Fume Hood Sash Materials & Baffle Flow Geometry

Literature Review & Technical Data Compilation

1. Literature Sources

#	Title	Source	Year
1	Glass Materials for Fume Hood Sashes: Which is Better?	BIENSI Lab Technical Blog	2025
2	Sash Arrangements & Materials	Clean Air Ltd (UK)	2026
3	How To Select The Right Laboratory Hood System — Sash Materials	Labconco / Dayitech	—
4	EHSRM Fume Hood Standard — Material Requirements	Texas State University	—
5	Analysis of the influence of the underside baffle and deflector of the fume hood on the flow field	Journal of Shandong University (Engineering Science), Vol.51 No.5	2021
6	Bypass Fume Hoods Compared Using CFD — Legacy vs STF Design	DAI Scientific / Flow Industries	2023
7	Part 1 — General Fume Hood Design (Baffle Slot Requirements)	Washington State University Facilities Services	2018
8	Fume Hood Systems: Design & Performance — Baffle Airflow Distribution	HVAC Systems Encyclopedia (ingener.by)	2026
9	Effect of Baffle Design Configuration to the Flow Performance of a Servco Fume Cupboard	UiTM Master's Thesis (M. A. A. Omar, Prof. W. Wisnoe)	2018
10	Computational Fluid Dynamics as a Method for Assessing Fume Cupboard Performance	The Annals of Occupational Hygiene, Oxford Academic, 44(3)	2000
11	EN 14175-2:2003 Fume Cupboards — Part 2: Safety and Performance Requirements	European Standard (CEN)	2003
12	ASHRAE 110 / SEFA 1 Type-Test Report — 150cm Bench-Type Fume Hood	Topair Systems Inc.	2025

2. High-Abrasion-Resistance Sash Materials

2.1 Material Comparison Overview

Material	Thickness (Typical)	Abrasion / Scratch Resistance	Heat Resistance	Chemical Resistance	Impact Strength	Light Transmission
Tempered Safety Glass	5–6 mm	**Excellent — hard surface, scratch-resistant**	Up to 200°C	Good — acids, alkalis, most organics	4–5× ordinary glass	~90%
Laminated Glass (PVB/SGP)	6+6 mm (interlayer)	**Excellent — same glass surface**	Up to 200°C	Good — same as glass	Very high — fragments stay bonded	~88–90%
Polycarbonate (PC)	5–8 mm	Poor — scratches easily; needs hard coating	Up to 120°C	Low — attacked by acetone, alcohols, aromatics	**200× glass (unbreakable)**	~89%
Acrylic (PMMA)	5–6 mm	Poor — scratches easily	Up to 80°C	Low — attacked by many solvents	Moderate — shatter-resistant	~92%

2.2 Tempered Glass — The Industry Standard

- **Standard thickness:** 6 mm toughened safety glass (Clean Air Ltd UK, Brau Grup)
- **Strength:** 4–5 times stronger than ordinary annealed glass of equal thickness
- **Breakage pattern:** Shatters into small, blunt cuboid fragments (diced pattern) — safe, no sharp shards
- **Heat resistance:** Withstands temperature differential up to 200°C (392°F)
- **Abrasion performance:** Hard glass surface resists cleaning abrasion, chemical wiping, and daily contact wear — the best choice for long-term optical clarity
- **Standard mandate:** Texas State University EHSRM standard explicitly states "Only tempered plate glass shall be used" for fume hood sashes

> Source: Texas State University EHSRM Fume Hood Standard; Clean Air Ltd; BIENSI Lab Technical Guide (2025).

2.3 Laminated Glass — High-Security Variant

- Two glass plies bonded with PVB (polyvinyl butyral) or SGP interlayer
- When shattered, fragments adhere to interlayer — no falling shards, no opening created
- Blocks up to 99% of UV radiation
- Better sound insulation than monolithic tempered glass
- Used in high-security labs, high-pressure reaction labs, and facilities requiring blast-resistant viewing panels

2.4 Polycarbonate (PC) — Impact-Resistant but Abrasion-Limited

- Impact resistance up to **200× that of glass** — used in bulletproof windows
- Half the weight of glass — easier sash operation
- **Key limitation for abrasion:** Soft surface scratches easily from cleaning, contact with lab equipment, and sliding track friction
- **Solution:** Abrasion-resistant hard-coat (e.g., MR-10, AR coating) must be applied for long-term service — uncoated PC clouds within 1–2 years of lab use
- **Chemical caveat:** Not compatible with acetone, alcohols, aromatic hydrocarbons, chlorinated solvents — stress cracking risk
- **Primary application:** Hydrofluoric acid (HF) acid hoods — PC does not fog or etch when exposed to HF fumes (Labconco selection guide)

> Source: Labconco "How To Select The Right Laboratory Hood System"; Made-in-China acid-resistant hood specifications; BIENSI Lab (2025).

