

Air Pollution Control

Strategies	2030 Goals	2026 Targets	2025 Achievements
Adopt Best Available Technology Adopt the Best Available Technology to control pollutants emitted from TSMC operations and minimize environmental impact	Reduce air pollution composite indicator by >90%[Note 1]	Reduce air pollution composite indicator by >85%	Reduced unit air pollutant emissions[Note 2] by 58% ✓ Target: 58%
	Reduction rate of volatile organic gases: >99%	Reduction rate of volatile organic gases: >98.7%	Reduction rate of volatile organic gases: 98.9% ↑ Target: >98.6%
Strengthen Monitoring for Air Pollution Control Equipment Leverage backup systems and dual-track management, along with pollutant monitors, to ensure that the equipment works as intended and to prevent abnormalities	Report <1 abnormal occurrence[Note 3] in air pollution control equipment	Report <1 abnormal occurrence in air pollution control equipment	Reported 0 abnormal occurrences in air pollution control equipment ✓ Target: <1

Applicable to all TSMC fabs around the world | Applicable to TSMC fabs in Taiwan and other specific fabs | Only applicable to TSMC fabs in Taiwan | Applicable to TSMC overseas fabs | ↑ Exceeded | ✓ Achieved | — Missed Target

Note 1: To strengthen air quality management and environmental resilience, TSMC adopted the ">90% reduction rate in air pollution composite indicator " target in 2025, replacing the previous target of "65% reduction in unit air pollutant emissions" to more effectively measure pollution control performance. The composite indicator covers eight air pollutants: total hydrocarbons (THC), sulfuric acid (H_2SO_4), hydrochloric acid (HCl), nitric acid (HNO_3), hydrofluoric acid (HF), phosphoric acid (H_3PO_4), chlorine (Cl_2), and ammonia (NH_3). The reduction rate is calculated by taking the emission control concentration for each pollutant in new processes as stipulated by the "Air Pollution Control Act" (including draft amendments) as the baseline, subtracting TSMC's actual emission concentration, and then dividing by the aforementioned control concentration to obtain the average value.

Note 2: Unit air pollutant emissions are calculated by dividing the air pollutant amount (grams) by the 12-inch wafer equivalent (with 2015 as the base year).

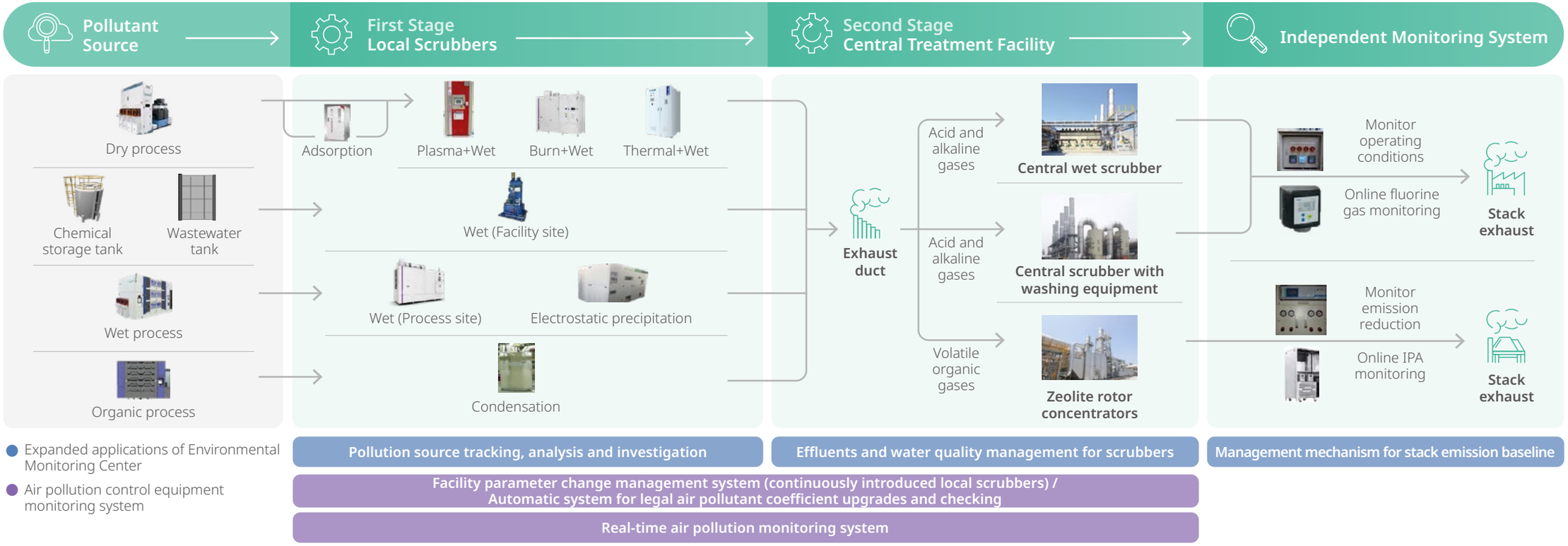
Note 3: Abnormalities in air pollution control equipment indicate abnormal air pollution caused by malfunctioning equipment with no backup that could not be repaired in 24 hours, or equipment that ceased functioning.

