GREAT HARDWARE

CleanAir™ Industrial Filtration Unit

MAINTENANCE MANUAL

31S-GH00-XX21

September 2025

The technical content of this document has been reviewed and approved under the authority of the CleanAir™ **Engineering Design Authority** in compliance with applicable international standards, including **ISO 9001 (Quality Management Systems)** and **ISO 14644 (Cleanroom and Controlled Environments)**.

Reference: **CEA.ENG.2025.041**

CleanAir™ Industrial Filtration Unit 31S-GH00-XX21

September 2025

The following icons are used throughout this manual to highlight important information. Familiarize yourself with their meanings before proceeding with installation or commissioning.

Icon	Explanation
	Information: Provides general details or background to help you understand a maintenance step, feature, or specification. This content is not safety-critical but can improve efficiency and comprehension.
	Warning: Indicates a potential hazard that could cause personal injury, equipment damage, or process interruption if instructions are not followed correctly. Always exercise caution when this symbol appears.
	Danger: Highlights a serious hazard that can result in severe injury or major equipment damage if ignored. These instructions are mandatory and must be strictly observed at all times.
	Tip: Offers helpful advice, recommended practices, or shortcuts to improve safety, reliability, and efficiency during maintenance.
	Note: Draws attention to specific details, exceptions, or references that are important for completing the procedure correctly.

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1. Introduction

The CleanAir™ family of industrial air filtration and HVAC systems are designed for demanding environments such as manufacturing floors, laboratory cleanrooms, and healthcare facilities. Reliable operation requires **periodic inspection, cleaning, and replacement** of key components.

This Maintenance Manual provides:

- A structured **preventive maintenance schedule**.
- Step-by-step **procedures for filter, fan, control, and electrical checks**.
- **Visual figures** to guide technicians.
- A **troubleshooting reference** for common faults.
- Templates for **recording service actions**.

Following the prescribed schedule will extend equipment lifetime, reduce unplanned downtime, and ensure compliance with ISO cleanroom and occupational health standards.

> **Note on Compliance**
> This manual aligns with ISO 14644, OSHA workplace safety guidelines, and standard HVAC preventive maintenance practices. Always verify with your facility's internal SOPs before performing tasks.

2. Safety Guidelines

Maintenance work on CleanAir™ industrial filtration and HVAC systems involves risks that must be properly managed. This section details all safety protocols, protective equipment requirements, and procedures that technicians must follow before, during, and after performing maintenance.

> **Never bypass safety interlocks.** Some units include electrical and airflow interlocks that prevent operation when panels are open. Forcing the system to run in bypass mode is strictly prohibited and may cause injury.

2.1 General Safety Principles

- Only **qualified technicians** trained in HVAC maintenance should perform the tasks described in this manual.
- Always review the latest **User Manual** and facility **Standard Operating Procedures (SOPs)** before starting.
- Maintenance should only be performed in **well-ventilated areas** with sufficient lighting.

Electrical Safety

High Voltage Hazard
The system operates on mains electricity. Contact with live wires can result in severe injury or death.

- Always disconnect the unit from the **main breaker**, not just the local power switch.
- Use a **lockout/tagout (LOTO)** system to prevent accidental reconnection.
- Verify power isolation with a **voltage detector** before handling wires.
- Do not touch electrical components with wet hands or while standing on damp surfaces.
- Replace damaged power cables immediately.
- Ensure all electrical work complies with **IEC/UL electrical standards**.

Mechanical Safety

Rotating and Moving Parts
Fans and moving assemblies can cause injury if touched during operation.

- Allow fans to **fully stop** before opening housings.
- Never insert tools, hands, or cleaning materials near moving parts.
- Replace worn vibration mounts to avoid uncontrolled movement.
- Use correct torque settings when tightening bolts to avoid over-stress and structural failure.

Chemical and Biological Safety

Filters capture contaminants from the air. Depending on the environment, these may include hazardous chemicals, biological agents, or allergens.

- Treat all used filters as **potentially hazardous waste**.
- Wear **respiratory protection (minimum N95, preferably P100 respirator)** when handling filters.
- Double-bag used filters in sealed, labeled bags for disposal according to facility regulations.
- For laboratory and cleanroom applications, follow **ISO 14644** and **OSHA biohazard handling protocols**.

Ergonomics and Lifting

Heavy Component Hazard
Some components exceed 40 kg and pose a lifting risk.

