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Confederation of Indian Industry

Corporate Air Emissions Reporting Guide

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Foreword

Today, as we find ourselves at the intersection of industrial progress and environmental responsibility, the Confederation of Indian Industry (CII) remains steadfast in its commitment to advancing sustainable development. Air pollution has emerged as the top environmental health issue which affects 99% of the global population. Clean air is fundamental to the well-being of our communities and the prosperity of our nation. It is a cause that requires collective action, innovative thinking, and unwavering commitment from all sectors of society.

The challenge of air pollution is complex, but it is one that we can address through strategic collaboration and shared responsibility. This guide represents a significant step forward in our journey towards cleaner air. It is a resource designed to empower businesses to better understand, quantify, and report their air emissions, which will ultimately contribute to its effective management, a healthier environment and stronger communities.

At CII, we recognize that the journey towards clean air is not just about meeting regulatory requirements—it is about leading the way in creating sustainable business practices that align with the larger goals of societal well-being and environmental stewardship. This guide is a testament to our belief in the power of industry to drive positive change. It provides the necessary guidance for businesses to integrate air quality management into their sustainability reporting, fostering a culture of transparency and accountability.

The strength of this guide lies in its ability to translate complex environmental data into tangible outputs for reporting air emissions. It is designed to be user-friendly, with practical steps that can be implemented across industries of all sizes. I urge all industry leaders to use this guide and make air quality management a central part of your business strategy. Whether you are a large corporation or an MSME, this guide will support your efforts to quantify your own air emissions and by doing so contribute to the collective goal of cleaner air.

We are all stewards of the environment, and together, we have the power to make a difference. Let us harness this knowledge piece & lead by example, ensuring that our legacy is one of sustainability, responsibility, and a deep commitment to the health of our planet.

Ms. Seema Arora,
Deputy Director General
Confederation of Indian Industry

Foreword

The world is grappling with the escalating air pollution crisis, demanding urgent action. As Chairperson of the CII Cleaner Air Better Life initiative and Regional Leader for Cummins in India, I am deeply committed to promoting sustainable practices that ensure cleaner air for our communities and future generations.

Air emissions significantly impact public health, climate stability, and socio-economic development. For businesses, this represents both a responsibility and an opportunity. Committing to cleaner air practices can safeguard our communities, protect our natural environment, and ensure sustainable economic growth. This guide is designed to be an essential resource for businesses aiming to take meaningful action towards better air quality.

Transparent and consistent air emissions reporting is a cornerstone of effective air quality management. It allows businesses to understand their impact, identify opportunities for improvement, and demonstrate their commitment to sustainability. More importantly, it fosters trust among stakeholders, from regulatory bodies to the communities we serve. This guide provides a comprehensive framework for accurately reporting air emissions, grounded in robust research and best practices.

The benefits of transparent air emissions reporting extend far beyond regulatory compliance. It is a critical tool for driving innovation, improving operational efficiency, and enhancing corporate reputation. By adopting the methodologies outlined in this guide, businesses can lead the way in environmental stewardship, contributing to a healthier, more sustainable future.

As leaders in our respective industries, it is incumbent upon us to take decisive action. This guide offers practical steps and insights to help integrate air quality goals into corporate strategies and day-to-day operations. By doing so, we can collectively significantly reduce air pollution and improve public health.

I call upon all businesses to utilize this guide and embrace the challenge of air quality management with the same enthusiasm and commitment that drive our business successes. Together, we can create a legacy of cleaner air and better life for future generations.

Let us move forward with determination and vision, leveraging our collective expertise and resources to ensure a cleaner, healthier environment for all.

Ms. Shveta Arya,
Chairperson, CII National Initiative 'Cleaner Air Better Life'
Regional Leader, Cummins in India
Managing Director, Cummins India Limited

Acknowledgements

The Confederation of Indian Industry and Environmental Management Centre would like to thank Clean Air Fund and PricewaterhouseCoopers Private Limited for their inevitable support through the process.

Table of Contents

Key Terms, Abbreviations

Terms	Description
GRI	Global Reporting Initiative (GRI) is a recognised framework for sustainability reporting that helps organisations report on their economic, environmental, and social impacts
SASB	Sustainability Accounting and Standards Boards Standards help companies disclose relevant sustainability information to their investors.
BRSR	Business Responsibility and Sustainability Reporting introduced by SEBI mandating top 1000 listed companies to disclose their ESG related information as a mandatory process
Assurance	Independent assessment by a qualified third-party assurance provider that a company's Business Responsibility and Sustainability Reporting disclosures are accurate and complete
GHG Protocol	A standard methodology for companies and organisations to measure and manage their greenhouse gases
Scope 1	Direct emissions that are owned or controlled by a company
Scope 2	Indirect emissions are a consequence of the activities of the company but occur from sources not owned or controlled by it
PM	Particulate Matter is the term for a mixture of solid particles and liquid droplets found in the air
VOC	Volatile Organic Compounds means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate, which participates in atmospheric photochemical reaction
HAP	Hazardous Air Pollutants also known as toxic air pollutants or air toxics, are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effect
POP	Persistent Organic Pollutants (POPs) are a group of organic compounds that are resistant to environmental degradation
CPCB	The Central Pollution Control Board (CPCB) is a statutory organisation under the Ministry of Environment, Forest and Climate Change (MoEFCC)
SPCBs	State Pollution Control Boards (SPCBs) are regulatory bodies established at the state level in India to implement environmental laws and regulations
Concentration Unit	Units in the form of mass per volume (ppm or mg or/$\mu g/m^3$)

1. Introduction

Monitoring air emissions is a foundational step for companies to devise suitable reduction strategies, which can then contribute to the company's sustainability agenda and regional or national clean air goals. Emission consolidation and transparent reporting at the corporate level enable informed decisions about their emission reduction strategies, which can further benefit companies through enhanced reputational capital, sustainability-linked benefits and ensuring compliance with regulatory requirements, most of which are evolving quickly.

The following sections throw light on the air pollutant disclosure provisions set by regulators (under SEBI's Business Responsibility and Sustainability Reporting) and other global reporting standards, following which the **Corporate Air Emissions Reporting Guide** (hereafter referred to as the CAER Guide or Guide) investigates challenges faced in emission reporting that occur due to variety of reasons, both internal and external to a company.

To assist companies in addressing these challenges, the CAER guide provides guidance on monitoring and reporting best practices aligned with the Business Responsibility and Sustainability Reporting framework.

1.1 Existing Frameworks for Emission Reporting

Before diving into air pollutant disclosure standards requirements for Business Responsibility and Sustainability Reporting, it is necessary to understand that global sustainability reporting frameworks such as GRI and SASB already provide ESG/sustainability parameters that a company can voluntarily align with. Disclosure of air pollutant parameters is one of the critical aspects of these disclosures.

Global Frameworks

Global Reporting Initiative (GRI) Reporting standards:

GRI is extensively used by organisations to report their impacts on the economy, environment, and society. One of the material topics to be covered under GRI disclosure is GRI 305- 7, which pertains to the reporting on nitrogen oxides (NO_x), sulphur oxides (SO_2), and other significant air emissions. This indicator requires reporting of the sources of emission factors, standards, methodologies, assumptions, and/or calculation tools used for each pollutant. It recommends providing a breakdown of air emissions data by business unit, country, type of source, type of activity, as applicable. Organisations are expected to disclose air emissions in absolute terms under GRI and data across air emissions sources is to be reported in kilograms or multiples thereof.

Sustainability Accounting Standards Board:

SASB provides industry-specific sustainability accounting standards to facilitate sustainability-related disclosures. There are 77 industry-specific sustainability accounting standards designed to assist organisations in disclosing information about sustainability-related risks and opportunities that could reasonably be expected to affect the entity's cash flows, its access to finance or cost of capital over the short, medium, or long term. The disclosure of air emissions is applicable based on sectoral materiality thresholds.

For instance, consider the standard for Electric Utilities and Power Generators recommends disclosures on pollutants – NO_x (excluding N_2O), SO_2, Particulate Matter (PM10), Lead (Pb) and Mercury (Hg). The standard requires organisations to disclose their emissions of air pollutants, in metric tonnes per pollutant. It also recommends disclosing the calculation methodology and source used, such as Continuous Emissions Monitoring Systems (CEMS), engineering or mass balance calculations.

1.2 India Specific Frameworks

The SEBI (Securities and Exchange Board of India) Business Responsibility and Sustainability Reporting (Business Responsibility and Sustainability Reporting) framework aims to enhance the disclosure and reporting practices of Indian listed companies concerning their environmental, social, and governance (ESG) performance.

The Business Responsibility and Sustainability Reporting mandates the top 1000 listed companies to provide quantitative data related to air emissions covering emissions of gases such as Particulate matter (PM), sulphur dioxide (SO_2), nitrogen oxides (NO_x), and other relevant pollutants, i.e. Volatile Organic Compounds (VoC), Persistent Organic Pollutants (PoP), Hazardous Air Pollutants (HAPs) and other pollutants. The framework recommends disclosure of any contextual information necessary to understand how the data has been compiled, such as any standards, methodologies, assumptions, and calculation tools used. It should be noted that Business Responsibility and Sustainability Reporting does not explicitly mention the unit in which air pollutant emissions are be reported. Business Responsibility and Sustainability Reporting has a guidance document, but it does not provide any additional note or guidance on air pollutant parameters.

1.3 Challenges in emission reporting

To understand how Indian companies report on air pollutant parameters, air emission parameters were analysed of top 1,000 through publicly available Business Responsibility and Sustainability Reporting data of companies published in FY 22-23.

Key insights from the Business Responsibility and Sustainability Reporting analysis include:

- A limited number of companies report air emissions on pollutants. The number of reporting companies further reduces for Volatile Organic Compounds (VOCs), Persistent Organic Pollutants (POPs), and Hazardous Air Pollutants (HAPs). This is possibly due to lack of guidance on measuring and reporting the same.
- Indian companies are accustomed to reporting air emissions in concentration units such as parts per million (ppm) and micrograms per cubic meter of air (ppm or mg or/$\mu g/m^3$). This is probably due to the requirements of statutory bodies such as Central/State Pollution Control Boards which set concentration threshold and requires disclosure in the concentration units. The Global frameworks prefer reporting in tonnes/mass units as this facilitates comparisons and consolidations at a company level.
- It is noteworthy that, most assured reports currently present emissions in concentration units. It is essential to recognize that the choice of units for reporting is not a standardized criterion for assurance.

The inconsistencies highlighted underscore the need for a definitive guide on air pollution emission monitoring and reporting.

A deep dive into the challenges associated with emission monitoring and reporting was conducted through primary consultations with Indian companies reporting on Business Responsibility and Sustainability Reporting was done.The team consulted stakeholders from companies across metals, automobiles, chemicals, pharmaceuticals, laminates, gas utility, fast moving consumer goods sectors to understand the practices and challenges associated with emission monitoring and reporting.

Key insights based on the consultations include:

- An absence of specific guidance on which air pollutants should be considered under VOCs, HAPs, and POPs. Overlaps in guidelines on the classification of pollutants within HAPs, POPs and VOCs makes it difficult for companies to allocate appropriate categories to pollutants.
- A company follows the “Consent to Establish/Operate” sanctioned by their respective State Pollution Control Board. Therefore, the monitored parameters (for a similar manufacturing process/products) can differ according to consent. Organisations lack clarity due to varying standards across different geographies, thus consolidating air emissions at corporate level is challenging.
- Limited clarity exists on the boundary, apart from scope of sources for air emissions that should be covered in reporting.
- There is a limited conceptual clarity on reporting between “air emissions” and “ambient air monitoring”, which often get interchanged in disclosures.
- The cost of monitoring for HAPs and POPs and agencies available can be a major deterrent towards reporting air emissions.

1.4 Objective of the Guide

The objective of the CAER Guide is to provide comprehensive guidance to Indian businesses that are disclosing air emissions as part of their Business Responsibility and Sustainability Reporting obligations. The principles and methods set forth in this guide may also be applicable to air emissions reporting within other ESG disclosure frameworks globally. The CAER Guide aims to create awareness and enhance the capacities of reporting teams ensuring consistent air emissions monitoring and reporting, it provides steps and tools to convert air emissions data into relevant units, thus, facilitating easier comprehension and comparison. The overarching objective is to empower Indian businesses to effectively manage their air pollution emissions, enhance transparency in reporting practices, and contribute to a cleaner, healthier environment for present and future generations.

1.5 Users of this Guide

This guide is for organisations of all sizes, all economic sectors and across various types of ownership structures. Users can leverage relevant parts of this guide to develop accounting and reporting processes, specifically in alignment with Business Responsibility and Sustainability Reporting. Additionally, it is applicable to a range of other organisations and institutions, both public and private. Throughout this guidebook, the term “company” is used as a shorthand to refer to the entity developing air emissions inventory.

1.6 How to Use this Guide

This guide is designed to serve as a comprehensive resource for reporting air emissions reporting. For the ease of use, content is divided into four sections; Scoping of Air Emissions, Calculations and Consideration, Reporting and Assurance and Annexures. Further, we have developed the guide in Q&A format to enhance the usability.

2. Overview of Air Emissions Reporting in India

The objective of the CAER Guide is to provide comprehensive guidance to Indian corporations on disclosing their air emissions to the Business Responsibility and Sustainability Reporting framework. The principles and outlined in this guide may also be applicable to reporting within other global ESG disclosure frameworks.

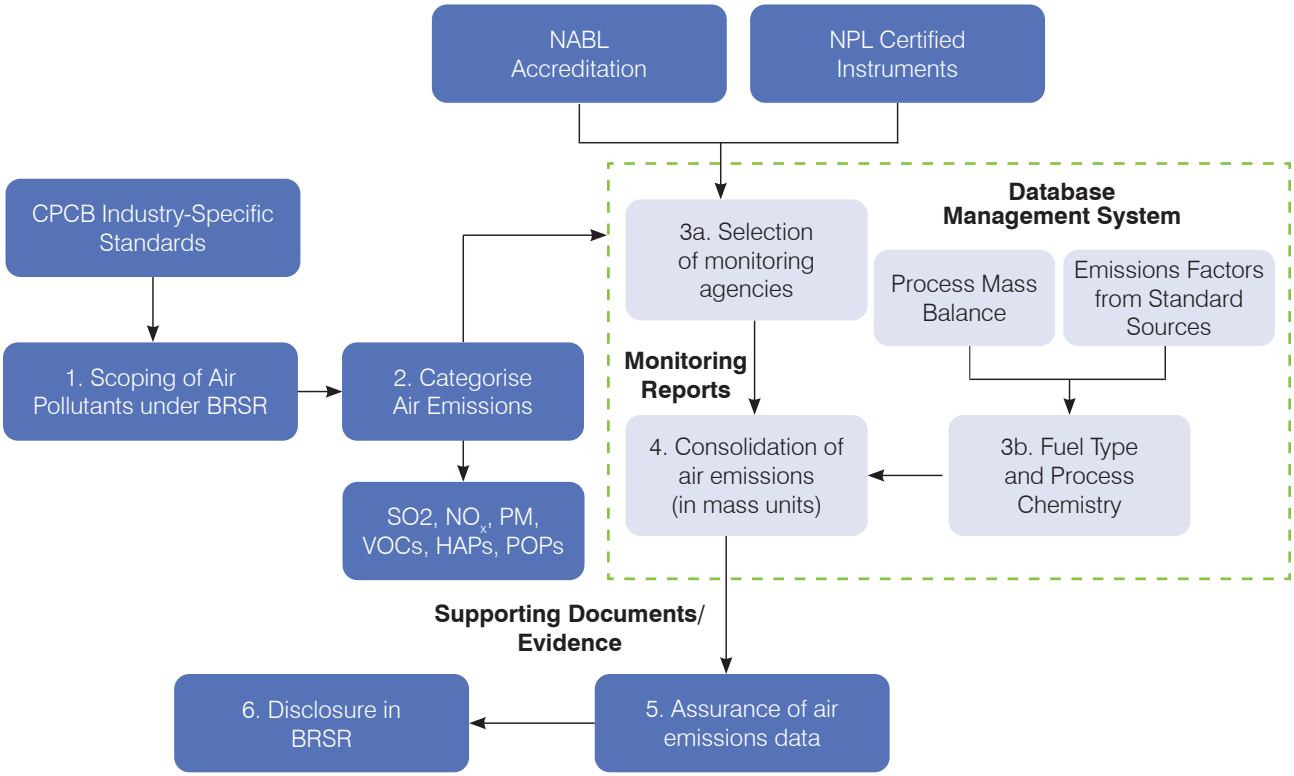

Figure 1 Schematic diagram of steps to be followed for air emissions disclosure

The schematic above (Figure 1) illustrates the systematic process for air emissions disclosure. It outlines the essential steps—from scoping air pollutants to categorising emissions, collecting and analyzing data, consolidating results, and securing assurance.

The steps are listed below:

Step 1:

Scoping of air pollutants involves identifying and defining air pollutants within Business Responsibility and Sustainability Reporting guidelines, including relevant regulations and thresholds.

Step 2:

Categorising emissions according to various sources or activities within the business aids in effective data organisation and management.

Step 3:

(a) Air pollutant data: Selecting accredited monitoring agencies capable of providing monitoring data on air pollutants.

(b) Analyzing the chemical composition of fuels used and the processes generating air emissions to compute air pollutant data.

Step 4:

Consolidating air emissions data into mass units for each identified pollutant category, enables businesses to quantify total emissions accurately.

Step 5:

Obtaining external assurance to validate air emissions data.

Step 6:

Presenting air emissions data along with any relevant information in the Business Responsibility and Sustainability Reporting format.

Companies disclosing to the Business Responsibility and Sustainability Reporting framework often disclose ambient air quality values instead of reporting air emissions. This trend was observed in some of the existing reports for the previous financial years.

The reporting boundaries for air emissions, including air pollutants emitted because of company operations, are listed below:

- emissions from combustion,
- leakages, and
- industrial processes

These emissions may be under the company's direct financial and/or operational control.

Figure 2 shows a schematic diagram for the scope of disclosure under the Business Responsibility and Sustainability Reporting framework.

