

Life-Cycle and Performance Comparison of Non-Ducted and Ducted Fume Cupboards.

A Technical White Paper for Facility Managers & Safety Leads

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CONTENTS

- **Executive Summary**
- **Introduction**
- **1. Non-Ducted [Recirculating Fume Cupboards**
- **2. Ducted Fume Cupboards**
- **3. Cost & Life-Cycle Considerations**
- **4. Safety, Compliance & Material Suitability**
- **5. Environmental & Sustainability Considerations**
- **6. Decision Framework for Containment Selection**
- **7. Case Study - Dual Installation Project**
- **8. Recommendations**
- **9. Conclusion**
- **Glossary**
- **Standard Disclaimer**

EXECUTIVE SUMMARY

This white paper provides guidance on the selection and evaluation of non-ducted [recirculating] and ducted fume cupboards in controlled facilities.

It examines containment performance, operational considerations, energy use, and lifecycle costs, framed against BS EN 14175 principles.

The aim is to support facility managers, safety leads, and technical teams in making evidence-based decisions about containment strategies, while maintaining compliance and operational efficiency.



INTRODUCTION

Controlled facilities handling hazardous substances require effective containment strategies to protect personnel and the environment.

Two primary containment device types are considered:

- Non-Ducted [Recirculating] Fume Cupboards, which filter and return air to the facility.
- Ducted Fume Cupboards, which exhaust contaminated air externally.

This paper examines both systems objectively, highlighting performance considerations, operational constraints, and verification principles.



1. NON-DUCTED [RECIRCULATING] FUME CUPBOARDS

1.1 Overview

Non-ducted fume cupboards filter contaminated air through activated carbon or HEPA filters before recirculating it back into the working area. They require no external ductwork.

1.2 Advantages

- **Lower Installation Cost**

No ductwork, external fans, or building penetrations are required.

- **Energy Efficiency**

Because air is not exhausted outdoors, no make-up air is needed. This reduces heating and cooling demands.

- **Flexibility and Mobility**

Units can be relocated as facility layouts and requirements evolve.

- **Sustainability Benefits**

Reduced energy consumption supports lower carbon emissions.

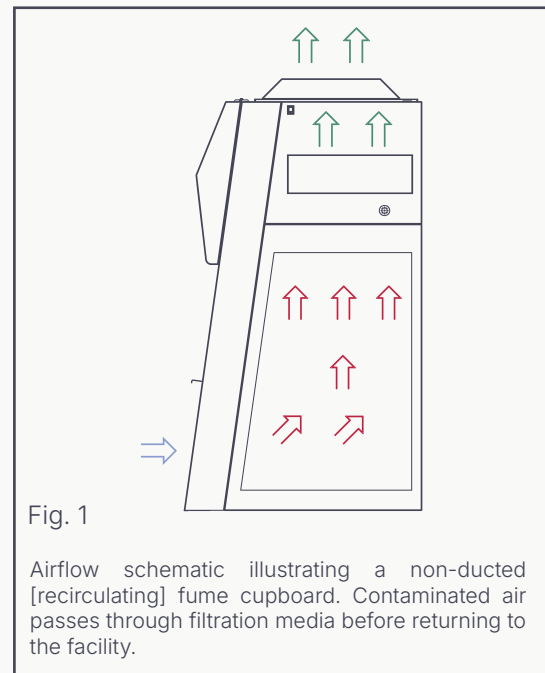


Fig. 1

Airflow schematic illustrating a non-ducted [recirculating] fume cupboard. Contaminated air passes through filtration media before returning to the facility.

1.3 Limitations

- **Filter Maintenance**

Filters must be monitored and replaced regularly. Poor filter management can compromise containment.

- **Chemical Suitability Limits**

Some hazardous, corrosive, or high-volume solvents cannot be safely used in recirculating systems.

- **Performance Dependency**

Efficiency is dependent on correct filter selection and maintenance schedules.

Guidance Note: Recirculating systems are generally appropriate for low- to medium-risk substances, demonstration areas, or flexible facilities with limited infrastructure.

2. DUCTED FUME CUPBOARDS

2.1 Overview

Ducted fume cupboards extract air from the laboratory and expel it outside the building, ensuring fumes are fully removed from the internal environment.

2.2 Advantages

- **Robust Fume Removal**

Hazardous vapours, corrosive gases, and heavy solvent loads are safely directed outside.

- **Lower Long-Term Maintenance**

Fewer internal filters mean reduced maintenance frequency.

- **Consistent Performance**

Suitable for high-hazard, high-volume, and continuous-use applications.

2.3 Limitations

- **Higher Capital Cost**

Installation requires ducting, specialist fans, building penetration, and sometimes make-up air systems.