- Always lift with **two persons** or use a mechanical lifting aid (hoist, lift cart).
- Use proper lifting techniques: keep back straight, lift with legs, avoid twisting motions.
- Ensure the work area is clear of obstructions before moving large parts.
- For maintenance at height, use **certified ladders or platforms**.

Fire and Environmental Safety

- Do not perform maintenance near open flames or flammable vapors.
- Ensure the system is placed on a **stable, level surface** free from combustible materials.

- Dispose of filters and worn parts in compliance with **local environmental regulations**.
- Keep a **fire extinguisher** (Class C for electrical fires) accessible during maintenance.

Personal Protective Equipment (PPE)

Always wear the following PPE when servicing CleanAir™ systems:

- **Safety glasses or goggles** to protect against dust and particles.
- **Cut-resistant gloves** when handling filters and sharp metal edges.
- **Respiratory protection** when removing used filters.
- **Protective footwear** with non-slip soles.
- **Hearing protection** if working near operating fans in a noisy environment.

Lockout/Tagout (LOTO) Procedure

Critical Safety Step
LOTO prevents accidental energizing of the unit during service.

1. Identify the main breaker supplying the system.
2. Switch breaker to OFF.
3. Attach a **lockout device** to the breaker handle.
4. Place a **warning tag** with technician's name and date.
5. Verify power isolation using a voltage tester.
6. Proceed with maintenance only after confirmation.

Emergency Procedures

- In case of **electrical shock**, disconnect power immediately and call emergency medical services.
- For **fire**, use a Class C fire extinguisher and evacuate if necessary.
- If **contaminated material spills** during filter replacement, follow facility hazardous material protocols.
- Report all incidents to the **safety officer** for documentation.

3. System Overview

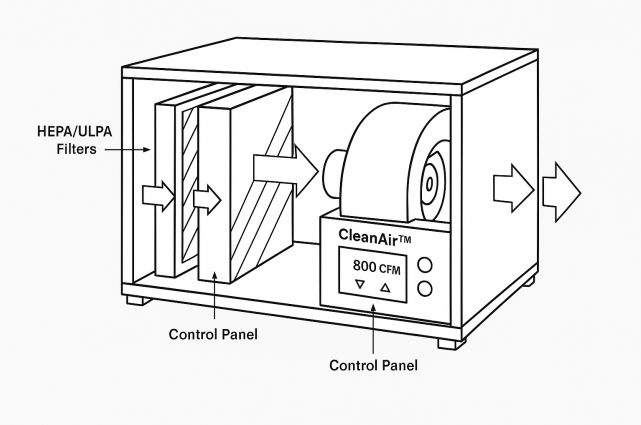
The CleanAir™ system is engineered as an integrated solution for environments that demand precise air quality control. Its modular design allows facilities to adapt capacity and performance to their specific requirements, whether in high-volume manufacturing, sterile laboratory environments, or healthcare facilities requiring constant air purity.

> ⚠ **Critical Components**
> Filters and sensors are precision components. Do not attempt to modify, clean, or alter them in ways not described in this manual. Doing so may compromise filtration performance.

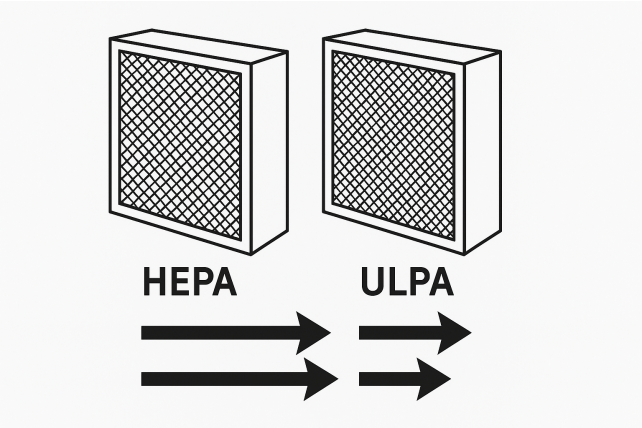
Filtration Modules

At the heart of the system are the **HEPA** (High Efficiency Particulate Air) and **ULPA** (Ultra-Low Penetration Air) filtration units.

- **HEPA Filters** are designed to capture 99.97% of airborne particles as small as 0.3 µm, making them ideal for general industrial applications.
- **ULPA Filters** provide an even higher level of protection, capturing at least 99.999% of particles down to 0.12 µm, essential for cleanrooms, pharmaceutical production, and microelectronics.
- Filters are housed in **sealed cartridges** to prevent bypass leakage and maintain airflow integrity.
- Each filter module includes **pressure drop sensors**, enabling the control panel to issue maintenance alerts when airflow resistance reaches a critical threshold.