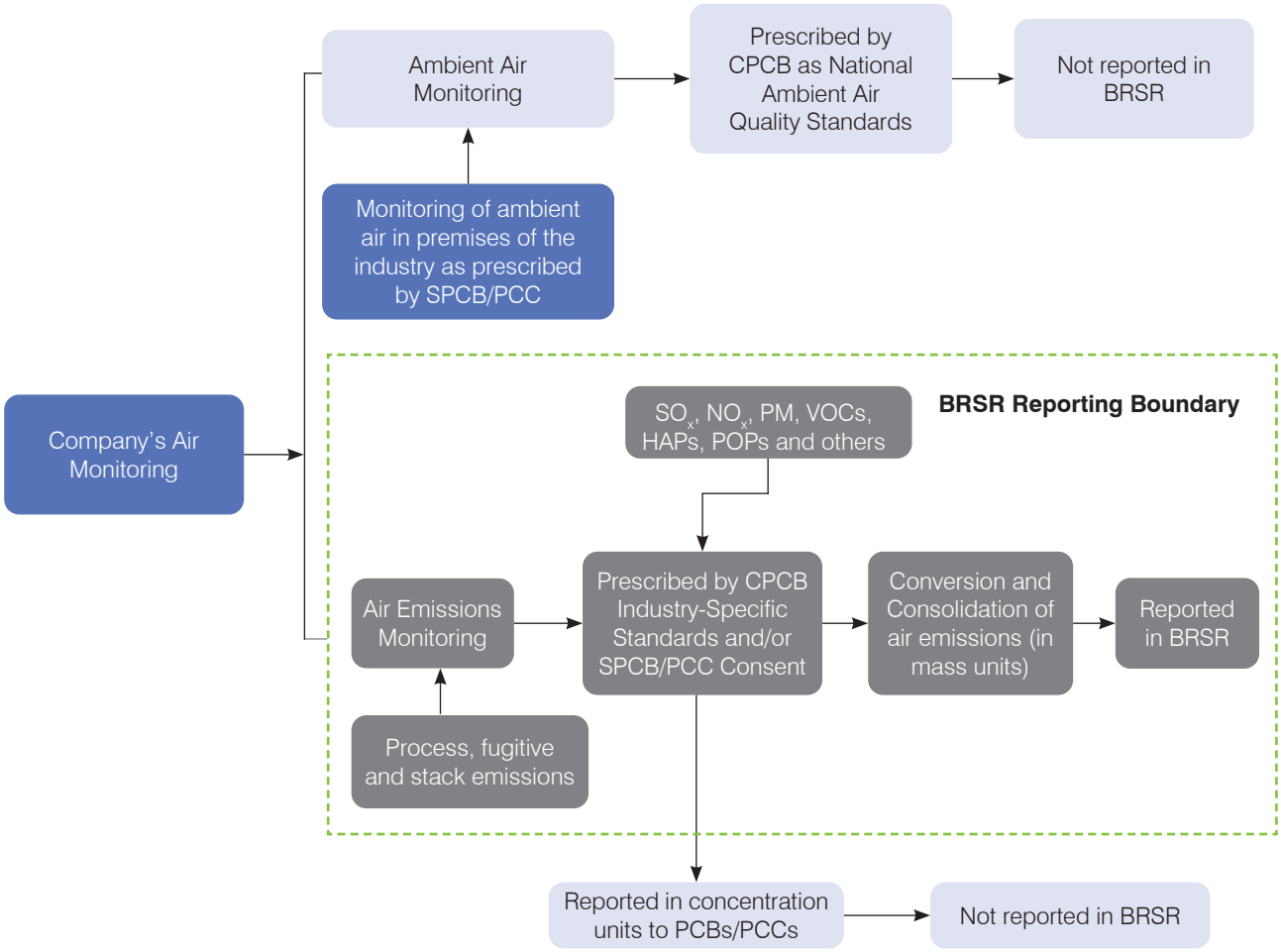

Figure 2 Scope of the Business Responsibility and Sustainability Reporting framework in terms of air emissions disclosure.

For a company, ambient air monitoring involves tracking air quality within premises as prescribed by the State Pollution Control Board (SPCB) or Pollution Control Committee (PCC). This process ensures that the air quality in and around the company's areas meets the National Ambient Air Quality Standards (NAAQS) set by the Central Pollution Control Board (CPCB). However, while compliance with these standards is crucial, this ambient air monitoring data is not reported in the Business Responsibility and Sustainability Reporting.

Air emissions monitoring focuses on specific pollutants released directly due to company operations, such as emissions from combustion, leakages, and industrial processes. The Business Responsibility and Sustainability Reporting framework requires companies to convert and consolidate this air emissions data into mass units for standardized reporting. Data in concentration units required specific to PCBs/PCCs are excluded from Business Responsibility and Sustainability Reporting reports.

3. Scoping of Air Emissions

The primary objective of this guide is to enable the users to effectively answer Point Number 5 under Principle 6 of the Business Responsibility and Sustainability Reporting framework. An illustration of the same has been given below:

Table 1: Air Emissions disclosures in Business Responsibility and Sustainability Reporting format

Parameter	Please specify unit	FY (Current Financial Year)	FY (Previous Financial Year)
NO_x			
SO_x			
Particulate matter (PM)			
Persistent organic pollutants (POP)			
Volatile organic compounds (VOC)			
Hazardous air pollutants (HAP)			
Others - please specify			

Note: Indicate if any independent assessment/ evaluation/ assurance has been carried out by an external agency? (Y/N) If yes, name of the external agency.

The CAER guide provides essential steps required to report air emissions, meeting the Business Responsibility and Sustainability Reporting format.

Part A: Scoping of Air Emissions

3.1 What are the air emissions covered under the Business Responsibility and Sustainability Reporting framework?

a) Emission Sources

As a primary step, consider the below-mentioned air emission sources

- direct emissions: under the operational control of the company
- indirect emissions: emissions from the value chain not under the reporting company's operational control.

These distinctions are essential for assessing air emissions from a company's activities, particularly in the context of corporate reporting.

Direct Emissions

- On-site Combustion: These emissions result from the combustion of fossil fuels on-site, such as in company-owned boilers, furnaces, or vehicles. This includes emissions like carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM). This includes combustion of fuels (diesel, petrol, CNG etc) in owned vehicles.
- Process Emissions: These emissions directly result from specific industrial processes. For example, greenhouse gases are released during cement or chemical manufacturing.
- Fugitive Emissions: These are unintentional releases of gases, often from leaks or venting, such as acid fume emissions from oil and gas operations. This may include emissions of leaked refrigerants from HVAC systems for service sector companies.

Indirect (value chain related) Emissions:

Indirect emissions can be categorised as:

- Emissions from energy purchase (electricity, steam, heating and cooling): These includes emissions from the production of electricity, heat, or steam that a company purchases from an external generator. These emissions are considered indirect because they occur off-site but are associated with the company's activities. The company may not have operational control over these emissions, but it finances these air emissions through its direct activities.
- Emissions from the company's value chain include:
  - Emissions from the transportation of raw materials and finished goods
  - Emissions by suppliers that originate during the production of raw materials
  - Emissions by consumers that arise from the utilisation of goods sold by the company.

Indirect emissions (from the value chain) have been excluded from the scope of this guide as they are not specified as a requirement within the Business Responsibility and Sustainability Reporting framework.

3.1.1 Boundary of reporting

The CAER Guide recommends that companies disclosing to the Business Responsibility and Sustainability Reporting framework include emissions resulting from activities directly under their operational control (direct emissions).

The disclosure should include all the air pollutants prescribed under the general and special conditions in

the consent issued by the State Pollution Control Board or Pollution Control Committee. Concentration based emission standards for these pollutants are defined by the CPCB, SPCBs and/or PCCs. While the emission standards (prescribed in concentration units) may vary across different units and geographies, they do not affect the disclosure requirements of air emissions (in mass units) under Principle 6 of the Business Responsibility and Sustainability Reporting framework.

The CAER Guide recommends mandatory disclosure of PM, SO_2 and NO_x, even in the absence of prescribed emission standards by CPCB. This recommendation is made because general conditions and limits may apply to these three pollutants. For instance, in a service sector company operating from an office building, there may not be specific emission standards for emissions from DG Sets. Nevertheless, companies are encouraged to estimate and report emissions from such sources using guidelines in the CAER Guide. The CAER Guide encourages the inclusion of air emissions beyond the categories/species prescribed by the regulatory bodies and demonstrates foresight and stewardship in disclosing air emissions.

Steps for the company

1. Identify all air emission sources.
2. Categorise air emissions as direct and indirect emissions.
3. Exclude indirect air emissions from the reporting boundary

3.1.2 How do companies decide what air emissions apply to them?

To determine the air emissions applicable to a company, consider the air pollutants regulated by the State Pollution Control Boards & Pollution Control Committee. Figure 4 is a decision tree matrix to facilitate the identification of applicable air emissions.

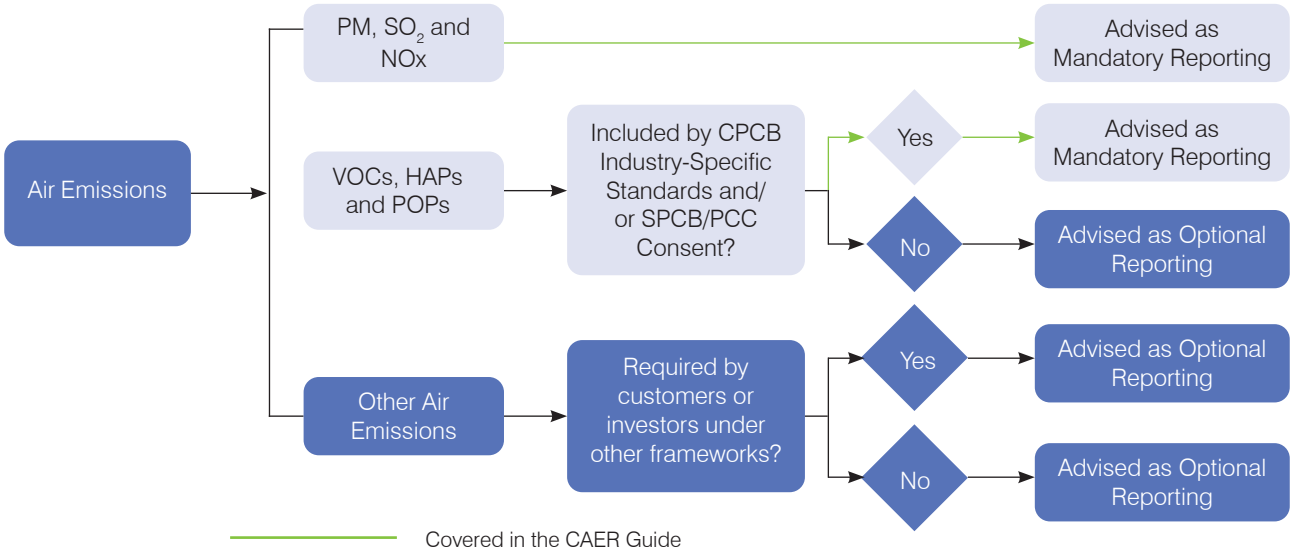

Figure 3 Decision tree matrix for applicable air emissions

a) Mandatory disclosure: PM, SO_2 and NO_x

Particulate matter, oxides of sulphur and oxides of nitrogen are criteria pollutants regulated by the State Pollution Control Boards. These pollutants are included as general conditions in the consents issued by the State Pollution Control Boards (SPCBs) to regulate and monitor emissions. The CAER guide recommends mandatory monitoring or estimation and reporting of the three pollutants. Box 1 provides a detailed description of the criteria pollutants to be reported.

Box 1 Description of criteria pollutants.

Oxides of Sulphur

Oxides of Sulphur: Oxides of sulphur refer to compounds composed of sulphur and oxygen. The most common sulphur oxides are sulphur dioxide (SO_2) and sulphur trioxide (SO_3). These compounds play a significant role in atmospheric chemistry and are associated with air pollution.

- Sulphur Dioxide (SO_2): This is a colourless gas with a pungent odour. It is produced by the combustion

of fossil fuels containing sulphur, such as coal and oil, and during certain industrial processes like metal smelting. Sulphur dioxide can contribute to air pollution and acid rain formation. It can have adverse effects on respiratory health when present in high concentrations.

- Sulphur Trioxide (SO_3): This compound is less common in ambient air compared to sulphur dioxide. It is a highly reactive and hygroscopic substance that readily reacts with water vapour to form sulphuric acid. Sulphur trioxide is often an intermediate product in the formation of sulphuric acid in the atmosphere.

Sulphur dioxide is a regulated air pollutant due to its environmental and health impacts. Efforts to reduce emissions of these compounds involve the use of cleaner technologies, such as desulphurization processes in industrial facilities and the adoption of cleaner fuels.

Oxides of Nitrogen: Oxides of nitrogen, often abbreviated as NO_x, refer to a group of nitrogen and oxygen compounds that are pollutants and play a role in atmospheric chemistry. The primary oxides of nitrogen include nitrogen monoxide (NO) and nitrogen dioxide (NO_2). These compounds are produced through various combustion processes, particularly in vehicles and industrial activities.

- Nitric Oxide (NO): Nitric oxide is a colourless gas that forms when nitrogen and oxygen in the air react under high-temperature conditions, such as those found in combustion engines and industrial furnaces. It is a precursor to other nitrogen oxides and can contribute to forming nitrogen dioxide in the atmosphere.

- Nitrogen Dioxide (NO_2): Nitrogen dioxide is a reddish-brown gas with a characteristic sharp odour. It results from the oxidation of nitric oxide in the presence of oxygen. Nitrogen dioxide is a prominent component of smog and is associated with various respiratory and environmental problems. It can also contribute to the formation of acid rain.

NO_x emissions can lead to air quality issues and have environmental and health impacts. Regulatory measures are implemented to control and reduce NO_x emissions, such as using catalytic converters in vehicles, adopting cleaner industrial processes, and enforcing emission standards.

Particulate Matter: Particulate matter (PM) refers to tiny particles or droplets in the air composed of various solid or liquid materials. These particles vary in size, shape, and composition. They can originate from natural sources, such as wildfires or volcanic eruptions, as well as human activities, including industrial processes, vehicle emissions, and construction.

Particulate matter is categorised based on size, commonly denoted as PM10 and PM2.5, referring to particles with aerodynamic diameters less than 10 micrometres and 2.5 micrometres, respectively. PM10 includes particles like dust and pollen, while PM2.5 represents finer particles that can penetrate the respiratory system deeper.

Sources of particulate matter include:

- Combustion Processes: Burning fossil fuels in vehicles, power plants, and industrial facilities can release particulate matter into the air.

- Construction and Demolition: Construction and demolition can generate dust particles, contributing to PM levels.

- Agricultural Activities: Tilling of soil, livestock operations, and using certain fertilizers can produce particulate matter.

- Natural Sources: Wildfires, volcanic eruptions, and dust storms contribute to naturally occurring particulate matter.

Particulate matter can adversely affect human health, especially when the particles are small enough to reach the respiratory system. Short-term exposure to elevated PM levels can lead to respiratory and cardiovascular problems. In contrast, long-term exposure may be associated with chronic respiratory diseases, cardiovascular diseases, and other health issues.

Regulatory measures are in place to monitor and control particulate matter emissions, with established air quality standards to protect public health and the environment. Monitoring and mitigation strategies include air filtration systems, emission controls, and public awareness campaigns.

b) HAPs, POPs, and VOCs as per consent issued by CPCBs/SPCBs/PCCs

HAPs, POPs and VOCs are emitted from specific industrial processes and operations and include a wide range of chemical species. The Central Pollution Control Board has set emission standards for these air pollutants for specific industries. Each industry type is issued a Consent to Establish & Operate (CTE, CTO) by the State Pollution Control Board or Pollution Control Committee.

It is recommended that the company estimates and reports these pollutants from its units as prescribed in the consent issued and consolidates them at the company level. These emission standards are provided in Annexure A.

Note: There are specific categories of air pollutants which may be classified as either HAPs, POPs, or VOCs. In case of such overlaps, it is suggested that another criterion in terms of the level of threat (based on health effects and persistence in the atmosphere) can be used to categorise these emissions under a suitable group. The order of priority for such a classification is:

POPs > HAPs > VOCs

For instance, if a pollutant species can be reported under both VOCs and HAPs, it should be reported under HAPs as they contribute to more severe health impacts compared to VOCs. This recommendation essentially ensures that air emissions are reported with higher impact consideration in disclosures. Box 2 provides a detailed description of HAPs, POPs and VOCs.

Box 2 Detailed description of HAPs, POPs and VOCs

HAPs: Hazardous Air Pollutants (HAPs), also known as air toxics or toxic air pollutants, pose a significant risk to human health and the environment due to their toxic properties. These pollutants are regulated by environmental agencies to protect public health and the environment.

The United States Environmental Protection Agency (EPA) defines Hazardous Air Pollutants under the Clean Air Act. The list of HAPs includes a variety of chemicals and compounds known or suspected to cause serious health effects, such as cancer, reproductive and developmental disorders, neurological effects, respiratory problems, and other adverse effects.

Examples of Hazardous Air Pollutants include benzene, formaldehyde, lead, mercury, vinyl chloride, and many others. These pollutants can be emitted from various sources, including industrial facilities, motor vehicles, and other processes. Regulatory efforts aim to limit the emissions of these pollutants and establish standards to reduce their impact on human health and the environment.

POPs: Persistent Organic Pollutants (POPs) are a group of highly stable organic compounds that resist degradation through natural processes and persist in the environment for extended periods. These substances are characterized by their ability to travel long distances through air and water, leading to their widespread distribution globally.

The Stockholm Convention on Persistent Organic Pollutants, an international treaty adopted in 2001, identifies and aims to eliminate or restrict the production and use of specific POPs due to their adverse effects on human health and the environment. The Convention initially listed 12 POPs, known as the "Dirty Dozen," which includes pesticides like DDT, industrial chemicals like polychlorinated biphenyls (PCBs), and certain unintentionally produced chemicals such as dioxins and furans.

The persistence, bioaccumulation, long-range transport, and toxic effects of POPs make them a significant concern. These pollutants can accumulate in the fatty tissues of organisms, leading to biomagnification as they move up the food chain. Exposure to POPs has been associated with various health issues, including developmental and reproductive disorders, immune system disruption, and certain cancers.

Efforts to mitigate the impact of POPs include international agreements, like the Stockholm Convention, which aims to reduce or eliminate the production, use, release, and storage of these substances to protect human health and the environment.

VOCs: Volatile Organic Compounds (VOCs) are a group of organic chemicals that can easily evaporate into the air at room temperature. These compounds contain carbon and various other elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulphur, or nitrogen. VOCs are released into the atmosphere from multiple sources, including both human-made and natural sources.

Common sources of VOCs include:

Industrial Processes: Certain manufacturing activities, such as painting, printing, and chemical production, can release VOCs into the air.

Vehicle Emissions: Combustion of fossil fuels in vehicles, including cars, trucks, and motorcycles, can release VOCs into the atmosphere.

Consumer Products: Many household items, such as paints, solvents, cleaning products, air fresheners, and personal care products, contain VOCs that can evaporate into the air.

Natural Sources: Some VOCs are released by natural processes, such as vegetation (biogenic VOCs) or wildfires.