2.5 Material Selection Decision Matrix

Application Scenario	Recommended Sash Material	Reason
General chemistry, pharmaceutical, research labs	6 mm Tempered Glass	Best abrasion resistance, chemical resistance, cost balance
High-security / high-pressure / explosion-risk labs	Laminated Safety Glass	Bonded interlayer prevents shard ejection and opening breach
Hydrofluoric acid (HF) applications	Hard-coated Polycarbonate	Glass etches/fogs from HF fumes; PC is HF-resistant
Perchloric acid hoods	Tempered Glass (all-stainless/PVC construction)	Perchloric acid requires nonporous inorganic construction; PC not compatible
Low-risk / teaching / budget installations	Acrylic (PMMA)	Low cost, good clarity; acceptable for gentle use

3. Rear Baffle Flow-Channel Geometry Parameters

3.1 Standard Baffle Configuration — Three-Slot System

The classic rear baffle design uses **three horizontal exhaust slots** at different heights to distribute airflow vertically across the hood work zone.

Slot Position	Typical Slot Width (Legacy Design)	Flow Allocation (Recommended)	Function
Lower slot (at / below work surface level)	3.0 in (76 mm) — legacy; 2.5 in (64 mm) — modified low-flow design	**50–60% of total exhaust**	Captures dense vapors and gases near work surface; prevents spill-back at sill
Middle slot (work zone mid-height)	1.0 in (25 mm) — legacy horizontal; replaced by vertical perforations in modern designs	20–30% of total exhaust	Handles mid-height contaminant release; balances vertical flow profile
Top slot (upper hood volume)	0.5 in (13 mm)	10–20% of total exhaust	Captures hot/buoyant vapors rising to top of chamber; prevents top eddy

> Sources: DAI Scientific CFD Comparison Report (2023); WSU Facilities Standard 11-53-13; HVAC Systems Encyclopedia baffle distribution guidance.

3.2 Legacy vs. Modified Baffle Geometry — CFD Comparison

Legacy Design (1970s–1990s, 80 FPM face velocity)

- Top front bypass slot: 3 in (76 mm) wide
- Topmost rear slot: 0.5 in (13 mm)
- Middle rear slot: 1.0 in (25 mm) horizontal
- Lower rear slot: 3.0 in (76 mm) horizontal
- Specified airflow: 778 CFM
- **CFD finding:** Slow cyclonic vortex directly above mid-front high-flow zone, adjacent to sash interior — containment achieved only at 100 FPM per ASHRAE 110-1995

Modified Low-Flow Design (STF, 60 FPM face velocity)

- Overlapping sash bypass replaces 3 in top front slot
- Topmost slot moved down to top of single back panel: 0.5 in (13 mm)
- **Middle slot eliminated** — replaced by **four vertical slots**, each 12 in (305 mm) tall × 3/8 in (9.5 mm) wide
- Vertical slot side gaps: 0.5 in (13 mm) to sidewalls

- Lower slot reduced to 2.5 in (64 mm)
- Sash inner flange added
- Specified airflow: 375 CFM (at 60 FPM)
- **CFD finding:** Low-velocity area near top-front sash opening significantly reduced; radial (not cyclonic) flow pattern; downward clean air curtain just behind sash — better containment at half the airflow

> Source: DAI Scientific / Flow Sciences — CFD Comparisons: Legacy vs STF Bypass Fume Hoods (2023).

3.3 Underside Baffle & Deflector Geometry — Shandong University CFD Study

Yan et al. (2021) at Shandong University School of Energy and Power Engineering conducted a parametric CFD study on the underside sash baffle and deflector geometry.