System schematic overview

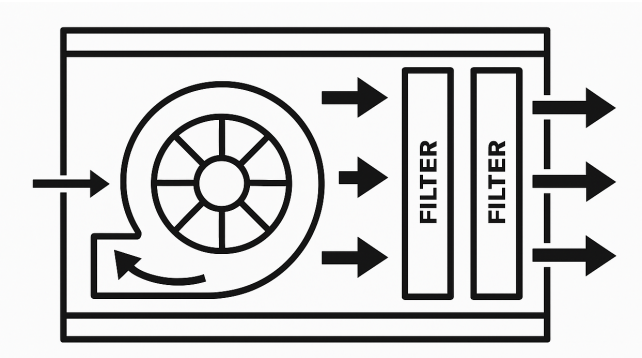


Filter modules detail

Airflow Management

CleanAir™ systems use **low-noise, vibration-isolated fans** to maintain consistent airflow across the filters.

- Fans are mounted on **rubberized vibration dampeners** that absorb mechanical shocks, reducing structural fatigue.
- Airflow channels are optimized to minimize turbulence, ensuring laminar airflow where required.
- Variable-speed operation allows the system to adjust flow rates depending on environmental demands or scheduled cycles.
- A built-in **airflow test function** continuously monitors fan efficiency and alerts operators to abnormal operation.

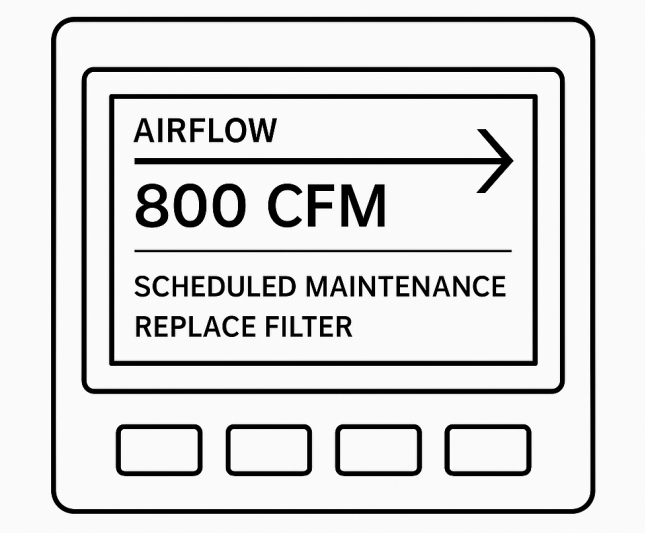


Fan assembly and airflow path

Control Panel and Smart Monitoring

The digital control panel is the system's intelligence hub, ensuring that performance is both efficient and predictable.

- Features a **touch interface** with clear readouts for airflow, filter status, and error codes.
- Integrates with **smart scheduling** software that automatically issues reminders for filter replacement and inspection.
- Capable of remote monitoring and integration with SCADA or building management systems.
- Provides **firmware update capability** to extend features over time.
- Logs operational history, which can be exported for compliance and auditing purposes.

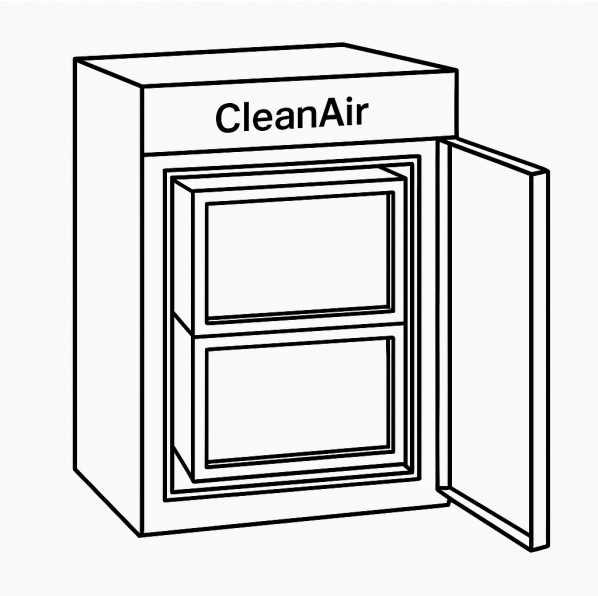


Control panel interface

Housing and Mounting Brackets

The system chassis is designed for **industrial durability** and **ease of maintenance**.