While not all VOCs are harmful, some can contribute to the formation of ground-level ozone and smog, and certain VOCs may have adverse health effects. Examples of specific VOCs include benzene, toluene, formaldehyde, and xylene.

Regulatory authorities often establish limits on VOC emissions to address air quality concerns and protect human health and the environment. Efforts are made to reduce VOC emissions by developing and implementing cleaner technologies and using low-VOC or VOC-free products.

c) Other air emissions

In addition to the air emissions described in Sections- a) and b), it is also important to consider other air emissions required for reporting to investors or customers, as mandated by various sustainability reporting frameworks. This is optional under the Business Responsibility and Sustainability Reporting framework.

Steps for the company

1. Identify air pollutants regulated by SPCBs/PCCs outlined in the CTE/CTOs applicable to your company, including criteria pollutants and HAPs, PAPs and VOCs.

2. Review sustainability frameworks for additional emissions required for reporting to customers or investors

d) Frequently Asked Questions (FAQs)

Q: What air emissions are applicable to companies in the service and financial sectors?

A: Although service and financial sector companies do not engage in manufacturing processes, combustion activities, or material handling, they may still generate air emissions by operating DG sets (for power backup) and refrigerant gas leaks from HVAC systems. The CAER Guide encourages companies to disclose these emissions, regardless of quantity. For detailed guidance, refer to Scoping of Air Emissions.

Q: Do companies need to estimate air emissions from owned vehicles?

A: Yes. Combustion of gasoline, diesel and CNG in the company owned vehicles leads to the generation of air pollutants such as NO_x, PM, CO and VOCs. The emission factors (EFs) for these sources are available in sources such as the US EPA AP-42. Companies may use such EFs to estimate emissions from vehicles owned and operated by the company.

Q: Is there specific guidance on which air pollutants should be considered VOCs, HAPs, and POPs, and how should companies allocate appropriate categories to pollutants given the overlap in guidelines?

A: Please refer to 3.1.2 of the CAER Guide.

Q: How does the boundary of reporting, based on Consent to Establish/Operate sanctioned by respective State Pollution Control Boards, affect the clarity and consolidation of air emissions at the corporate level given the varying standards across different geographies? (The monitored parameters (for a similar manufacturing process/products) can differ as per consent.)

A: Please refer to 3.1.2 of the CAER Guide.

3.2 How do companies decide the materiality of air emissions?

3.2.1 Materiality

Materiality thresholds in sustainability reporting prioritize disclosure of environmental, social, and governance (ESG) factors. To set a materiality threshold for air emissions, quantitative and qualitative factors must be considered to determine the significance or importance of information. This threshold helps assess what information is considered material or relevant enough to influence the decisions of stakeholders.

Establishing materiality thresholds requires striking a balance between providing relevant information for decision-making and avoiding unnecessary information overload.

a) Criteria for inclusions

In sustainability reporting, inclusions and exclusions refer to the decisions made by companies regarding what information to disclose and what to omit. These decisions are crucial for transparency, accountability, and meeting regulatory requirements.

Inclusions

- Determine Relevant Information: Assess and include information essential for understanding the company's financial position, performance, and operational aspects, such as financial data, key performance indicators (KPIs), and other information.
- Ensure Compliance with Standards: Align inclusions with reporting standards, regulations, and guidelines. Companies may include details required by accounting standards, industry norms, or sustainability reporting frameworks to ensure compliance. Regularly review information on Consent to Establish/ Operate. Companies are encouraged to refer to the latest standards published by CPCB to identify what pollutants include.
- Address Stakeholder Expectations: Companies may include information based on the expectations and interests of their stakeholders, including investors, customers, employees, regulatory authorities, and other relevant parties.

- Provide Contextual Information: Include contextual information alongside reported data to offer stakeholders a deeper understanding of the information presented. This could include explanations, narratives, and qualitative details that provide a comprehensive picture.

b) Justifications for exclusions

Exclusions

Immaterial Information: When considering exclusions in reporting, companies must assess what information is immaterial or not significant to the understanding of the reported subject matter.

- Protect Confidential or Sensitive Information: Exclude certain information, such as trade secrets, proprietary information, or sensitive data, to protect the company's competitive position and comply with privacy and security considerations.
- Ensure Legal and Regulatory Constraints: Exclude information that is subject to legal and regulatory constraints such as confidentiality agreements or non-disclosure agreements, to meet legal obligations and prevent unauthorized disclosure.
- Eliminate Redundant Details: Exclude redundant or duplicative information to streamline reporting and prevent information overload. Focusing on essential details allows stakeholders to grasp the most critical information effectively.
- Consider Practical Constraints: Assess practical considerations, such as resource limitations or data availability, which may impact exclusions. In situations where obtaining certain information is impractical or challenging, companies can exclude such details from their reports.

Achieving a balance between inclusion and exclusions is essential to produce informative and concise reports that meet the needs of stakeholders (here, the Business Responsibility and Sustainability Reporting framework). This involves conducting thorough materiality assessments, ensuring compliance with legal constraints, engaging stakeholders, and streamlining reporting by excluding redundant or immaterial information.

Steps for the company

1. Establish the materiality threshold by prioritizing ESG factors.

2. For inclusions- determine essential information that aligns with standards and stakeholder expectations

3. For exclusions-omit immaterial information, exclude sensitive data and consider practical limitations

4. Consolidation of Air Emissions

4.1 How do companies account for relevant and monitored air emissions?

Air emissions monitoring is crucial for meeting regulatory and/or internal requirements set by reporting company. Companies often utilize third-party monitoring services to track air pollutants effectively. The accuracy and credibility of stack emissions monitored and reported depends on factors such as equipment quality, installation method, operation and maintenance of the setup and calibration. This is critical irrespective of whether air emissions are being monitored by an in-house team in the industry or by a hired external service agency.

The emissions monitoring procedure requires a standardized measurement methodology, monitoring frequency and reporting procedure. These parameters directly impact data quality, posing a question of reliability. It indicates the quality, quantity, source, and type of air pollutant emitted, which can further determine pollution control measures to be undertaken.

Acknowledging the role of certification and accreditation of monitoring methods as well as calibration of measuring instruments, is thus essential.

4.1.1 Selection of Monitoring Agencies

When selecting monitoring agencies for air emissions, reporting companies should adhere to the following criteria:

- **Expertise:** Ensure that the monitoring agency has a team of experts capable of sampling and analyzing air emissions according to standard methods. These methods are detailed in Annexure E.
- **Instrument Certification:** Verify that the monitoring agency utilizes instruments certified by the National Physical Laboratory, Delhi, and possesses valid calibration certificates. Relevant details can be found in Annexure F.
- **Laboratory Accreditation:** Confirm that the monitoring agency conducts sample analysis in laboratories accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL). Refer to Annexure G for additional information regarding accredited laboratories.

4.1.2 Stack emissions – report format and calculations

As advised by the State Pollution Control Board and/or Pollution Control Committee, air emissions from stacks are usually done periodically. In periodic monitoring, a stack sampling assembly is prepared, which includes temperature and pressure probes, an isokinetic sampler, a blower

assembly, and absorbing/adsorbing media to collect air pollutant species of interest.

The sample collected during the exercise is then sent to a laboratory to measure the air emissions concentrations, and a report is submitted to the company.

The Central Pollution Control Board has also directed many companies to install Continuous Emissions Monitoring Systems (CEMS), which samples and measures air emissions on a continuous basis and reports at a high temporal frequency, usually every 15 minutes.

There are two main types of monitoring to be considered when conducting stack emissions monitoring.

Periodic measurements (source testing)

These assessments are conducted at regular intervals. Samples are collected from the emission source and analysed remotely or directly at the site.

There are two main approaches to conduct this assessment:

- Manual method: Samples are taken on-site and subsequently examined in a laboratory.
- Instrumental or automated method: Samples are collected and analysed on-site using a portable automated measuring system.

The frequency of sampling may vary from every 30 minutes to several hours, depending on the specific requirements. Box 3 describes a sample of air emission testing and calculations from periodic measurements or source testing. Box 4 presents periodic measurements/source sample report format and calculations.

Box 3 Example on periodic measurements/source sample report format and calculations.

Recement Pvt Ltd is a cement manufacturing company that operates a captive power plant using bituminous coal as the primary fuel source for power generation. The company aims to estimate the annual emission rates of criteria pollutants from their stack due to coal combustion. The results from stack monitoring conducted over a one hour period, are provided below.

Case 1: The company recorded the quantity of coal burned during the monitoring period. This data can be used to estimate emissions more accurately, considering the process variations and production rates. For example, this method may be used if the equipment is only operating for part of the year or the fuel feed rate fluctuates based on the facility's production rate. The annual quantity of coal burned during the reporting year was 378.76 tonnes.

Parameter		Result	Unit
Flue gas temperature	T	64	°C
Flue gas velocity	V	7.62	m/s
Flue gas flow rate			
Q	18,512	Nm3/hr	
Particulate Matter (PM)	CPM	23	mg/Nm3
Sulphur Dioxide (SO_2)	CSO_2	47	mg/Nm3
Oxides of Nitrogen (NO_2)	CNO_2	316	mg/Nm3
Coal consumed rate	μ	73	kg/hr

For Emission rate of PM,

$$E_{PM} = \frac{Q \times C_{PM}}{10^3}$$

$$= \frac{18512 \times 23}{10^3}$$

$$= 425 \frac{g}{hr}$$

Emission factor of PM,

$$EF_{PM} = \frac{E_{PM}}{\mu}$$

$$= \frac{425}{73}$$

$$= 5{\cdot}822 \frac{g}{kg}$$

$$= 5{\cdot}822 \frac{kg}{tonne}$$

Annual Emission rate of PM,

$$E_{PM} = EF_{PM} \times 378{\cdot}76$$

$$= 5{\cdot}822 \times 378{\cdot}76$$

$$= 2205{\cdot}14 \frac{kg}{year}$$

$$2{\cdot}205 \frac{tonnes}{year}$$

Same procedure can be followed to calculate the annual emission rate for all measured pollutants.

Case 2: The company recorded the cement production rate for the stack emissions monitoring for the period of one hour and it is 34 tonnes per hour. The mercury emissions were at 2 mg/ Nm3 during this period. The annual cement production for the reporting year totalled 2471 tonnes. All other parameters remain as detailed in the preceding table.

This methodology is applicable if the process operates only for a portion of the year, or if the production rate varies in response to demand.

For Emission rate of Hg,

$$E_{Hg} = \frac{Q \times C_{Hg}}{10^3}$$

$$= \frac{18512 \times 2}{10^3}$$

$$= 37{\cdot}024 \frac{g}{hr}$$

Emission factor of Hg,

$$EF_{Hg} = \frac{E_{Hg}}{R_P}$$

$$= \frac{37{\cdot}024}{34}$$

$$= 1{\cdot}089 \frac{g}{tonne}$$

Annual Emission rate of Hg,

$$E_{Hg} = EF_{Hg} \times 2471$$

$$= 1{\cdot}089 \times 2471$$

$$= \frac{2690{\cdot}919 g}{year}$$

$$= 2{\cdot}692 \frac{kg}{year}$$

Box 4 Periodic measurements/source testing report format and calculations

Periodic measurements/source testing refers to taking a snapshot of emissions during the test period by collecting samples from the exhaust stack, which are analysed on-site or sent to a laboratory.

Data required:

Contaminant concentration (a) = amount of contaminant collected / volume of the sample

Volumetric stack gas flow rate (b)

Emission rate = (a) X (b)

Emission loadings are determined from the Emission Rate and Period of Operation.

Example of Source Testing Results:

A Chemical Company A has conducted source testing for 5,000 hours period of operation under normal operating conditions.

Table 2: Calculation Example for Chemical Company A using Source Testing

Source Testing Results	Stack Gas Flow Rate, [Q] (m3/ min)	Emission Rate			Calculated Annual Emissions for a period of 5000 hours (T) in a year [Ex]	
		SO_2 (kg/ hr)	NO_x (kg/ hr)	Conversion in NO (0.6522* NO_x)	SO_2 (kg/ year)	NO (kg/ year)
1	2.20	130	70	34.78	5,00,000.00	1,73,920.00
2	1.80	70	30			
3	2.00	100	60			
Average	**2.00**	**100**	**53**			

Equation for Emissions Estimation at Test Conditions:

$$E_x = \{Er_x \times T\}$$

Where,

Er_x = Average emission rate of contaminant x (kg/hr)

E_x = Emission of contaminant x (kg/year)

T = Time (total operating hours in a given year)

For example,

To calculate the annual emissions of SO_x and NO_x for process operation of 5,000 hours under normal (i.e. testing) conditions in the reporting year, the calculations are:

For SO_2,

$$E_{SO_2} = \{Er_{SO_2} \times 5000\}$$

$$= \{100\, kg / hr \times 5000\}$$

$$= 500000\, kg / year$$

For NO_x,

As per the reporting requirements NO_x needs to be expressed as NO.

$$NO_x \text{ (expressed as NO)} = 0.6522 \times NO_x \text{ (expressed as } NO_2\text{)}$$

$$= 0.6522 \times 53$$

$$= 34.78 \text{ kg/hr}$$

$$E_{NO} = \{Er_{NO} \times 5{,}000\}$$

$$= \{34.78 \text{ kg/hr} \times 5{,}000\}$$

$$= 1{,}73{,}920.00 \text{ kg/year}$$

Continuous Emissions Monitoring Systems (CEMS)

Follow these steps for continuous stack emission monitoring

- Ensure consistent data collection with minimal interruptions by conducting measurements continuously.
- Choose between in situ monitoring directly within the emission source or extractive sampling using a permanently installed instrument close by.
- Refer to Annexure E for detailed guidelines on monitoring pollutants using standard methods approved by CPCB and/or accepted internationally.

Box 5 describes a sample of air emission monitoring report and calculations from CEMS.

Box 5 Sample CEMS air pollution report and calculations

A Continuous Emission Monitoring System (CEMS) refers to a continuous record of emissions over an extended and uninterrupted period of time based on photometric (light-based method) measurements.

Data required:

Contaminant concentration (a)

Volumetric stack gas flow rate (b)

Emission rate = (a) X (b)

Example of a CEMS output for a Boiler Burning Coal:

Chemical Company X has a continuous emission monitoring system (CEMS) that measures emissions from a coal-fired boiler.

Table 3: Calculation Example for Chemical Company X using CEMS

Period	Stack Gas Flow Rate, [Q] (m3/min)	Measured Concentration [CX] (mg/m3)		Calculated Emission Rate [ErX] (equation shown below the table)	
		SO_2	NO_x	SO_2 (kg/hr)	NO_x (kg/hr)
9:00 - 9:15	4.44	1.11	0.21	774	104
9:15 - 9:30	4.50	1.09	0.21	770	107
9:30 - 9:45	4.42	1.07	0.22	741	108
9:45 - 10:00	4.46	1.01	0.22	707	110
10:00 - 10:15	4.48	1.04	0.22	731	109
10:15 - 10:30	4.50	1.10	0.20	777	103
10:30 - 10:45	4.43	1.07	0.22	744	110
10:45 - 11:00	4.43	1.10	0.20	766	100
11:00 - 11:15	4.41	1.08	0.22	748	108
11:15 - 11:30	4.49	1.01	0.21	708	109

Equation for Emission Rate Estimation of a Contaminant:

$$Er_x = \left\{ \frac{(C_x \times 1000) \times MW_x \times (Q \times 1000) \times 60}{V \times 10^6} \right\}$$

Where,

Er_x = Emission rate of contaminant x (kg/hr)

C_x = Concentration of contaminant x (mg/m3)

MW_x = Molecular weight of the contaminant x (g/g-mole) [$MWSO_2$ = 64, $MWNO_x$ = 46 (as $MWNO_2$)]

Q = Dry stack gas volumetric flow rate at reference conditions (m3 /min) (reference conditions: 101.325 kPa and 25°C)

V = Volume occupied by 1 mole of ideal gas at reference conditions (= 24.45 litres/g-mole)

Note:

To calculate the emissions for the reporting year sum all the hourly values for that reporting period. Average value of the Calculated Emission Rates for each interval is taken for respective hours.

For example,

Total SO_2 emissions for the 1st hour = (774+770+741+707) /4 kg = 748 kg SO_2

Total SO_2 emissions for the 2nd hour = (731+777+744+766) /4 kg = 755 kg SO_2

To calculate annual emissions, sum hourly emission values or quarterly emission values for the year.

Please note that the preceding examples already consider the impact of Air Pollution Control Technologies (APCTs) for removing air pollutants from flue and fugitive gases. This is because monitoring is conducted at the final point of emission.

Guidelines for air emissions sampling and monitoring

The following table outlines key air pollutants, their respective guidelines, and methodologies for source emission monitoring. These methodologies provide approved guidelines for sampling and monitoring.