Tested Geometry Parameters

Parameter	Tested Range	Optimal Finding
Arc baffle radius (mm)	20, 30, 40, 50, 60	Larger radius reduces vortex height
Elliptical arc baffle length (mm)	30, 60, 90, 120, 150	Length ≥ 90 mm significantly reduces vortex
Deflector radius (mm)	50, 70, 90, 110, 130	**≤ 70 mm — larger radii trigger secondary vortices**
Underside baffle height (mm)	Varied	**≥ 50 mm required**
Underside baffle length (mm)	Varied	**≥ 90 mm required**

Key Conclusions

- When underside baffle height is low and length is short, large vortices appear at hood center and near side walls
- Baffle height **>50 mm** and length **>90 mm** significantly reduce center vortex and baffle-to-sidewall junction vortex
- Adding a deflector plate eliminates the center vortex entirely
- **Deflector radius must not exceed 70 mm** — larger radii excite obvious vortices on the outer side and at the trailing edge of the deflector

> Source: Yan R, Dong Z, Lu S, Lai Y, Lü M. Analysis of the influence of the underside baffle and deflector of the fume hood on the flow field. Journal of Shandong University (Engineering Science), 2021, 51(5): 122–130. DOI: 10.6040/j.issn.1672-3961.0.2021.177

3.4 Baffle Perforation Shape & Distribution — UiTM Study

Omar (2018) at Universiti Teknologi MARA investigated perforated half-Y-shaped baffles using CFD (NUMECA) against experimental validation.

- **Best perforation shape:** Circular perforations produced the highest flow uniformity index compared to rectangular and slotted openings
- **Optimal location:** Openings placed just below the slanted component of the Y-baffle gave the best flow quality improvement
- **Perforation count:** Increasing number of perforations progressively improved flow uniformity index (within tested range)
- CFD vs. experimental validation error: <10% at selected comparison points

> Source: Omar MAA. Effect of Baffle Design Configuration to the Flow Performance of a Servco Fume Cupboard. MSc Thesis, UiTM, 2018.

3.5 Internal Geometry Reference Dimensions (ASHRAE 110 Test Report)

Dimension	Typical Value (1500 mm wide bench hood)
External width	1500 mm
Internal depth (wall to sash plane)	640–670 mm
Internal depth (baffle to sash plane)	585–620 mm
Internal work opening height	~1050 mm
Recommended sash operating height (VAV)	± 500 mm working height (nominal)

> Sources: ASHRAE 110 / SEFA 1 Type-Test Report, Topair FH-150; Statitech Fumetop 1500 test report.

4. Standards & Regulatory References

Standard	Scope / Relevant Requirement
ANSI/AIHA Z9.5	Laboratory Ventilation — sash material, baffle adjustability, face velocity uniformity
ASHRAE 110 / SEFA 1	Method of Testing Performance of Laboratory Fume Hoods — face velocity, smoke visualization, tracer gas containment
EN 14175-2:2003	Fume Cupboards — Part 2: Safety and Performance Requirements (European standard)
JG/T 222—2007	Variable Air Volume Fume Hoods (China construction industry standard)

YY 0569—2011	Biological Safety Cabinet (China pharmaceutical standard — related airflow geometry)
California Code of Regulations Title 8, §5154.1	Ventilation Requirements for Laboratory-Type Hood Operations

5. Key Conclusions

1. **Sash material selection is driven by abrasion + chemical compatibility:** Tempered glass (5–6 mm) remains the default because its hard surface offers the best long-term abrasion resistance against daily wiping and track friction. Polycarbonate's extreme impact advantage is undermined by poor scratch resistance — hard coating is mandatory for abrasion-sensitive service.
2. **HF acid is the exception:** Hydrofluoric acid etches and fogs glass permanently, which is why PC sashes are mandated for HF hoods despite their abrasion limitations.
3. **Baffle slot geometry directly controls containment:** The three-slot system allocates ~50–60% of flow to the lower slot (work surface capture), 20–30% to middle, and 10–20% to top — vertical perforated baffles (modern low-flow designs) outperform legacy horizontal slots at 60 FPM.
4. **Deflector geometry has strict size limits:** Shandong University CFD data shows underside deflector radius should not exceed 70 mm; baffle height ≥50 mm and length ≥90 mm are minimum thresholds for vortex suppression.
5. **Circular perforated baffles improve uniformity:** UiTM CFD-validated study confirms circular perforations below the Y-baffle slant give the best flow uniformity index, with perforation count positively correlated to uniformity.

This report is compiled from publicly available literature and manufacturer technical data for engineering reference.