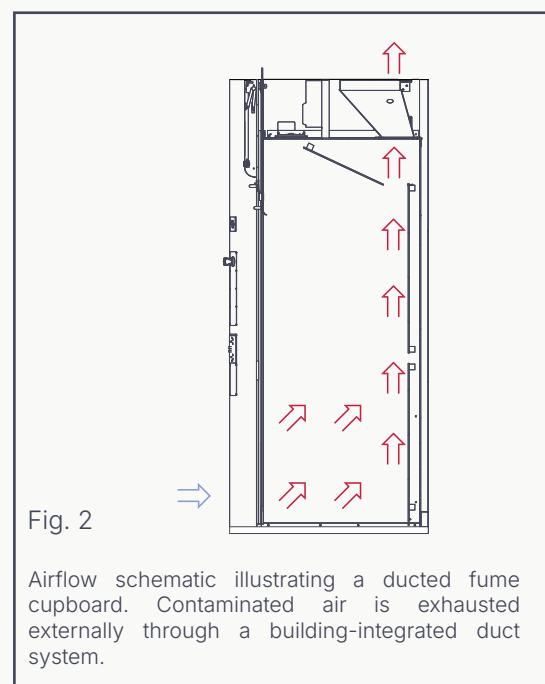
- **Increased Energy Use**

Conditioned lab air must be replaced, increasing heating and cooling costs.

- **Immobility**

Once installed, the unit cannot be easily relocated.

Guidance Note: Ducted systems are preferred where maximum containment is required and facility infrastructure supports exhaust integration.



3. COST AND LIFECYCLE CONSIDERATIONS

3.1 Initial Cost

- **Non-Ducted [Recirculating] Fume Cupboard** [Circulaire® CT1100] - **£6,506**
- **Ducted Fume Cupboard** [Ductaire D1200] - **£11,251**

Non-ducted systems offer a significant initial cost advantage.

3.2 Running Costs

- **Non-Ducted [Recirculating] Fume Cupboard**
Lower electrical consumption; periodic filter replacements are required.
- **Ducted Fume Cupboard**
Higher airflow power requirements; increased HVAC load.

3.3 Five-Year Operating Cost

- **Non-Ducted [Recirculating] Fume Cupboard** - Total: Approx. **£12,254**
- **Ducted Fume Cupboard** - Total: Approx. **£15,647**

In this comparison, non-ducted units delivered an approximate 28% cost saving.

3.4 Capital and Operational Costs

	Non-Ducted [Recirculating] Fume Cupboard	Ducted Fume Cupboard
Equipment & Installation	CT1100 1100mm x 1235mm x 700mm [WDH] £5,911.00	D1200 1200mm x 700mm x 1026mm [WDH] £3,801.00
	Equipment Cost Saving Ducted £2,110.00 35%	
	Delivery, Installation & Commissioning £595.00	Delivery, Installation & Ducting* £7,450.00
	Installation Cost Saving Non-Ducted £6,855.00 92%	
	CAP EX Total £6,506.00	CAP EX Total £11,251.00
CAP EX Cost Saving Non-Ducted £6,506.00 73%		
Operating & Maintenance	Electrical Use @ 0.5m/s** £105.78	Electrical Use @ 0.5m/s** £509.18
	Operating Cost Saving Non-Ducted £403.40 79%	
	Service & Filters*** £1,044.00	Service £370.00
	Maintenance Cost Saving Ducted £674.00 65%	
	OP EX Total**** £5,748.90	OP EX Total**** £4,395.90
OP EX Cost Saving Ducted £1,353.00 24%		
Total	Non-Ducted Total £12,254.00	Ducted Total £15,646.90
	Total Cost Saving Non-Ducted £3,392.00 28%	

* Duct run cost based upon; Fan, inverter + duct [2no. Straight + 2no. Bend]
 ** Energy usage; 8 hrs/365 days @ 22.5p/kWh
 *** MonSci recommendation to replace activated carbon filters annually [2no. Filters in CT1100]
 **** Operating + Maintenance over a 5-year period

4. SAFETY, COMPLIANCE & MATERIAL SUITABILITY

Selecting the correct fume cupboard type must be based on a chemical hazard assessment.

Non-Ducted systems are suitable for:

- Low-risk chemicals
- Light solvent use
- Teaching and demonstration labs
- Facilities requiring frequent reconfiguration

Ducted systems are recommended for:

- High-hazard or corrosive vapours
- Large volumes of solvents
- Continuous or intensive use
- Processes with unknown or variable chemical loads

Regular performance testing and certification are essential for both types.

5. ENVIRONMENTAL & SUSTAINABILITY CONSIDERATIONS

5.1 Energy Use

Non-ducted cupboards reduce HVAC energy losses by recirculating conditioned air. Ducted systems continually remove internal air, resulting in higher energy consumption.

5.2 Material and Infrastructure Use

Non-ducted systems reduce building modification, material use, and long-term environmental impact associated with fixed ductwork.

5.3 Carbon Footprint Impact

Recirculating systems support corporate carbon-reduction strategies by minimising heating and cooling demand.

6. DECISION FRAMEWORK FOR CONTAINMENT SELECTION

- **Hazard Identification**

Assess substance type, toxicity, volatility, and quantity.

- **Required Containment Performance**

Target containment levels, acceptable exposure limits, test verification requirements.

- **System Capability**

Airflow stability, filtration efficiency, structural constraints, media suitability.

- **Verification and Monitoring**

In-situ testing, breakthrough monitoring, periodic inspection.