Table 4: Sampling of air emissions

Sr. no.	Pollutant	Category	Standard	Source
1	Sulphur Dioxide (SO_2)		CPCB guidelines	Guidelines on methodologies for Source Emission Monitoring
2	Oxides of nitrogen (NO_x)		CPCB guidelines	Guidelines on methodologies for Source Emission Monitoring
3	Particulate matter (PM)		CPCB guidelines	Guidelines on methodologies for Source Emission Monitoring
4	Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofuran (Can be modified to simultaneously sample and analyse PAH and PCB)	POPs	CPCB guidelines	Sampling Method for PCDD and PCDF from stationary sources
5	VOCs (pollutants covered are highlighted in yellow in the list of VOCs)		USEPA	Determination of gaseous organic compounds by direct interface gas chromatography-mass spectrometry
6	Metals and non-metals (Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Ni, As, Tl and Zn.)	HAPs	CPCB guidelines	Guidelines on methodologies for Source Emission Monitoring
7	Hydrogen halides (HCl, HBr, and HF) and halogens (Cl2 and Br)	HAPs	CPCB guidelines	Guidelines on methodologies for Source Emission Monitoring
8	Ammonia (NH3)	HAPs	BIS	IS 11255 (Part 6):1999, Reaffirmed 2003
9	Carbon Monoxide (CO)	HAPs	US EPA Method 10B	Determination of carbon monoxide emissions from stationary sources
10	Total Flourides	CPCB industry wise classification	IS 11255-5	Methods for measurement of emissions from stationary sources, Part 5: Total fluorides
11	Phosgene	HAP	USEPA	Draft Method XPHS
12	Hydrogen Cyanide	HAP	USEPA	DRAFT METHOD OTM-29
13	Toluene Diisocyanate and Methylene Diphenyl Diisocyanate	HAP	USEPA	Method OTM - 14
14	Mercury	HAP	USEPA	Determination of Particulate and Gaseous Mercury Emissions from Chlor-Alkali Plants (Air Streams)
15	Acid mist/Sulphur Trioxide	HAP	USEPA	Determination of Sulphuric Acid and Sulphur Dioxide Emissions from Stationary Sources
16	Hydrogen sulfide	HAP	USEPA	Determination of Hydrogen Sulfide Content of Fuel Gas Streams in Petroleum Refineries
17	Phenol	HAP	USEPA	DRAFT METHOD XXXX
18	Acetonitrile		USEPA	XACN: Acetonitrile Fiel Test EPA 600/R October 1997

Sr. no.	Pollutant	Category	Standard	Source
19	Dichloromethane		USEPA	Method 0030 Volatile Organic Sampling Train Method 0031 Sampling Method For Volatile Organic Compounds (Smvoc) Method 0040 Sampling Of Principal Organic Hazardous Constituents From Combustion Sources Using Tedlar® Bags
20	Acetone			Specific methods (approved in India or globally) are not available.
21	Butadiene		USEPA	Method 0040 Sampling Of Principal Organic Hazardous Constituents From Combustion Sources Using Tedlar® Bags
22	Ethylene Oxide		USEPA	CARB 431
23	Ethylene Dichloride		USEPA	Method 0030 Volatile Organic Sampling Train Method 0031 Sampling Method For Volatile Organic Compounds (Smvoc)
24	Acrylonitrile		USEPA	Method 0030 Volatile Organic Sampling Train Method 0031 Sampling Method For Volatile Organic Compounds (Smvoc)
25	Propylene Oxide		USEPA	Method 0040 Sampling Of Principal Organic Hazardous Constituents From Combustion Sources Using Tedlar® Bags
26	MA (maleic Anhydride)		USEPA	Method 0010 Modified Method 5 Sampling Train
27	PA (Phthalic Anhydride		USEPA	Method 0010 Modified Method 5 Sampling Train
28	EG		USEPA	Method 0010 Modified Method 5 Sampling Train
29	PG (do we remove)			Specific methods (approved in India or globally) are not available.
30	TOC			Specific methods (approved in India or globally) are not available.
31	P2O5 as H3PO4			Specific methods (approved in India or globally) are not available.
32	Dimethyl Formamide		USEPA	Method 0010 Modified Method 5 Sampling Train

Steps for the company

1. Select a monitoring agency with expertise in air emissions monitoring, ensuring they have certified instruments and accredited laboratories.

2. Implement appropriate stack emissions monitoring methodologies based on facility type, selecting suitable equipment and following established protocols.

3. Ensure adherence to regulatory guidelines and industry standards for monitoring based on air pollutants.

Note: The cost of monitoring for HAPs and POPs and the availability of competent monitoring agencies can significantly deter reporting air emissions.

The CAER Guide considers these constraints and recommends mandatory disclosure of air pollutants monitored and reported as per the SPCBs/PCCs guidelines. The CAER Guide also endorses sampling and monitoring methods approved by the CPCB and/or internationally recognised bodies (US EPA, DEFRA, CDC etc). Companies are advised to refrain from using monitoring methods/ instruments which are low-cost but not approved / pending approval by the regulatory bodies in India.

The cost of monitoring for air emissions (with parameter-wise costs) published by the Central Pollution Control Board is available here.

4.2 How do I account for air emissions that are relevant but not monitored

4.2.1 Accounting for process emissions using stoichiometry

Stoichiometric calculations are deployed to estimate theoretical quantities of air emissions. Specific chemical processes in industries lead to the generation of direct air emissions, for instance, SO_2 or HCl fumes due to the chemical reactions in the reactor.

- Identify chemical reactions in the industrial process leading to the generation of direct air emissions.
- Determine stoichiometric coefficients for each reactant and product involved in these reactions.
- The total mass of such air pollutants emitted is a function of the amount of raw material processed or the amount of production for a single batch or over a period of time.

The example below in Box 6 describes stoichiometric calculations for estimating theoretical quantities of air emissions.

Box 6: Stoichiometric calculations for process-related air emissions

Data required:

- Mass of raw material (source of air emission generation)
- Chemical equation

Example of Annual Emissions using Mass Balance Method:

Company X is into producing finished ceramic goods, which is a highly air polluting endeavour. The SO2 produced during the firing of ceramic raw materials partly comes from the oxidation of coarse-grained pyrite in the high-temperature stage raw materials, and part comes from the decomposition of natural sulphate auxiliary minerals in the raw materials.

The main sulphur impurities in ceramic raw materials include FeS_2, $Fe_2(SO_4)_3$, $CaSO_4$ and Na_2SO_4. In the high-temperature firing process, a series of oxidation-reduction reactions occur in the raw materials, releasing gases such as SO2.

For instance, the chemical reaction equation of FeS2 oxidation decomposition reaction is shown in the formula below. According to the principle of chemical equilibrium, every gram of FeS2 reacts completely at high temperatures to produce 1.07g of SO2.

$$4FeS_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2$$

These chemical equations can be used to estimate the mass of air emissions incurred for a particular volume of raw material input / production.

This is applicable where process emissions are not monitored. If the process emissions are monitored per the SPCB/PCC guidelines, use the guidance provided in 3.1.

4.2.2 Accounting for consumption-based air emissions using emission factors.

The following steps outline the procedure for accounting for consumption-based air emissions using emission factors:

- Access Available Emission Factors: Emission estimation using emission factors includes using the emission contaminant rate relative to the level of source activity. These factors are derived from source tests for different emission source categories. Obtain emission factors compiled by organisations like the USEPA or specific industrial associations and agencies. These factors provide valuable data for estimating emissions.
- Develop Custom Emission Factors: If necessary, develop custom emission factors based on direct monitoring (CEMS/PEMS) or measurement (source testing) results specific to your facility.

The example below Box 7 in depicts calculations for accounting consumption-based air emissions using emission factors.

Box 7: Air emissions calculations using emission factors

Data required:

- Activity Rate or Base Quantity (a)
- Emission Factor (b)

Emission rate = (a) X (b)

Example of Annual Emissions using Emission Factors:

Foundry X produced 7,000 tonnes of grey iron by melting scrap metal in an electric induction furnace in the given year. Foundry F has to (i) calculate the emissions of applicable contaminants listed in the table below:

Table 5: Calculation Example for Foundry X using Emission Factors

Base Quantity [BQ] (kg)	Contaminant	Emission Factors derived from various sources [Efx] (kg/ tonne)	Emissions [Ex] (kg)
7000	Aluminum	0.00585	40.95
	Arsenic	0.00005	0.35
	Bromine	0.0001	0.7
	Cadmium	0.00005	0.35
	Chlorine	0.01125	78.75
	Chromium	0.000108	0.756
	Cobalt	0.000009	0.063
	Copper	0.00054	3.78
	Iron	0.02565	179.55
	Lead	0.02725	190.75
	Manganese	0.01125	78.75
	Nickel	0.000441	3.087
	PM	0.45	3150
	PM10	0.43	3010
	PM2.5	0.42	2940
	Titanium	0.00216	15.12
	Vanadium	0.00003	0.21
	Zinc	0.01305	91.35

Equation for Emissions Estimation for contaminants listed in the table above using Emission Factors:

$$E_x = BQ \times EF_x \times ((100 - CE_x) \div 100)$$

Where,

E_x = Emission of contaminant x (kg)

BQ = Activity rate or base quantity (BQ) (tonne)

EF_x = Uncontrolled emission factors of contaminant x (kg/tonne)

CE_x = Overall emission control efficiency of contaminant x (%)

or

$$E_x = BQ \times CEF_x$$

Where,

E_x = Emission of contaminant x (kg)

BQ = Activity rate or base quantity (BQ) (tonne)

CEF_x = Controlled emission factors of contaminant x (kg/tonne)

For example,

$$E_{Aluminium} = BQ \times CEF_{Aluminium}$$

$$= 7{,}000 \times 0.00585$$

$$= 40.95$$

Multiple sources of air pollutant emission factors are published by regulatory bodies of different countries and internationally recognised bodies. One such exhaustive source is the compendium of emission factors compiled by the US EPA under their AP 42 documents.

4.2.3 Accounting for fugitive emissions using mass balance

Mass Balance refers to the application of the law of conservation of mass. It implies that the total mass entering a system must equal the total mass exiting the system, accounting for any changes in storage within the system.

This method is appropriate for contaminants such as metals, SO_2, VOCs and CO_2. However, the method cannot be used to estimate NO_x emissions due to the high variability of emissions in most combustion processes.

Emission estimation from some contaminants may require further analysis, owing to the possibility of pollutants transitioning into various physical or chemical states.

An illustrative example of accounting for fugitive emissions using mass balance has been shown in Box 8 below:

Box 8 : Calculations of fugitive emissions using mass-balance

Data required:

Mass of compound

Example of Annual Emissions using Mass Balance Method:

A Chemical Company A applied 10,000 litres of 'SpecCOAT' (a surface coating compound) in a given year.

Material Safety Data Sheet (MSDS)

Section 1 – Chemical Product and Company Identification

Product Name: SpecCOAT

Supplier: XYZ Corporation

Section 2 – Composition / Information on Ingredients

Chemical Name	CAS #	Percent by Weight
Methyl Ethyl Ketone	78-93-3	25%
Xylene	1330-20-7	25%
Ethyl Benzene	100-41-4	15%
N-Butyl Alcohol	123-86-4	10%
Carbon Black	133-86-4	<2%
Other		Balance

Section 3 – Chemical Product and Company Identification

Specific Gravity: 1.35

Percent Volatiles: 80% by weight

Equation for Emissions Estimations at Test Conditions:

$$M_e = M_i - M_p - M_a - M_a$$

Where,

M_e = Mass of compound A emitted (kg)

M_i = Mass of compound A in the input stream (kg)

M_p = Mass of compound A in the finishing product (kg)

M_a = Mass of compound A accumulated in the system (kg)

M_c = Mass of compound A captured for recovery or disposal (kg)

Surface coatings usually consist of resins (binders), pigments, additives, solvents, diluents, and thinners. Resins, pigments, and additives are solid compounds. The volatile portion of the coating consists of water, solvents, diluents, and thinners, which evaporate during mixing, application, and curing of the coating.

In the given example, there will be no loss of coating compounds to the coating equipment or system's liquid/solid waste streams in the coating process. To estimate the emissions, VOC content in the the coating compound needs to be obtained from Material Data Safety Sheet (MSDS) for that compound. Whereas, the annual consumption of the compound can be obtained from the facility's operation log or sales slips.

Equation for Estimated Emissions using Percent by Weight

1. To calculate uncontrolled VOC emissions from the coating material using the above MSDS

$$E_{VOC} = Q \times p \times d \div 100$$

Where,

EVOC = Total uncontrolled VOC emission (kg)

Q = Total annual consumption of coating material (litres)

p = Density of coating material (kg/L)

d = VOC content by weight in coating material (%)

For density of coating material:

Density of coating material (p) = Specific Gravity*1 kg/litre

= 1.35*1 kg/litr

= 1.35 kg/litre (from MSDS)

VOC content by weight (d) = 80 % (from MSDS)

$$E_{VOC} = 10,000 \times 1{\cdot}35 \times 80 \div 100$$

= 10,800 *kg/year*

2. To calculate emissions of individual compounds

$$M_Y = Q \times p \times w_Y \div 100$$

Where,

M_Y = Quantity of compound y in the coating material (kg)

Q = Total annual consumption of coating material (litres)

p = Density of coating material (kg/L)

w_Y = Percent by weight of compound y in the coating material (%)

For Methyl Ethyl Ketone

$$M_{Methyl\ Ethyl\ Ketone} = 10,000 \times 1{\cdot}35 \times 25 \div 100$$

= 3,375

For Xylene

$$M_{Xylene} = 10,000 \times 1{\cdot}35 \times 25 \div 100$$

= 3,375

For Ethyl Benzene

$$M_{Ethyl\ Benzene} = 10,000 \times 1{\cdot}35 \times 15 \div 100$$

= 2,025

For N-Butyl Alcohol

$$M_{N-Butyl\ Alcohol} = 10,000 \times 1{\cdot}35 \times 15 \div 100$$

= 1,350

Note:

The quantities of water and other non-VOC components must be excluded from the % volatiles if reported in the MSDS for VOC emissions calculations.

Box 9: Calculations of emissions using emission factors

Company X provides logistics services to various chemical industries and has fleet of 70 trucks for transportation of hazardous chemicals.

The company needs to calculate their air emissions from:

(a) Diesel combustion during transportation of hazardous chemicals

(b) Fugitive emissions from the loaded trucks during transportation of HCL chemicals having a leakage rate of 0.02%

The average diesel consumed by per truck is 160 litres per day, including to and fro transportation. The total loading capacity of the truck is 16,000 litres.

Example of Annual Emissions using Emission Factors:

(a) The following example demonstrates the air emissions of CO and NO_x released from the mobile combustion of diesel in the trucks during logistics transportation. To attain the base quantity of fuel, total fuel quantity is calculated using the fuel consumed per truck per day and total fleet utilisation. (for this case full-fleet utilisation is assumed)

Total fuel consumed:

= Diesel consumed by per truck per day X Number of trucks

= 160 X 70

= 11,200 litres

In absence of monitoring of air emissions as in this case, emission factors of contaminants and total fuel consumed is used to calculate the emissions.

Table 6: Calculation Example for Logistics Company X using Emission Factors

Base Quantity [BQ] (litres)	Contaminant	Emission Factors derived from various sources [Efx] (g/litre)	Emissions [Ex] (kg)
11,200	CO	32.5 g	364.00
	NO_x	52.8 g	591.36

Equation for Emissions Estimation for contaminants using Emission Factors:

$$E_x = BQ \times CEF_x$$

Where,

EX = Emission of contaminant x (kg)

BQ = Activity rate or base quantity (BQ) (litres)

CEFX = Controlled emission factors of contaminant x (g/litres)

For example,

$$E_{CO} = BQ \times CEF_{CO}$$

$$= (11{,}200 \times 32{\cdot}5) \div 1000$$

$$= 364kg$$

The estimated emissions are calculated for per day emissions while operating in its full-fleet capacity. To calculate annual emissions, the emissions need to be estimated based on per day fleet utilisation and number of operational days.

Note:

- Sector specific emission factors for various air emissions contaminants are derived from US EPA AP 42 (https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors-stationary-sources).
- WebFIRE Database is USEPA's online database to derive emission factors for criteria and hazardous air pollutants for non-industrial and industrial processes. (https://cfpub.epa.gov/webfire/)
- Relevant published studies are also a good source of emission factors for a particular contaminant if emission factors are not available in the databases.

Example of Annual Emissions using Mass Balance Method:

(b) The following example demonstrates the fugitive air emissions of HCL released from the closed container trucks during the transportation of chemicals. The air emissions are estimated using the leakage rate of HCL and total container capacity of the truck.

Total chemical transported:

= Total container capacity X Number of trucks

= 16,000 X 70

= 11,20,000 litres

= 13,32,800.00 kg

Equation for Emissions Estimation for contaminants using Mass Balance:

To calculate fugitive HCL emissions:

$$E_{HCL} = Q \times r$$

Where,

- EHCL = Total uncontrolled HCL emission (kg)
- Q = Total container capacity of the truck (kg)
- r = leakage rate (%)

$$E_{HCL} = 13,32,800 \times 0{\cdot}0002$$

$$= 2,66{\cdot}5 kg$$

The estimated emissions are calculated for per day emissions while operating in its full-fleet capacity. To calculate annual emissions, the emissions need to be estimated based on per day fleet utilisation, quantity of transported chemicals and number of operational days.

Note:

The leakage rate of the closed container truck for a contaminant can be estimated based on past records of the different in the chemical quantity at the time of loading and unloading.

Steps for the company

1. Select the appropriate method to calculate air emissions when monitoring results are unavailable or for data triangulation purposes

4.3 How do I consolidate air emissions across my organization?

Bottom-up approach for consolidating air emissions data

Air emissions must be reported at the corporate level under Principle 6 of the Business Responsibility and Sustainability Reporting framework. The CAER guide advises that data reported by each functional business units (manufacturing plants, offices and other units) at the company level, and reporting the emissions in mass units.

To achieve this, the company may undertake several preparatory steps:

1. Hire human resources and build capacity of the existing human resources in the Environment, Health, Safety (EHS) as well as Environmental, Social and Governance (ESG) functions.
2. Identify data requirements from each business unit, and allocate human resources to monitor, collect, maintain and share the database the database.
3. Each facility-level EHS/ESG personnel should report their activities related to air emissions identification, monitoring and reporting to a central functionary at the corporate level.

This preparedness will enable the corporates to manage their air emissions data, improve traceability and accountability, and smoothen the process of obtaining assurance on the air emissions reported. Figure 4 illustrates this process for a company primarily operating in the chemical sector.

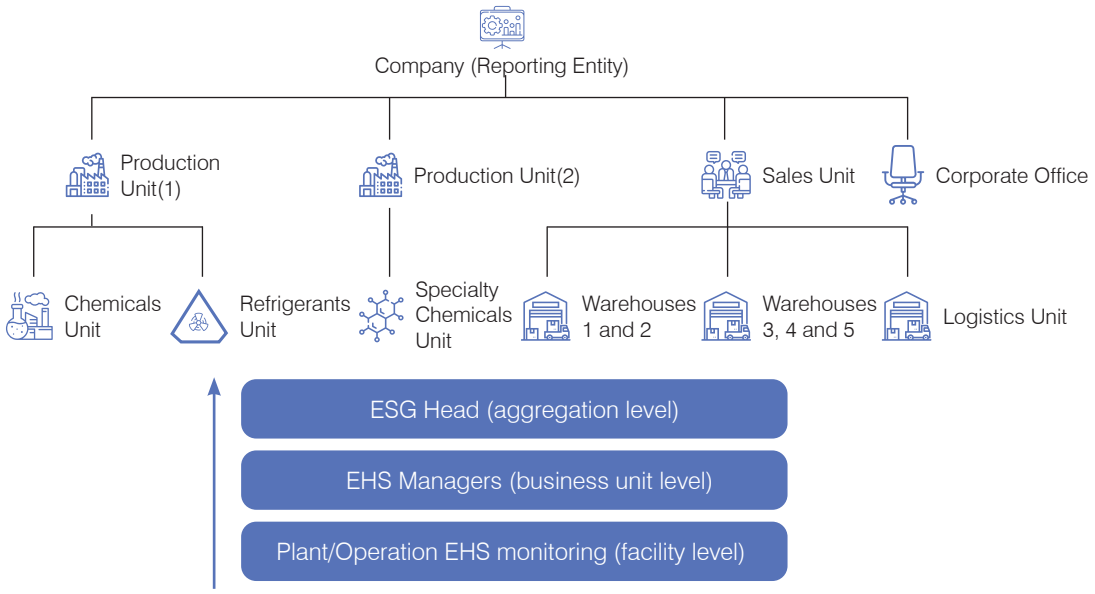

Figure 4: Illustrative example of consolidation approach for reporting air emissions

5: Reporting and Assurance

5.1 How do companies report their air emissions?

There is a lack of guidance available for companies disclosing their air emissions under the Business Responsibility and Sustainability Reporting framework. In addition, the reporting companies do not use standard terminology to report their air emissions, as observed in the existing Business Responsibility and Sustainability Reporting disclosures of 1000 companies. The existing disclosures feature terms such as "Not applicable" or "NA" or "0", without any supporting justification for the chosen response.