TSMC drives air pollution reduction through source segregation and multi-stage treatment technologies, minimizing pollutant emissions. In 2025, the volatile organic compounds (VOC) reduction rate reached 98.9%, reflecting strong environmental management performance. The Environmental Monitoring Center expanded its scope of services by adding 11 new testing items and obtained ISO/IEC 17025 accreditation — the international standard for laboratory competence and quality — enhancing the accuracy and credibility of testing data and supporting environmental sustainability.

Adopt Best Available Technology

Acid and alkaline gases and VOCs are the primary air pollutants generated during semiconductor manufacturing. TSMC addresses these issues through two approaches: segregation and reduction at the exhaust source, and enhanced processing at terminal-end equipment, applying multi-stage treatment systems to achieve best available technology standards. For high-concentration acid and alkaline gases, as well as greenhouse gases with toxic, corrosive, or flammable properties, first-stage segregation directs exhaust to high-performance local scrubbers for pre-treatment, after which residual trace acid/alkaline gases are conveyed to central scrubbers for second-stage wet scrubbing and neutralization. VOCs are evaluated based on boiling point to determine the need for condensation-type local scrubbers; treated exhaust is then routed to zeolite rotor concentrators for adsorption, effectively cutting emissions.

Air Pollution Control Procedures



Different Types of Local Scrubbers

Process	Semiconductor Fabrication	Target Pollutant	Control Technologies	Equipment	Reduction Rate	Real-time Parameter Monitoring
Dry process	Epitaxial dry etching	Corrosive gases	Burn-wet		>99%	• Natural gas flow • Oxygen flow • Circulating water flow • Inlet pressure
		Perfluorocarbons	Burn-wet			
	Dry etching	Corrosive gases Perfluorocarbons Flammable gases	Plasma-wet		>95%	• Current amperage • Circulating water flow • Inlet pressure
	Thin film Diffusion Sputtering	Corrosive gases Perfluorocarbons Flammable gases	Thermal-wet with chemical dosing		>95%	• Reactor temperature • Circulating water flow • pH value • Inlet pressure
		Hydrochloric acids Particulate matters	Thermal-wet with chemical dosing (Add high-efficiency spray device)		Hydrochloric acids >87% Particulate matters >86%	
	Ion implantation sputtering epitaxy	Toxic gases	Adsorption		>95%	• Pressure difference of local scrubber • Inlet pressure
	Thin film	Nitrous oxide (N_2O)	High-temperature thermal+wet		>90%	• Reactor temperature • Circulating water flow • Inlet pressure
Wet process	Wet etching	Corrosive gases Organic gases	Wet + chemical dosage		>95%	• Differential pressure of local scrubber • Circulating water flow • Inlet pressure • pH value
		Alkaline gases $PM_{2.5}$	Wet electrostatic precipitation		>90%	• Inlet pressure • Corona voltage • Corona current
Organic process	PR stripping	High boiling point organics	Condensation		Specific high boiling point organics >95%	• Differential pressure of local scrubber • Condensation temperature
Storage tanks	Chemical Storage tank Wastewater tanks	Corrosive gases Acid and alkaline gases	Wet + chemical dosage (Facility site)		>95%	• Differential pressure of local scrubber • pH value • Circulating water flow • Inlet pressure

