure in ecosystem on long term basis.
- Regular air quality audit of cities, locations and structural spaces will enable stakeholders to develop meteorology and exposure models of the areas under study.
- Air quality assessment helps teams to develop methods for quantifying and forecasting pollutant level effects on ecosystem and its constituents.
- Air Quality Audit leads to implementation of measures for prevention of air deterioration which ultimately results in health benefits from improved quality air to the occupants.

VII. CONCERNS OF AIR QUALITY AUDIT

- Time lag in reporting data delays the plan of action to be taken to control the levels of contaminants and pollutants in air.
- Scope of Audit must be well defined to cover all serious aspects of air monitoring and review for a particular projected area. If scope is limited audit serves no conclusive purpose.
- Lack of support from occupants in data dissemination to the IAQ teams to identify related problems.
- Top management disinterest in the audit exercise makes the job futile and worthless.
- Real time execution implementations of solutions identified is not possible as entire exercise from audit initiation to reporting of findings take a lot of time.
- Level of prejudice is also one of the major concern as lot of agencies, set of teams, individuals are involved in stages of audit, each having their own inequitable or different outlook.
- Quantification and measurement of emissions is onerous task unless CEMS (Continuous emission monitoring systems) are used. As other measure and instruments provide inadequate and non-harmonized set of data.
- Tracking of pollution exposure and pollutants trends on continuous basis for seamless indoor air quality audit turns out to be unaffordable exercise for certain auditee clients, which makes the exercise less favored.

VIII. SUMMARY AND CONCLUSION

Air Quality audit be it indoor or outdoor, have greater significance for future and present generations for the objective which is expected to be derived from its execution. There can be hardly any chances for reconsideration to the fact that in times where greenhouse gas concentration is at peak due to human industrial and developmental activities, AQ Audit, evaluation and monitoring is the only remedy left to bring things under control and to make unrelenting sources accountable for hazardous pollutants levels in the air.

Air quality audits have enormous potential benefits and no detriments as such. To make world a better and sustainable place to live for present and future generations, it has come up as an indispensable solution to be applied and exercised.

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