It has also been observed that wherever not applicable, the emissions were reported as "0", which can lead to an inference that the emission category is relevant, but the total emissions are zero.

To avoid misinterpretation of the disclosed air emissions, the CAER Guide recommends the convention described in Table 6 for companies disclosing to Business Responsibility and Sustainability Reporting.

Table 7: Reporting convention for air emissions

Use Case	Terminology	Units
Emissions are relevant, and estimated/calculated/ measured	Numerical value as obtained from measurements/ calculations.	kg or MT
Emissions are relevant, but not estimated/calculated/ measured	"Not determined"	-
Emissions are relevant, and the total mass emitted is zero	"0"	kg or MT
Emissions are not relevant, and not measured/calculated/ estimated	"Not applicable"	-
Emissions are not relevant, but measured/calculated/ estimated	Numerical value as obtained from measurements/ calculations. Companies are advised to report such emissions under category "Others"	kg or MT

5.2 How do companies get their air emissions data assured?

5.2.1 Documents required for assurance

To ensure the accuracy and reliability of air emissions data, (calculated using a combination of methods described in Part B of the CAER Guide), the following documents are critical:

- Monitoring report by third party agencies, which include information on stack/vent dimensions, sampling conditions (exit gas velocity, temperature and pressure) and sampling time.
- NABL accreditation certificate from the testing laboratory
- Instrument related certification (approval by NPL as well as calibration certificates) for the instruments used for monitoring.
- Data on production volume and chemical equations of all reactions within the plant boundary.
- Purchase records for fuel consumption, raw materials procured, and refrigerants refilled for the reporting year.
- MSDS of all the products and raw materials manufactured and handled within the facility.
- Calculations files (hard copies and/or MS Excel files) showing detailed calculations with formula, data source and references.
- SOPs for methodology used to measure, monitor, estimate and calculate air emissions to be disclosed in the Business Responsibility and Sustainability Reporting format.

5.2.2 Understanding assurance type, and processes.

Assurance Readiness for Air Emissions

The International Auditing and Assurance Standards Board defines an assurance engagement where a practitioner collects enough appropriate evidence to express a conclusion that enhances the confidence of users, other than the responsible entity, in the results of a measurement or evaluation of a subject matter against certain criteria.

In this context, to obtain assurance of sustainability reporting, an external third party is to be engaged to assess the sustainability report's adherence to specified standards. A sustainability report that includes an assurance report that, informs readers about the report's compliance with the set criteria.

Previous research has indicated that such independent assurance affects how user's perception of the quality and

trustworthiness of the disclosed information. To enhance reputation, minimise the risk associated with information accuracy, and establish authenticity, companies may incorporate an assurance statement in their sustainability reports.

The level of assurance refers to the degree of confidence that the independent auditor or assurer can provide on the accuracy and completeness of a company's disclosures.

Within levels of assurance, the distinction lies in the depth of testing, evidence level, cost, and perceived credibility. The categories for level of assurance are different for various assurance standards.

For AA1000, ISAE 3000 and SSAE 3000, the commonly used assurance standards for ESG reporting, the categorisation is given in the table below.

Table 8: Category for Level of Assurance for Assurance Standards

Sr. No.	Assurance Standard	Category for Level of Assurance
1	AA 1000	**High Assurance and Moderate Assurance** • **High assurance** requires extensive evidence gathering and provides a relatively high level of confidence in the organisation's disclosures. • **Moderate assurance** requires limited evidence gathering and provides a relatively lower level of confidence in the organisation's disclosures.
2	ISAE 3000	**Reasonable Assurance and Limited Assurance** • **Reasonable Assurance**: In a reasonable assurance engagement, the practitioner minimises the risk to a low level as a basis for the practitioner's conclusion. • **Limited Assurance**: In a limited assurance engagement, the risk is higher than in a reasonable assurance engagement, to an acceptable level in the given terms of engagement.
3	SSAE 3000	**Reasonable Assurance and Limited Assurance** • **Reasonable Assurance: In a reasonable assurance engagement, the practitioner minimises the risk to a low level as a basis for the practitioner's conclusion.** • **Limited Assurance:** In a limited assurance engagement, the risk is higher than in a reasonable assurance engagement, to an acceptable level in the given terms of engagement.

Steps for the company:

1. Gather critical documents for assurance, including monitoring reports from third-party agencies, NABL accreditation certificates, instrument certifications, production volume data, purchase records, and MSDS of products and raw materials.

2. Engage a third-party assurance provider, to assure air emissions as per the assurance standards of AA 1000, ISAE 3000, and SSAE 3000.

3. Determine the level of assurance needed, considering information available to provide evidence and satisfy the assurance requirements.

6: Annexures

Annexure A: CPCB Industry specific emission standards

Sr. No	Sector	Parameter	Limit Conc. (mg/NM³)	
1	Pharmaceuticals	Chlorine	15	
		Hydrochloric acid vapor	35	
		Ammonia	30	
		Benzene	5	
		Toluene	100	
		Acetonitrile	1000	
		Dichloromethane	200	
		Xylene	100	
		Acetone	2000	
2	Petrochemical (Basic and intermediate)	Specific pollutant	Existing plants	New plants
		Chlorine	10	10
		Hydrochloric Acid Mist	30	30
		Ammonia	75	75
		Hydrogen Sulphide	5	5
		Phosgene	1	1
		Hydrogen Cyanide (HCN)	10	10
		VOC (HAPs)- TDI and MDI	0.1	0.1
		VOC (HAPs)- Benzene and Butadiene	5	5
		VOC (HAPs)- Ethylene Oxide, Vinyl Chloride Monomer, Ethylene Dichloride, Acrylonitrile, Propylene Oxide	20	10
		General pollutant		
		VOC (MA, PA and Phenol)	20	
		VOC (Ethyl benzene (EB), Toluene, Xylene, Styrene, Aromatics, EG and PG)	100	
		paraffin, Acetone, and Olefins	150	
3	Thermal Power plants	Mercury	0.03	
4	Dye and Dye intermediates	HCL (acid mist)	35	
		Ammonia	30	
		Chlorine	15	

Sr. No	Sector	Parameter	Limit Conc. (mg/NM³)	
5	Cement	HCl	10	
		HF	1	
		TOC	10	
		Hg and its compounds	0.05	
		Cd +Tl and their compounds	0.05	
		Sb+As+Pb+Co+Cr+Cu+Mn+Ni+V and their compounds	0.5	
		Dioxins and Furans	0.1 ngTEQ/Nm³	
6	Phosphatic Fertilizer Plants	Total Fluoride as F-	20	
7	Ammonium Nitrate/ Calcium Ammonium Nitrate/NPK plant	Ammonium as NH3	300	150
		Total Fluoride as F-	<10 (Only NPK plant)	
8	Sulphuric Acid Plant Upto 300 TPD Above 300 TPD	Acid mist/ Sulphur Trioxide	90 70	70 50
9	Caustic Soda	Mercury	0.2	
		Chlorine	15	
		HCL mist	35	
10	Large Pulp and Paper	H2S	10	
11	Pesticide Industry	HCL	20	
		Cl2	5	
		H2S	5	
		P2O5 as H3PO4	10	
		NH3	30	
		CH3Cl	20	
		HBr	5	
12	Ceramic Industry (Kilns)	Fluoride	10	
		Chloride	100	
13	Beehive Hard Coke Oven	Hydrocarbons	25	
14	Lead Acid Battery Manufacturing Industries	Lead	10	
		Manganese	5	
15	Man-made fibre	VOC: Dimethyl Formamide and Acrylonitrile	50	

Annexure B: List of HAPs

Sr. No	CAS Number	Chemical Name	Uses	Sources as per EEA
1	79345	1122-Tetrachloroethane	In production of other chemicals. As an insecticide fumigant and weed killer and as a degreasing agent in the past.	During its manufacturing and use.
2	79005	112-Trichloroethane	Used as a solvent, especially in degreasing applications and cleaning of metals.	During its manufacturing and use, particularly in industrial cleaning processes.
3	57147	11-Dimethyl hydrazine	Used as a rocket propellant, in chemical synthesis, and as a laboratory reagent.	Released during its manufacturing and use in aerospace and industrial applications.
4	120821	124-Trichlorobenzene	Used as a solvent, dye carrier, and in chemical synthesis.	Emissions during manufacturing, use, and disposal processes.
5	96128	12-Dibromo-3-chloropropane	Previously used as a soil fumigant and nematicide.	Released from agricultural applications and soil fumigation processes.
6	122667	12-Diphenylhydrazine	Used in chemical synthesis, particularly in the production of dyes and organic intermediates.	Emissions during manufacturing and use in industrial chemical processes.
7	106887	12-Epoxybutane	Used in chemical synthesis, particularly as a reactive intermediate in various industrial processes.	Released during its manufacturing and use in chemical production.
8	75558	12-Propylenimine (2-Methyl aziridine)	Used in chemical synthesis, particularly in the production of rubber and as a curing agent for plastics.	Emissions during manufacturing and use in industrial chemical processes.
9	106990	13-Butadiene	Used in the production of synthetic rubber and plastics.	Released during the production and use of synthetic rubber and from vehicle exhaust.
10	542756	13-Dichloropropene	Used as a soil fumigant to control nematodes.	Released during agricultural applications and fumigation processes.
11	1120714	13-Propane sultone	Used as a chemical intermediate in the production of various organic chemicals.	Emissions during manufacturing and use in chemical production.
12	106467	14-Dichlorobenzene(p)	Used as a deodorizer and pesticide.	Released during manufacturing, usage, and waste disposal.
13	123911	14-Dioxane (14-Diethyleneoxide)	Used as a solvent stabilizer for chlorinated solvents, in personal care products, and as a laboratory reagent.	Released during industrial manufacturing, particularly from chemical production and the use of products containing it.
14	106945	1-Bromopropane	Used as a solvent in industrial cleaning, adhesive formulations, and as a chemical intermediate.	Released during manufacturing, usage in degreasing, and adhesive applications.
15	540841	224-Trimethylpentane	Used as a component in gasoline and as a solvent in laboratories.	Released during its use in fuel and industrial processes.
16	1746016	2378-Tetrachlorodibenzo-p-dioxin	Have no uses outside of research and laboratory use and are not intentionally manufactured.	Formed by the combustion of fuels and wastes, processing of metals, and the production of pulp and paper.
17	95954	245-Trichlorophenol	Used in the synthesis of pesticides and antiseptics.	Released during production and use in chemical manufacturing.
18	88062	246-Trichlorophenol	Used as a fungicide, bactericide, and in wood preservation.	Released during production, use, and disposal in treated wood products.
19	94757	24-D salts and esters	Used as a herbicide to control broadleaf weeds.	Released during agricultural applications and manufacturing processes.
20	51285	24-Dinitrophenol	Used as a pesticide, and in the manufacturing of dyes and explosives.	Released during manufacturing and use in industrial processes.
21	121142	24-Dinitrotoluene	Used in the production of polyurethane foams, explosives, and dyes.	Released during manufacturing and disposal of products containing it.

Sr. No	CAS Number	Chemical Name	Uses	Sources as per EEA
22	95807	24-Toluene diamine	Used in the production of polyurethane foams and as a chemical intermediate.	Released during manufacturing and industrial processes.
23	584849	24-Toluene diisocyanate	Used in the production of polyurethane foams, coatings, and adhesives.	Released during manufacturing, usage, and disposal of products containing it.
24	53963	2-Acetylaminofluorene	Used in research as a standard for evaluating the carcinogenic potential of chemicals.	Released during research and laboratory use.
25	532274	2-Chloroacetophenone	Used in the production of pharmaceuticals and as a riot control agent (tear gas).	Released during manufacturing, and use in law enforcement.
26	79469	2-Nitropropane	Used as a solvent, especially in coatings, inks, and adhesives, and as a chemical intermediate.	Released during manufacturing, and use in industrial processes.
27	91941	33-Dichlorobenzidene	Used in the production of dyes, pigments, and polymers.	Released during manufacturing and industrial chemical processes.
28	119904	33-Dimethoxybenzidine	Used as an intermediate in the manufacture of dyes.	Released during manufacturing and use in industrial dye production.
29	119937	33'-Dimethyl benzidine	Used in the production of dyes, pigments, and polymers.	Released during manufacturing and chemical processes.
30	101144	44-Methylene bis(2-chloroaniline)	Used in the production of polyurethane elastomers.	Released during manufacturing and use in industrial chemical processes.
31	101779	44'-Methylenedianiline	Used in the production of polyurethane foams and resins.	Released during manufacturing and use in industrial chemical processes.
32	534521	46-Dinitro-o-cresol and salts	Used as a pesticide and in the manufacture of dyes and explosives.	Released during manufacturing and agricultural applications.
33	92671	4-Aminobiphenyl	Used in research, especially in studies related to carcinogenesis.	Released during research and laboratory use.
34	92933	4-Nitrobiphenyl	Used in research and in the production of dyes.	Released during manufacturing and research.
35	100027	4-Nitrophenol	Used in the manufacture of dyes, pesticides, and pharmaceuticals.	Released during manufacturing and industrial use.
36	75070	Acetaldehyde	Used in the production of perfumes, dyes, and as an intermediate in organic synthesis.	Released during manufacturing, combustion processes, and industrial use.
37	60355	Acetamide	Used as a solvent and plasticizer, and in the synthesis of pesticides and pharmaceuticals.	Released during manufacturing and industrial use.
38	75058	Acetonitrile	Used as a solvent in chemical analysis, pharmaceuticals, and as a precursor in organic synthesis.	Released during manufacturing, use in laboratories, and chemical industries.
39	98862	Acetophenone	Used in the production of fragrances, pharmaceuticals, and as a solvent.	Released during manufacturing and use in industrial processes.
40	107028	Acrolein	Used in the production of acrylic acid, as a biocide, and in organic synthesis.	Released during manufacturing, combustion, and industrial processes.
41	79061	Acrylamide	Used in the production of polyacrylamides for water treatment, paper production, and in chemical synthesis.	Released during manufacturing and use in industrial processes.
42	79107	Acrylic acid	Used in the production of polymers, resins, and as a chemical intermediate.	Released during manufacturing and industrial use.
43	107131	Acrylonitrile	Used in the production of plastics, acrylic fibers, and as a chemical intermediate.	Released during manufacturing and industrial processes.

Sr. No	CAS Number	Chemical Name	Uses	Sources as per EEA
44	107051	Allyl chloride	Used in the production of pharmaceuticals, plastics, and as a chemical intermediate.	Released during manufacturing and chemical processes.
45	62533	Aniline	Used in the production of dyes, pharmaceuticals, and rubber chemicals.	Released during manufacturing, use in chemical industries, and from vehicle exhaust.
46		Antimony Compounds	Used in flame retardants, alloys, and electronics.	Released during the production of flame retardants, electronics, and from smelting operations.
47		Arsenic Compounds (inorganic including arsine)	Agricultural pesticides and wood preservatives. Also used in glass, metal alloys, bronzing, and in pyrotechnics.	Burning fossil fuels in power stations, use in pesticides, and wood preservatives.
48	1332214	Asbestos	Used in pipe coverings, insulation in buildings, cement, and fireproof clothing.	Demolition of old structures, dumping of asbestos wastes, and maintenance work on buildings containing asbestos.
49	71432	Benzene (including benzene from gasoline)	Used in the production of dyes, detergents, coatings, plastics, fibers, and pesticides.	Vehicle exhaust emissions from its production and use in the manufacture of other chemicals.
50	92875	Benzidine	Used in the production of dyes and pigments.	Released during manufacturing and chemical processes.
51	98077	Benzotrichloride	Used as a chemical intermediate in the production of dyes, perfumes, and resins.	Released during manufacturing and industrial processes.
52	100447	Benzyl chloride	Used in the production of plasticizers, resins, and as a chemical intermediate.	Released during manufacturing and use in chemical industries.
53		Beryllium Compounds	Used in aerospace materials, nuclear reactors, and electronics.	Released during metal processing, electronics manufacturing, and combustion processes.
54	57578	beta-Propiolactone	Used in the sterilization of vaccines, biological products, and as a chemical intermediate.	Released during manufacturing and use in medical and laboratory settings.
55	92524	Biphenyl	Used in the production of heat transfer fluids, as a fungicide, and in the manufacture of organic chemicals.	Released during manufacturing, use in industrial processes, and disposal.
56	117817	Bis(2-ethylhexyl)phthalate (DEHP)	Used in the production of PVC to make it more flexible.	Evaporates from products containing it and also when products are disposed of in landfills.
57	542881	Bis(chloromethyl)ether	Used in chemical synthesis and as a reagent in organic reactions.	Released during manufacturing and industrial use.
58	75252	Bromoform	Used in the manufacture of pharmaceuticals and as a laboratory reagent.	Released during manufacturing, use in laboratories, and disposal.
59		Cadmium Compounds	Used in batteries, corrosion-resistant metal plating, pigments, and plastics. Also used in low melting point metal alloys.	Released during metal processing, recycling of batteries, and the combustion of fossil fuels in power stations.
60	156627	Calcium cyanamide	Used as a fertilizer and in the manufacture of chemicals.	Released during manufacturing and agricultural applications.
61	105602	Caprolactam	Used in the production of nylon and as a chemical intermediate.	Released during manufacturing and industrial processes.
62	133062	Captan	Used as a fungicide in agriculture and horticulture.	Released during agricultural applications and from treated products.
63	63252	Carbaryl	Used as an insecticide in agriculture, horticulture, and on pets.	Released during agricultural applications, manufacturing, and use in household products.
64	75150	Carbon disulfide	Used in the production of rayon, cellophane, and rubber chemicals.	Released during manufacturing, industrial processes, and from vehicle exhaust.