- Constructed from **powder-coated, corrosion-resistant steel** to withstand harsh industrial environments.
- Compact **rack form factor** allows easy integration into existing HVAC infrastructures.
- Quick-release **access panels** allow technicians to reach filters, fans, and wiring without disassembling the entire unit.
- Reinforced **mounting brackets** ensure stability, especially in facilities with vibration or heavy foot traffic.

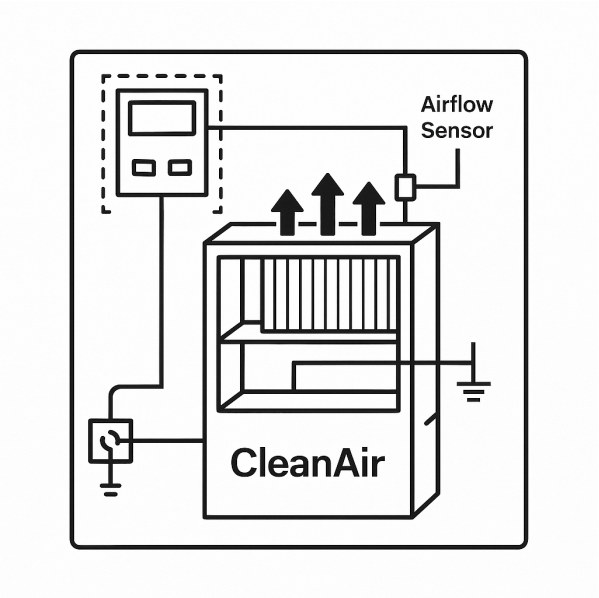


System housing detail

Electrical and Sensor Systems

Electrical integrity and continuous sensor feedback are crucial for maintaining both safety and performance.

- **Power input** supports standard industrial electrical connections with ground fault protection.
- **Wiring harnesses** are color-coded and secured with insulated connectors to minimize human error during servicing.
- Integrated **airflow sensors** continuously track resistance across filters and automatically adjust fan speed.
- Optional **humidity and temperature sensors** can be added to monitor environmental parameters in real-time.

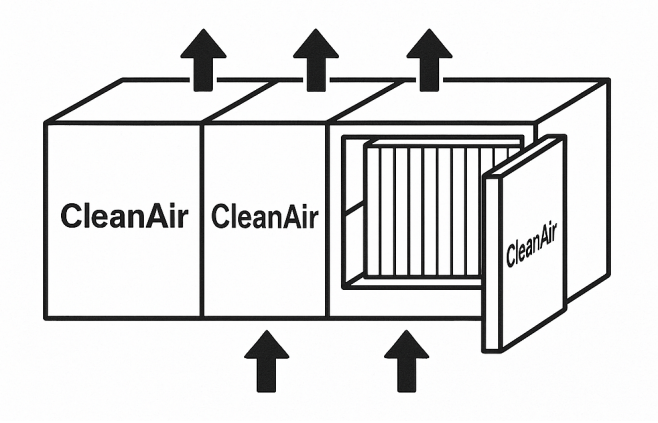


Electrical and sensor overview

Modular Expandability

CleanAir™ systems are built to scale with facility growth.

- Multiple units can be **daisy-chained** to handle higher air volumes.
- Modular racks allow technicians to upgrade from **HEPA-only** to **HEPA + ULPA configurations** without replacing the entire system.
- Software is designed to recognize new modules automatically, adjusting scheduling and monitoring accordingly.



Modular expandability diagram

4. Maintenance Schedule

Preventive maintenance is the foundation of the CleanAir™ system's long-term performance. While the system is designed for durability, every component has a natural service life that must be respected to avoid downtime, degraded filtration, or unsafe operating conditions.

Regular inspections and timely replacements:

- **Extend component lifespan** by detecting early signs of wear.
- **Maintain air quality compliance** in cleanliness-critical environments.
- **Reduce operating costs** by preventing energy waste caused by clogged filters or unbalanced fans.
- **Ensure safety** by monitoring electrical and mechanical integrity before failures occur.

> **Tip for Facilities with High Dust Load**
> In environments such as woodworking shops, pharmaceutical production, or metalworking, filters may clog earlier than expected. Consider halving the intervals listed in the schedule.