Source Reduction and Management - High Efficiency Local Scrubbers

To prevent air pollution risks arising from new processes and chemicals, TSMC operates a two-stage review mechanism through its New Tool and New Chemical Review Committee to ensure comprehensive control and minimize environmental impacts. In 2025, the Committee completed 330 reviews, including 160 new tools and 170 new chemical evaluations. The first-stage review focuses on assessing risks associated with new chemicals and establishing corresponding control measures. The second-stage review evaluates potential environmental impacts of emission testing results to determine the most appropriate exhaust segregation strategy and local scrubbers. Pre-treatment technologies include electrothermal, combustion, plasma, chemical scrubbing, adsorption, condensation, and wet scrubbing systems.

In 2025, TSMC adopted a nitrous oxide (N_2O) reduction technology that passed both the SEMI S2 Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment and the TSMC New Tool and New Chemical Review Committee review in 2024. It was deployed at Fab 12A, Fab 12B, Fab 14A, Fab 14B, Fab 15A, and Fab 15B. The Company plans to complete the retrofit or replacement of electric-heating local scrubbers throughout all existing fabs by 2028, with the aim of further improving abatement efficiency and enhancing overall emission control performance.

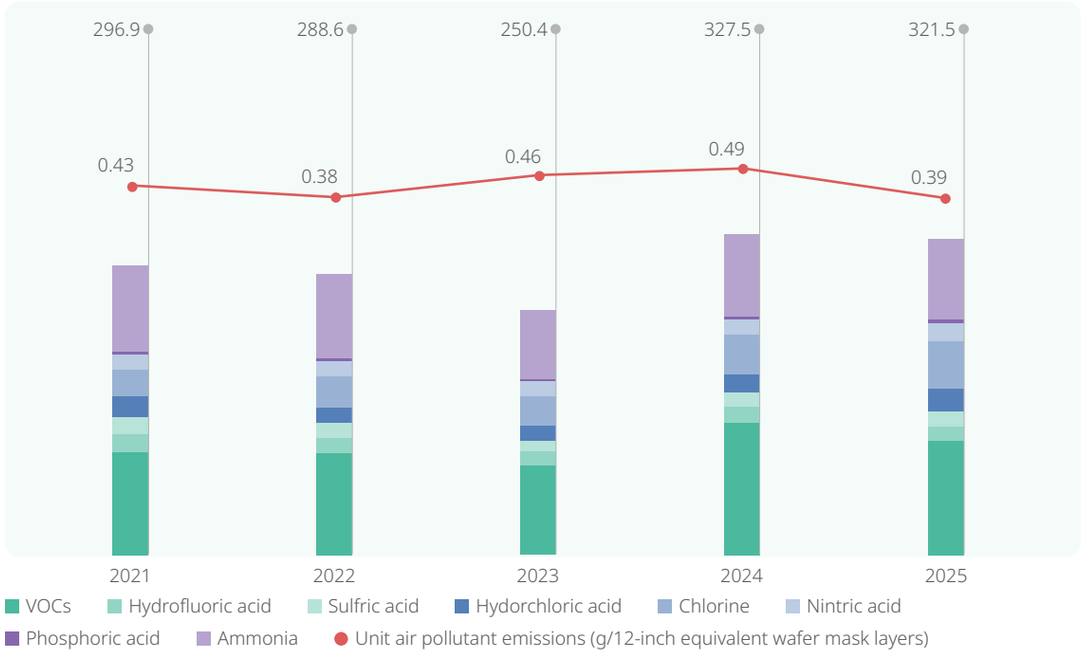
Strengthening Management of Terminal Prevention Facilities - Central Scrubbers