Sr. No	CAS Number	Chemical Name	Uses	Sources as per EEA
65	56235	Carbon tetrachloride	Used in the manufacturing of other chemicals, particularly refrigerants.	Released from industrial spillages and from landfill sites where waste containing TCM has been buried.
66	463581	Carbonyl sulfide	Used as an intermediate in the production of chemicals and in fumigation.	Released during industrial processes and agricultural applications.
67	120809	Catechol	Used in the production of pharmaceuticals, dyes, and as a photographic developer.	Released during manufacturing and use in chemical industries.
68	133904	Chloramben	Used as a herbicide in agriculture.	Released during agricultural applications and manufacturing processes.
69	57749	Chlordane	Used on agricultural crops as a contact insecticide.	Released during use as a pesticide on crops, manufacture, transportation, and storage.
70	7782505	Chlorine	Used in water treatment, disinfectants, and in the production of various chemicals.	Released during production, transportation, and use in industrial processes.
71	79118	Chloroacetic acid	Used in the production of dyes, pharmaceuticals, and pesticides.	Released during manufacturing and industrial chemical processes.
72	108907	Chlorobenzene	Used as a solvent in the manufacture of chemicals, rubber, and as a degreasing agent.	Released during manufacturing and industrial use.
73	510156	Chlorobenzilate	Used as an acaricide in agriculture.	Released during agricultural applications and manufacturing processes.
74	67663	Chloroform	Used as a solvent and in the manufacture of chemicals such as pesticides.	Released during use as a solvent and chemical intermediate.
75	107302	Chloromethyl methyl ether	Used in chemical synthesis and as an intermediate in the production of other chemicals.	Released during manufacturing and industrial use.
76	126998	Chloroprene	Used in the production of synthetic rubber.	Released during manufacturing and industrial processes.
77		Chromium Compounds	Used as an important component of stainless steel and high-performance alloys, in furnace bricks, dyes, pigments, and chrome plating.	Released during chemical manufacturing, combustion of fossil fuels, waste incineration, and steel making.
78		Cobalt Compounds	Used in the production of high-performance alloys, batteries, and as a catalyst in chemical reactions.	Released during mining, refining, and industrial processes.
79		Coke Oven Emissions	Released from coke production during the heating of coal in the absence of air.	Emissions from coke ovens during steel production.
80	1319773	Cresols/Cresylic acid (isomers and mixture)	Used in the production of disinfectants, wood preservatives, and as chemical intermediates.	Released during manufacturing and use in industrial processes.
81	98828	Cumene	Used in the production of phenol and acetone, and as a solvent in the chemical industry.	Released during manufacturing, use in chemical industries, and combustion processes.
82		Cyanide Compounds 1	Used in a variety of industrial processes including chemical and plastic production, rubber and explosives, and as pesticides.	Released from vehicle exhausts, industrial processes, waste incineration, and use as pesticides.
83	3547044	DDE	Used as a breakdown product of DDT, a pesticide.	Released from agricultural applications and breakdown of DDT in the environment.
84	334883	Diazomethane	Used as a methylating agent in organic synthesis.	Released during chemical manufacturing and laboratory use.
85	132649	Dibenzofurans	Used in the manufacture of certain pesticides and as chemical intermediates.	Released during combustion processes and industrial waste disposal.

Sr. No	CAS Number	Chemical Name	Uses	Sources as per EEA
86	84742	Dibutylphthalate	Used as a plasticizer in PVC, adhesives, and printing inks.	Released during manufacturing, use of products containing it, and disposal in landfills.
87	111444	Dichloroethyl ether (Bis(2-chloroethyl)ether)	Used in the manufacture of insecticides, herbicides, and pharmaceuticals.	Released during manufacturing and industrial processes.
88	62737	Dichlorvos	Used as an insecticide in agriculture, public health, and domestic pest control.	Released during agricultural applications, use in household products, and manufacturing.
89	111422	Diethanolamine	Used in the production of cosmetics, detergents, and as a corrosion inhibitor.	Released during manufacturing and use in industrial and consumer products.
90	64675	Diethyl sulfate	Used in the manufacture of dyes, perfumes, and as a chemical intermediate.	Released during manufacturing and industrial use.
91	60117	Dimethyl aminoazobenzene	Used as a dye intermediate and in research as a carcinogenic agent.	Released during manufacturing and research.
92	79447	Dimethyl carbamoyl chloride	Used in chemical synthesis, particularly in the production of pharmaceuticals and pesticides.	Released during manufacturing and industrial processes.
93	68122	Dimethyl formamide	Used as a solvent in chemical reactions, in the production of synthetic fibers, and as an intermediate in the manufacture of pharmaceuticals.	Released during manufacturing, use in chemical processes, and from industrial emissions.
94	131113	Dimethyl phthalate	Used as a plasticizer, in insect repellents, and as a solvent for organic compounds.	Released during manufacturing, use of products containing it, and disposal.
95	77781	Dimethyl sulfate	Used as a methylating agent in chemical synthesis, particularly in the production of pharmaceuticals and pesticides.	Released during manufacturing and use in industrial processes.
96	106898	Epichlorohydrin (l-Chloro-23-epoxypropane)	Used in the production of epoxy resins, synthetic glycerin, and as a chemical intermediate.	Released during manufacturing and industrial processes.
97	140885	Ethyl acrylate	Used in the production of polymers, resins, and as a chemical intermediate.	Released during manufacturing and industrial use.
98	100414	Ethyl benzene	Used in the production of chemicals and other products including rubber and plastics.	Released from chemical and petroleum industries, combustion processes, and cigarette smoke.
99	51796	Ethyl carbamate (Urethane)	Used as an intermediate in the production of pharmaceuticals and as a chemical reagent.	Released during manufacturing and laboratory use.
100	75003	Ethyl chloride (Chloroethane)	Used as a refrigerant, in the production of tetraethyl lead, and as a local anesthetic.	Released during manufacturing, use in laboratories, and industrial processes.
101	106934	Ethylene dibromide (Dibromoethane)	Used as a fumigant, in leaded gasoline, and as a chemical intermediate.	Released during agricultural applications, manufacturing, and combustion of leaded fuels.
102	107062	Ethylene dichloride (12-Dichloroethane)	Used in the production of vinyl chloride, as a solvent, and as a chemical intermediate.	Released during manufacturing, use in chemical industries, and from contaminated sites.
103	107211	Ethylene glycol	Used in antifreeze, as a coolant in engines, and in the production of polyester fibers.	Released during manufacturing, automotive emissions, and industrial processes.
104	151564	Ethylene imine (Aziridine)	Used in chemical synthesis, particularly in the production of polymers and as a cross-linking agent.	Released during manufacturing and industrial processes.

Sr. No	CAS Number	Chemical Name	Uses	Sources as per EEA
105	75218	Ethylene oxide	Used in the chemical industry to produce products such as antifreeze, cosmetics, and pharmaceuticals due to its highly reactive properties.	Released from industries that are using the chemical.
106	96457	Ethylene thiourea	Used as a fungicide, and in the production of rubber and plastics.	Released during manufacturing, agricultural applications, and industrial processes.
107	75343	Ethylidene dichloride (11-Dichloroethane)	Used as a solvent and in the production of vinyl chloride and other chemicals.	Released during manufacturing and industrial use.
108		Fine mineral fibers 3	Used in insulation, as a reinforcing agent in materials, and in the production of cement.	Released during manufacturing, construction, and demolition activities.
109	50000	Formaldehyde	Used in the production of resins, as a preservative in medical laboratories, and in the manufacture of building materials.	Released during manufacturing, use in consumer products, and from combustion processes.
110		Glycol ethers	Used as solvents in paints, coatings, and cleaning products, and as intermediates in chemical synthesis.	Released during manufacturing, use in consumer products, and industrial processes.
111	76448	Heptachlor	Used as a pesticide to kill insects in homes and on food crops.	Released from leaks at landfills and hazardous waste sites.
112	118741	Hexachlorobenzene	Used in the manufacturing of chlorinated organic solvents.	Released as a bi-product of the burning of coal, waste incineration, and some metal processes. Also from its use as a fungicide.
113	87683	Hexachlorobutadiene	Used in the manufacture of lubricants and rubber compounds. Also used as a heat transfer liquid and hydraulic fluid.	Released during its manufacture and disposal in waste incinerators or landfill.
114	77474	Hexachlorocyclopentadiene	Used as an intermediate in the production of pesticides, flame retardants, and other chemicals.	Released during manufacturing and industrial processes.
115	67721	Hexachloroethane	Used in the production of rubber, aluminum, and as a degassing agent in metal processing.	Released during manufacturing, metal processing, and industrial processes.
116	822060	Hexamethylene-16-diisocyanate	Used in the production of polyurethanes, coatings, and adhesives.	Released during manufacturing and industrial use.
117	680319	Hexamethylphosphoramide	Used as a solvent, and in the production of resins and polymers.	Released during manufacturing, industrial use, and disposal in waste.
118	110543	Hexane	Used as a solvent in the extraction of vegetable oils, and in the production of adhesives and coatings.	Released during manufacturing, industrial processes, and from vehicle exhaust.
119	302012	Hydrazine	Used as a rocket propellant, in the production of polymers, and as a laboratory reagent.	Released during manufacturing, aerospace applications, and industrial processes.
120	7647010	Hydrochloric acid	Used in the production of chlorides, in the refining of ore, and as a cleaning agent.	Released during manufacturing, industrial use, and chemical processing.
121	7664393	Hydrogen fluoride (Hydrofluoric acid)	Used in the production of aluminum, in petroleum refining, and in glass etching.	Released during manufacturing, industrial use, and from chemical processes.
122	7783064	Hydrogen sulfide	Used in the production of sulfuric acid, and as a by-product in petroleum refining and natural gas processing.	Released during industrial processes, petroleum refining, and natural gas extraction.

Sr. No	CAS Number	Chemical Name	Uses	Sources as per EEA
123	123319	Hydroquinone	Used in the production of photographic developers, antioxidants, and in the synthesis of chemicals.	Released during manufacturing, industrial processes, and chemical synthesis.
124	78591	Isophorone	Used as a solvent in paints, coatings, and adhesives, and in the production of polymers.	Released during manufacturing, industrial use, and chemical processes.
125		Lead Compounds	Used in lead-acid batteries, as a roofing material, in solders, in electrical systems, and as radiation shielding.	Released from metal production and processing, burning of fossil fuels in power stations, and from the chemical industry.
126	58899	Lindane (all isomers)	Used as an insecticide for timber.	Released during use as an insecticide.
127	108316	Maleic anhydride	Used in the production of resins, coatings, and as a chemical intermediate.	Released during manufacturing, industrial processes, and chemical synthesis.
128		Manganese Compounds	Used in steel production, batteries, and as a component in fertilizers.	Released during mining, refining, and industrial processes.
129	108394	m-Cresol	Used in the production of disinfectants, preservatives, and in chemical synthesis.	Released during manufacturing, industrial processes, and chemical synthesis.
130		Mercury Compounds	Used in thermometers, dental fillings, batteries, and to manufacture chlorine gas and caustic soda. Mercury vapor is used in fluorescent lamps.	Released during waste incineration, use in manufacturing, metal production, coal combustion, and dental surgeries.
131	67561	Methanol	Used as a solvent, antifreeze, and in the production of formaldehyde and other chemicals.	Released during manufacturing, combustion processes, and from vehicle exhaust.
132	72435	Methoxychlor	Used as an insecticide in agriculture and domestic pest control.	Released during agricultural applications, use in household products, and from treated surfaces.
133	74839	Methyl bromide (Bromomethane)	Used as a fumigant, and in the production of chemicals.	Released during agricultural applications, manufacturing, and disposal.
134	74873	Methyl chloride (Chloromethane)	Used as a refrigerant, in the production of silicones, and as a chemical intermediate.	Released during manufacturing, industrial processes, and from chemical industries.
135	71556	Methyl chloroform (111-Trichloroethane)	Used as a solvent for cleaning metal parts and circuit boards, photoresist solvent in the electronics industry, aerosol propellant, cutting fluid additive, and solvent for inks, paints, adhesives, and other coatings.	Released through evaporation during its use as a solvent.
136	78933	Methyl ethyl ketone (2-Butanone)	Used as a solvent in paints, coatings, adhesives, and in chemical synthesis.	Released during manufacturing, use in industrial processes, and chemical synthesis.
137	60344	Methyl hydrazine	Used as a rocket propellant, in chemical synthesis, and as a laboratory reagent.	Released during manufacturing, aerospace applications, and industrial processes.
138	74884	Methyl iodide (Iodomethane)	Used as a fumigant, and in chemical synthesis.	Released during agricultural applications and chemical manufacturing.
139	108101	Methyl isobutyl ketone (Hexone)	Used as a solvent in paints, coatings, adhesives, and in the production of rubber chemicals.	Released during manufacturing, use in industrial processes, and chemical synthesis.
140	624839	Methyl isocyanate	Used in the production of pesticides, plastics, and as a chemical intermediate.	Released during manufacturing and industrial processes.
141	80626	Methyl methacrylate	Used in the production of acrylic plastics, coatings, and as a chemical intermediate.	Released during manufacturing and industrial processes.

Sr. No	CAS Number	Chemical Name	Uses	Sources as per EEA
142	1634044	Methyl tert butyl ether	Used as a gasoline additive to increase octane and reduce engine knocking.	Released during fuel combustion, manufacturing, and from contaminated sites.
143	75092	Methylene chloride (Dichloromethane)	Used in paint removers, aerosol solvents, in the manufacture of certain pharmaceuticals, and as a degreasing agent in the electronics industries.	Released through the use of industrial and domestic products.
144	101688	Methylene diphenyl diisocyanate (MDI)	Used in the production of polyurethane foams, coatings, and adhesives.	Released during manufacturing and industrial use.
145	108383	m-Xylenes	Used in the production of chemicals, solvents, and as a component in gasoline.	Released during fuel combustion, chemical manufacturing, and industrial processes.
146	121697	NN-Dimethylaniline	Used in the production of dyes, pesticides, and in chemical synthesis.	Released during manufacturing and chemical processes.
147	91203	Naphthalene	Used in mothballs, insecticides, and in the manufacture of dyes.	Released during the burning of fossil fuels, chemical manufacturing, and from products containing it.
148		Nickel Compounds	Used in the manufacture of steel and other alloys, extensively in batteries, in chemical, petroleum, and electrical industries. Also used in ceramics and electroplating.	Released during the burning of fossil fuels, mining, refining processes, and from waste incineration.
149	98953	Nitrobenzene	Used in the production of aniline, dyes, and in chemical synthesis.	Released during manufacturing and chemical processes.
150	62759	N-Nitrosodimethylamine	Used as an intermediate in chemical synthesis, particularly in the production of rubber and pesticides.	Released during manufacturing, industrial processes, and chemical synthesis.
151	59892	N-Nitrosomorpholine	Used as a solvent and in chemical synthesis.	Released during manufacturing and chemical processes.
152	684935	N-Nitroso-N-methylurea	Used in research as a carcinogenic agent, and in chemical synthesis.	Released during manufacturing and research.
153	90040	o-Anisidine	Used in the production of dyes, pigments, and in chemical synthesis.	Released during manufacturing and industrial chemical processes.
154	95487	o-Cresol	Used in the production of disinfectants, preservatives, and in chemical synthesis.	Released during manufacturing, industrial processes, and chemical synthesis.
155	95534	o-Toluidine	Used in the production of dyes, pigments, and in chemical synthesis.	Released during manufacturing and industrial chemical processes.
156	95476	o-Xylenes	Used in the production of chemicals, solvents, and as a component in gasoline.	Released during fuel combustion, chemical manufacturing, and industrial processes.
157	56382	Parathion	Used as an insecticide in agriculture.	Released during agricultural applications, manufacturing, and from treated surfaces.
158	106445	p-Cresol	Used in the production of disinfectants, preservatives, and in chemical synthesis.	Released during manufacturing, industrial processes, and chemical synthesis.
159	82688	Pentachloronitrobenzene (Quintobenzene)	Used as a fungicide in agriculture.	Released during agricultural applications and manufacturing processes.
160	87865	Pentachlorophenol	Used as a wood preservative and biocide on masonry.	Released from timber and masonry that has been treated with PCP and from its manufacture.
161	108952	Phenol	Used in the manufacture of chemicals and resins.	Released as a waste product from industrial practices and their use as pesticides.

Sr. No	CAS Number	Chemical Name	Uses	Sources as per EEA
162	75445	Phosgene	Used in the production of chemicals, particularly polyurethanes and pesticides.	Released during manufacturing, chemical synthesis, and industrial processes.
163	7803512	Phosphine	Used as a fumigant and in the production of semiconductors.	Released during manufacturing, agricultural applications, and chemical synthesis.
164	7723140	Phosphorus	Used in sugar refining, fertilizers, water softeners, and detergents.	Released from the use of fertilizers, human sewage, and industrial use of detergents.
165	85449	Phthalic anhydride	Used in the production of plasticizers, resins, and as a chemical intermediate.	Released during manufacturing, industrial processes, and chemical synthesis.
166	1336363	Polychlorinated biphenyls (Aroclors)	Used mainly as electrical insulating material in capacitors and transformers. Also used as flame retardants.	Released during their manufacture and use, and from leakage during the disposal of PCB-containing equipment.
167		Polycyclic Organic Matter 4	Produced during the incomplete combustion of organic matter.	Released from burning fossil fuels, waste, and biomass.
168	106503	p-Phenylenediamine	Used in the production of dyes, hair coloring, and in chemical synthesis.	Released during manufacturing, use in consumer products, and chemical processes.
169	123386	Propionaldehyde	Used as a chemical intermediate, in the production of plastics, and in organic synthesis.	Released during manufacturing and industrial use.
170	114261	Propoxur (Baygon)	Used as an insecticide in public health and agriculture.	Released during agricultural applications, public health pest control, and use in household products.
171	78875	Propylene dichloride (12-Dichloropropane)	Used as a solvent, in the production of polymers, and in organic synthesis.	Released during manufacturing, industrial processes, and chemical synthesis.
172	75569	Propylene oxide	Used in the production of polyurethanes, as a fumigant, and as a chemical intermediate.	Released during manufacturing, industrial processes, and from contaminated sites.
173	106423	p-Xylenes	Used in the production of chemicals, solvents, and as a component in gasoline.	Released during fuel combustion, chemical manufacturing, and industrial processes.
174	91225	Quinoline	Used in the production of dyes, pharmaceuticals, and as a corrosion inhibitor.	Released during manufacturing, industrial processes, and chemical synthesis.
175	106514	Quinone	Used in the production of dyes, as a photographic developer, and in chemical synthesis.	Released during manufacturing, industrial processes, and chemical synthesis.
176		Radionuclides (including radon) 5	Naturally occurring and used in medical treatments, energy production, and scientific research.	Released from natural sources, medical applications, and during energy production.
177		Selenium Compounds	Used in electronics, glass manufacturing, and as a dietary supplement.	Released during mining, refining, and from industrial processes.
178	100425	Styrene	Used in the production of polystyrene plastics, resins, and as a chemical intermediate.	Released during manufacturing, industrial processes, and combustion of materials containing styrene.
179	96093	Styrene oxide	Used as a chemical intermediate, in the production of epoxy resins, and as a laboratory reagent.	Released during manufacturing, industrial processes, and laboratory use.
180	127184	Tetrachloroethylene (Perchloroethylene)	Used as a dry-cleaning agent for textiles and fabrics. Also used for metal degreasing and in some consumer products.	Released through its use in dry-cleaning and as a degreasing agent when it evaporates.
181	7550450	Titanium tetrachloride	Used in the production of titanium metal, pigments, and as a chemical intermediate.	Released during manufacturing and industrial processes.