The maintenance schedule is organized by **component type** and broken into three levels of action:

- **Inspection** – Routine checks for wear, contamination, or malfunctions.
- **Replacement** – Scheduled renewal of consumables or degraded parts.
- **Notes** – Special considerations, such as environmental conditions, usage intensity, or regulatory requirements.

The schedule is further divided into **time intervals**: every 6 months, 12 months, 18 months, and 24 months. These intervals represent the maximum time between checks or replacements; in high-load facilities, maintenance may be required more frequently.

Find table in next page.

Component	Description	Task	6 months	12 months	18 months	24 months	Notes
HEPA Filter Module	Captures airborne particles ≥0.3 µm	Inspection	**X**	**X**	**X**	**X**	Check for discoloration, clogging, and airflow resistance
		Replacement		**X**			Replace annually or sooner if pressure drop >200 Pa
ULPA Filter Module	Captures particles down to 0.12 µm, used in labs/clean zones	Inspection		**X**	**X**	**X**	Ensure seals are tight, test airflow
		Replacement			**X**		Replace every 18 months
Fan Vibration Mounts	Rubberized mounts reducing vibration & noise	Inspection		**X**		**X**	Look for cracks or compression
		Replacement				**X**	Replace at 24 months or earlier if degraded
Control Panel	Digital scheduler, diagnostics, and alerts	Inspection	**X**	**X**	**X**	**X**	Test display, buttons, and logs

Component	Description	Task	6 months	12 months	18 months	24 months	Notes
		Replacement				X	Replace if unresponsive, otherwise software update
Electrical Wiring	Power cable, connectors, and insulation	Inspection		X		X	Look for wear, overheating
		Replacement					As needed only
Mounting Brackets	Supports housing stability	Inspection		X		X	Tighten bolts, check corrosion
Housing (External)	Steel chassis with protective coating	Inspection	X	X	X	X	Clean dust buildup, inspect coating
Airflow Sensors	Monitors flow rates for efficiency	Inspection	X	X	X	X	Test and calibrate
		Replacement		X			Replace annually in critical environments

5. Maintenance Procedures

The following procedures must be carried out at the prescribed intervals to ensure the CleanAir™ system remains fully functional. Each procedure should be documented in the service log to maintain compliance with ISO, OSHA, and facility-specific standards.

Filter Replacement

Filters are the most critical consumables in the CleanAir™ system. A clogged or damaged filter not only reduces efficiency but also risks contamination of controlled spaces.

> **Hazardous Waste Handling**
> Used HEPA/ULPA filters may contain hazardous particulates. Always dispose of them according to local environmental regulations and facility waste protocols.

Preparation:

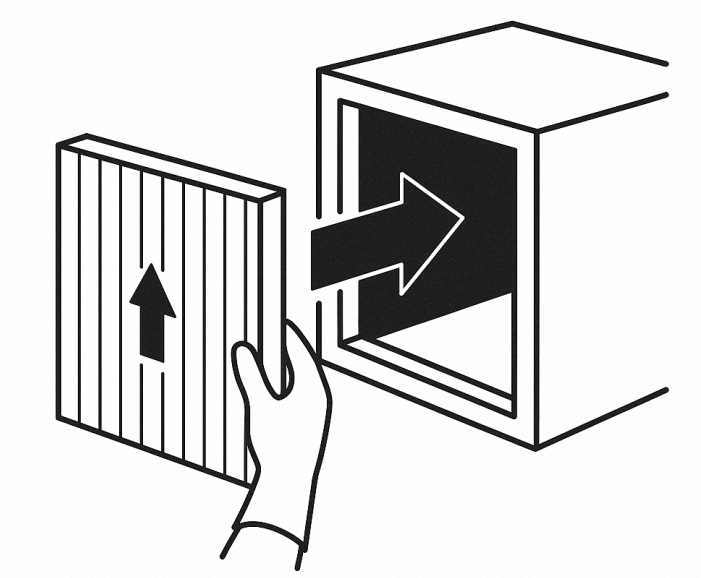
- Power down the system and engage **lockout/tagout**.
- Don the required **PPE**: respirator, gloves, goggles.
- Prepare a clean work area with disposal bags for used filters.

Steps:

1. Open the front housing panel using a screwdriver.
2. Release the retaining clips holding the filter in place.
3. Carefully slide out the old filter — avoid shaking or knocking it.
4. Immediately place it into a double-sealed disposal bag.
5. Inspect the filter frame and sealing gasket for debris or damage.
6. Insert the new filter with airflow arrows aligned correctly.
7. Lock retaining clips and close the housing panel.
8. Run a **post-installation airflow test** via the control panel.