- **Operational and Facility Constraints**

Ductwork feasibility, energy, space, and maintenance considerations.

Guidance Note: Selection should be informed by performance verification, not assumptions about system type.

Requirement	Recommended Type
High-hazard or high-volume chemical work	Ducted
Occasional or low-hazard work	Non-Ducted
Teaching labs and flexible spaces	Non-Ducted
Sustainability priority	Non-Ducted
Strict compliance or varied chemical portfolio	Ducted

7. CASE STUDY - DUAL INSTALLATION PROJECT

7.1 Client

Green Fuels Research

Location

Berkeley, UK

Sector

Industrial & Telecom



Green Fuels Research [GFR] is a leader in renewable fuels and bioenergy. Their research is centred on sustainable aviation and marine fuels, advanced agronomy systems, agricultural waste processing, and renewable catalysis.

By integrating innovative research with real-world applications, the team at Green Fuels Research is driving the global transition to cleaner, more sustainable energy solutions.

7.2 Challenge

As GFRs' R&D activities expanded, the existing laboratory setup was no longer sufficient to accommodate the increasing volume of solvent extraction, biofuel research processes and more complex experiments.

The company found that more fume cupboards were necessary to maintain high safety standards and ensure an efficient workflow.



7.3 Solution

Project Specification

- Circulaire® CT1100 Recirculating Fume Cupboard [Monmouth Scientific].
 - Recirculating design optimises the handling of solventless samples.
 - Frees up existing ducted fume cupboards for more demanding solvent extraction tasks.
- Airone XP 1500 Ducted Fume Cupboard [Safelab Systems].
 - Capable of handling solvent extraction processes with high chemical emissions.
 - Guarantees efficient operation for critical R&D tasks involving high-risk chemicals.

7.4 Result



Multiple staff members can now work at the same time on various aspects of biofuel research and development, leading to greater efficiency and a more collaborative environment.

Resources are also allocated more effectively with the introduction of a ductless fume cupboard, which is designated for non-solvent tasks and helps maintain a safer, more organised laboratory.

All critical solvent extraction processes are carried out within the ducted fume cupboard to ensure safe handling of volatile or hazardous materials, maintain a controlled environment, and protect personnel from potential chemical vapours and spills.

By confining these processes to a well-ventilated and contained area, the laboratories experienced significantly reduced downtime and minimised risk of accidents or contamination, particularly



during high-volume or complex experimental work.

The dual fume cupboard solution enables GFR to complete research projects more quickly and efficiently, accelerating the pace of their biofuel innovation and product development.

The design offers the flexibility to expand resources and infrastructure seamlessly, ensuring the company can easily scale its operations to meet evolving research and development needs.

7.5 Feedback



We are expanding our capabilities, and one key issue that became evident is the shortage of fume cupboards. We needed to increase our lab capability. The previous setup wasn't enough to guarantee efficient operation, especially for solvent extraction activities.

The new recirculating fume cupboard enabled work on solventless samples, freeing up space in the ducted fume cupboards.

Monmouth Scientific and Safelab Systems provided an excellent service from day one through installation and maintenance. The extra fume cupboards help increase the volume and efficiency of our R&D work.

Dr. Sergio Lima, Research Director

8. RECOMMENDATIONS

- Conduct facility-specific hazard assessments.
 - Define required containment performance before selection.
 - Verify all systems in situ per BS EN 14175.
 - Maintain filtration and exhaust systems to sustain performance.
 - Consider both energy use and operational flexibility in lifecycle planning.
 - Document and periodically review containment strategies.
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9. CONCLUSION

Ducted and non-ducted fume cupboards each offer valuable benefits, and the correct choice depends on chemical workload, safety requirements, sustainability priorities, and budget.

For high-hazard or intensive use, ducted systems provide reliable and robust protection. For flexible, cost-efficient, and low-hazard applications, non-ducted systems offer strong performance with notable environmental and financial advantages.

A mixed approach may be optimal for facilities requiring both heavy-duty and flexible workstation capability.



GLOSSARY

- **Activated Carbon Filter**

Adsorbs hazardous vapours in recirculating systems.

- **Airflow Velocity**

Air speed through the opening, used to assess containment.

- **Containment**

Prevention of hazardous substance escape into the facility.

- **Ducted Fume Cupboard**

Exhausts air externally.

- **HEPA Filter**

Captures particulates in recirculating systems.

- **Non-Ducted Fume Cupboard**

Filters and returns air internally.

- **Life-Cycle Cost**

Total ownership cost including installation, energy, and maintenance.

STANDARDS DISCLAIMER

This white paper provides technical guidance on containment strategies for hazardous substances in controlled facilities.

It references BS EN 14175 principles and related guidance but does not replace formal risk assessment, site-specific containment testing, or professional judgement. Final selection, installation, and operation of containment equipment must follow applicable standards, regulatory requirements, and project-specific risk assessments.

protecting what matters.

controlled clean environments for critical applications.

Fume Containment | Biological Safety | Modular Cleanrooms | Powder Handling | Laminar Flow

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