Sr. No	CAS Number	Chemical Name	Uses	Sources as per EEA
182	108883	Toluene	Used as a solvent and is often blended into petrol. Also used in paints, thinners, adhesives, and some printing processes.	Released during the combustion of fuels and from the evaporation of toluene-containing products such as paint and paint thinners, adhesives, and nail polish as they are used and disposed of.
183	8001352	Toxaphene (chlorinated camphene)	Previously used as an insecticide.	Released through its use as an insecticide from hazardous waste sites and into the air by evaporation.
184	79016	Trichloroethylene	Used as a metal degreasing agent and as a solvent in paints, lubricants, and paint strippers. In the past it was used for fumigating grain and as an anesthetic.	Released through its use as a solvent and disposing of products that contain it.
185	121448	Triethylamine	Used as a curing agent in the production of resins and as a catalyst in chemical synthesis.	Released during manufacturing, industrial processes, and chemical synthesis.
186	1582098	Trifluralin	Used as a herbicide to control weed growth amongst crops.	Released during agricultural applications and manufacturing.
187	108054	Vinyl acetate	Used in the production of polyvinyl acetate and other polymers, in adhesives, and as a chemical intermediate.	Released during manufacturing, industrial processes, and from chemical industries.
188	593602	Vinyl bromide	Used in the production of flame retardants, resins, and as a chemical intermediate.	Released during manufacturing, industrial processes, and from chemical industries.
189	75014	Vinyl chloride	Used to manufacture PVC (polyvinylchloride) plastics, which have a variety of uses.	Released from the plastics industry.
190	75354	Vinylidene chloride (11-Dichloroethylene)	Used in the production of polymers, as a solvent, and in chemical synthesis.	Released during manufacturing, industrial processes, and from chemical industries.
191	1330207	Xylenes (isomers and mixture)	Used in the manufacturing of chemicals, plastics, in solvents, and in paints.	Released from the petroleum and chemical industries, combustion processes, and industrial use.

Annexure C: List of POPs

Sr. no	CAS Number	Chemical Name	Uses	Sources as per EEA
1	309-00-2	Aldrin	Aldrin is a pesticide used to control soil insects and to protect wooden structures.	Through use of pesticides
2	57-74-9	Chlordane	Used on agricultural crops as a contact insecticide	Through its use as a pesticide on crops. Other releases are through its manufacture, transportation and storage.
3	50-29-3	DDT	Used as an insecticide against a wide variety of pests, particularly for crop protection.	From its use as a pesticide.
4	60-57-1	Dieldrin	Used as an insecticide	From its use as a pesticide.
5	72-20-8	Endrin	Used as an insecticide	From its use as a pesticide.
6	76-44-8	Heptachlor	Used as a pesticide to kill insects in homes and on food crops.	From leaks at landfills and hazardous waste sites.

7	118-74-1	Hexachlorobenzene	Manufacturing of chlorinated organic solvents.	As a bi-product of the burning of coal, waste incineration and some metal processes. Also been released through its use as a fungicide.
8	2385-85-5	Mirex	Used as an insecticide and has been commonly used as a fire retardant.	Through its use as an insecticide.
9	8001-35-2	Toxaphane	Used as an insecticide.	Use as an insecticide and into the air by evaporation.
10	1336-36-3	Polychlorinated biphenyls	Used mainly as electrical insulating material in capacitors and transformers. They are also used as flame retardants.	From their manufacture and use. Also leakage during disposal of PCB containing equipment.
11	1746-01-6	Polychlorinated dibenzo-p-dioxins (PCDD)	No uses outside of research and laboratory use and are not intentionally manufactured.	By the combustion of fuels and wastes, processing of metals and the production of pulp and paper.
12	1746-01-6	Polychlorinated dibenzofurans (PCDF)	No uses outside of research and laboratory use and are not intentionally manufactured.	By the combustion of fuels and wastes, processing of metals and the production of pulp and paper.

Annexure D: List of VOCs as per US EPA

Very volatile (gaseous) organic compounds	VVOC	Propane, butane, methyl chloride
Volatile organic compounds	VOC	Formaldehyde, d-Limonene, toluene, acetone, ethanol (ethyl alcohol) 2-propanol (isopropyl alcohol), hexanal
Semi volatile organic compounds	SVOC	Pesticides (DDT, chlordane, plasticizers (phthalates), fire retardants (PCBs, PBB))

List of VOCs as per Agency for Toxic Substances and Disease Registry (CDC)

1	1,1,1-Trichloroethane	23	Chloroethane
2	1,1,2,2-Tetrachloroethane	24	Chloroform
3	1,1,2-Trichloroethane	25	Chloromethane
4	1,1-Dichloroethane	26	Dichlorobenzenes
5	1,1-Dichloroethene	27	Dichloropropenes
6	1,2,3-Trichloropropane	28	Ethylbenzene
7	1,2-Dibromo-3-Chloropropane	29	Ethylene Dibromide
8	1,2-Dibromoethane	30	Formaldehyde
9	1,2-Dichloroethane	31	Gasoline, Automotive
10	1,2-Dichloroethene	32	Hexachlorobutadiene
11	1,2-Dichloropropane	33	Hexachloroethane
12	1,3-Butadiene	34	Hydrazines
13	2-Butanone	35	Methyl Mercaptan
14	2-Hexanone	36	n-Hexane
15	Acetone	37	Nitrobenzene
16	Acrolein	38	Stoddard Solvent
17	Benzene	39	Styrene
18	Bromodichloromethane	40	Tetrachloroethylene (PERC)
19	Bromomethane	41	Toluene
20	Carbon Disulfide	42	Trichloroethylene (TCE)
21	Carbon Tetrachloride	43	Vinyl Chloride
22	Chlorobenzene	44	Xylenes

Annexure E: Assurance Standards

AA1000 Assurance Standards v3

The AA1000 Series of Standards developed by **AccountAbility**, are based on inclusivity, materiality, responsiveness, and impact principles, including the AA1000AP (AcountAbility Principles), the AA1000AS (Assurance Standard), and the AA1000SES (Stakeholder Engagement Standard).

The standards are governed by a diverse and representative group of experts in the AccountAbility Standards Board which approves the standards strategy and ensures the quality and integrity of the standards.

The AA1000AS v3 is a standard for high-quality sustainability assurance that assesses and provides conclusions on the adherence to the AA1000AP and the reliability and quality of sustainability performance information.

The standard is divided into four sections: Purpose and Scope, Preconditions, Conducting an Engagement, and Issuing an Assurance Statement and Report to Management. It is the result of a multi-stakeholder consultation and revision process that started in 2018 and ended in 2020 and incorporates feedback and best practices from the market and the users of the standard.

Purpose and Scope

- The purpose of the AA1000AS v3 is set forth the requirements for AccountAbility licensed assurance providers to conduct high-quality sustainability assurance on the application of the AA1000AP by reporting organisations.
- The scope of the AA1000AS v3 covers the preconditions, the conduct, and the output of an assurance engagement, and describes how to define the subject matter, the type, and the level of assurance.
- The intended users of the AA1000AS v3 are assurance providers, practitioners, and reporting organisations seeking assurance in accordance with the AA1000AP, as well as other stakeholders interested in the credibility and quality of sustainability information.
- The applicability of the AA1000AS v3 is for any organisation, of any size, in any industry, anywhere in the world, and can be used with other assurance standards or frameworks, as long as the requirements of the AA1000AS v3 are met.
- The licensing agreement is a mandatory contract between AccountAbility AA1000CIC (Community Interest Company) and each assurance provider that binds the user to adhere to the requirements of the AA1000AS v3 and the code of practice.
- The standard also provides an issue resolution process mechanism to maintain the integrity of the AA1000 series and to address any queries or complaints regarding the assurance statements issued by licensed assurance providers.

Preconditions for an AA1000AS v3 Engagement

- The independence and impartiality of the assurance provider means that there is no conflict of interest with the reporting organisation or its stakeholders that could affect the objectivity and credibility of the assurance statement.
- The competence of the assurance provider means that the individual practitioners and organisations involved in the assurance engagement have the necessary skills, knowledge, and experience to perform the assurance effectively and professionally.
- The engagement agreement is a contract between the reporting organisation and the assurance provider that defines the responsibilities and expectations of both parties, the scope and subject matter of the assurance, the type and level of assurance, and the criteria and disclosures to be used.
- The scope of the assurance engagement is the boundary of the information to be assured, which may include the whole or part of the reporting organisation, the reporting period, the reporting format, and the reporting standards or frameworks.
- The subject matter of the assurance engagement is the information that is assessed and reported on by the assurance provider, which may include the adherence to the AA1000AP, the reliability and quality of sustainability performance information, or both.
- The type of the assurance engagement is the nature and extent of the assessment and reporting on the subject matter, which may be either Type 1 (assurance on adherence to the AA1000AP) or Type 2 (assurance on adherence to the AA1000AP and reliability and quality of sustainability performance information).
- The level of assurance refers to the degree of confidence that the assurance provider has in the conclusions of the assurance engagement.

There are two levels of assurance according to the AA1000AS v3: High and Moderate.

- High assurance requires extensive evidence gathering and provides a relatively high level of confidence in the organisation's disclosures. Moderate assurance requires limited evidence gathering and provides a relatively lower level of confidence in the organisation's disclosures.
- The level of assurance is determined by the assurance provider in agreement with the reporting organisation and may vary for different subject matters within the same engagement. The level of assurance should be clearly stated in the assurance statement, along with the criteria and methodology used.

Conducting an AA1000AS v3 Engagement

1. Planning the Engagement

- Assurance providers must carefully plan the engagement, considering the scope, objectives, and expectations.
- Understand the reporting organisation's context, materiality, and sustainability management practices.
- Identify risks, opportunities, and relevant stakeholders.

2. Due Care and Documentation

- Collect evidence related to adherence to the AA1000 AccountAbility Principles (Type 1).
- Evaluate the reliability and quality of sustainability performance information (Type 2).
    a) Assess the organisation's processes, systems, and controls.
    b) Review the organisation's sustainability disclosures and performance data.
    c) Test the processes used to collect, verify, and report information.
- **Limitations**
    a) Transparency is crucial to build trust with stakeholders.
    b) Highlight any constraints or areas where assurance cannot be provided.

Issuing an AA1000AS v3 Assurance Statement and Optional Report to Management

1. Assurance Statement:

Assurance providers prepare an Assurance Statement that communicates the results of the engagement. Key components include:

- **Assurance Information**
    a) Intended users of the Assurance Statement.
    b) Responsibilities of the reporting organisation and assurance provider.
    c) Reference to the AA1000AS v3 and other assurance standard(s), if used.
    d) Description of the scope, subject matter, the type, and level of assurance provided.
    e) Reference to criteria used.
    f) Description and sources of disclosures covered.
    g) Description of methodology.
    h) Limitations and approach used to mitigate limitations.
    i) Notes on the independence and competencies of the assurance provider.
    j) Name of the assurance provider
    k) Date and place.
- **Performance-Related Information**
    a) Findings and conclusions concerning adherence to the AA1000 AccountAbility Principles of Inclusivity, Materiality, Responsiveness, and Impact (in all instances)
    b) For Type 2 assurance, findings and conclusions concerning the reliability and quality of specified performance information.
- The Assurance Statement is transparent, concise, and aligned with AA1000AS v3 requirements.

2. Optional Report to Management

- Assurance providers may create a more detailed Report to Management based on the engagement agreement.
- This report provides additional insights, context, and recommendations.
- It helps the reporting organisation enhance its sustainability practices.
- The report can address specific issues, risks, or opportunities identified during the engagement.

ISAE 3000

The International Standard on Assurance Engagements (ISAE) focuses on assurance engagements beyond the scope of historical financial audits or reviews, which International Standards cover on Auditing (ISAs) and International Standards on Review Engagements (ISREs). As mentioned, it applies to non-financial information assurance engagements, which may include environmental, social and governance, or sustainability disclosures. ISAE encompasses both attestation engagements, where a third party evaluates the underlying subject matter, and direct engagements, where the practitioner themselves conducts the evaluation. It provides guidelines for both reasonable and limited assurance engagements and can be adapted for direct engagements as needed.

The ISAE is based on two main premises: firstly, that those

involved in the engagement, including any engagement quality control reviewers, adhere to the ethical standards set forth by the International Ethics Standards Board for Accountants (IESBA Code) or equivalent standards; and secondly, that the practitioner is part of a firm that meets the quality control standards as demanding as ISQC 1, concerning the firm's quality control system.

Quality control and adherence to ethical principles, especially independence, are deemed crucial for the public interest and the quality of assurance engagements. Professional accountants are typically familiar with these requirements, but competent practitioners from other backgrounds who wish to comply with ISAEs must recognize and adhere to these stringent quality and ethical standards.

There are two main levels of assurance engagements as per ISAE 3000, and they differ primarily in the scope and depth of the assessment:

- **Reasonable Assurance:** In a reasonable assurance engagement, the practitioner minimises the risk to a low level as a basis for the practitioner's conclusion. It is done by providing a conclusion based on their opinion regarding the evaluated outcome against set criteria.
- **Limited Assurance:** In a limited assurance engagement, the risk is higher than in a reasonable assurance engagement, to an acceptable level in the given terms of engagement. The practitioner conducts procedures to achieve a level of assurance as per the practioner's professional judgement.

Scope

- ISAE focuses on non-financial assurance engagements, different from audits or reviews of historical financial information.
- If a subject-matter-specific ISAE exists, it should be used alongside this general ISAE for relevant engagements.
- Not all tasks performed by practitioners qualify as assurance engagements, including:
  - Tasks governed by International Standards on Related Services (ISRS), like agreed-upon procedures and compilations.
  - Tax return preparation without an assurance conclusion.
  - Advisory services, such as management and tax consulting.
- Assurance engagements under ISAEs can be part of larger projects, but ISAEs apply only to the assurance aspects.
- Certain engagements may resemble assurance tasks but are not considered as such under ISAEs if:
  - They involve giving professional opinions incidental to the main engagement.
  - Any reports are restricted to specified users.
  - There's an agreement that the engagement is not for assurance purposes.
  - The engagement is not represented as an assurance engagement in any reports.

Conditions for an Assurance

- To achieve either reasonable or limited assurance on whether the subject matter information is free from significant errors.
- To issue a written rep obtaining ort expressing a conclusion on the evaluation or measurement of the subject matter, providing the basis for either a reasonable or limited assurance conclusion.
- To communicate any additional information as mandated by ISAE and any other applicable ISAEs.

Requirements:

- **Compliance with Standards**
  - Practitioners must adhere to the requirements of this ISAE and any subject matter-specific ISAEs pertinent to the engagement.
  - Claims of compliance with this or any ISAEs are only valid if all relevant ISAE requirements have been met.
- **Understanding ISAEs**
  - Practitioners need to thoroughly understand the text, application, and explanatory materials of an ISAE to properly grasp its objectives and apply its requirements.
- **Complying with Requirements**
  - Practitioners are obligated to comply with each requirement of this ISAE and any applicable subject matter-specific ISAEs, except when a requirement is conditional and the condition does not apply.
  - Requirements specific to either limited assurance or reasonable assurance engagements are indicated by "L" or "R" after the paragraph number.
- **Departure from Requirements**
  - In exceptional cases, practitioners may deviate from

a requirement if it is ineffective in the engagement's specific circumstances. Alternative procedures should be performed to meet the requirement's aim.

- **Failure to Achieve Objectives**
  - If achieving an ISAE's objective is not possible, practitioners must decide whether to modify their conclusion or withdraw from the engagement, if allowed by law or regulation.
  - Inability to meet an objective signifies a significant issue that must be documented as per ISAE guidelines.

Preconditions for the Assurance Engagement

Before commencing an assurance engagement, the practitioner must assess if preconditions are met by gaining preliminary knowledge and discussing with relevant parties to determine:

- If the roles and responsibilities of involved parties are suitable.
- The engagement must have certain characteristics:
  - The subject matter is appropriate.
  - The criteria for preparing subject matter information are suitable and exhibit relevance, completeness, reliability, neutrality, and understandability.
  - The criteria will be accessible to the intended users.
  - The practitioner can gather the necessary evidence to support their conclusion.
  - A written report will contain the practitioner's conclusion, tailored to either a reasonable or limited assurance engagement.
  - There is a rational purpose for the engagement, ensuring meaningful assurance can be obtained, especially in limited assurance engagements.

If preconditions are not met, the practitioner must discuss this with the engaging party. If adjustments to fulfil preconditions are not possible, the practitioner should not accept the engagement as an assurance engagement unless legally obligated. In such cases, the engagement does not comply with ISAE standards, and the assurance report should not mention compliance with this ISAE or any other ISAEs.

Planning and Performing the Assurance Engagement

- **Planning the Engagement**
  - The practitioner is required to meticulously plan the engagement to ensure it is conducted efficiently, defining the scope, timing, and direction, and deciding on the detailed procedures needed to meet the engagement's objectives.
  - Assess the suitability of the criteria for the engagement, ensuring they align with the characteristics outlined previously, such as relevance and reliability.
  - If it becomes apparent after accepting the engagement that preconditions are not met, the practitioner must engage in discussions to see if issues can be resolved, decide if the engagement should continue, and determine how to report the matter.
  - Discovering unsuitable criteria or inappropriate subject matter after acceptance may lead the practitioner to consider withdrawing from the engagement, if possible. Otherwise, they must issue a qualified, adverse, or disclaimer of conclusion as warranted.
- **Materiality Consideration**
  - Materiality must be factored into both the planning and execution of the engagement, particularly in evaluating if the subject matter information is free of significant misstatements.
- **Understanding Subject Matter and Circumstances**
  - Inquiries should be made about the following:
    - Any known misstatements or non-compliance with laws and regulations.
    - The existence and findings of an internal audit function concerning the subject matter.
    - Use of experts in preparing the subject matter information.

Assurance Report

- The assurance report must be written and clearly state the practitioner's conclusion regarding the subject matter information.
- The practitioner's conclusion should be distinctly separated from any additional information or explanations that do not influence the conclusion. This includes Emphasis of Matter, Other Matter, specific findings, recommendations, or any extra details provided in the report.
- The language used in the report should clarify that any Emphasis of Matter, Other Matter, findings, recommendations, or added information does not undermine the validity of the practitioner's conclusion.