Best Practice: Always keep one spare set of filters onsite to avoid downtime in case of unexpected clogging alerts.

Filter removal process



Filter insertion proces

Fan Assembly Inspection

The fan ensures constant airflow and even pressure across the filters. Any imbalance or vibration reduces both efficiency and lifespan.

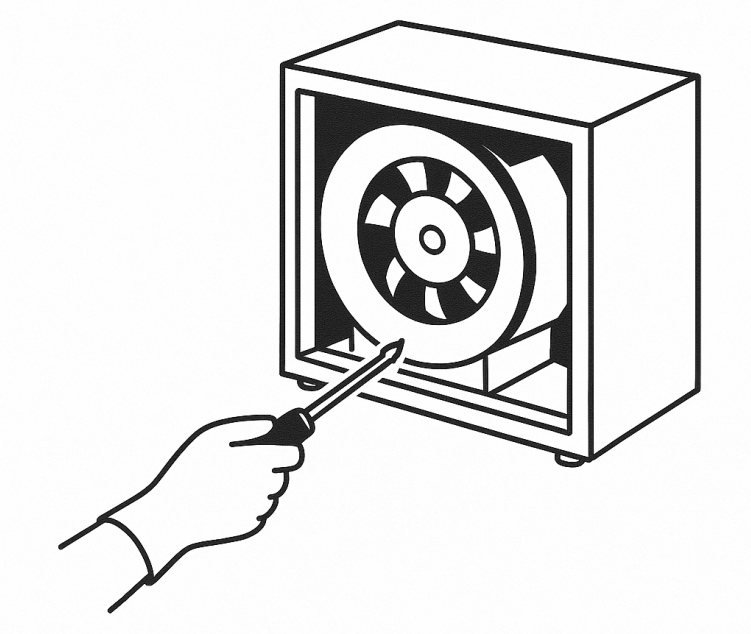
Preparation:

- Ensure system is powered off and secured.
- Use protective gloves and hearing protection when testing under load.

Steps:

1. Remove the fan access panel.
2. Visually inspect fan blades for dust accumulation or physical damage.
3. Rotate blades manually to check for resistance or wobble.
4. Inspect vibration mounts for cracks, deformation, or excessive softness.
5. Clean blades with a lint-free cloth and, if required, compressed air.
6. Reinstall the fan assembly, ensuring bolts are tightened to torque specifications.
7. Restart system and listen for abnormal vibration or noise.

Best Practice: Use a **vibration meter** if available to measure oscillations against baseline factory values.



Fan assembly inspection

Control Panel Diagnostics

The control panel is the monitoring and intelligence hub of the system. Preventive checks ensure technicians detect faults early.

Preparation:

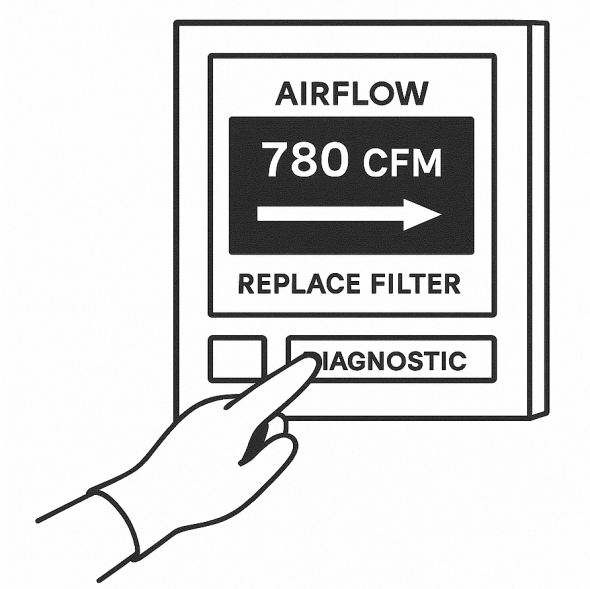
- Power system ON.
- Ensure the display is visible and not obstructed by dust or glare.

Steps:

1. Enter the diagnostics menu on the panel.

2. Run the “Airflow Test” and record the airflow measurement.
3. Check for filter alerts or warnings logged in the system.
4. Review historical event logs for anomalies (unexpected shutdowns, surges).
5. Confirm current firmware version; if outdated, perform a secure update.
6. Verify that communication with external monitoring systems (e.g., SCADA) is stable.
7. Exit diagnostics and return the panel to standby mode.