Acid and alkaline gases are first treated by local scrubbers and then routed to central scrubbers for wet scrubbing and acid–base neutralization. For wet processes, which generate relatively higher volumes of acid and alkaline gases, a centralized scrubber system combined with water-wash equipment is applied through a two-stage scrubbing process to enhance pollutant removal efficiency. For VOC treatment, existing fabs continue to execute the "Replacement Program for Inefficient Single Zeolite Rotor Concentrators," and new fabs adopt dual zeolite rotor concentration systems. In 2025, advanced backend fabs further improved VOC removal performance by optimizing zeolite rotor material selection to enhance methanol adsorption capacity.

To address potential secondary nitrogen oxide (NOx) emissions arising from high-temperature combustion of VOC-concentrated exhaust from zeolite rotor systems, low-NOx burners were deployed at newly built facilities in 2025, including Fab 20 Phase 2, Advanced Backend Fab 7, and Advanced Backend Fab 8. These systems utilize low-oxygen combustion and flow field control technologies to reduce NOx emissions. The VOC reduction rate reached 98.9% in 2025.

Historical Emissions and Emissions Per Unit of Production

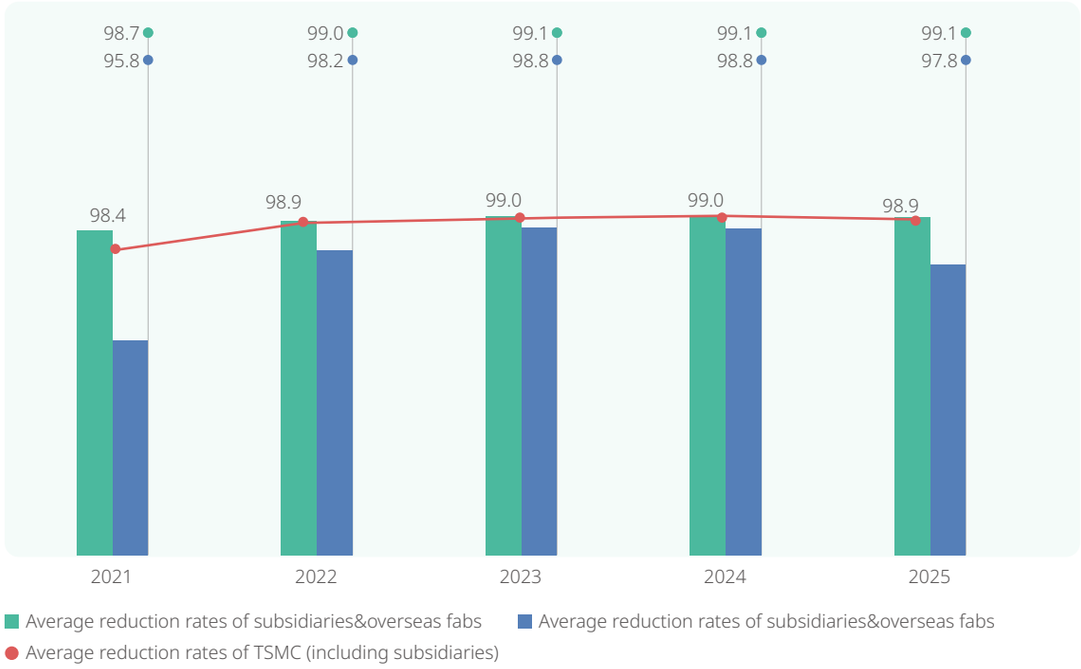
Unit: Tons/year



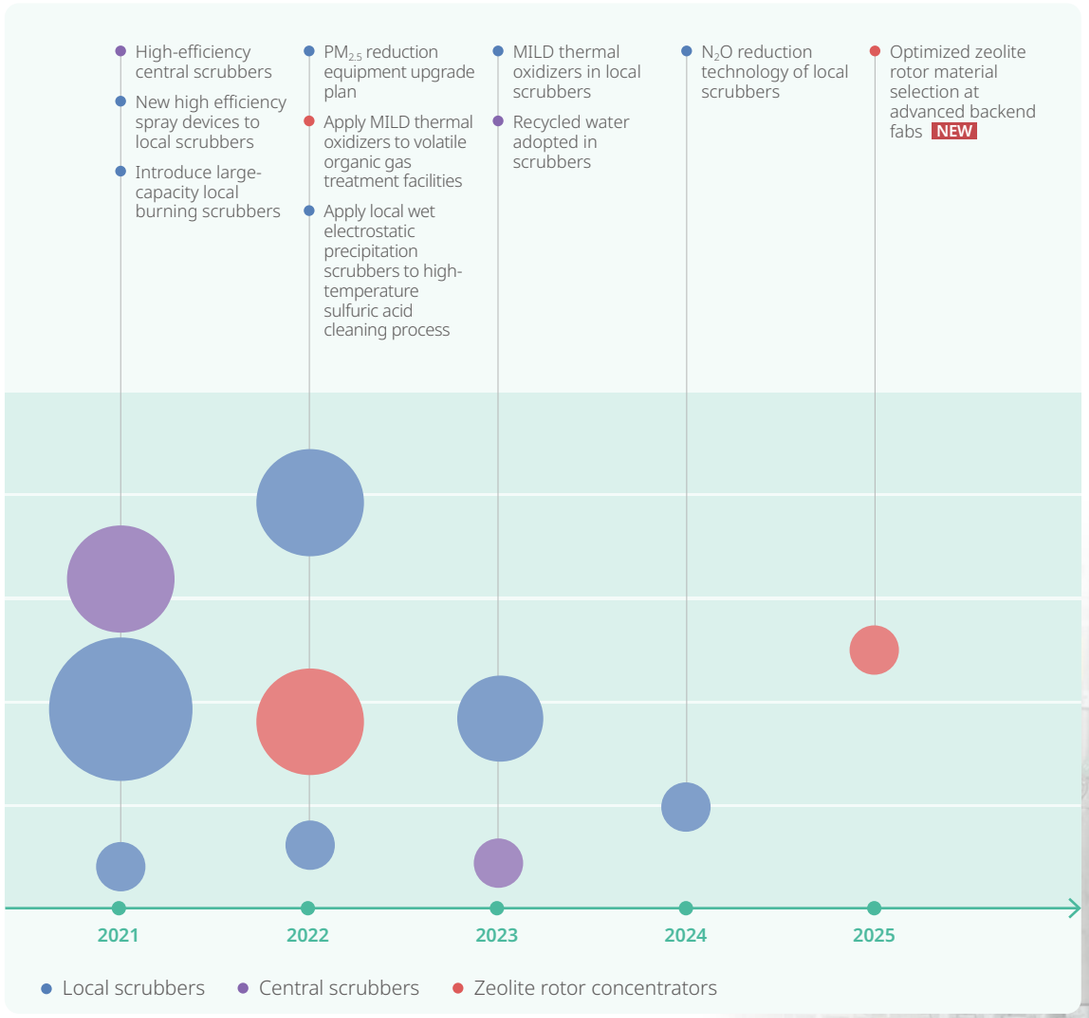
Note: TSMC air pollutant emissions are reported in accordance with local laws and regulations.

Historical Volatile Organic Gas Reduction Rates

Unit: %



Historical Assessment of Air Pollution Control Technology and Reduction Performance



Note: Size of the bubble indicates the technology's reduction efficiency.

Enhanced Monitoring of Air Pollution Prevention Equipment

TSMC continues to improve the stability and monitoring capability of its air pollution control systems by installing automated monitoring instruments across emission stacks, including total hydrocarbon monitors and online monitoring systems for isopropanol and fluorine gas, to verify monitoring data against actual emissions. The Company leverages the "Automated Verification System for Air Pollution Reporting Legal Coefficients," the "Facility Parameter Change Management System," and the "Facility Monitoring and Data Collection System" to track operating parameters of local scrubbers, while using automated cross-checking and verification functions to ensure reporting accuracy and prevent data loss or errors caused by human factors.