SSAE 3000

The Institute of Chartered Accountants of India (ICAI), through the Sustainability Reporting Standards Board (SRSB) issued the Standard on Sustainability Assurance Engagements (SSAE) 3000, Assurance Engagements on Sustainability Information (the standard). SSAE 3000 refers to ISAE 3000, issued by the IAASB, and offers guidance for both limited and reasonable assurance, depending on the specific engagement type. It outlines comprehensive requirements that practitioners must adhere to when providing assurance on sustainability information. The standard elucidates the overall criteria for conducting assurance engagements on sustainability information, ensuring clarity and guidance for practitioners based on the nature of the engagement, whether it requires limited or reasonable assurance.

Scope:

SSAE 3000 outlines standards for sustainability assurance engagements, specifically focusing on an entity's sustainability information. It is a comprehensive framework that applies universally to all assurance engagements concerning sustainability information. While it aligns with the "Framework for Assurance Engagements" issued by ICAI, if any conflicts arise between SSAE 3000 and the framework, SSAE 3000 takes precedence. When a specific assurance standard, such as SAE 3410 for GHG emissions, is applicable, SSAE 3000 supplements it.

Importantly, if engagements are subject to laws or regulations, SSAE 3000 does not override them. In cases of conflict between laws/regulations and the standard, compliance with laws/regulations takes precedence. The practitioner can claim compliance with SSAE 3000 alongside laws/regulations only if all SSAE 3000 requirements are met. The document clarifies that not all practitioner engagements are assurance engagements; other types, like those covered by Standards on Related Services (SRS) or consulting engagements, have their standards and are distinct from SSAE 3000. Overall, SSAE 3000 serves as a comprehensive guide for sustainability assurance engagements, emphasizing compliance with applicable standards and acknowledging the diversity of practitioner engagements.

An assurance engagement may be either an attestation engagement or a direct reporting engagement. SSAE 3000 deals solely with attestation engagements.

Objectives

1. Obtain reasonable or limited assurance on the subject matter information to determine its freedom from material misstatement.
2. Express a conclusion in a written report, conveying either reasonable or limited assurance on the outcome of the measurement or evaluation of the underlying subject matter, and describe the basis for the conclusion.
3. Communicate additional information as required by SSAE and any other relevant SSAEs.

Additional Requirement: If reasonable or limited assurance cannot be achieved, and a qualified conclusion is insufficient for reporting to intended users, the practitioner is mandated by this SSAE to either disclaim a conclusion or withdraw/ resign from the engagement, where withdrawal is possible under applicable law or regulation.

Requirements

Conduct of an Assurance Engagement in accordance with SSAEs

- **Understanding SSAE**
  - Comprehensive understanding of SSAE text, including application and explanatory material, to grasp objectives and apply requirements appropriately.
- **Compliance with Requirements**
  - Strict adherence to all SSAE and subject matter-specific requirements.
  - Identification of limited (L) or reasonable (R) assurance labels for tailored application.
  - Rare deviations in exceptional situations with alternative procedures if requirements prove ineffective.
- **Level of Assurance**
  - There are two main levels of assurance engagements, and they differ primarily in the scope and depth of the assessment:
- **Reasonable Assurance**
  - In a reasonable assurance engagement, the practitioner minimises the risk to a low level as a basis for the practitioner's conclusion. It is done by providing a conclusion based on their opinion regarding the evaluated outcome against set criteria.
- **Limited Assurance**
  - In a limited assurance engagement, the risk is higher than in a reasonable assurance engagement, to an acceptable level in the given terms of engagement. The practitioner conducts procedures to achieve a level of assurance as per the practitioner's professional judgement.
- **Ethics and Independence**

- Confirmation of adherence to ethical and professional standards before accepting or continuing engagements.

- **Engagement Acceptance and Continuance**
  - Verification of proper procedures for client relationships and assurance engagements by the engagement partner.
  - Prompt notification of information that could impact engagement acceptance decisions.
- **Preconditions to Engagement Acceptance**
  - Thorough assessment of preconditions' presence, evaluating roles, responsibilities, and engagement characteristics.
  - Non-presence discussion with engaging party, withholding acceptance unless legally mandated.
  - Non-compliance results in refraining from referencing SSAE compliance in the assurance report.
- **Limitation on Scope**
  - Non-acceptance of engagement unless legally mandated, if the engaging party limits the scope in a way leading to disclaiming a conclusion.
- **Agreement on Terms**
  - Agreement on engagement terms, specified in detail in written form, covering objectives, scope, responsibilities, applicable criteria, and entity's agreement to provide written representations.
- **Acceptance of Change in Terms**
  - Non-consent to modifications without valid reasons, with a prohibition on ignoring previously gathered data if changes are made.
- **Assurance Report Compliance with Law or Regulation**
  - Evaluation of potential misunderstanding by intended users of assurance conclusion.
  - Mitigation of possible misunderstanding through additional explanation in the assurance report.

Understanding the Underlying Subject Matter and Other Engagement Circumstances

The reporting on non-financial information involves a combination of quantitative and qualitative factors. The standard emphasizes that the identified underlying subject matter, as designated by management, should possess two crucial characteristics. Firstly, it should be measurable or evaluable against relevant criteria. Secondly, it should be subject to procedures allowing the gathering of information necessary for supporting the assurance conclusion, involving verification of systems and procedures through discussions with personnel.

Furthermore, the practitioner must engage with relevant parties, including functional or department heads and supervisors, to ascertain any knowledge of intentional misstatements affecting the subject matter information. Additionally, inquiries should be made about the existence and activities of an internal audit function and whether the responsible party engaged experts in preparing the subject matter information.

Materiality

The standard underscores that the practitioner must assess an appropriate materiality threshold when planning and executing assurance engagements. This involves determining the procedures' nature, timing, and extent, along with evaluating the subject matter information for freedom from material misstatement. To establish the materiality threshold, various quantitative and qualitative factors should be considered. These factors encompass the number of individuals or entities impacted by the underlying subject matter, the characteristics of the adopted presentation for subject matter information (especially when criteria allow presentation variations), and the deviation from an identified threshold or benchmark value in the procedure's outcome. This holistic approach ensures a comprehensive consideration of elements that may influence the determination of materiality in the context of the assurance engagement.

Reporting

Following the assessment of gathered evidence and the derived conclusion, the practitioner is required to draft a written assurance report. This report must distinctly articulate the practitioner's conclusion regarding the subject matter information. SSAE 3000 specifies essential elements for inclusion in the assurance report, encompassing details such as the underlying subject matter, applicable criteria, procedures undertaken, and a description of inherent limitations linked to the engagement. To facilitate reference, the standard also provides an illustrative format for both limited and reasonable assurance reports. Importantly, the assurance report is mandated to carry a date not preceding the day on which the practitioner acquires the evidence forming the basis of their conclusion. This temporal alignment ensures that the report accurately reflects the most recent and relevant information, maintaining the integrity and contemporaneity of the assurance process.

Annexure F: Testing and Calibration of Instruments

National Physical Laboratory (NPL)

The Central Pollution Control Board in India has provided technical calibration and performance evaluation guidelines. However, the Council of Scientific and Industrial Research-National Physical Laboratory (CSIR-NPL) has been appointed by the Ministry of Environment, Forest and Climate Change (MoEFCC) as the national body for certification of instruments and equipments used in air emissions monitoring.

Previously, instruments were imported with certification issued by agencies such as EPA, Technischer Überwachungsverein (TUV), and Monitoring Certification Scheme (MCERTS). CSIR-NPL shall prove to be instrumental in optimizing equipment performance for Indian conditions and encourage domestic manufacturing of instruments. CSIR-NPL has launched the CSIR-NPL India Certificate Scheme (NPLI CS) for the performance certification of air pollution monitoring equipment. To support this initiative, CSIR-NPL, with MoEF&CC's financial assistance, has set up up the 'National Environmental Standard Laboratory'. This facility will be a state-of-the-art lab dedicated to testing and calibrating air pollution monitoring equipments. ISO 11255 is an internationally recognised standard considered for accreditation of most stack emission measurement requirements.

Certification process for instruments is carried out at Centre for Calibration & Testing (CFCT). The detailed process is described below.

(https://www.nplindia.org/index.php/commercial-services/calibration-testing/)

Step 1: Requesting a Calibration/Testing Quote

- Initiate the process by sending details of your requirements for calibration/testing. This should include the name of the equipment, parameters (e.g., pollutants to be measured), range, and desired accuracy. Send this information via email to cfct@nplindia.org, via Post or through the official website at nplindia.org under the "Calibration and Testing" section.

Step 2: Payment Process

- Upon receiving a quote, prepare a Demand Draft (DD) for the exact amount in favour of the "Director, National Physical Laboratory" and payable at "New Delhi".
- Retain a copy of the DD and the quotation for your records.

Step 3: Submission of Documents and Payment

- Along with the DD, prepare a CTR (Calibration/Test Request) form, an authorization letter on your company/institute's letterhead, and a copy of the NPL quotation.
- Send these documents to The Head CFCT, CSIR-National Physical Laboratory, Dr. K.S. Krishnan Marg, New Delhi-110012. Specify the type of booking: Normal, Express, Time Slot, or Site Calibration.
- If you have not received a formal quote, describe where you found the calibration/test charges (e.g., website link).

Step 4: Booking and Slot Allocation

- Once your request is processed, NPL's CFCT will book a slot for your calibration/testing job and inform you of the submission date and the expected completion date (EDC). A unique case number will be provided for future correspondence.

Step 5: Equipment Submission

- Bring your equipment to NPL for calibration/testing as per the scheduled date.

Step 6: Job Completion

- After the EDC, reach out to CFCT via email, telephone, or post to confirm the completion of your job.

Step 7: Collection of Equipment and Certificates

- Upon receiving confirmation of job completion, collect your equipment and the accompanying certificates/test reports from NPL.
- The individual collecting the equipment should carry an identity proof (preferably issued by the company) and an authorisation letter from the company.

Note: Additional Information

- **Public Dealing Hours:** Ensure compliance with NPL's public dealing time from 10:00 AM to 04:00 PM on all working days.
- **Courier Submissions:** Small items eligible for courier submission must be accompanied by full payment and the unique case number. Schedule courier deliveries must arrive around the expected submission date.
- **Calibration/Test Charges Information**
  - To find detailed charges, visit the NPL website, navigate to "Calibration & Testing" and then to "Calibration & Testing Charges".
  - Select the relevant calibration or test area to view specific charges for your equipment parameters.

Annexure G: Laboratory Analysis of Samples

National Accreditation Board for Testing and Calibration Laboratories (NABL)

Various industries opt for independent labs for stack emissions monitoring. In order to ensure credibility to

the results of the monitored emissions, verification and certification plays a critical role. Accreditation of testing laboratories ensure validity, traceability and comparability of the results. National Accreditation Board for Testing and Calibration Laboratories (NABL) is the accrediting body in India and has scoped stack emissions monitoring under the category of Chemical – Atmospheric Pollution for various pollutants.

The National Accreditation Board for Testing and Calibration Laboratories (NABL) is an independent entity operating under the Department of Science & Technology, Government of India, and is registered under the Societies Act. It adheres to a worldwide accreditation framework led by two organizations, namely, the International Laboratory Accreditation Committee (ILAC) and the International Accreditation Forum (IAF), operating under a Mutual Recognition Arrangement (MRA). The National Accreditation Board for Testing and Calibration Laboratories (NABL) is the organization that holds membership with APLAC (Asia Pacific Laboratory Accreditation Cooperation) and is responsible for accrediting all laboratories. NABL assesses and provides certificate of accreditation as per ISO/IEC 17025:2017.

Accreditation process for laboratories is given in detail below.

*Optional for laboratories (Testing/Calibration/Medical Testing)

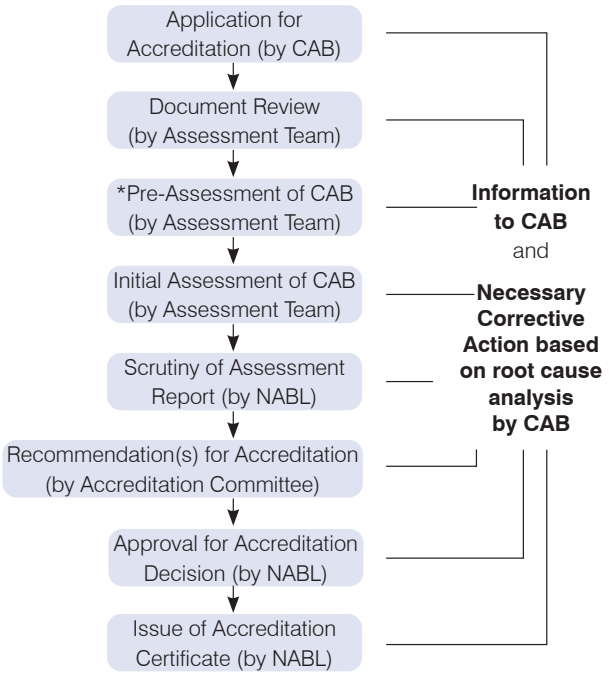

Figure 5: Accreditation Process

Preparing for accreditation

- **Develop a Clear Plan:** Create a specific action plan outlining the steps for securing accreditation.
- **Appoint a Coordinator:** Designate an individual responsible for managing all accreditation-related activities.
- **Ensure Familiarity with Existing Systems:** The appointed coordinator should have a thorough understanding of the laboratory's current quality management system.
- **Direct Interaction with NABL:** The laboratory should communicate directly with NABL, as the organisation does not work with external consultants or advisors.
- **Acquaintance with NABL Requirements:** The laboratory must familiarize itself with pertinent NABL documents, grasp the assessment process, and learn the procedure for completing the online application.

Eligibility for accreditation

- **Adhere to ISO Standards:** Comply with all clauses of the ISO/IEC 17025:2017 standard.
- **Follow NABL Specific Criteria:** Where relevant, meet the specific criteria set out by NABL.
- **Participate in Proficiency Testing:** Engage in a proficiency testing program run by an accredited or applicant PT provider prior to applying.
- **Conduct Internal Audits and Management Review:** Complete at least one internal audit of all activities and locations, and perform a management review that covers all required agenda points before applying to NABL.

Step 1: Laboratory Application

- The laboratory needs to submit an application to NABL using the specified format for testing (format 151) and calibration (format 152) along with the quality manuals.
- The submitted application is checked for completeness for the relevant accreditation.

Step 2: Nomination of Lead Assessor

- NABL assigns a Lead Assessor who reviews the application and quality manuals for adequacy and completeness.

Step 3: Adequacy Report

- A pre-assessment report is prepared by the Lead Assessor which is submitted to the NABL Secretariat.
- The Lead Assessor creates an Adequacy Report which is sent to the laboratory for any necessary corrective actions for compliance.
- The laboratory implements corrective measures suggested and submits a Corrective Action Report to NABL.

Step 5: Pre-assessment Audit

- The lead assessor also forms an assessment team which carries out the pre-assessment visit to the laboratory to note the non-conformities in the implementation of quality system and degree of preparedness.
- The pre-assessment audit at the laboratory site also estimates the man-days required for the final assessment.
- A pre-assessment report is given to the laboratory for corrective actions and further the lab needs to submit a Corrective Action Report to NABL.

Step 6: Final Assessment

- NABL appoints an Assessment Team comprising the Lead Assessor and Technical Assessors/Experts covering the relevant fields within the laboratory's scope. The team conducts a thorough review of the laboratory's management system, compliance, and technical competence.
- The Lead Assessor submits a consolidated report to NABL, which also includes recommendations for accreditation based on the findings.

Step 7: Accreditation Committee Review

- NABL's Accreditation Committee examines the assessment report and recommends corrective measures as required.
- Further, if the laboratory has satisfactorily addressed all the non-conformities, it recommends accreditation.

Step 9: Grant of Accreditation

- Upon recommendation by the Accreditation Committee, NABL issues an accreditation certificate to the laboratory, which remains valid for two years.

Additional Note

- NABL conducts annual surveillance audits to ensure the laboratory maintains compliance with the accreditation standards. A reassessment of the laboratory is carried out every two years. For continued accreditation, the laboratory must apply 6 months prior to the expiry of the current accreditation to maintain uninterrupted accreditation status.
- NABL certification is provided to all types of testing and calibration labs, which also include environmental labs, both nationally and internationally, without any regard to their ownership, legal status, size, or level of autonomy.

For instruments: National Physical Library (NPL)

National Physical Laboratory (NPL), which is governed by the Council of Scientific and Industrial Research (CSIR) will become the national verification and certification agency for the instruments and equipment used for air emission monitoring and ambient air quality monitoring.

The CSIR-National Physical Laboratory (CSIR-NPL), New Delhi is the National Metrology Institute (NMI) of India, member of the "Metre Convention" and of the Asia-Pacific Metrology Programme (APMP). India is also a signatory of International Bureau of Weights & Measures (BIPM) and Mutual Recognition Arrangement (CIPM-MRA). CSIR-NPL has responsibility for maintaining the National Standards of Measurements, traceability of measurement through Bilateral/International key comparisons and the Quality System as per ISO/IEC 17025:2017 and ISO 17034:2016. Centre for Calibration & Testing (CFCT) Section has been established at CSIR-NPL, New Delhi to promote calibration and testing of the laboratory. It acts as an interface between all the calibrating & testing groups of CSIR-NPL with nearly 4200 customers from industries, various laboratories and government organisations from all over the country and abroad.

References

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About EMC:

We are a strategic management consulting company established by Dr Prasad Modak in 1996 in Mumbai, India. Over the past 28 years, we have positioned ourselves as a niche player in environmental management consulting across the globe.

We work 'glocally' as we blend our global experience with the local context to provide solutions that are contemporary and future-ready.

EMC's consultancy services are essentially strategic, knowledge-driven and supported through research and training. In all the consulting assignments, EMC's expertise lies in harmonizing economic, environmental, and social considerations in business development plans and policy frameworks.

About CII:

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to India's development, partnering Industry, Government, and civil society through working closely with Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness and business opportunities for industry.

For over 125 years, CII has been working on shaping India's development journey and, it will continue to transform the Indian industry's engagement in national development proactively. The premier business association has more than 9100 members from the private and public sectors and an indirect membership of over 300,000 enterprises from around 288 national and regional sectoral industry bodies.

With 68 offices, including 9 Centres of Excellence in India, and 11 overseas offices in Australia, China, Egypt, France, Germany, Indonesia, Singapore, South Africa, UAE, UK, and the USA, as well as institutional partnerships with 394 counterpart organisations in 133 countries, CII serves as a reference point for Indian industry and the international business community.

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