Best Practice: Document firmware updates in the **Service Record** to maintain compliance with IT/cybersecurity policies.



Control panel diagnostic mode

Housing & Bracket Checks

The external housing and support brackets ensure the unit remains secure and stable during operation. Regular checks prevent structural failure or misalignment.

Preparation:

- Ensure system is powered down.
- Use a torque driver and corrosion-resistant lubricant.

Steps:

1. Inspect external housing panels for scratches, dents, or corrosion.
2. Clean surfaces with mild detergent and a lint-free cloth.
3. Open side panels and check for dust accumulation inside the chassis.
4. Examine mounting brackets for structural integrity.

5. Tighten bolts with torque driver to manufacturer specifications.
6. If corrosion is present, sand affected area lightly and apply protective coating.

Best Practice: Keep brackets slightly lubricated in humid environments to reduce risk of rust.

Bracket inspection

Electrical System Verification

Electrical reliability is essential for safety and system performance. Small issues like frayed cables or loose connectors can escalate into major hazards if ignored.

> ⚠ **Electrostatic Discharge (ESD)**
> When working near control boards or sensors, use an ESD strap or grounding method to prevent damaging sensitive electronics.

Preparation:

- Switch off power and apply lockout/tagout.
- Use insulated tools and wear dielectric gloves.

Steps:

1. Remove the rear electrical access panel.

2. Inspect wiring harnesses for cracked insulation or discoloration.
3. Verify grounding continuity using a multimeter.
4. Check all connectors for secure seating; reseat if loose.
5. Look for signs of overheating, such as melted plastic or scorch marks.
6. Reinstall the access panel securely.
7. Restore power and verify voltage output within normal range.

Best Practice: Use thermal imaging (if available) to detect hidden hotspots during live testing.

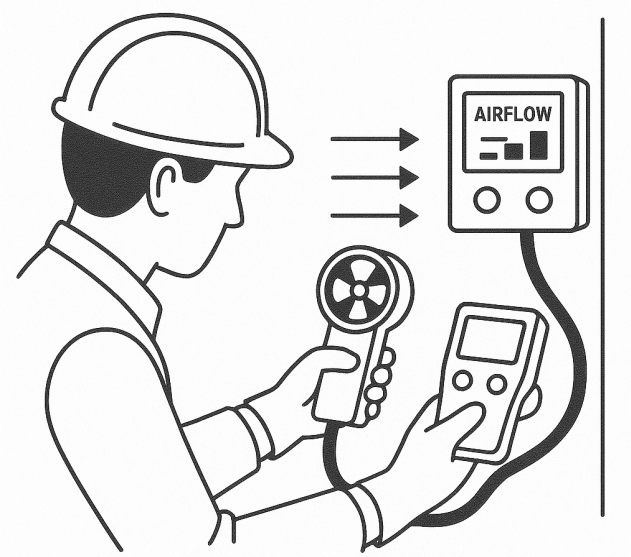
Power cable inspection

Airflow Sensor Calibration

Although not always required at every interval, sensors are critical for reliable performance and should be checked when filters are replaced.

Steps:

1. Access the airflow sensor chamber through the side panel.
2. Use a calibrated test meter to compare system readings to independent values.
3. If deviation exceeds ±5%, recalibrate using control panel procedure.
4. Replace sensors that fail to recalibrate.



Airflow sensor calibration

6. Troubleshooting Guide (Quick Reference)

This quick reference is intended for **on-site technicians** who need to resolve common issues rapidly. It summarizes the most frequently encountered problems, their likely causes, and the recommended corrective actions.

For complex issues, error codes, or repeated faults, consult the dedicated **Troubleshooting Guide** document provided with the CleanAir™ system. That guide includes detailed flowcharts, error code libraries, and advanced diagnostic procedures.

Common Symptoms and Corrective Actions

> **See Also**
> This quick table only covers common scenarios. For error codes, detailed flowcharts, and escalation instructions, consult the separate *CleanAir Troubleshooting Guide*.