In response to advances in process technology and fab expansion needs, TSMC continued the 2024 upgrade of its Facility Parameter Change Management System in 2025, incorporating key control parameters of local scrubbers into the change management scope at newly built Fab 20 Phase 2, Advanced Backend Fab 7, and Advanced Backend Fab 8, ensuring stable operation of air pollution control equipment.

To maintain the stable operation of air pollution control systems, TSMC adopts an "N+1" model with backup systems, monitoring mechanisms, and alarm functions for abnormal conditions. In the event of equipment failure, the Facility Department and Industrial Safety and Environmental Departments can immediately activate backup units or initiate emergency repairs, supported by uninterruptible power supply (UPS) systems to minimize operational risk, achieving the zero-failure target for pollution control systems. In 2025, no abnormal events involving air pollution control equipment occurred, and no penalties or fines were incurred due to non-compliance with air pollution regulations.



Enhancing the Functional Capabilities of the Environmental Monitoring Center

Through sampling and analytical techniques, TSMC's Environmental Monitoring Center helps fabs identify optimal treatment methods for target pollutants, strengthening overall pollution control performance. In 2025, the Center further expanded its testing scope by adding fluorinated greenhouse gas analysis for air emissions, as well as fluoride salts and ammonia nitrogen testing for effluent. In the waste recycling domain, it developed eight analytical methods for sludge and waste organic solvent testing. Sludge analyses include moisture content, calcium fluoride and calcium carbonate in fluoride sludge, calcium fluoride in silicon-containing sludge, volatile solids, and elemental composition, while waste organic solvent testing includes moisture content and organic acid–base value analysis.

Beyond technical advancements, the Environmental Monitoring Center further strengthened the independent sampling and analytical capabilities of related personnel. In 2025, three workshops were conducted with a total of 39 participants, completing 96 hours of hands-on training in acid, alkaline, and heavy metal sampling, as well as data interpretation. These initiatives enhance air pollution abatement efficiency and create value for environmental protection.

Four Key Applications of the Environmental Monitoring Center

Air Emissions
- Emission stack management system
- Traceability investigation
- Air pollution data digitalization and anomaly tracking
- $PM_{2.5}$ testing
- Self-sampling training
- Fluorinated greenhouse gas and nitrogen oxide testing NEW

Effluents
- Effluent and scrubber water quality management system
- Water pollution data digitalization and anomaly tracking
- Total phosphorus and NO_3-N testing
- Fluoride salt and ammonia nitrogen testing NEW



Surrounding Area
- Monitor surrounding areas with air quality vehicles
- Set up fixed testing stations at Zhunan, CTSP, and Tainan Science Park
- Organic photochemical precursor testing

Waste Recycling
- Sludge testing
- Waste organic solvent testing NEW

Case Study

Advance ISO/IEC 17025 Accreditation to Enhance Testing Capabilities

To improve environmental emissions management, TSMC's Environmental Monitoring Center enhances monitoring and control of pollutants in emission sources. Based on fab requirements, sampling and analysis are conducted for volatile organic compounds, acids, and alkaline substances to accurately identify pollutant types and enable source tracing, improving the efficiency and coverage of abatement systems. To ensure data accuracy, consistency, and reliability, TSMC established a laboratory quality management system compliant with ISO/IEC 17025 international standards, providing comprehensive control over personnel, facilities and environments, equipment traceability and calibration, and analytical technical processes. The Center conducts regular sample comparisons with the National Environmental Research Academy (NERA) accredited laboratories and maintains comprehensive documentation of testing processes to support traceability and technical improvement.

Following the ISO/IEC 17025 international accreditation obtained by the Facility Environmental Laboratory at TSMC (Nanjing), TSMC's Environmental Monitoring Center and Facility Diagnostic and Analysis Center in Taiwan was also successfully accredited in 2025. TSMC will continue to promote its in-house testing mechanisms and standardized practices across additional fabs, while providing technical support to further enhance environmental monitoring capabilities throughout its global operations.



The Environmental Monitoring Center passes ISO/IEC 17025 accreditation.