Symptom	Possible Cause	Corrective Action
Reduced airflow	Clogged or saturated filter	Replace filter and reset filter alert
	Fan operating below target speed	Run diagnostics → verify fan speed settings
Vibration or noise	Loose vibration mounts	Tighten or replace mounts
	Fan blades imbalanced with dust	Clean blades, check for deformation
Control panel error code	Outdated firmware	Perform software update
	Faulty sensor input	Calibrate or replace sensor
Unit does not power on	Damaged power cable	Inspect and replace if worn
	Loose connector or tripped breaker	Reseat connections, reset breaker
Frequent filter alerts	High particulate load in environment	Replace filters more frequently; review facility filtration pre-stages

Symptom	Possible Cause	Corrective Action
	Airflow sensors miscalibrated	Run sensor calibration procedure
Unusual odor	Mold or chemical contamination in filter	Replace filters, inspect housing for residue
	Electrical overheating	Check wiring for discoloration or damage
Fan runs continuously	Scheduler misconfigured	Reset control panel scheduling
	Relay or control fault	Contact authorized service technician

When to Escalate

If any of the following conditions are observed, do **not** attempt to repair the unit beyond the procedures described in this manual:

- Persistent error codes that cannot be cleared.
- Electrical arcing, smoke, or burning odor.
- Repeated breaker trips.
- Significant structural damage to housing or brackets.

In such cases, refer immediately to the **CleanAir Troubleshooting Guide** for advanced steps or contact an **authorized service technician**.

7. Maintenance Record

Product: CleanAir™ Industrial Filtration Unit

Number: 31S-GH00-XX21

Date	Performed by	Performed Maintenance	Notes

Date	Performed by	Performed Maintenance	Notes

Date	Performed by	Performed Maintenance	Notes

Date	Performed by	Performed Maintenance	Notes

8. Notes

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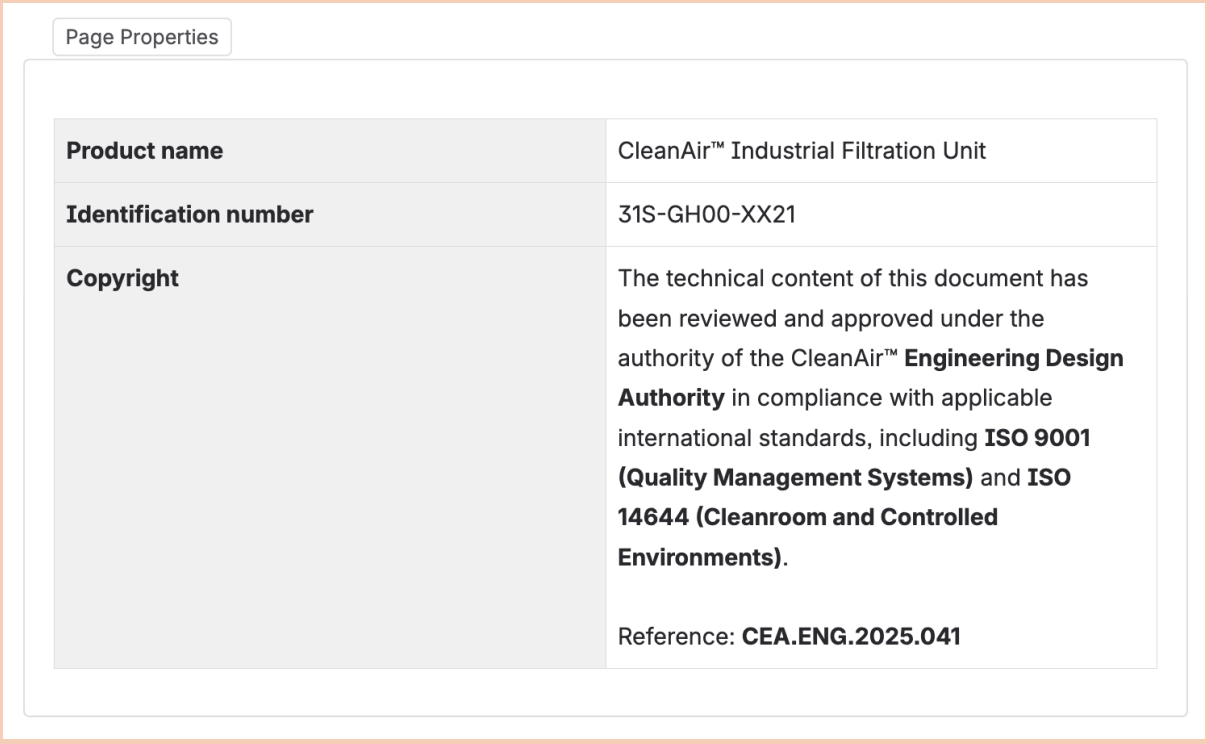

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